

University of Niš

Mechanical  
Engineering Faculty



## PROCEEDINGS

The 7<sup>th</sup> INTERNATIONAL SCIENTIFIC CONFERENCE  
**RESEARCH AND DEVELOPMENT OF  
MECHANICAL ELEMENTS AND SYSTEMS**

27<sup>th</sup> & 28<sup>th</sup> of April, 2011, Zlatibor, Serbia

Co-organisers:



IFToMM

International Federation for the Promotion of  
Mechanism and Machine Science



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## MACHINES DEVELOPMENT AND CONSTRUCTION CENTRE



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## Preface

New technologies, globalization and individualization of customer demands, as well as high quality of modern products, are forcing industrial enterprises to improve their processes of product development. This implies the support of enterprise processes throughout the product lifecycle, from the product idea through product development, manufacturing, improvement and quality assurance to maintenance during operation. Processes of product development are more than just usual engineering. A product portfolio must be analyzed and product concept must be examined from the aspect of its realization. This requires linking internal domain with external teams. New products must be introduced to market with high quality and low development costs. The prerequisite for development of high quality products and high productivity manufacturing is to master the knowledge, which is a result of research in science and technology.

The aim the 7th International Scientific Conference “Research and Development of Mechanical Elements and Systems” 2011 in Zlatibor is:

- to gather experts and researchers in the field of scientific research and industrial product development;
- to present new design solutions related to energy efficiency, application of available resources, product price reduction, ...
- to exchange knowledge and experience, through presentations of research results and expert information, with the aim of stimulating industrial activities in the region.



*Participant countries*

The best 114 abstracts were selected among 154 submitted by authors from Europe and Asia. The lectures came from Austria, Bosnia and Herzegovina, Belarus, Bulgaria, France, Germany, Greece, Croatia, Czech Republic, Hungary, Italy, Kazakhstan, Macedonia, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia and Spain. The presentations emphasize future trends in area research and development of mechanical elements and systems and cover the following topics:

- Industrial Product Development
- Computer Added Product Development - CAPD
- Mechatronics and Automatic Control
- Safety, Quality and Reliability
- Materials, Technology and Tribology
- Vibration and Noise, Testing and Monitoring
- Mechanical Systems and Components

The conference offers the possibility for participants to discuss the presented results in detail and share their experience.

### **Conference President**

Prof.Dr.-Ing. Vojislav Miltenović, Full Professor, Machines Development and Construction Centre (CERP), University of Niš, Faculty of Mechanical Engineering, Niš, Serbia





# CONTENTS

## Plenary Session

- INGENIEURAUUSBILDUNG IM GEBIET PRODUKTENTWICKLUNG I  
Vojislav MILTENOVIĆ, University of Niš, Mechanical Engineering Faculty, Nis, Serbia  
Radivoje MITROVIĆ, University of Belgrade, Mechanical Engineering Faculty, Belgrade, Serbia
- SPIROID GEARBOXES FOR ACTUATORS OF PIPELINE VALVES VII  
Veniamin GOLDFARB, Eugene TRUBACHEV, Dmitry GLAVATSKIKH, Andrey KUZNETSOV,  
Institute of Mechanics, Izhevsk State Technical University, Izhevsk, Russia
- CRITICAL LOAD CONDITIONS FOR CONTACT STRESS CALCULATIONS OF UNDERCUT XIII  
HELICAL GEAR TEETH  
José I. PEDRERO, Miguel PLEGUEZUELOS, Miryam SÁNCHEZ, Departamento de Mecánica, UNED,  
Madrid, Spain  
Vicente YAGÜE, Mecánica Aplicada E Ingeniería Proyectos, Universidad de Castilla – La Mancha,  
Albacete, Spain

## Industrial Product Development

- 1.1. MULTYDISCIPLINARY CONCEPTUAL DESIGN, CASE STUDY 1  
Milosav OGNJANOVIĆ, Sanja VASIN, University of Beograd, Mechanical Engineering Faculty, Beograd
- 1.2. THE DESIGN OF A FORMULA STUDENT RACE CAR 7  
Athanasios MIHAILIDIS, Ioannis NERANTZIS, Georgios KARAOGLANIDIS, Aristotle University of  
Thessaloniki, Faculty of Engineering Laboratory of Machine Elements & Machine Design, Thessaloniki,  
Greece  
Zissis SAMARAS, George FONTARAS, Aristotle University of Thessaloniki, Faculty of Engineering  
Laboratory of Applied Thermodynamics, Thessaloniki, Greece
- 1.3. GLOBAL PRODUCT REALIZATION OF A PROSTHETIC KNEE FOR ALPINE SKIING 17  
Ivan DEMŠAR, Jože DUHOVNIK, University of Ljubljana, Faculty of Mechanical Engineering, Ljubljana,  
Slovenia  
Zmago VIDRIH, ART-LEG d.o.o., Žalec, Slovenia
- 1.4. SYSTEM APPROACH TO SOLVING BRAKE NVH ISSUES 25  
Jasna GLIŠOVIĆ, Miroslav DEMIĆ, Danijela MILORADOVIĆ, Dobrivoje ĆATIĆ, University of  
Kragujevac, Faculty of Mechanical Engineering, Kragujevac, Serbia
- 1.5. SYNERGY OF EDUCATIONAL – SCIENTIFIC INSTITUTIONS WITH SMALL AND MEDIUM 33  
ENTERPRISES IN PRODUCT DEVELOPMENT TASKS  
Dragan MILČIĆ, Miroslav MIJAJLOVIĆ, Marko RISTIĆ, Dalibor STEVANOVIĆ, Miodrag MILČIĆ,  
University of Niš, Faculty of Mechanical Engineering, Niš, Serbia
- 1.6. GENERATING NEW PRODUCTS ACCORDING TO INTERNATIONAL STANDARDS AND 39  
COMPETITIVE AUTOMOTIVE MARKET  
Saša RANDJELOVIĆ, Miroslav TRAJANOVIĆ, University of Niš, Mechanical Engineering Faculty, Niš,  
Serbia  
Bratislav DENIĆ, Serbian Railway Company, Belgrade, Serbia
- 1.7. A STUDY ON WORK OF DISLOCATED TEAMS: VIRTUAL PROJECT REALISATION 43  
Biljana MARKOVIĆ, University of East Sarajevo, Mechanical Faculty, Republic of Srpska, Bosnia and  
Herzegovina  
Dragan MILČIĆ, Miroslav MIJAJLOVIĆ, University of Niš, Faculty of Mechanical Engineering, Niš, Serbia
- 1.8. INTEGRATION OF TOPOLOGY AND SHAPE OPTIMIZATION INTO THE PROCESS OF THE 49  
DESIGN OF MECHANICAL STRUCTURES ELEMENTS  
Nenad MARJANOVIĆ, Blaža STANOJEVIĆ, Zorica DJORDJEVIĆ, University of Kragujevac, Faculty of  
Mechanical Engineering, Kragujevac, Serbia  
Biserka ISAILOVIĆ, Svetogorska 11/36, Kragujevac

- 1.9. MODERN WASTE TYRE RECYCLING SYSTEM 57  
 Petar S. ĐEKIĆ, Dragan TEMELJKOVSKI, Bojan RANČIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia  
 Stojančo NUSEV, University St. Kliment Ohridski Bitola, Faculty of Engineering, Bitola, Macedonia

### Computer Aided Product Development - CAPD

- 2.1. IMPLEMENTATION OF GEOMETRICALLY NONLINEAR FEM-FORMULATIONS IN MBS SOFTWARE PACKAGE ADAMS 63  
 Dragan MARINKOVIĆ, Berlin Institute of Technology, Department of Structural Analysis, Berlin, Germany  
 University of Niš, Faculty of Mechanical Engineering, Niš, Serbia  
 Manfred ZEHN, Berlin Institute of Technology, Department of Structural Analysis, Berlin, Germany
- 2.2. ANALYSIS OF AN AUTOMATIC WRAPPING MACHINE: NUMERICAL MODELS AND EXPERIMENTAL RESULTS 69  
 Giangiacomo MINAK, Cristiano FRAGASSA, University of Bologna, DIEM department, Bologna, Italia  
 Zlatan ŠOŠKIĆ, Snežana ĆIRIĆ KOSTIĆ, University of Kragujevac, Faculty of Mechanical Engineering, Kraljevo, Serbia
- 2.3. MODELING AND SIMULATION OF OFF – ROAD VEHICLE WITH FOUR WHEEL STEERING (4 WS) 77  
 Stanislav PEHAN, Jože FLAŠKER, University of Maribor, Mechanical Engineering Faculty, Maribor, Slovenia  
 Shpetim LAJQI, University of Prishtina, Mechanical Engineering Faculty, Kosovo (UNMIK 1244)  
 Jože PŠENIČNIK, RTC - Automotive Research & Development Center, Maribor, Slovenia
- 2.4. DYNAMIC BEHAVIOR OF DAMAGED STRUCTURE OF CRANE IN THE FOLLOWING INCIDENTAL EVENT 85  
 Goran RADOIČIĆ, PUC “Mediana”, Niš, Serbia  
 Predrag MILIĆ, Miomir JOVANOVIĆ, University of Niš, Faculty of Mechanical Engineering, Niš, Serbia
- 2.5. LOW CYCLE FATIGUE AND ELASTO-PLASTIC MATERIAL BEHAVIOUR SIMULATION 89  
 Marina FRANULOVIĆ, Robert BASAN, Božidar KRIŽAN, University of Rijeka, Faculty of Engineering, Dept. of Mechanical Engineering Design, Rijeka, Croatia
- 2.6. A WEB-BASED MATERIAL PROPERTIES DATABASE AND SYSTEM FOR ESTIMATION OF MATERIAL PARAMETERS - CONCEPT AND IMPLEMENTATION 95  
 Robert BASAN, Marina FRANULOVIĆ, Božidar KRIŽAN, University of Rijeka, Faculty of Engineering, Dept. of Mechanical Engineering Design, Rijeka, Croatia  
 Ivan PREBIL, University of Ljubljana, Faculty of Mechanical Engineering, Ljubljana, Slovenia
- 2.7. MODELLING AND SIMULATION OF ENERGY EFFICIENT SERVO PNEUMATIC SYSTEM WITH SEMI-ROTARY ACTUATOR 99  
 Vladislav BLAGOJEVIĆ, Miodrag STOJILJKOVIĆ, Dušan PETKOVIĆ, University of Niš, Faculty of Mechanical Engineering, Niš, Serbia
- 2.8. DEVELOPING OF INTEGRATED PLATFORM FOR SYSTEMS PLANNING, MODELLING, DESIGNING, SIMULATION AND MONITORING 103  
 Saša MARKOVIĆ, Predrag MILIĆ, Nikola PETROVIĆ, University of Niš, Faculty of Mechanical Engineering, Niš, Serbia
- 2.9. ARTIFICIAL INTELLIGENCE IN CAM MODELING OF ASSEMBLY OPERATIONS OF TANK WAGONS 109  
 Marina PLJAKIĆ, Nemanja ILIĆ, Arandel BABIĆ, University of Kragujevac, Faculty of Mechanical Engineering, Kraljevo, Serbia
- 2.10. INTELIGENT CAD DESIGN AND ASSEMBLY PLAN OF MILLING HEADS 113  
 Nemanja ILIĆ, Marina PLJAKIĆ, Arandel BABIĆ, University of Kragujevac, Faculty of Mechanical Engineering, Kraljevo, Serbia
- 2.11. ALMANAC OF INFORMATION MATERIALS, 3D IMAGES, ANIMATIONS AND OTHER VISUALIZATIONS AS AN AID IN STUDYING MACHINE ELEMENTS 119  
 Peter NENOV, Vyarka RONKOVA, Emilia ANGELOVA, Trifon TRIFONOV, University of Ruse, Faculty of Transport, Ruse, Bulgaria

2.12.	SOFTWARE PACKAGE FOR KINEMATICS AND DYNAMIC ANALYSIS AND SYNTHESIS OF CAM MECHANISMS WITH ROLLER TRANSLATOR FOLLOWER Tale GERAMITCIOSKI, Ljupco TRAJCEVSKI, University "Sv. Kliment Ohridski" Bitola, Technical Faculty Bitola, Macedonia	127
2.13.	THE MECHANISM OF DRAG REDUCTION DUE TO A STEADY PERTURBATION IN THE WAKE OF A BLUFF BODY Vladimir PAREZANOVIĆ, ParisTech, Ecole Polytechnique, Palaiseau, France Olivier CADOT, Romain MONCHAUX, ParisTech, ENSTA-UME, Palaiseau, France	133
2.14.	FE MODEL OF STEEL BRANCHED TUBE IN PIPELINES UNDER CRITICAL WORKING PRESSURE Jelena MILISAVLJEVIĆ, Petar ĐEKIĆ, Dušan MARKOVIĆ, Mladen TOMIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	139
2.15.	SIMULATION OF SELF-ORGANIZING MAPS FOR SOLVING TRAVELLING SALESMAN PROBLEM Danijel MARKOVIĆ, Miloš MADIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia Sonja STOJKOVIĆ, University of Niš, Faculty of Economics of Niš, Serbia	145
2.16.	UNSTEADY COUETTE-POISEUILLE FLOW SIMULATION WITH FAVORABLE AND ADVERSE PRESSURE GRADIENTS Miloš M. JOVANOVIĆ, Jelena D. NIKODIJEVIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	151

### Mechatronics and Automatic Control

3.1.	ADVANCED PID CONTROLLER DESIGN FOR CONTINUOUSLY VARIABLE TRANSMISSION Vlastimir NIKOLIĆ, Žarko ČOJBAŠIĆ, Predrag RAJKOVIĆ, Ivan ĆIRIĆ, Emina PETROVIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	157
3.2.	STUDIES ON THE ALGORITHM OF SIZING AND CHOOSING LINEAR MOTORS USED IN DRIVE OF THE MACHINE TOOLS Stefan VELICU, Lucian MIHAI, Alexandru VELICU, University Politehnica of Bucharest, Engineering and Technological Systems Management Faculty, Bucharest	163
3.3.	DIMENSIONAL SYNTHESIS OF COMPLIANT SPRING GUIDING SYSTEMS Nenad T. PAVLOVIĆ, Nenad D. PAVLOVIĆ, Miloš MILOŠEVIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	167
3.4.	SIMULATIONS AS BASIS FOR DEVELOPMENT OF CONTAINER CRANE CONTROL SYSTEMS Milosav GEORGIJEVIĆ, Vladimir BOJANIĆ, Goran BOJANIĆ, University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia	175
3.5.	ON RESEARCHING TRANSMISSION CONTROL PROTOCOL VIA Q-CALCULUS Predrag RAJKOVIĆ, Vlastimir NIKOLIĆ, Srđan MATIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	183
3.6.	OPTIMUM MANIPULATOR MOBILITY, SIMULATED BY USING MATLAB/SIMULINK AND VIRTUAL REALITY TOOLBOX Hristijan MICKOSKI, Ivan MICKOSKI, Faculty of Mechanical Engineering, Ss Cyril and Methodius University, Skopje, Republic of Macedonia Blagoj PAVLOV, Faculty of Technical Sciences - Bitola, University "Sv. Kliment Ohridski", Bitola, Macedonia	187
3.7.	SUBSTITUTION OF PRISMATIC PAIR AT CAR WINDOW REGULATOR Miša TOMIĆ, Nenad D. PAVLOVIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia Bojan VUKČEVIĆ, Podgorica, Montenegro	191
3.8.	FAILURES OF MECHATRONIC MODULES OF MOTION Eugeni SHALOBAEV, Dmitri SURIKOV, National Research University of Information Technologies, Mechanics and Optics "ITMO", Academy "LIMTU", Saint-Petersburg, Russia Vladimir RASPOPOV, Vladimir KUKHAR, Tula State University, Tula, Russia Victor STARZHINSKY, V.A. Belyi Metal-Polymer Research Institute of National Academy of Sciences of Belarus, Gomel, Belarus	195

3.9.	EMBODIMENT DESIGN STEPS FOR AN AZIMUTHAL PV TRACKING SYSTEM WITH ROTATIONAL AND LINEAR ACTUATORS Radu VELICU, Gheorghe MOLDOVEAN, Transilvania University of Brasov, Faculty of Product Design and Environment, Brasov, Romania	199
3.10.	RADIO SHUTTLE RACKING – NEW GENERATION OF HIGH DENSITY STORAGE SYSTEM Rodoljub VUJANAC, Nenad MILORADOVIĆ, Radovan SLAVKOVIĆ, University of Kragujevac, Faculty of Mechanical Engineering, Kragujevac, Serbia	205

<b>Safety, Quality and Reliability</b>
--

4.1.	AUTOMATION IN DESIGN AND ANALYSIS OF HYDRAULIC CILINDERS Lubomir DIMITROV, Petko NEDYALKOV, Aleksandar TODOROV, Technical University of Sofia, Mechanical Engineering Faculty, Sofia, Bulgaria	209
4.2.	INFLUENCE OF TRANSITION SECTION OF SHAFT WITH FLANGE ON STRESS CONCENTRATION FACTOR Ivana ATANASOVSKA, Institut Kirilo Savić, Belgrade, Serbia Radivoje MITROVIĆ, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, Serbia Dejan MOMCILOVIĆ, Institute IMS, Belgrade, Serbia	213
4.3.	EXPERIMENTAL DETERMINATION OF STRESS CONCENTRATION INFLUENCE ON WELDED CONSTRUCTIONS STABILITY Andreja ILIĆ, Danica JOSIFOVIĆ, Vukić LAZIĆ, Lozica IVANOVIĆ, University of Kragujevac, Faculty of Mechanical Engineering, Kragujevac, Serbia	219
4.4.	DESIGN FOR RELIABILITY OF AUTOMOTIVE GEARBOXES Milosav OGNJANOVIĆ, University of Belgrade, Faculty of Mechanical Engineering, Machine Elements & Machine Design, Belgrade, Serbia Miroslav MILUTINOVIĆ, University of East Sarajevo, Faculty of Mechanical Engineering, Istočno Sarajevo, Republic Srpska, Bosnia and Herzegovina	225
4.5.	APPLICATION OF THE MODAL ANALYSIS IN IDENTIFICATION OF VIBRATIONS WITHIN CONSTRUCTION OF MECHANICAL SYSTEM Radomir SLAVKOVIĆ, Zvonko JUGOVIĆ, Nedeljko DUČIĆ, Ivan MILIĆEVIĆ, Marko POPOVIĆ, University of Kragujevac, Technical Faculty Čačak, Serbia	231
4.6.	DESIGN FOR RELIABILITY OF PLANETARY GEAR DRIVE FOR BUCKET WHEEL EXCAVATOR Milosav OGNJANOVIĆ, Miloš RISTIĆ, University of Belgrade, Faculty of Mechanical Engineering, Beograd, Serbia	239
4.7.	THE EFFECT OF GEOMETRY ON THE STRESS DISTRIBUTION OF CROSS SHAFT Katarina ŽIVKOVIĆ, Lozica IVANOVIĆ, Blaža STOJANOVIĆ, University of Kragujevac, Mechanical Engineering Faculty, Kragujevac, Serbia	245
4.8.	CRACK INITIATION LIFE OF TURBOJET ENGINE DISKS EXPRESSED IN EQUIVALENT CYCLES Strain POSAVLJAK, Milosav DJURDJEVIC, University of Banja Luka, Faculty of Mechanical Engineering, Republic of Srpska, Bosnia and Herzegovina Miodrag JANKOVIC, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, Serbia	253
4.9.	WEAR PROBABILITY TESTING OF PLANETARY DRIVE GEAR SATELLITES Predrag ŽIVKOVIĆ, University of Pristina, Faculty of Technical Science, Kosovska Mitrovica, Serbia	259
4.10.	REALIABILITY OF TRANSPORTATION BELT ROLLERS USED ON THE SURFACE COAL DIG Gradimir IVANOVIĆ, Mechanical Engineering Faculty, University of Beograd, Belgrade, Serbia Dragan JOVANOVIĆ, PD Termoelektrane i kopovi Kostolac, Kostolac, Serbia Radivoje MITROVIĆ, Mechanical Engineering Faculty, University of Beograd, Belgrade, Serbia	265
4.11.	RESEARCH OF THE FORCE VALUES DEPENDENCES IN HYDRO CYLINDERS OF THE MOBILE ELEVATING WORK PLATFORM ARTICULATED BOOM ON THE WORK POSITION AND LOAD WEIGHT Nebojša ZDRAVKOVIĆ, Milomir GAŠIĆ, Mile SAVKOVIĆ, Dragan PETROVIĆ, University of Kragujevac, Faculty of Mechanical Engineering Kraljevo, Kraljevo, Serbia	271
4.12.	ANALYSIS OF THE INFLUENCE OF LOCAL STRESS ON THE CARRYING CAPACITY OF BOX BEAMS Mirko ĐELOŠEVIĆ, Milomir GAŠIĆ, Mile SAVKOVIĆ, Dragan PETROVIĆ, Milan BIŽIĆ, University of Kragujevac, Mechanical Engineering Faculty, Kraljevo, Serbia	279

4.13.	CALCULUS OF METALIC AND STEEL-CONCRETE MIXED STRUCTURES AT FIRE ACTION Afronie Eugen-MARIUS, Tiberiu Stefan MANESCU, Chivu ADRIAN, "Eftimie Murgu" University of Resita Mechanics Department, Resita, Romania	285
4.14.	ANALYSIS OF CRITICAL LOAD OF THE ORTHOTROPIC PLATE STRUCTURES Radoljub TOMIĆ, "Prva Petoletka-S&R" JSC, Trstenik, Serbia Predrag PETROVIĆ, Tomislav JOVANOVIĆ, Institute "Kirilo Savić", Belgrade, Serbia	289

<b>Materials, Technology and Tribology</b>
--

5.1.	PRECISION MEASURING TECHNOLOGY AND PROCESS SIMULATION IN THE PRODUCTION OF WORM WHEELS Joerg HERMES, Siemens Geared Motors GmbH, Tuebingen, Germany Wolfgang PREDKI, Ruhr University, Bochum, Germany	293
5.2.	FRICITION GENERATED HEAT AND ITS EFFECTS IN LUBRICANTLESS PNEUMATIC DRIVES SEALS Geanina PODARU, Iulian Gabriel BIRSAN, Sorin CIORTAN, Lorena DELEANU, University of Galati, Mechanical Engineering Faculty, Galati, Romania	299
5.3.	NEUE WEGE ZUR SCHADENSIDENTIFIKATION AN BAUTEILEN AUS FASERVERBUNDWERKSTOFFEN Tobias KÄMPF, Manfred W. ZEHN, Berlin Institute of Technology, Department of Structural Analysis, Berlin, Germany Dragan MARINKOVIĆ, University of Niš, Faculty of Mechanical Engineering, Niš, Serbia Berlin Institute of Technology, Department of Structural Analysis, Berlin, Germany	305
5.4.	INFLUENCE OF HEAT TREATMENT ON THE SCC OF MARTENSITIC STAINLESS STEEL Goran RADENKOVIĆ, Dušan PETKOVIĆ, Vladislav BLAGOJEVIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	311
5.5.	RESEARCHING AND TESTING OF RUBBER-METAL SUSPENSION Dušan STAMENKOVIĆ, Miloš MILOŠEVIĆ, Nenad T. PAVLOVIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	315
5.6.	INFLUENCE KIND OF THE MATERIAL AND ANGLE OF FIBRES ORIENTATION ON STRESS AND STRAIN ANALYSIS OF COMPOSITE SHAFT Nenad KOSTIĆ, Zorica ĐORĐEVIĆ, Mirko BLAGOJEVIĆ, Nenad MARJANOVIĆ, University of Kragujevac, Mechanical Engineering Faculty, Kragujevac, Serbia	321
5.7.	INFLUENCE OF THE TECHNOLOGICAL HOLE IN WELDING PLATES ON WELD CREATION AND HEAT GENERATION DURING FRICTION STIR WELDING Miroslav MIJAJLOVIĆ, Dragan MILČIĆ, Boban ANĐELKOVIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia Aleksandar ŽIVKOVIĆ, EWE, IWE, GOŠA FOM, Smederevska Palanka, Serbia	327
5.8.	SOME SPECIFIC FEATURES OF A POLYMER COMPOSITES STAMPING PROCESS Predrag JANKOVIĆ, Bojan RANČIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	333
5.9.	HEREDITARY PROPERTIES OF ACTIVE AND INACTIVE TOOTH FLANKS REGENERATED BY TIG HARD FACING METHOD Svetislav Lj. MARKOVIĆ, Technical College, Čačak, Serbia Tatjana LAZOVIĆ, Aleksandar MARINKOVIĆ, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, Serbia Slobodan TANASIJEVIĆ, University of Kragujevac, Faculty of Mechanical Engineering, Kragujevac, Serbia	339
5.10.	RESEARCH OF VARIABLE BLANK HOLDER FORCE INFLUENCE ON SQUARE DRAWING PROCESS FROM TAILOR-WELDED BLANKS Peter KOVÁČ, Ľudmila KRŠIAKOVÁ, Peter ZEMKO, Slovak University of Technology, Faculty of Materials Science and Technology, Trnava, Slovakia	345
5.11.	THE STRUCTURE OF FLEXIBLE MANUFACTURING UNIT Ljubinko JANJUŠEVIĆ, Marina KUTIN, Miroslav RADOSAVLJEVIĆ, GOŠA Institute, Belgrade, Serbia	349
5.12.	MECHANICAL PROPERTIES OF FABRIC REINFORCED COMPOSITES Vasile BRIA, Victor UNGUREANU, Igor ROMAN, Iulian-Gabriel BIRSAN, Adrian CIRCIUMARU, Dunarea de Jos University, Mechanical Engineering Faculty, Galati, Romania	355

5.13.	TRIBOLOGICAL ANALYSIS OF FABRIC REINFORCED COMPOSITES	359
	Igor ROMAN, Vasile BRIA, Victor UNGUREANU, Adrian CIRCIUMARU, Iulian-Gabriel BIRSAN, Dunarea de Jos University, Mechanical Engineering Faculty, Galati, Romania	
5.14.	PHYSICAL PROPERTIES OF CLAY-TALC/EPOXY COMPOSITES	363
	Victor UNGUREANU, Igor ROMAN, Vasile BRIA, Iulian-Gabriel BIRSAN, Adrian CIRCIUMARU, Dunarea de Jos University, Mechanical Engineering Faculty, Galati, Romania	
5.15.	3C-SIC FILMS GROWN ON 4H- AND 6H-SIC SUBSTRATE MESAS DURING STEP-FREE SURFACE HETEROEPITAXY	367
	Cristiana VOICAN, Technical College of Bucharest, Romania C.D. STANESCU, Polytechnic University of Bucharest, Romania Carmen GHEATA, Technical College of Bucharest, Romania	

### Vibration and Noise, Testing and Monitoring

6.1.	LABORATORY INSTALLATION FOR BELT CONVEYORS IDLERS TESTING ON SERVO HYDRAULIC TESTING MACHINE ZWICK HB-250	371
	Radivoje MITROVIĆ, Zoran STAMENIĆ, Žarko MIŠKOVIĆ, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, Serbia Milan TASIĆ, Tehnikum Taurunum, College of applied sciences, Belgrade, Serbia	
6.2.	TEST BED FOR EXPERIMENTAL RESEARCH ON WIND TURBINE DRIVE TRAIN BASED ON CVT	377
	Milan BANIĆ, Vojislav MILTENOVIĆ, Miodrag VELIMIROVIĆ, Aleksandar MILTENOVIĆ, Dejan RANDELOVIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	
6.3.	INSTALLATION FOR CARRIER ROLLER IDLERS OF BELT CONVEYORS TESTING ON THE OPEN PIT MINING	383
	Radivoje MITROVIĆ, Zoran STAMENIĆ, Žarko MIŠKOVIĆ, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, Serbia Milan TASIĆ, Tehnikum Taurunum, College of applied sciences, Belgrade, Serbia Dragan JOVANOVIĆ, PD Termoelektrane i kopovi Kostolac d.o.o., Kostolac, Serbia	
6.4.	DETERMINATION OF RESIDUAL LIFE OF FINE-MODULE GEARS	389
	Oleg BERESTNEV, Nikolai ISHIN, Arkadi GOMAN, Andrei SKOROKHODOV, Joint Institute of Mechanical Engineering of the NAS of Belarus, Scientific and Technical Center “Mechanical Engineering”, Minsk, Republic of Belarus Victor STARZHINSKY, V.A. Belyi Metal-Polymer Research Institute of National Academy of Sciences of Belarus, Gomel, Belarus	
6.5.	ON THE METHODS TO MEASURE THE REAL LOADING AT MECHANICAL SYSTEMS	395
	George DOBRE, Radu Florin MIRICA, University POLITEHNICA of Bucharest, Faculty of Mechanical Engineering and Mechatronic, Bucharest, Romania Radu ONOFREI, IMSAT Group SNEF, Complex Project Division, Bucharest, Romania	
6.6.	SUSTAINABLE APPROACH FOR PERFORMANCE MEASUREMENT OF MECHANICAL AND AUTOMATED SYSTEMS	401
	Roumiana ILIEVA, Todor NESHKOV, Lubomir DIMITROV, Technical University of Sofia, Faculty of Management, Sofia, Bulgaria	
6.7.	ROLLING BEARING VIBRATION DETECTION – CASE STUDIES	407
	Tale GERAMITCIOSKI, Ljupco TRAJCEVSKI, Vangelce MITREVSKI, University “Sv. Kliment Ohridski” Bitola, Technical Faculty Bitola, Macedonia	
6.8.	IDENTIFICATION OF LOAD SPECTRUM FOR DRIVING SYSTEM OF BUCKET EXCAVATOR WORKING WHEEL	413
	Slobodan MILADINOVIĆ, Technical College of Kosovska Mitrovica, Serbia Đorđe MILTENOVIĆ, Textile College of Leskovac, Leskovac, Serbia	
6.9.	TEST STAND FOR CALIBRATION OF MEASUREMENT RAILWAY WHEELSETS	419
	Milan BIŽIĆ, Dragan PETROVIĆ, University of Kragujevac, Faculty of Mechanical Engineering, Kraljevo, Serbia Miloš TOMIĆ, University of Beograd, School of Electrical Engineering, Belgrade, Serbia Zoran ĐINOVIĆ, Vienna University of Technology, Institute for Sensors and Actuators Systems, Wien, Austria, Integrated Microsystems Austria GmbH, Wiener Neustadt, Austria	

6.10.	VIBROACOUSTIC MONITORING OF TRIBOENGINEERING PARAMETERS UPON ACCELERATED TESTING OF DINAMICALLY LOADED GEAR DRIVES Vladimir BASINIUK, Elena MARDOSEVICH, Joint Institute of Mechanical Engineering of National Academy of Sciences, Minsk, Belarus Victor STARZHINSKY, Andrei GRIGORIEV, V.A. Belyi Metal-Polymer Research Institute of National Academy of Sciences of Belarus, Gomel, Belarus	425
6.11.	OPTIMAL PREVENTIVE MAINTENANCE USING THE THEORY OF MARKOV PROCESSES AND GENETIC ALGORITHMS Goran PETROVIĆ, Žarko ČOJBAŠIĆ, Zoran MARINKOVIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	431
6.12.	PROCEDURES OF DIAGNOSTICS AND TESTING THE TWO STAGE CONE CYLINDRICAL GEAR REDUCER Svetislav Lj. MARKOVIĆ, Technical College, Čačak, Serbia Danica JOSIFOVIĆ, Svetislav JOVIČIĆ, University of Kragujevac, Faculty of Mechanical Engineering, Kragujevac, Serbia Mitar MILOŠEVIĆ, Termoelektrana Gacko, Republic Srpska, Bosnia and Herzegovina	437
6.13.	PIC MICROCONTROLLERS IN ROTATION SYSTEM CONDITION MONITORING Miloš MILOVANČEVIĆ, Jelena STEFANOVIĆ MARINOVIĆ, Vlastimir ĐOKIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	443

<b>Mechanical Systems and Components</b>
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7.1.	OPERATING EXPERIENCE WITH THE OPTIMISED CVT HYBRID DRIVELINE Bernd-Robert HÖHN, Karsten STAHL, Hermann PFLAUM, Thomas DRÄXL, Technische Universität München, Gear Research Centre (FZG), Garching, Germany	447
7.2.	TRANSMISSIONS FOR AVIATION – PRODUCTS WITH SPECIAL TRIBOLOGICAL REQUIREMENTS Michael WEIGAND, Vienna University of Technology, Institute for Engineering Design and Logistics Engineering, Vienna, Austria	453
7.3.	EFFICIENCY MODELS OF WIND TURBINES GEARBOXES WITH HYDROSTATIC CVT Carlo GORLA, Paolo CESANA, Politecnico di Milano, Department of Mechanical Engineering, Milano, Italia	461
7.4.	PROPOSAL OF ASSESSMENT METHOD FOR THE CONCEPTUAL DESIGN OF UNIVERSAL HELICAL GEAR REDUCERS Milan RACKOV, Siniša KUZMANOVIĆ, University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia	469
7.5.	SPECIALLY SHAPED SPUR GEARS A STEP TOWARDS USE IN MINIATURE MECHATRONIC APPLICATIONS Gorazd HLEBANJA, University of Ljubljana, Faculty of Mechanical Engineering, Ljubljana, Slovenia	475
7.6.	NUMERICAL MODELING OF SPUR GEAR FRICTIONAL HEAT Janko D. JOVANOVIĆ, Radoš B. BULATOVIĆ, University of Montenegro, Faculty of Mechanical Engineering, Podgorica, Montenegro	481
7.7.	PREDICTION OF THIN-RIM GEARS BENDING FATIGUE CRACK INITIATION LIFE Milan OPALIĆ, Krešimir VUČKOVIĆ, Dragan ŽEŽELJ, University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Zagreb, Croatia Stjepan RISOVIĆ, University of Zagreb, Forestry Faculty, Zagreb, Croatia	487
7.8.	THE EFFECT OF CYLINDRIC EVOLVING GEARS PROFILE DISPLACEMENT ON POWER TRANSMISSION Aleksandar MARIĆ, University “UNION” of Belgrade, Faculty of Business & Industrial, Management, Kruševac, Serbia Dragoljub ŠEVIĆ, University of Novi Sad, Faculty of Engineering, Novi Sad, Serbia Ljubodrag ĐORĐEVIĆ, High school for Mechanical Engineering, Trstenik, Serbia	493

7.9.	GEAR CONTINUOUSLY VARIABLE TRANSMISSION OF WINDTURBINE Konstantin IVANOV, Almas DINASSYLOV, Almaty University of Power Engineering and Telecommunications, Faculty of Information Technology, Almaty, Kazakhstan Elena YAROSLAVCEVA, Saint-Petersburg University of Technology and Design, Information Faculty, St. Petersburg, Russia	499
7.10.	LOADED TOOTH CONTACT ANALYSIS IN FACE-HOBBED SPIRAL BEVEL GEARS Vilmos SIMON, Budapest University of Technology, Faculty of Mechanical Engineering, Budapest, Hungary	507
7.11.	ON THE INFLUENCE OF GEOMETRY OVER THE TRANSVERSE LOAD FACTOR FOR BENDING STRESS OF THE STRAIGHT BEVEL GEARS APPLIED TO A PV TRACKING SYSTEM Gheorghe MOLDOVEAN, Radu VELICU, Bianca R. BUTUC, Transilvania University of Brasov, Faculty of Product Design and Environment, Brasov, Romania	515
7.12.	NOMINAL MASS CRITERIA FOR MANIPULATOR OPTIMIZATION OF MOBILE MACHINES Dragoslav JANOŠEVIĆ, Nikola PETROVIĆ, Predrag MILIĆ, Vesna NIKOLIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	521
7.13.	INFLUENCE OF THE PROFILE SHAPE OF BARREL ON WORK PROPERTIES OF SMALL ARMS Desimir JOVANOVIĆ, Zastava arms, Kragujevac, Serbia Milomir ČUPOVIĆ, State University of Novi Pazar, Novi Pazar, Serbia Bogdan NEDIĆ, University of Kragujevac, Faculty of Mechanical Engineering, Kragujevac, Serbia	525
7.14.	AN APPLICATION OF OPTIMAL SOLUTION CHOOSING METHODS IN PLANETARY GEAR TRANSMISSION OPTIMIZATION Jelena STEFANOVIĆ-MARINOVIĆ, Miloš MILOVANCEVIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	529
7.15.	EFFECT OF EXTERNAL LOADS AT THE OUTPUT SHAFT END OF UNIVERSAL WORM GEAR REDUCER ON ITS THERMAL CAPACITY Branimir BARIŠIĆ, University of Rijeka, Faculty of Engineering, Rijeka, Croatia Siniša KUZMANOVIĆ, Milan RACKOV, University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia	535
7.16.	FEM UNTERSUCHUNGEN DER VERSCHLEIß UND TRAGBILD DER SCHRAUBRADGETRIEBE Wolfgang PREDKI, Ruhr University, Bochum, Germany Aleksandar MILTENOVIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia	541
7.17.	CONTRIBUTIONS TO THE STRUCTURAL SYNTHESIS OF THE DOUBLE HARMONIC TRANSMISSION Sava IANICI, Draghița IANICI, Liviu COMAN, Eftimie Murgu University of Reșița, Faculty of Engineering, Reșița, România	549
7.18.	STRESS AND STRAIN STATE OF SINGLE – STAGE CYCLOIDAL SPEED REDUCER Mirko BLAGOJEVIĆ, Nenad MARJANOVIĆ, Zorica ĐORĐEVIĆ, Blaža STOJANOVIĆ, University of Kragujevac, Faculty of Mechanical Engineering, Kragujevac, Serbia	553
7.19.	INFLUENCE OF TORQUE VARIATION ON TIMING BELT DRIVE'S LOAD DISTRIBUTION Ivan MILANOVIĆ, Blaža STOJANOVIĆ, Mirko BLAGOJEVIĆ, Nenad MARJANOVIĆ, University of Kragujevac, Faculty of Mechanical Engineering, Kragujevac, Serbia	559
7.20.	GRENZDREHZAHLERMITTLUNG AN AXIAL-SCHRÄGKUGELLAGER FÜR GEWINDETREIBE Vladislav KRSTIĆ, Umka, Serbia Aleksandar MILTENOVIĆ, Milan BANIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia Đorđe MILTENOVIĆ, Textile College of Leskovac, Leskovac, Serbia	563
7.21.	DETERMINING AND ANALYSIS OF THE CHARACTERISTIC MOMENTS OF AXIAL BALL-BEARING Branko PEJOVIĆ, Faculty of Technology, Zvornik, Republic of Srpska, Bosnia and Herzegovina Ljubica LAZIĆ VULIĆEVIĆ, Cvijan ŽEPINIĆ, Technical College in Zrenjanin, Serbia	569
7.22.	DETERMINATION OF OPTIMAL WAY FOR THE DIAGONAL SIEVES JOINING Nada BOJIĆ, Fabrika sita i ležaja "FASIL" A.D., Arilje, Serbia Zvonimir JUGOVIĆ, Technical Faculty, Čačak, Serbia Ružica NIKOLIĆ, Vukić LAZIĆ, Rajko ČUKIĆ, University of Kragujevac, Faculty of Mechanical Engineering, Kragujevac, Serbia	573



- 7.23. UNIVERSAL EXTENDABLE SEMI-LOW BED TRAILER FOR TRANSPORTATION OF ROAD MACHINERY 579  
 Grzegorz KOSZALKA, Andrzej NIEWCZAS, Hubert DĘBSKI, Lublin University of Technology, Mechanical Engineering Faculty, Lublin, Poland  
 Mariusz GOLEC, Maciej KACZOR, Leszek TARATUTA, Wielton, Wieluń, Poland

### Poster presentations

- 8.1. SERVICE ORIENTED METHODOLOGY FOR REDESIGN BUSINESS PROCESS MANAGEMENT SYSTEM 585  
 Branislav JEVIĆ, Danilo OKLOBDŽIJA, Branislav BOGDANOVIĆ, Vladimir MLADENOVIĆ, Business school of professional studies – Blace, Serbia
- 8.2. THE INFLUENCE OF THE EDUCATIONAL ROBOT LEGO® MINDSTORMS® NXT APPLIANCE IN TEACHING PRACTICE ON THE FUTURE PROFESSIONAL ORIENTATION OF THE HIGH SCHOOL STUDENTS 589  
 Snežana MIJALOVIĆ, Gimnazija “Takovski ustanak”, Gornji Milanovac, Serbia
- 8.3. DEVELOPMENT OF INFORMATION SYSTEMS IN THE DATABASE FIREBIRD 593  
 Muzafer SARAČEVIĆ, Hamza KAMBEROVIĆ, University of Niš, Faculty of Science and Mathematics, Niš, Serbia  
 Sead MAŠOVIĆ, Zoran LONČAREVIĆ, University of Belgrade, Faculty of Organizational Sciences, Belgrade, Serbia  
 Esad MEĐEDOVIĆ, University of Kragujevac, Technical Faculty Čačak, Čačak, Serbia
- 8.4. REASONS FOR SOME TROUBLES OCCURRING IN URBAN RAILWAY 599  
 Maia IVANOVA, Yanitsa IVANOVA, Todor Kableshkov Higher School of Transport, Transport Building Faculty, Sofia, Bulgaria
- 8.5. FE MODELING OF SHEET STEEL SPECIMEN UNDER BIAXIAL LOADING 603  
 Nikola NIKOLOV, Ana YANAKIEVA, Dessislava PASHKOULEVA, Bulgarian Academy of Sciences, Institute of Mechanics, Sofia, Bulgaria
- 8.6. ACCELERATION OF INTRODUCTION – IS AN IMPORTANT FACTOR OF THE PROCESS OF SURFACES FORMATION BY MEANS OF BENDING 611  
 Dmitry BABICHEV, Tyumen State Oil and Gas University, Institute of Transport, Tyumen, Russian Federation
- 8.7. IDENTIFY SOURCE VIBRATION AND NOISE OF DISC BRAKE 619  
 Huynh Le Hong THAI, Němeček PAVEL, Phan Thanh NHAN, Technical University of Liberec, Mechanical Engineering Faculty, Liberec 1, Czech Republic
- 8.8. QUALITATIVE INDEXES OF FLAT ENGAGEMENTS OPERATION 623  
 Denis BABICHEV, Anatoly SEREBRENNIKOV, Dmitry BABICHEV, Tyumen State Oil and Gas University, Institute of Transport, Tyumen, Russian Federation
- 8.9. CONTRIBUTION TO CREATION OF KINEMATICS PAIRS MODELS FOR WORKPIECE CLAMPING 631  
 Jarmila ORAVCOVÁ, Eva RIEČIČAROVÁ, Peter KOŠŤÁL, Faculty of Material Science and Technology, Slovak University Of Technology, Trnava, Slovakia
- 8.10. DEVELOPMENT OF SYSTEM FOR EXPLOITATION OF HYDRO-GEOTHERMAL RESOURCES OF THERMO MINERAL WATER OF THE NISKA BANJA MUNICIPALITY 633  
 Dušan MARKOVIĆ, Gordana STEFANOVIĆ, Mladen TOMIĆ, Jelena MILISAVLJEVIĆ, Petar ĐEKIĆ, Goran VUCKOVIĆ, University of Niš, Mechanical Engineering Faculty, Niš, Serbia
- 8.11. SYNTHESIS OF PLANAR LINKAGE MECHANISMS WITH INTERNAL BONDS THROUGH FOLLOWER 639  
 Amandyk Kuatovich TULESHOV, National engineering academy of the Republic of Kazakhstan, Almaty, Kazakhstan  
 Yurii Mihailovich DRAKUNOV, Al-Farabi Kazakh National University, Almaty, Kazakhstan

### Index of Authors





THE 7<sup>TH</sup> INTERNATIONAL CONFERENCE RESEARCH AND DEVELOPMENT OF MECHANICAL ELEMENTS AND SYSTEMS

**A STUDY ON WORK OF DISLOCATED TEAMS: VIRTUAL PROJECT REALISATION**

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**Abstract:** *Modern age requires several improvements in realizations of a project: interdisciplinary teams, moveability, ductility, high adaptation and tolerance of team members, sustainability of a project and, more important, results of a project and fast information flow between team members.*

*In most cases, today's projects are realized in several cities, states, continents – team members have never met in person before, they have never exchanged opinions face – to – face but, still, they manage to fulfil demands of their superiors and create a product. They work on a virtual project realization but they develop a real product. Difficulties, conflicts, challenge – teams need to find optimal solutions for all of them. aLeP project, a cooperation project between several niversities from different countries gives significant material for analysis and improvements of dislocated team's work.*

**Key words:** *Virtual Team, Virtual Project, Dislocated Teams*

## 1. INTRODUCTION

Modern age has delivered numerous advances to the society and mankind: technology, education, knowledge, but it seems that the most important one is information and extraordinary speed of information distribution. Nowadays information travel duration, from North to South or from East to West of our planet, is measured in minutes (or even seconds). This speed and information flow has influenced our mankind: everything we want to know and learn is relatively easy to find.

One of the socio-results of such an improvement is laziness – it is in human nature to be lazy, to use all the comfort and to neglect the fact that some other (human, animal, machine, nature) has to work hard for the comfort that humans use. But, laziness is a fact that has to be left behind for a moment. Engineers are humans that work hard to develop something new, innovative, useful, something that will help other humans to work less and be more progressive and satisfied. Unfortunately, information flow has delivered to them tremendous issue: since information travel fast, humans easily adopt new designs, new products and it is harder and harder to create a new product that completely fulfils “global standards” (delivered by market, for example), stays low – cost and eco – free. Triangle “price, value and eco-influence” is always an issue of greatest kind.

Solutions are various: from complete changes of products/habits to modes or minimal adjustments of the existing. An example might be “selling use instead of product approach” [1]: preserve resources, reduce costs and provide needed service.

Like always, economists and mangers react first recognizing the financial costs of information flow, recognizing how easily money can be re-directed in a product development process, they organize virtual teams – persons scattered around the Globe working on the same problem (or same problems of a problem), responding only to the one centre/person.

## 2. VIRTUAL TEAM

Definition of a virtual team is quite simple: “A virtual team (a geographically dispersed team or GDT) is a group of individuals who work across time, space and organizational boundaries with links strengthened by webs of communication technology”. A bit specified definition defines a virtual team as “groups of geographically, organizationally and/or time dispersed workers brought together by information and telecommunication technologies to accomplish one or more organizational or other tasks” [4].

There are several different types of virtual teams, but engineers are mostly involved in *project development teams*. Project development teams are mainly focused on creating new products, information systems or organizational processes for users and/or customers. These teams have the added ability to make decisions rather than just make recommendations. Project development teams may also add or remove members of their team at any given of time, as needed for their area of expertise.

The necessity for teamwork in product development is generally accepted because of the size and complexity of most design projects, design which are usually accomplished by teams, rather than by individuals. The

results of teamwork depend on qualified team members, well-structured development processes, design methods as a support to the process. Working in teams requires style of problem-solving of every team member's. Task processes are the different functions that happen when a team is doing its work. Communication is one of the most crucial things in virtual teams. It starts from selecting excellent communicators for the team members and the right technology for them to use. Some empirically found challenges in successful communication in virtual teams are failure to communicate due to wrong or lacking contextual information, unevenly distributed information, interpretation of the meaning of silence and technical problems. Because of the lack of face-to-face time, the team can miss nonverbal communication altogether. The extensive reliance on communication technology leads to reduced impact and difficulties in management compared to the traditional teams. Predictability and feedback also frequently improve communication effectiveness, creating trust and better team performance. In addition, in one study researchers tested the question of whether adding video to electronic communication helps in explaining a detailed task to another person. They found that for native speaker pairs it did not bring any additional benefits, but for non-native speaker pairs it brought significant improvement to the task.

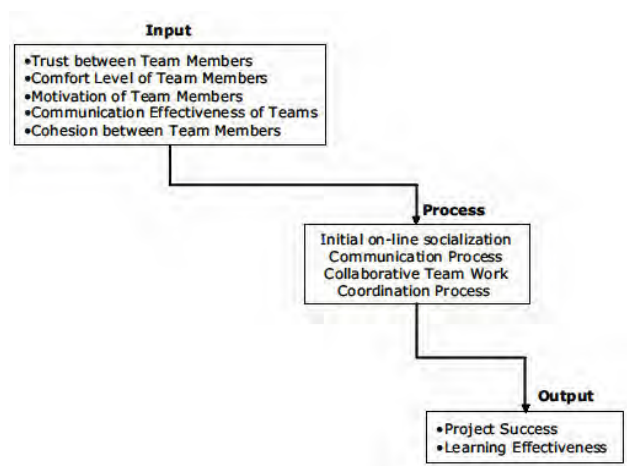


Figure 1 An example of research model

It is, naturally, more difficult to coordinate virtual teams in different time zones, cultures and mental models. Collaboration norms have to develop for the team to function well. As mentioned, periodical face-to-face meetings are a good way to form relationships and also a good vehicle to coordinate activities and to drive the project forward. When face-to-face meetings are not feasible, one alternative is to develop coordination protocols with communication training.

### 2.1. Virtual team advantages disadvantages and challenges

Virtual teams are a great way to enable teamwork in situations where people are not sitting in the same physical office at the same time.

Virtual teams are governed essentially by the same fundamental principles as traditional teams. Yet, there is

one critical difference. This difference is the way in which the team members communicate. Instead of using the full spectrum and dynamics of in-office face-to-face exchange, they now rely on special communication channels enabled by modern technologies, such as e-mails, faxes, phone calls and teleconferences, virtual meetings, and alike.

Due to more limited communication channels, the success and effectiveness of virtual teams is much more sensitive to the type of project the group works on, what people are selected, and how the team is managed.

Not every type of project is suitable for a virtual organization. One challenging case is projects that rely heavily on sequential or integrated work, as often the case in manufacturing. In particular, when each person's work depends much on what someone else is doing at the same moment, there is an ongoing heavy exchange of information in real time, and/or the tasks have to go through a strict sequence of workers within a short time.

Not everyone can perform well in a virtual team environment. The members should be self motivated and able to work independently. They need to be able to keep working effectively without much of external control or structure. The next important quality is strong result-orientation. Unless the person shows clear results, there is nobody around to see how intense his or her work activities are. Another critical factor is communication skills. The team member should be able to communicate clearly, constructively, and positively even through the more limited channels of technology, in spite of the loss of many nonverbal cues of face-to-face communications.

Managers of virtual teams also need to pay much more attention to maintaining clear goals, performance standards, and communication rules. People have varying assumptions on what to expect from each other. To avoid build-ups of misunderstandings, in a virtual organization it is critical to replace those implicit assumptions with clear rules and protocols that everyone understands and agrees upon, especially for communication.

One of the biggest challenges of virtual teams is building and maintaining trust between the team members. Trust is critical for unblocking communication between members and sustaining motivation of each person involved. The issue of trust needs special attention at any stage of team existence.

At the end it is necessary to point advantages ( + ) and disadvantages ( - ) of virtual teams:

- + *Increased productivity*: Virtual teams often see an increase in productivity because more personal flexibility is achieved, commute time is reduced, and work is not limited by the traditional 9-5 work day schedule. In turn, the company never sees an off hour. The team on the other side of the globe simply picks up where the prior team left off. This approach is commonly referred to as "Follow the Sun Approach". This advantage can translate to a much faster time to market for new products and technology.
- + *Extended market opportunity*: This is a major benefit of geographically dispersed teams due to direct access to different market opportunities. With work teams located in different parts of the globe, organizations are able to establish their presence with customers worldwide. This also gives small business owners the

ability to compete on a global scale as well without being limited to a particular customer base.

- + *knowledge transfer*: This is one of the most important benefits of a virtual team utilizing people with different types of knowledge spread out across the globe can be very beneficial to any organization. Online meetings, remote computer access, wireless technology, and conferencing systems offer a way for participants to join a complex discussion from anywhere in the world. This benefit can enable most companies to compete on a global scale.
- *Communication deficiency*: The biggest disadvantage that any virtual team can suffer from is the lack of efficiency in communication, partly due to constraints in virtual communication mediums. This is also primarily due to the fact that humans communicate better when they are able to communicate with their body language. Inevitably, virtual teams may face obstacles due to restrictions of the Internet which in turn may lead to incorrect assumptions if a message is not laid out clearly. Failure to properly communicate and clearly address messages or emails could lead to frustration and eventually failure.
- *Poor leadership and management*: Poor leadership can result in the failure of any team, whether virtual or not however, it becomes much more prominent problem in virtual teams. Messages must be sent across accurately and clearly. Inability to effectively communicate to members of the team can all greatly affect a project.
- *Incompetent team members*: Virtual teams should only consist of competent and experienced team members due to the distance factor which can overtly affect the timing and completion date of a project. Projects are more likely to fail if the team consists of individuals who are lazy or lack sufficient knowledge to complete their assigned tasks. It only takes one incompetent team member to have a negative effect on the rest of the team.

### 3. Virtual project realization

Organized by the University of Karlsruhe, Germany, University of Niš, Faculty of Mechanical Engineering has joined the project based on KaLeP education model. KaLeP is a general concept oriented to a real product development process in industry based on construction theory in education, created to improve developing engineer's competence in product development [4].

KaLeP method (Fig.2.) goal is to inform participants in complex product development environment (who are currently in the education process), about the aspects of a real working environment and teaches them the best possible basis for complex challenges development in further professional career. Also, the mentioned model is enabling work on concrete project's tasks, in working conditions which are very similar to real requirements of industry.

Details about the project must remain unknown due to privacy agreement, but KaLeP project realization gives excellent data for analysis of virtual teams and virtual project realization.



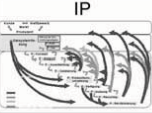
	Systems	Methods	Processes
Education	MKL 	PE 	IP 
Key qualification	high	medium	extreme high
Key qualification content	<ul style="list-style-type: none"> <li>• Team work</li> <li>• Self organization</li> <li>• Communication</li> <li>• Elaboration potential</li> </ul>	<ul style="list-style-type: none"> <li>• methodological skills</li> <li>• Creativity techniques</li> </ul>	<ul style="list-style-type: none"> <li>• Team leading</li> <li>• Team development</li> <li>• Project management</li> <li>• Presentation techniques</li> </ul>
Number	800 students	400 students	30 students

Figure 2. Elements of aLeP model: systems, methods, processes

In order to reach an innovative idea for human resource management in process of product development and to make improvement in evaluation of engineer profile competences (as team members), a real experiment had placed in the base of joint project of collaboration between Mechanical faculty in Niš (Serbia) and Mechanical faculty in Karlsruhe (Germany). That project included 4 teams, 2 from Serbia and 2 from Germany, a combination of unique-culture teams with cross-culture cooperation, with common aim – development of a new product for German's industry demands. That fact was specific for this project. The manner of target realization was a unique, education model KaLeP.

Both Universities have organized teams of students (in groups, 5 to 10 students per group). An assignment for students was unique: multi-disciplinary analysis of a complex problem, solution searching and decision making, with prototyping a selected solution and proof of functionality. UNIK and UNIN teams had coordinators from their Universities and they had to coordinate only with them, while coordinators had to communicate with project managers from UNIK.

This experiment was the first time that two different faculties have been involved in. Also, KaLeP model was an aim of knowledge transfer between Mechanical faculties Karlsruhe and Niš. In that circumstances, in order to control and monitor project, it was necessary to set the same limited conditions for realization. That was also challenge and that was base for comparison of project results.

Basic education plans and programs on these faculties are very different, so basic students knowledge was very different, as their background in whole. This unique cooperation is maintained by coordination during project, at the start of the project until first turning point. Also, goal was not only education and gaining experience through work in virtual teams, but development task based on KaLeP method, in two different working and living conditions, and the output of this process is a working prototype for industry needs

### 3.1. Motivation of teams and team members

Results of analyses during project period are: Reasons for applying and activation of students from Karlsruhe on this project were:

- Gaining practical experience in work

- Participation in team work problem solving,
- Finding place in a team,
- New product development,
- Application of theoretical knowledge in real working conditions.

Reasons for applying for KaLeP project for students from Niš were the same as listed, but there were some reasons that are important but different from reasons of German students:

- Possibility of comparing strengths with colleagues from different country (specially Germany), meaning competition and proving
- Possibility to visit one of the most developed countries of Europe and see everything that most people did not have chance to see, meaning motivation came from possibility to travel and see new which is not accessible in every day life.

Also, UNIN teams were fully motivated at the beginning of the project realisation – students had no previous experience in serious team work but they were competitive especially versus foreign teams students were near the end of their studies and they were willing to

try their skills. Huge motivation of the students was set on the fact that they might have a chance to be seen by foreign industrials.

Due to their inexperience, UNIN teams have misjudged complexity of the problem how the project timeline was going, their motivation was dramatically falling. At first some team members have felt that they might not be capable of fulfilling all the demands and they wanted to resign. Some team members were felt neglected or they felt “overbooked” in product realisation. Teams have almost fallen apart. However, there was no delay in project realisation – all “milestones” were successful. In the beginning of joint project, while UNIK team members had a vision about future work and profile orientation, UNIN team members were “down to earth oriented”.

### 3.2. Competences of team members

MBTI test, which has been used during previous years in IPD projects at Institute IPEK Karlsruhe, was made on basis of experience of utilization in other fields of interest, and adapted to Institute needs as well as needs of German education system.

#### competence-profile of the workshop in MD II (WS 2003/04)

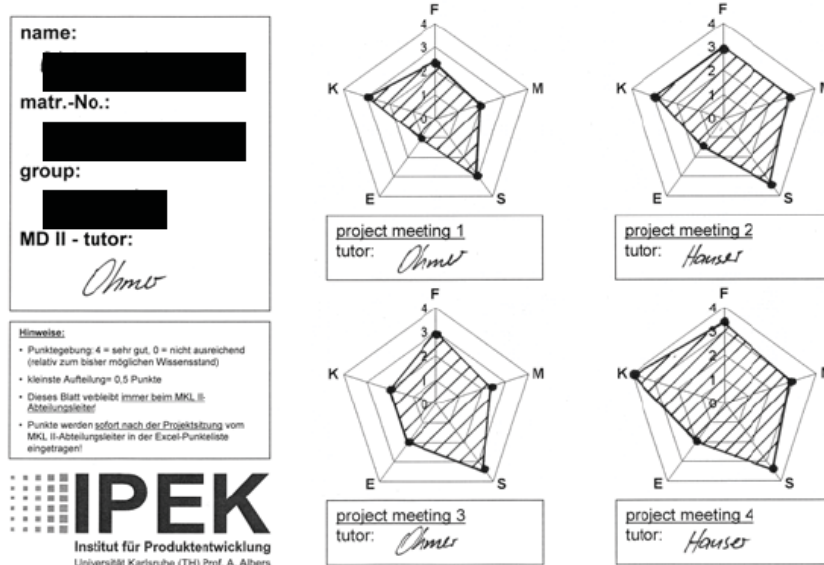


Figure 3. Competence assessment scheme (an example from the project 2003/2004 – IPEK)

This test was not applicable to students from Faculty of Mechanical Engineering in Niš, because they were not able to answer many questions. Reason for this problem is in completely different education systems in Serbia and Germany, different subjects, different field of exploration within subjects. More over, there was possibility to adjust this test to knowledge of Serbian students based on number and contents of subjects, but that was not done because of knowledge transfer and setting identical starting points for project starting and candidates (student) selection.

Also, in order to achieve project goal, but also to collect as many information as possible from this project, students had to conduct one more test, Balbin personality test. Students from Niš didn't have any problems with writing their personal data, as well as grading and

determining which team roles are suitable based on this test. Based on student's opinion, analyses of the two tests and conducted interview, it can be deduced that Balbin test has much better results than MBTI test, meaning that all project participants gave positive mark to Balbin personality test, but not to MBTI test. Based on the example of some students from Germany who participated in conducting Balbin test as well as MBTI test, and by comparing their roles in these two tests it can be concluded that results from Balbin test are much more efficient and consistent way of personality determination. UNIN had too few students to make an adequate selection of team members. After competence tests, UNIN teams had way too many “workers”, or too few “leaders”, “problem solvers” etc. Team members had to adapt and to give more than expected.

Selected team leaders were strong persons with abilities to coordinate and motivate team members. This was fully seen at the end of project realisation, when, after severe failures (caused by many external and internal factors) they have managed to provide sufficient material for developing functional prototypes of products.

### 3.3. Cultural differences between team members

Review of relationship between the students from Germany and the coordinator of the project and the students from Serbia, and according their interest to be a part of investigation which has performed through project is like this:

- Surprise from the project start was minimized after time, and that was a fact only. German students' mentality is specific it is very difficult to detect any kind of emotions. From their side, it was adopted a fact that they will do with students from different country on same task, which roused their interest and fighting spirit.
- Students didn't know each other before project start, and that fact is not important. They were working like team, without any enter of emotions inside of team. From their aspect, it is better that team members are not friends.
- Their experience before start of project has given a much better base for work, from viewpoint of possibilities for future development, knowledge acquirement and progress. The most of them had work experience through student's practice, student's interchange, even with different countries, which gives possibilities for higher level of foreign language knowledge and usage (not only English language, other languages from Europe also).
- Before the first presentation, German students didn't show any interest to meet their colleagues from Niš. But, presentation "State of art" motivated their attention because they noticed a hard work and high level of care from side of students from Niš. They noticed that including notable professors and scientists from defined field in joint work, it was very essential for project progress.
- After establishing first mutual contact, on coordinator's initiative, they realised necessity of information exchange and usage of different resources, which could be accessible to anyone by information server, in order to avoid time loss for finding information, to avoid danger that results (outcomes from project) could be identical or similar in both sides.
- Students, team members from Germany, showed a good mood for testing, which was performed during the project, what was different from the will of their assistants. Assistants, students managers, didn't want to cooperate in this field, they had an attitude that questionnaire is of personal nature and that students will not give any answers to questions. But, students were quite communicative, with open mind for cooperation, more flexible and ready for joint work then their assistants and managers, who had a noticeable dose of reserve and mistrust towards project participants from Serbia.

A first impression after development process was that cultural differences during process in the formal work arrangement were less visible then expected. Only obvious cultural factor which had influence on common work was verbal, language, pronunciation, which was incomprehensible for all project participants during project performing.

Generally, it looks like there are more cultural differences in informal interaction than in the formal procedure. Based on differences in language usage – it is necessary to take care of specific technical terms, gesticulation and intonation [4].

Certain interaction between team members was necessary before in order to reach a better understanding amongst them. It is a heavier and more important to place interaction between cross-culture teams, then between unique-culture teams before the project start. This could induce a problem in distributed cross-culture teams, where is heavier to realise informal interaction before the project start. Of course, few days after the project beginning, it was obvious that discussion inside unique-culture teams begins much straight, than inside cross-culture teams. There predominates a feeling that differences in created view points, in cross-culture teams, lead to the better understanding and much creative/better products. For instance, during a brainstorming training, differences of created ideas have exceeded expected variety of ideas in unique-culture teams. Probable reasons for that are differences in knowledge fields. Also, usage of foreign language are disabling a creativity because a person who is listening a foreign language should think about what has been said, then about nucleus of problem [4].

Knowledge about culture (especially in a case of target market) has notable influence on requirements which are important, and on specific focused product's characteristics (price, physical effects). It looks like the best way to ensure these demands is the understanding of the same, from the side of concrete culture. Depending on considered demands, in some occasions it will be necessary to include people from precise defined cultures in design team, in order to design a product according to specific market demands.

## 4. CONCLUSION

Generally, cultural differences could induce major time consumption in development process. According to that a phase of target clarifying could be much slow then expected. Separated from target clarifying, it looks like those next steps of planning can take much more time then in unique-culture teams. Strict defined planning could have a positive effect on efficient teamwork in whole. Withal, there need to be interesting how team performances could be more measurable, and in which phase of the process they could be a benefit or lack, and which performances affect it.

Knowledge and convention about design methods could be critical in distributed design. That leads to postulation that knowledge about design methodology could have even bigger influence on inter-culture teams and process. That postulation couldn't be approved because every team member has basic knowledge about design methodology

and they are usually oriented in the same way. That means - used methods and tools are very close to participants. This more by that – concrete joint project of cooperation has placed as a means for transfer of knowledge and model for education, where attempted to work in same way in all phases, by same techniques, tools and methods.

The next problem is in communication means. In situation when project is performed by teamwork, on one place, in unique-cultural teams, a means for drawing (for example – sketch, scheme) usually is a paper. But, if there is distributed project, paper isn't appropriate means of communication. A question about means (media) of communication in distributed teams begins to be dominant for successful and good work, and that question mustn't be ignored. This aspect of cooperation has performed crucial role in the first phases of product development, to the phase of concept choice, in the example of common IRP project Karlsruhe-Niš. All these facts are leading to general appreciation that culture influences are more powerful in distributed teams, then in other teams (which didn't distribute).

The success of project realization is a result of good team member selection, good project performing and project coordination. Students demonstrated strong motivation and achievement orientation. Their presence on the lectures was over 95 %, so in some critical phases of the project they demonstrated the behaviour that vastly exceeded demands of classical education model. Although the involvement in this project is based on a hard work, the knowledge and experience gained in this way can be directly applied in a practical work. That makes great benefit for future development engineers once they graduate.

Results of students' development project are two products that could be instantly implemented in the manufacturing program of the company that has sponsored the project. The quality of the project and the effectiveness of the students' project and new model for evaluation of development engineer's competences are proven in the best possible way.

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