

# TEAM 2014

**TECHNIQUE, EDUCATION, AGRICULTURE & MANAGEMENT**

## PROCEEDINGS OF TEAM 2014



**6th International  
Scientific and Expert Conference  
of the International TEAM Society  
November 10-11 2014 - Kecskemét, Hungary**



Proceedings of TEAM 2014

6<sup>th</sup> International Scientific and Expert Conference  
of the International TEAM Society

10–11<sup>th</sup> November 2014, Kecskemét, Hungary



# Proceedings of TEAM 2014

6<sup>th</sup> International Scientific and Expert Conference of the  
International TEAM Society

10–11<sup>th</sup> November 2014,  
Kecskemét, Hungary

Organizers of TEAM 2014 Conference:

- Kecskemét College, Faculty of Mechanical Engineering and Automation, Hungary
- International TEAM Society

The conference is organized under the auspices of the International TEAM Society:

- Kecskemét College, Faculty of Mechanical Engineering and Automation (GAMF), Kecskemét, Hungary
- University of Applied Sciences of Slavonski Brod, Slavonski Brod, Croatia
- Mechanical Engineering Faculty in Slavonski Brod, Josip Juraj Strossmayer University of Osijek, Slavonski Brod, Croatia
- Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Trnava, Slovakia
- Faculty of Manufacturing Technologies with seat in Prešov, Technical University of Košice, Slovakia



All papers are reviewed.

The authors are only responsible for the accuracy and contents of all published material. The Editors do not accept any liability for the accuracy of articles, or responsibility for mistakes (editorial or typographical), nor for any consequences that may arise from them.

Publisher:	Kecskemét College, Faculty of Mechanical Engineering and Automation
Copyright:	© Kecskemét College
Editor in Chief:	Andrea Ádámné Major
Editors:	Lóránt Kovács, Zsolt Csaba Johanyák, Róbert Pap-Szigeti
ISBN	978-615-5192-22-7
Volume	VI
Number	1
Year	2014
Pages	1- 499

## Scientific Committee Chairman

KOVÁCS, Lóránt, Assoc. Prof., Ing., PhD., Vice-dean for science

## Scientific Committee Members

ÁDÁMNÉ MAJOR, Andrea, Kecskemét College, HU  
AILER, Piroska, Kecskemét College, HU  
BÁRTA, Jozef, FMST in Trnava, SK  
BARTOLOVIĆ, Višnja, VUSB Slavonski Brod, HR  
BENKOVIĆ-LAČIĆ, Teuta, University of Applied Sciences Slavonski Brod, HR  
BEŇO, Pavel, FEMT - Technical University in Zvolen, SK  
BOŠNJAKOVIĆ, Mladen, VUSB Slavonski Brod, HR  
CAR, Zlatan, TF - University of Rijeka, HR  
ČEP, Robert, ŠB - TU Ostrava, CZ  
CHATTOPADHYAYA, Somnath, Indian School of Mines, Dhanbad, IN  
DIMKOW, Svetoslav, Technical University, Sofia, BG  
DURAKBASA, Numan M., Vienna University of Technology, A  
FÁBIÁN, Csaba, Kecskemét College, HU  
FOLDYNA, Jozef, Institute of Geonics AS CR, CZ  
GALETA, Tomislav, MEFSB - University of Osijek, HR  
GUBELJAK, Nenad, FS - University of Maribor, SLO  
GUBERAC, Vlado, FA - University of Osijek, HR  
GYENGE, Csaba, Technical University of Cluj-Napoca, RO  
HADZIKADUNIC, Fuad, University of Zenica, BIH  
HATALA, Michal, FVT TUKE, SK  
HERZOG, Michael, TH Wildau, D  
HLOCH, Sergej, FVT Tuke, SK  
HODOLIČ, Janko, FTN - University of Novi Sad, RS  
HOLESOVSKY, František, FPTM Uni J. E. Purkyně Ústí Nad Labem, CZ  
HVIZDOŠ, Pavol, Slovak Academy of Sciences, SK  
IVANDIĆ, Željko, MEFSB - University of Osijek, HR  
JOHANYÁK, Zsolt Csaba, Kecskemét College, HU  
JOSIPOVIC, Marko, Agricultural Institute Osijek, HR  
JURAGA, Ivan, FAMENA - University of Zagreb, HR  
KADNÁR, Milan, Slovak Agriculture University Nitra, SK  
KLADARIĆ, Ivica, MEFSB - University of Osijek, HR  
KLJAJIN, Milan, MEFSB - University of Osijek, HR  
KOLEDA, Peter, Technical University in Zvolen, SK  
KOVÁCS, Lóránt, Kecskemét College, HU  
KOZAK, Dražan, MEFSB - University of Osijek, HR  
LACATUS, Elena, Politechnica University Bucharest, RO  
LACKOVIĆ, Ivica, University of Applied Sciences Slavonski Brod, HR  
LEE, Ho-Sung, Korea Aerospace Research Institute, Daejun, KR  
LIPÓCZINÉ CSABAI, Sarolta, Kecskemét College, HU  
LÍSKA, János, Kecskemét College, HU  
MAGLIĆ, Leon, MEFSB - University of Osijek, HR  
MARKOVIĆ, Monika, Faculty of agriculture, UNI Osijek, HR  
MARÔNEK, Milan, FMST in Trnava, SK  
MATANOVIĆ, Damir, FE - University of Osijek, HR  
MILKOVIĆ, Marin, University North Varaždin, HR  
MIROSAVLJEVIĆ, Krunoslav, VUSB Slavonski Brod, HR  
MLÁDKOVÁ, Ludmila, University of Economics, Prague, CZ  
MODRÁK, Vladimír, FVT TUKE, SK  
MONKA, Peter, FVT TUKE, SK  
MONKOVÁ, Katarína, FVT TUKE, SK  
MULLER, Miroslav, Czech university of life sciences, Cz  
NOVÁK MARCINČIN, Jozef, FVT TUKE, SK  
OHLÍDAL, Miloslav, SF VÚT Brno, CZ  
PAŠKO, Ján, FVT TUKE, SK



PAVIĆ, Zlatko, MEFSB - University of Osijek, HR  
PETŐ, Judit, Kecskemét College, HU  
PETROPOULOS, George, University of Thessaly, GR  
PIŠTORA, Jaromír, VŠB - TU Ostrava, CZ  
PREINER, Darko, Faculty of agriculture, Uni Zagreb, HR  
RAOS, Pero, MEFSB - University of Osijek, HR  
RUGGIERO, Alessandro, University of Salerno, I  
RUŽBARSKÝ, Juraj, FVT TUKE, SK  
SAMARDŽIĆ, Ivan, MEFSB - University of Osijek, HR  
ŠARIĆ, Tomislav, MEFSB - University of Osijek, HR  
SEDMAK, Aleksandar, MF Uni Belgrade, RS  
SEGOTA, Suzana, Ruder Boskovic Institute, HR  
SENNAROĞLU, Bahar, Marmara University, TR  
ŠERCER, Mladen, FAMENA - University of Zagreb, HR  
SHARMA, Vinay, Birla Institute of Technology, Mesra, IN  
ŠIMUNOVIĆ, Goran, MEFSB - University of Osijek, HR  
ŠIMUNOVIĆ, Katica, mefsb uni osijek, HR  
ŠOSTARIĆ, Jasna, PFOS - University of Osijek, HR  
STOIĆ, Antun, MEFSB Slavonski Brod, HR  
ŠUGÁR, Peter, FMST in TRNAVA, SK  
SURZENKOV, Andrei, Tallinn University of Technology, EE  
TÓTH, Ákos, Kecskemét College, HU  
TOZAN, Hakan, Turkish Naval Academy, Istanbul, TR  
TRAUSSNIGG, Udo, Campus 02 TU GRAZ, A  
TROPŠA, Vlado, VELV Varaždin, HR  
VÁCLAVÍK, Vojtech, VŠB - TU Ostrava, CZ  
VAJNAI, Tibor, Kecskemét College, HU  
VALÍČEK, Jan, VŠB - TU Ostrava, CZ  
VASILKO, Karol, FVT TUKE, SK  
VAYVAY, Özalp, Marmara University, Istanbul, TR  
VINAY, Sharma, Birla Institute of Technology, IN  
VUKELIĆ, Djordje, FTN Uni Novi Sad, RS  
YASHAR, Javadi, Islamic Azad University - Semnan Branch, IR  
ŽIVIĆ, Marija, MEFSB - University of Osijek, HR

#### Organising Committee Chairman

JOHANYÁK, Zsolt Csaba, Prof., PhD.

#### Organising Committee Members

HLOCH, Sergej, FVT Technical University of Košice, SK  
KOZAK, Drazan, MEFSB University of Osijek, HR  
JOHANYÁK, Zsolt Csaba, Kecskemét College, HU  
LÍSKA, Katalin, Kecskemét College, HU  
TÓTH, Ákos, Kecskemét College, HU

## Acknowledgement

The conference has been supported by  
Knorr-Bremse Fékrendszer Kft.  
Phoenix-Mecano Kft.  
Szimikron Ipari Kft.  
Kunplast-Karsai Műszaki Műanyagipari Kft.  
Linamar Kft.  
Diákhitel

The support is gratefully acknowledged.



## TABLE OF CONTENT

### Plenary session

Antun Stoić, Tomislav Palatinuš, Borut Kosec, Miroslav Duspara and Marija Stoić: <i>The Effects of Life Cycle Management of Abrasives on sustainable WJ Cutting</i> .....	14
Krunoslav Mirosavljević, Davor Požežanac-Hajić, Slavica Antunović and Teuta Benković-Lačić: <i>Modern Application of UV-VIS Spectroscopy in Agriculture</i> .....	20
György Várallyay: <i>Environmental Aspects of Soil Management and Moisture Control</i> .....	26

### Agriculture and Horticulture - Papers

Monika Marković, Jasna Šoštarić, Marko Josipović, Dragutin Petošić, Ivan Šimunić and Vladimir Zebec: <i>Implementation of Irrigation Scheduling Based on Monitoring of Soil Moisture Content in extreme Weather Conditions (Invited Paper)</i> .....	34
Andrija Alković, Teuta Benković-Lačić, Robert Benković and Krunoslav Mirosavljević: <i>The Influence of Pruning on Vine Yield (Vitis Vinifera L.)</i> .....	38
Ferenc Baglyas, Endre Pölös and Csaba Szabó: <i>The Impact of different Rooting Media in the Propagation of some Grape Varieties</i> .....	40
Bozica Japundžić-Palenić, Ivana Vukoja, Matija Japundžić and Nataša Romanjek-Fajdetić: <i>Pea (Pisum Sativum L.) Seedlings Properties under Influence of different Temperatures</i> .....	43
Marko Martinović, Tomislav Ćosić and Ivica Lacković: <i>Recycling and Disposal of electronic Waste (Invited Paper)</i> .....	48
Viktor József Vojnich, Endre Pölös and András Palkovics: <i>Biological Plant Protection of Indian Tobacco (Lobelia Inflata L.)</i> .....	54
Viktor József Vojnich, Endre Pölös, Judit Pető, Attila Hüvely and András Palkovics: <i>The total Alkaloid Production of Indian Tobacco (Lobelia Inflata L.) in Open Field Conditions</i> .....	56

### Agriculture and Horticulture - Posters

Ljiljana Božić-Ostojić, Slavica Antunović, Branimir Vujčić and Mirjana Martić: <i>Cognition and Agricultural Producers Opinion on new Law Regulations in the Field of Plant Protection in Eastern Croatia</i> .....	59
Blanka Buzetky: <i>Soil Moisture Monitoring between the Danube and the Tisza River</i> .....	64
Anikó Czinege: <i>The Study of the Vigor of the Rootstocks – Plum Variety Combinations</i> .....	68
Anikó Czinege: <i>The Study of the Yield of the Rootstock and Plum Variety Combinations</i> .....	71
Eleonóra Kecskés-Nagy and Péter Sembery: <i>Reduction of DON-Toxin Content IN Wheat</i> .....	74
Judit Pető, Attila Hüvely and Imre Cserni: <i>Plantation Programs and their Observations in the South-Eastern Hungarian Region</i> .....	78
Bojan Stipešević, Bojana Brozović, Danijel Jug, Irena Jug, Ljubica Ranogajec and Davor Šego: <i>Economic Comparison of different Cropping Systems for Niger (Guizotia abyssinica) in Croatia</i> .....	81
Zsuzsanna Tóthné Taskovics, Judit Pető, Attila Hüvely and András Kovács: <i>The Effect of some Plant Conditioning Materials on the Quality and Quantity of Green Pepper</i> .....	86
Zsuzsa Turi-Farkas and Dezső Kovács: <i>Propagation of Taxus Baccata</i> .....	89
Zsuzsa Turi-Farkas and Zoltán Pádár: <i>Analysis of Growth and Age of urban mature Trees</i> .....	93

### Computer and Information Technology - Papers

László Gyöngyösi: <i>Quantum Computing (Invited Presentation)</i> .....	98
Peter Nagy and Peter Tasnádi: <i>Interaction-free Measurements</i> .....	99
Marko Martinović, Dino Lovaković and Tomislav Ćosić: <i>Network Security Issues in Regard to OSI Reference Model Layers</i> .....	105
Istvan Pinter, Lorant Kovacs, Andras Olah, Rajmund Drenyovszki, David Tisza and Kalman Tornai: <i>On-line Change Point Detection in Household's Electricity Power Consumption Data Series for Smart Grid Applications</i> .....	108
Vedran Novoselac and Zlatko Pavić: <i>Outlier Detection in Experimental Data using a modified Expectation Maximization Algorithm</i> .....	112
Zlatko Pavić and Vedran Novoselac: <i>Jensen's and Hermite-Hadamard's Inequality</i> .....	116
Zlatko Pavić, Maja Čuletić Čondrić and Veljka Žugec: <i>Power and Logarithmic Means</i> .....	120

Bence Koszteczyk and Gyula Simon:	
<i>Intrusion Detection System with Sensor Networks</i> .....	124
Gábor Kátai-Urbán, Ferenc Koszna and Zoltán Megyesi:	
<i>Omnidirectional Camera Calibration</i> .....	129
Rajmund Drenyovszki, Lóránt Kovács, Bence Csák and Krisztián Bársony:	
<i>GPS Based Vehicle Trajectory Prediction and Error Analysis</i> .....	134
Zénó Dömötör, Ambrus Kóházi-Kis and Bence Csák:	
<i>Automatic Li-ion Battery Test System</i> .....	141
József Osztényi, Rafael Alvarez Gil, Kálmán Bolla, Edit Csizmás, Csaba Fábrián, Lóránt Kovács, Tamás Kovács, Krisztián Medgyes and Tibor Vajnai:	
<i>The Parameter Estimation of the Link Performance Functions</i> .....	146
Zlatko Pavić:	
<i>The Significance of the Convex Combination Center</i> .....	150
Elvira Antal:	
<i>Optimization Questions in BitTorrent Communities</i> .....	154
Zsolt Csaba Johanyák, Piroska Gyöngyi Ailer and László Göcs:	
<i>A simple Fuzzy Control Design for Series Hybrid Electric Vehicle</i> .....	159
<b>Computer and Information Technology - Posters</b>	
Rafael Pedro Alvarez Gil:	
<i>Application of Fuzzy Petri Nets in the Specification of Adaptive Web-based Systems</i> .....	165
Kálmán Bolla, Tamás Kovács and Gábor Fazekas:	
<i>Trajectory Building Method for Autonomous Mobile Robots</i> .....	170
Csaba Fábrián, Edit Csizmás and Tibor Vajnai:	
<i>Modeling Uncertainty for stochastic Optimisation</i> .....	174
Attila Végh:	
<i>On free and nonfree Dirichlet-Voronoi Cells</i> .....	179
<b>Education - Papers</b>	
Ágnes Maródi, István Benedekfi, Iván Devosa and Zsuzsa Buzás:	
<i>Teaching and Learning Music with the Aid of Digital Technology</i> .....	186
Hrvoje Sivrić, Nebojša Zagorac and Kristijan Marić:	
<i>The Effect of selected motor Abilities on the Results in the athletic Discipline – Running Long Jump (Invited Paper)</i> .....	190
Ágnes Maródi, Iván Devosa, István Benedekfi and Zsuzsanna Buzás:	
<i>ICT Tool for Education of European Citizenship. Educational Program for Spreading the Culture of the European Union     Member Countries</i> .....	194
Zoltán Senkei-Kis and Lilla Koltói:	
<i>Is it legal or illegal to use Torrents? – Views of Students of Library Science about Downloading</i> .....	198
Mária Hercz, Lilla Koltói, Róbert Pap-Szigeti and Erika Török:	
<i>Assessing Competencies of Freshmen: an On-line Measurement in the College</i> .....	202
Maria Hercz, Lilla Koltói and Róbert Rigó:	
<i>Competences for the Success of Students Learning in Dual Training System: The Firms' Voice</i> .....	206
Erika Török and Zsuzsanna Kovács:	
<i>Challenges and Opportunities in the Dual Training Model at Kecskemét College</i> .....	211
Mihály Görbe:	
<i>Establishing new Course for the Education of Sensorics at the GAMF faculty of Kecskemét College</i> .....	216
Ildikó Szabó and Veronika Szinger:	
<i>Action Research-Based Innovation in Teachers' Professional Development     at Kecskemét College Teacher Training Faculty</i> .....	223
Ildikó Szabó and Sarolta Lipóczi-Csabai:	
<i>Developing, Implementing and Piloting Interactive Teaching Resources in a European Context</i> .....	227
Ágnes Horváth:	
<i>Value Ranking as a special Task for Students</i> .....	232
Éva Ujlakyné Szűcs:	
<i>College Students' Difficulties in Developing their Foreign Language Competences</i> .....	237
Judit Hardi:	
<i>Metacognitive Strategies in EFL Vocabulary Learning</i> .....	241
István Zsigmond:	
<i>Metacognitive Methods of Writing Development (Invited Paper)</i> .....	248
<b>Management - Papers</b>	
Milan Stanić and Ivana Martinović:	
<i>Calculation of Cost Fixed Assets</i> .....	254
Akos Toth:	
<i>The Financial Crisis and its Effect on the Quality of Governance and the Financing of the Cultural Sector</i> .....	259

Snežana Kirin, Tatjana Janovac, Aleksandar Sedmak and Branislav Jakić: <i>Research of Knowledge and Skills Effects on Achievement of Employees Aims (Invited Paper)</i> .....	264
Sanja Knežević and Maja Pelivan: <i>New Product - The Key Factor of Companies' Development</i> .....	270
Michael Schwandt: <i>Statistical Analysis of Employee's Knowledge about Risk Management – A Comparison of three Central Eastern European Countries (Invited Paper)</i> .....	274
Anita Kulaš and Lucija Kraljić: <i>The Importance of Investing in Education of Human Resources in Management</i> .....	281
Tibor Ferenczy: <i>Possibilities of Determining the Value of urban green Areas</i> .....	285
<b>Management - Posters</b>	
Višnja Bartolović and Dajana Džeba: <i>The Representation of Business Ethics Topics in the Study Programmes at Higher Education Institutions in the Republic of Croatia</i> .....	289
Ivona Blažević, Jelena Vuković and Marija Tokić: <i>Comparative Analysis of selected Generating and Receiving Markets of organized Trips in Europe</i> .....	293
Lena Duspara and Ana Čalušić: <i>Woman Entrepreneurship in Croatia</i> .....	298
Arpad Ferencz and Marta Notari: <i>Livelihood of economic Assesment in rural Areas</i> .....	303
Andreja Katolik, Jelena Vuković and Zvonimir Jurković: <i>Analysis of Tourist Markets of organized Trips in Croatia</i> .....	307
Anita Kedačić and Ivana Mendeš: <i>Human Resources as a Basis of Hospital Care</i> .....	311
Petar Kurečić, Lukša Lulić and Tomislav Ivančević: <i>The Influence of States' Dependence on Natural Resources Exploitation on GDP and GNI per capita: A Comparative Study</i> .....	315
Stanislav Nakić: <i>Has the Value Added Tax been necessary?</i> .....	320
Stanislav Nakić: <i>Image as a Career Development Component of a Manager</i> .....	324
Marta Notari and Arpad Ferencz: <i>Price-sensitive Examinations of traditional Products</i> .....	330
Maja Vretenar Cobović, Mirko Cobović and Sanja Tumbas: <i>Analysis of Internet Banking in Practice of Croatian Banks</i> .....	333
<b>Mechanical Engineering - Papers</b>	
Csaba Gyenge: <i>Main Results of 50 Years Researches in the Field of Gear Transmissions Manufacturing (Invited Paper)</i> .....	340
Márton Máté: <i>The micro-geometric Model of the Toothflanks of a cylindrical Gear With Archimedean Spiral Shaped Toothline</i> .....	348
Saurabh Dewangan, Somnath Chattopadhyaya and Sergej Hloch: <i>Analysis of Wear Mechanism in conical Pick for Coal Cutting</i> .....	356
Antal Fodor and Pál Boza: <i>The Effect of the parametric CNC Programming for the Drilling Tool Life</i> .....	361
József Danyi, Bertalan Kecskés and Ferenc Végvári: <i>Evaluation of Spring Back of the Tailor-Welded Blanks in „V” Free Bending Process (Invited Paper)</i> .....	364
Peter Šugár, Jana Šugárová and Ján Petrovič: <i>Study of Metal Spun Parts Surface Layers Topography</i> .....	368
Zoltán Weltsch, József Hlinka, Ágnes Cziráki, Zsolt Fogarassy, Antal Lovas, Miklós Berczeli, Géza Tichy and Attila Tóth: <i>Wetting Features of Ag-Sn Liquid and the Phase Structure in solidified State</i> .....	372
József Hlinka, Zoltán Weltsch and Artúr Acél: <i>Effects of multiple Reflows on Wettability in Sn-Ag-Cu lead-free Solder Alloys</i> .....	378
János Kodácsy and János Liska: <i>Roller Burnishing and Deburring Using Apparatus with Permanent Magnet (Invited Paper)</i> .....	383
János Kodácsy, János Liska and Attila Zólyomi: <i>Machineability of the Ni-based Superalloys by End Milling</i> .....	388
Tomislav Šarić, Danijela Pezer, Goran Šimunović and Roberto Lujčić: <i>Tool Path Optimization of Drilling Sequence using Genetic Algorithm</i> .....	393
Dino Bučević-Keran, Marko Kuna, Dražan Kozak and Josip Sertić: <i>Determination of the critical Position during the Assembly of the Boiler Heat Exchanger Package due to the Stresses of the Auxiliary Frame Structure</i> .....	399

Mario Šokac, Željko Santoši, Tatjana Puškar, Siniša Mirković, Mirko Soković and Igor Budak: <i>Application of different Segmentation Approaches on CB-CT Images for the Reconstruction of 3D Model of Mandible</i> .....	405
Zlatko Pavić and Ana Bodlović: <i>Analytical Study of Stress</i> .....	410
Ratnesh Kumar, Bhabani Bora, Prashant Kumar and Somnath Chatopadhyaya: <i>Experimental and theoretical Investigation of Effect of Process Parameter on Temperature Development during Friction Stir Welding</i> .....	414
József Danyi, Ferenc Végyvári, Gábor Béres and Bertalan Kecskés: <i>Tube Expansion by elastic Medium</i> .....	420
Pál Lukács: <i>Recycling Possibilities of Process Residues from End of Life Vehicles (Invited Paper)</i> .....	423
Stanislav Kotšmíd, Ján Marienčík, Pavel Beňo, Marián Minárik, Dražan Kozak and Pejo Konjatić: <i>Accuracy in the geometrical Characteristics Reduction Method of Step Shaft at Deflection Computing</i> .....	428
Nedeljko Vukojević, Fuad Hadžikadunić and Nenad Gubeljak: <i>Diagnostics and Analysis of the Influence of Cracks on the Integrity of the Thick-walled Pressure Vessels</i> .....	434
Maja Čuletić Čondrić, Marija Stoić, Stipo Duspara and Slavko Zorica: <i>Measuring by using 3D Control Equipment</i> .....	440
Ravi Kumar, Somnath Chattopadhyaya, Anirudh Ghosh and Pedro Vilaca: <i>Thermal Modelling and Analysis of FSW: A Review</i> .....	445
József Danyi, Ferenc Végyvári, Gábor Béres and Bertalan Kecskés: <i>Deep-drawability of Tailor Welded Blanks</i> .....	452
Danijela Živojinović, Horia Dascau, Aleksandar Sedmak and Aleksandar Grbović: <i>Integrity Assessment of a Structure made of two FSW T-Welds</i> .....	456
Zsolt Dugár, Péter Barkóczy, Gábor Béres, Dávid Kis and Gergő Antalicz: <i>Determination of recrystallization Temperature of varying Degrees formed Aluminium, by DMTA Technique</i> .....	462

#### **Mechanical Engineering - Posters**

Jozef Bárta, Milan Marônek, Ladislav Morovič, Jozef Ertel: <i>Utilisation of optical 3D Scanning Methods in Measurement of Weld Joint Deformations</i> .....	465
Jozef Bárta, Milan Marônek, Miroslav Sahul and Jozef Ertel: <i>Influence of Laser Beam Welding Parameters on Weld Joints Microstructure of Duplex Steel</i> .....	469
Tomislav Baskaric, Mato Kokanovic, Dražan Kozak, Todor Ergic and Zeljko Ivandic: <i>Effect of Temperature Changes on the Function of the Electric Guitar</i> .....	472
Zdenko Cerin, Darko Damjanovic, Dražan Kozak and Zeljko Ivandic: <i>Analysis of Wind Influence to static Stability of the Eave Framework</i> .....	475
Katarina Knežević, Mladen Bošnjaković, Ivica Lacković and Igor Tidlačka: <i>Spending Ball or Roller Bearings depending on how the Rotation and Shape of the Load</i> .....	479
Pejo Konjatić, Filip Šakić, Dražan Kozak and Pavel Beňo: <i>Influence of Geometry of Pressure Vessel Nozzle Connection on Stress Intensity Factor</i> .....	483
Katalin Líska, János Líska and Roland Sándor: <i>Investigation Possibilities of Delamination at Drilling of Composite Materials</i> .....	488
Dejan Marić, Antonio Čavar, Željko Ivandić, Dražan Kozak and Ivan Samardžić: <i>Application of Vibro Methods in Practice for Reduction of residual Stresses</i> .....	492
Pero Raos, Josip Stojšic and Ante Pranić: <i>Using of Simulation Programs for the Injection Molding</i> .....	497

# THE PARAMETER ESTIMATION OF THE LINK PERFORMANCE FUNCTIONS

József Osztényi<sup>1\*</sup>, Rafael Alvarez Gil<sup>2</sup>, Kálmán Bolla<sup>2</sup>, Edit Csizmás<sup>2</sup>, Csaba Fábrián<sup>2</sup>, Lóránt Kovács<sup>2</sup>, Tamás Kovács<sup>2</sup>, Krisztián Medgyes<sup>2</sup> and Tibor Vajnai<sup>2</sup>

<sup>1</sup>Department of Natural Sciences and Engineering,

<sup>2</sup>Department of Information Technologies,

Faculty of Mechanical Engineering and Automation, Kecskemét College, Hungary

\* Corresponding author e-mail: [osztényi.jozsef@gamf.kefo.hu](mailto:osztényi.jozsef@gamf.kefo.hu)

## Abstract

The link performance function is a mathematical representation of the relation between flow (i.e. traffic volume) and travel cost (i.e. travel time) for any given link in the network. The results are presented of the calibration of performance functions. Two types of functions are presented: (a) linear function and (b) nonlinear functions, based on the widely used Bureau of Public Roads form. These functions are intended for use in network equilibrium studies requiring the assignment of explicit car flows.

## Keywords:

link performance function, travel simulation, regression

## 1. Introduction

Today it is an important challenge to minimize the travel cost of a particular urban transport system. The travel cost is usually considered to be travel time between the origin and the destination of travel. In order to calculate travel time between origin and destination, the network representation of the transport area is used [2].

The network includes two types of elements: a set of nodes (intersection of roads) and a set of links (street) connecting these nodes.

The other part of the urban transport system is the traffic flow (the mass of the moving vehicles).

The function, which is called Link Performance Function (LPF) [1], is presenting the relationship between link delays and link flows.

A performance function for a typical approach to a signalized intersection is shown in Figure 1. This function captures both the time spent in traveling along the approach under consideration and the delay at the downstream intersection. The travel time at zero flow is known as the free-flow travel time. At this point, a traveling car would not be delayed because of interaction with any other car moving along the link. The only source of delay at this point is the time associated with traversing the link and the expected delay associated with the probability of being stopped by a red signal indication. As the flow increases, the travel time monotonically increases since both the travel time

along the approach increases (because of vehicle interactions at higher traffic densities) and the intersection delay increases (because of queuing phenomena) with the flow.

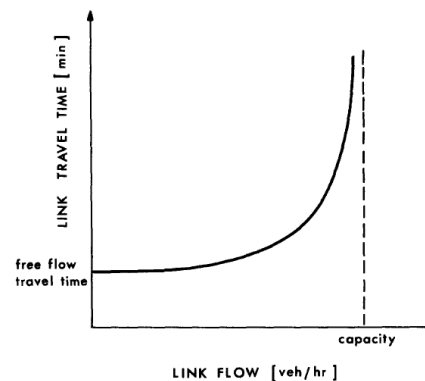


Figure 1. Typical link performance function for an approach to a signalized intersection.

Characteristically, the performance function is asymptotic to a certain level of flow known as the capacity of the transportation facility under consideration. The capacity is the maximum flow that can go through any transportation facility. When the flow approaches capacity, the queues at the intersection will start growing, clogging upstream intersections and finally causing traffic to come to a halt.

## 2. Common Link Performance Functions

The original intersection delay formula used by traffic engineers was calibrated by Webster [3] on the basis of Monte Carlo simulations:

$$t = \frac{r^2}{2c(1-\rho)} + \frac{R^2}{2q(1-R)} - 0.65 \left( \frac{c}{q^2} \right)^{1/3} R^{(2+5g/c)}$$

This is a complicated functional form, thus it imposes a significant computational burden on the calculations. During the equilibrium calculations the link performance functions have to be evaluated numerous times, so we use simplified formula.

A simplified function that is often used in practice is the equation developed by the U.S. Bureau of Public Roads (BPR). This equation is given by

$$t = t^0 \left[ 1 + \alpha \left( \frac{q}{C} \right)^\beta \right]. \quad (1)$$

In this formula  $t$  and  $q$  are the travel time of the flow,  $t^0$  is the free-flow travel time, and  $C$  is the capacity of link. The quantities  $\alpha$  and  $\beta$  are model parameters, for which the value  $\alpha = 0.15$  and  $\beta = 4.0$  are typically used to the highway.

In contrast with traffic flow theory the BPR curves are not asymptotic to any capacity value. A function that is asymptotic to a capacity flow was proposed by Davidson, based on queueing theory considerations. This function is

$$t = t^0 \left[ 1 + J \left( \frac{q}{C - q} \right) \right], \quad (2)$$

where  $C$  is the road's capacity and  $J$  is a parameter of the model. As with the BPR function,  $t^0$  denotes the free-flow travel time (i.e., the travel time at zero flow).

### 3. The method of the estimation

First we will attempt to model the relationship between the flow and the travel time by fitting a linear equation (3) to observed data set.

$$t = a + bq. \quad (3)$$

The coefficients of the linear regression line (3) are estimated by the least square method

$$\hat{b} = \frac{\sum_{i=1}^n (q_i - \bar{q})(t_i - \bar{t})}{\sum_{i=1}^n (t_i - \bar{t})^2},$$

$$\hat{a} = \bar{t} - \hat{b}\bar{q},$$

where  $\bar{q}$  and  $\bar{t}$  are the sample means of the flow ( $q$ ) and the travel time ( $t$ ).

In the model of BPR the parameters can be estimated by using a linear regression if a logarithmic transformation is used on the data set. First we order the equation (1)

$$\frac{t - t^0}{t^0} = \alpha \left( \frac{q}{C} \right)^\beta,$$

next we use logarithmic transformation

$$\ln \left( \frac{t - t^0}{t^0} \right) = \ln(\alpha) + \beta \ln \left( \frac{q}{C} \right).$$

Now if we introduce the following variable

$$v = \ln \left( \frac{t - t^0}{t^0} \right),$$

$$u = \ln \left( \frac{q}{C} \right),$$

then the coefficients of the linear regression line

$$v = \ln(\alpha) + \beta u$$

can be estimated by the least square method again.

Similarly we can transform the Davidson's model to linear regression model without the intercept term. We introduce the following variable

$$w = \frac{t - t^0}{t^0},$$

$$z = \frac{q}{C - q}.$$

Then the coefficients of the linear regression line

$$w = Jz \quad (4)$$

can be estimated by the ordinary least squares

$$\hat{J} = \frac{\sum_{i=1}^n q_i t_i}{\sum_{i=1}^n t_i^2}.$$

### 4. Microscopic simulation of the traffic

The traffic model used here is based on a microscopic simulation of movements of individual vehicles through a network. The essential property of our model is that the vehicles move in real time and that their space-time trajectories are determined by IDM car-following model, network controls such as stop on red and speed limit. The parameter values of the IDM were calibrated in [4].

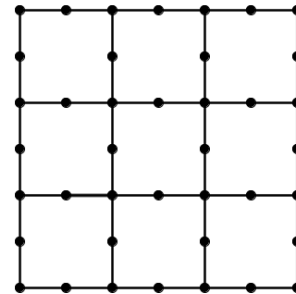


Figure 2. The Manhattan network.

In our Manhattan test bench start 12000 vehicles. We observe a 500 m long route with a signalized intersection on the end in the inside of the network. The cycle time of the traffic lights was 100 sec long, and the green time was 25 sec long. The departure of the intersection is 2.5 seconds per vehicle, so the capacity of the route was 360 vehicles per hour. The free-flow travel time can be computed by the following: the travel time is the sum of the average running time at zero flow level and the average time spent queueing at intersections, at that flow level. The average velocity of a car was 55 km/h, so it takes 32.73 seconds to drive the 500 m long route. If the arrival time at the intersection is a random time under the uniform distribution, then the average time spent queueing is



$$\frac{1}{4} \cdot 0 + \int_0^{75} \frac{1}{100} t dt = 28.125$$

seconds. That is the computed free-flow travel time is 60.855 seconds.

We measured the flow on the link in vehicle per hour and the average travel time in seconds. The result of the simulations is shown in Figure 3.

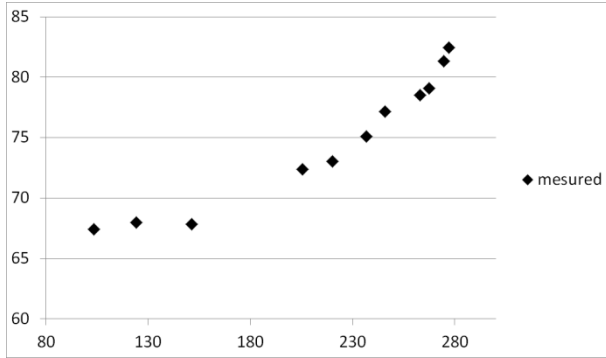


Figure 3. The measured data.

### 5. The estimation of link delay functions parameters

The estimated coefficients of the linear regression line are

$$\hat{a} = 56.7126, \hat{b} = 0.0838,$$

of BPR link performance function are

$$\hat{\alpha} = 0.4215, \hat{\beta} = 1.2368,$$

and Davidson's function is

$$\hat{f} = 0.1124.$$

We fitted these link performance functions to our data set, as we see in Figure 4.

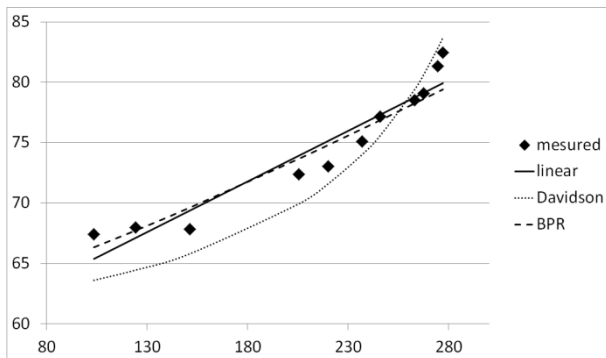


Figure 4. The fitted curves.

We computed all the three case the sample correlation coefficient ( $R$ ) and the mean squared error ( $MSE$ ) of the model. It was computed the correlation coefficient of the transformed sample in the BPR and Davidson's link performance functions.

Table 1. The value of  $R$  and  $MSE$

	linear	BPR	Davidson
$R$	0.9565	0.9593	0.9944

$MSE$	2.3019	2.2266	4.5257
-------	--------	--------	--------

The correlation coefficient is very high in all three cases, moreover it is the best in the case Davidson's function, however the mean squared error is the greatest in this case. The correlation coefficient gives the quality of a least squares fitting to the data set, but the best line is not fitting on the pole (Figure 5), however in model (4) we required it.

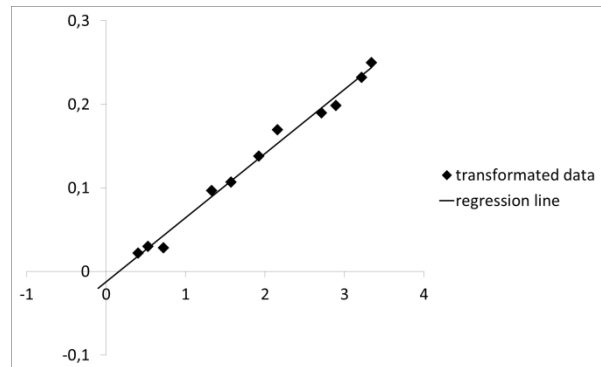


Figure 5. The best line to the transformed data.

We estimated the value of  $t^0$  by the least square method in model (2). That is we introduced the variable

$$z = \frac{q}{C - q}$$

and estimated the coefficients of the linear regression line

$$t = t^0 + (t^0 J)z.$$

The value of the estimated free-flow travel time and parameter  $J$  are

$$\hat{t}^0 = 65.184, \hat{f} = 0.0777.$$

The mean squared error of the new model is 0.2994. We can touch up the model of BPR by change the value of the free-flow travel time, but it requires other method to find the best.

Summarizing up we can use linear model in low flow and the Davidson's model close to the capacity.

### Acknowledgement

This work has been supported by the European Union and Hungary and co-financed by the European Social Fund through the project TÁMOP-4.2.2.C-11/1/KONV-2012-0012: "Smarter Transport" -- IT for Co-operative Transport Systems.

### References

- [1] Yosef Sheffi, "Urban Transportation Networks: Equilibrium Analysis with Mathematical Programming Methods". Prentice-Hall, Englewood Cliffs, New Jersey, 1985/1992.

- [2] Henry Lieu, "Revised monograph on traffic flow theory". *US Department of Transportation Federal Highway Administration*, Washington, D.C., 2003.
- [3] F.V. Webster, "Traffic Signal Settings", *Road Research Laboratory Report 39*, Crowthorne, Berkshire, England, 1958
- [4] Tamás Kovács, Rafael Alvarez Gil, Kálmán Bolla, Edit Csizmás, Csaba Fábián, Lóránt Kovács, Tamás Kovács, Krisztián Medgyes, József Osztényi, Attila Végh, "Parameters of the Intelligent Driver Model in Signalized Intersections", *Technical Gazette*, submitted.