University of Niš

Mechanical Engineering Faculty


# PROCEEDINGS

## The 7th INTERNATIONAL SCIENTIFIC CONFERENCE

# RESEARCH AND DEVELOPMENT OF MECHANICAL ELEMENTS AND SYSTEMS

**27th & 28th of April, 2011, Zlatibor, Serbia**

Co-organisers:

IFToMM

International Federation for the Promotion of Mechanism and Machine Science

ADEKO

Supported by:

Republic of Serbia

Ministry of Science and Technological Development

University of Niš

**MACHINES DEVELOPMENT AND CONSTRUCTION CENTRE**

Mechanical Engineering Faculty

## Associated organizations

International Federation for the Promotion of Mechanism and Machine Science - IFToMM
Asocition for Design, Elements and Constructions - ADEKO
Romanian Association of Mechanical Transmissions - ROAMET
Institute of Structural and Computational Mechanics, Berlin Institute of Technology (TU Berlin), Germany
Faculty of Technical Sciences, University of Novi Sad, Serbia
Mechanical Engineering Faculty, University of Belgrade, Serbia
Mechanical Engineering Faculty, University of Kragujevac, Serbia
Mechanical Engineering Faculty in Kraljevo, University of Kragujevac, Serbia
School of Mechanical Engineering, Aristotle University of Thessaloniki, Greece
Faculty of Mechanical Engineering, Slovak University of Technology in Bratislava, Republic
Faculty of Engineering, University of Resita "Eftimie Murgu", Romania
Faculty of Mechanical Engineering, Budapest University of Technology and Economics, Hungary
Faculty of Mechanical Engineering, University of Maribor, Slovenia
Faculty of Mechanical Engineering, Technical University of Sofia, Bulgaria
Mechanical Engineering Faculty, University of New Sarajevo, Bosnia and Herzegovina
Mechanical Engineering Faculty, University of Montenegro, Montenegro
Faculty of Mechanical Engineering, Ss. Cyril and Methodius University in Skopje, FYROM
Technical Faculty Bitola, University St. Kliment Ohridski in Bitola, FYROM

## Patrons

MINISTRY OF EDUCATION AND SCIENCE OF REPUBLIC OF SERBIA

## Cofinaciers

ELECTRIC POWER INDUSTRY OF SERBIA
DRINA-LIM HYDROPOWER PLANTS
GROUP ZASTAVA VEHICLES

## Scientific board

Prof. Dr.-Ing. Dr. hc. Albert Albers, Karlsruhe Institute of Technology, Germany
Prof. Dr.-Ing. Bernd-Robert Höhn, Technical University of Munich, Germany
Prof. Dr.-Ing. Wolfgang Predki, Ruhr-University of Bochum, Germany
Prof. Dr.-Ing. habil. Manfred Zehn, Berlin Institute of Technology (TU Berlin), Germany
Dr. Sc. Prof. Veniamin Goldfarb, Izhevsk State Technical University, Russia
Dr.-Eng. Sergey A. Lagutin, Elektrostal Heavy Engineering Work, Russia
Prof. Dr. Eng. José Ignacio Pedrero, Uned Madrid, Spain
Prof. Katsumi Inoue, Tohoku University, Japan
Prof. Ing. Carlo Gorla, Politechnico Di Milano, Italy
Dr. Eng. Alex Kapelevich, AKGears, USA
Prof. Dr.-Ing. Michael Weigand, Vienna University of Technology, Austria
Prof. Dr.-Ing. Datong Qin, Chongqing University, China
Prof. Athanassios Mihailidis, Aristotle University of Thessaloniki, Greece
Prof. Dr.-Ing. Vilmoš Simon, Budapest University of Technology and Economics, Hungary
Prof. Dr.-Ing. Lajos Fazekas, University of Debrecen, Hungary
Prof. Dr.-Ing. Jože Flašker, University of Maribor, Slovenia
Prof. Dr. Sc. (Eng.) Victor Strazhinsky, National Academy of Belarus, Belarus

Prof. Dr.-Ing. Konstantin Ivanov, Kazakh Technical University, Kazakhstan
Prof. Dr.-Ing. George Dobre, University Politehnica of Bucharest, Romania
Prof. Dr.-Ing. Sava Ianici, University of Resita "Eftimie Murgu", Romania
Prof. Dr.-Ing. Imre Kiss, University Politehnica Timisoara, Romania
Prof. Dr.-Ing. Miroslav Vereš, Slovak University of Technology in Bratislava, Slovakia
Prof. Dr.-Ing. Stanislaw Legutko, Poznan University of Technology, Poland
Prof. Dr.-Ing. Ljubomir Dimitrov, Technical University of Sofia, Bulgaria
Prof. Dr.-Ing. Branimir Barišić, University of Rijeka, Croatia
Prof. Dr.-Ing. Milan Opalić, University of Zagreb, Croatia
Prof. Dr.-Ing. Petar Simonovski, Ss. Cyril and Methodius University in Skopje, FYROM
Prof. Dr.-Ing. Tale Geramitcioski, University St. Kliment Ohridski in Bitola, FYROM
Prof. Dr.-Ing. Radoš Bulatović, University of Montenegro, Montenegro
Doc. Dr.-Ing. Milosav Đurđević, University of Banja Luka, Bosnia and Herzegovina
Doc. Dr.-Ing. Biljana Marković, University of New Sarajevo, Bosnia and Herzegovina
Prof. Dr.-Ing. Siniša Kuzmanović, University of Novi Sad, Serbia
Prof. Dr.-Ing. Radivoje Mitrović, University of Belgrade, Serbia
Prof. Dr.-Ing. Milosav Ognjanović, University of Belgrade, Serbia
Prof. Dr.-Ing. Nenad Marjanović, University of Kragujevac, Serbia
Prof. Dr.-Ing. Dragan Milčić, University of Niš, Serbia

## Organisation board

Prof. Dr.-Ing. Vojislav Miltenović, president
Prof. Dr.-Ing. Vlastimir Nikolić, Dean of Mechanical Engineering Faculty, University of Niš
Prof. Dr.-Ing. Vlastimir Đokić, Vice-Rector of University of Niš
Dipl.-Ing. Đorđi Biljanovski, TENT Kolubara
Mr.-Ing. Ljubiša Janković†, Group Zastava vehicles
Prof. Dr.-Ing. Dušan Stamenković
Prof. Dr.-Ing. Nenad T. Pavlović
Doc. Dr.-Ing. Boban Anđelković;
Doc. Dr.-Ing. Jelena Stefanović-Marinović
Doc. Dr.-Ing. Miloš Milošević
Mr.-Ing. Miodrag Velimirović
Mr.-Ing. Aleksandar Miltenović
Mr.-Ing. Miloš Milovančević
Dipl.-Ing. Milan Banić
Dipl.-Ing. Miroslav Mijajlović
Dipl.-Ing. Jelena Milisavljević
Dipl.-Ing. Dejan Ranđelović

Publisher

Mechanical Engineering Faculty Niš
Prof. Dr.-Ing. Vlastimir Nikolić, dean

Editor

Prof. Dr.-Ing. Vojislav Miltenović

Reviewers
Prof. Dr.-Ing. Vojislav Miltenović
Prof. Dr.-Ing. Siniša Kuzmanović
Prof. Dr.-Ing. Radivoje Mitrović

Technical preparation
Dipl.-Ing. Milan Banić
Mr.-Ing. Aleksandar Miltenović
Dipl.-Ing. Jelena Milisavljević
Dipl.-Ing. Dejan Ranđelović

Cover design

Tatjana Miltenović

Number of copies

180

Printing

SVEN, Niš

ISBN 978-86-6055-012-7

CIP – Каталогизација у публикацији
Народна библиотека Србије, Београд

621.01(082)

INTERNATIONAL Scientific Conference Research and Development of Mechanical Elements and Systems (7 ; 2011 ; Zlatibor)
Proceedings = The 7th International Scientific Conference Research and Development of Mechanical Elements and Systems - IRMES 2011, 27th & 28th of April, 2011, Zlatibor, Serbia / [editor Vojislav Miltenović]. - Beograd : Mechanical Engineering Faculty, 2011 (Niš : Sven). - 638 str. : ilustr. ; 30 cm

Tiraž 180. - Bibliografija uz svaki rad

ISBN 978-86-6055-012-7

a) Машинство - Зборници
COBISS.SR-ID 183139340

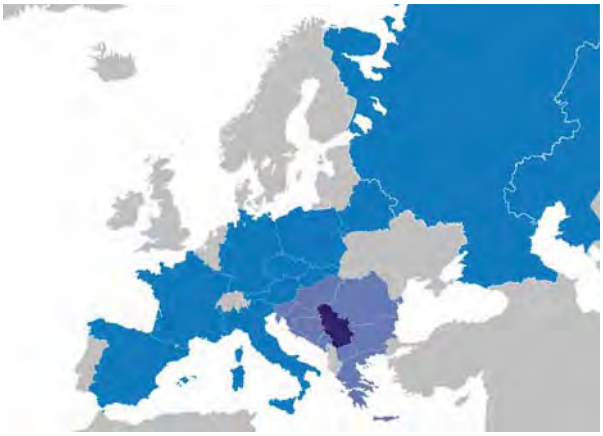

Ministry of Education and Science of the Republic of Serbia has participated in printing costs of the proceedings of the 7th International Scientific Conference Research and Development of Mechanical Elements and Systems - **IRMES 2011**

# 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 und Asia. The lectures came from Austria, Bosnia and Herzegovina, Belorus, 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



## Industrial Product Development

**Computer Aided Product Development - CAPD**

## Mechatronics and Automatic Control

## Materials, Technology and Tribology

## Vibration and Noise, Testing and Monitoring

## Mechanical Systems and Components

## Poster presentations



## Index of Authors

THE 7TH INTERNATIONAL CONFERENCE RESEARCH AND DEVELOPMENT OF MECHANICAL ELEMENTS AND SYSTEMS

# SYNERGY OF EDUCATIONAL – SCIENTIFIC INSTITUTIONS WITH SMALL AND MEDIUM ENTERPRISES IN PRODUCT DEVELOPMENT TASKS

**Dragan MILČIĆ**
**Miroslav MIJAJLOVIĆ**
**Marko RISTIĆ**
**Dalibor STEVANOVIĆ**
**Miodrag MILČIĆ**

***Abstract:*** *Virtual Product Development (VPD) is the practice of developing and prototyping products in a completely digital 2D/3D environment. VPD has four main components: virtual product design, virtual product simulation, virtual product staging, digital manufacturing. VPD typically takes place in a collaborative, web-based environment that brings together designers, customers/consumers, and value chain partners around a single source of real-time product "truth." VPD enables practitioners to arrive at the right idea more quickly, and to accurately predict its performance in both manufacturing and retail settings, ultimately minimizing time to value, market failure potential, and product development costs.*

***Key words****: Product design, Virtual Product Development, Power Transmission, CAD/CAM/CAE*

## 1. INTRODUCTION

Product design is often misunderstood as a concept. It is commonly seen, as the process of making products look aesthetically pleasing or stylish. Most product designers understand product design to mean much more than this. Product design is a multi-disciplinary process which usually involves market and technological research, concept design, prototype development, final product development and testing as well as post production refinement. Product Design is defined by Walsh et al (1992: 18) as: *"The activity in which ideas and needs are given physical form, initially as solution concepts and then as a specific configuration or arrangement of elements, materials and components".*
Rainey (2005) describes integrated product development (IPD) as "a strategy that integrates all activities from product concept through to production. IPD is a multidisciplinary management strategy that uses product teams and design tools such as modelling and simulation teams to develop products and processes to meet cost and performance objectives concurrently.
IPD involves understanding the customer's needs and managing those requirements together with,

- suppliers as partners,
- integrating product development and research and development with the business strategy and business plans,
- integrating the design of manufacturing and product support processes and managing cost from the start by effective planning,
- low-risk development and managing project scope.

Companies that are able to bring new products, that satisfy the expectations of the customer fast and efficient to the market, will manage to succeed in the intense and dynamic global environment in which it operates (Wheelwright and Clark, 1992). The US based Product Development & Management Association (PDMA) defines New Product Development as *"a disciplined and defined set of tasks and steps that describe the normal means by which a company repetitively converts embryonic ideas into saleable products or services"*
The NPD process is driven by one or more of the following three factors:
1. **Technology:** Advances in technology (either in-house or outside) provide an opportunity for the improvements to an existing product.
2. **Market:** The firm has to improve its existing product in response to:
(i) competitors' actions (such as lowering of their price or an improvement to their product) and/or,
(ii) feedback from customers through complaints about product performance.
3. **Management:** The motivation for improvement is:
(i) internal (e.g., to increase market share, or improve profits by reducing warranty cost) and,
(ii) external (e.g., new legislation with regards product performance).
The literature on NPD contains several alternative NPD process models (e.g., Wesner et al, 1995, Wind, 1982, Sounder, 1987, Pugh, 1991, Pahl and Beitz, 1988, Belliveau et al, 2002, and IEC 60300-1, 1991). It is possible to recognize the similarities between the different models. What they have in common is that the NPD process begins with an idea to build a product that meets specific needs (or create new needs for radically innovative products) defined by customers and/or the manufacturer, and ends when the product is launched on the market. This involves six phases as illustrated in Figure 1.

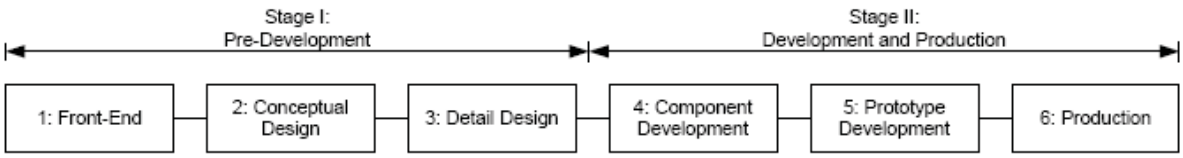



*Fig. 1: Six phases of NPD*

These six phases can be grouped into two stages (Stages I and II).

Stage I, the *predevelopment stage* consist of three first phases and is concerned with a *nonphysical* (or abstract) conceptualization of the product with increasing levels of detail.

Stage II, the *development and production stage*, consists of the next three phases and deals with the *physical* embodiment of the product resulting from the transformation of the conceptual product into a physical entity.

The high demand and competition of the market, caused by globalization and permanent technical innovation, exerts an enormous pressure on companies, especially in small and medium size enterprises (SME). These companies often do not have in their ranks enough personnel to dedicate to continuously develop new products, or to more fundamental research. For these companies, the most reasonable route to follow is to partner with an R&D institution (i.e. a University) and collaboratively develop new products. Both stand to gain from this type of collaboration. Nevertheless, this type of collaboration usually faces several barriers, namely related with communication, conceptual/abstract reasoning and time frames.

The R&D institution elements must be able to use a communication format that can be understandable by the SME's elements. The scientific terms and definitions must be adapted (or even misspelled) aiming to find a common language matrix, despite the level of engineering and/or technological skills existing in the company. Furthermore, an effort has to be made to achieve compatibility between the objectives of the researchers in the project (usually to produce thesis, papers, patents, etc.) with the SME's objectives (usually the design of competitive product/technology, the productivity increase, the better use of the resources, etc.). Also it is absolutely necessary to define early in the project the intellectual property rights of both parts. The day-by-day demands in a SME implies for a highly practical approach to solve the emerging problems and to develop the business. This behavior is also present when a SME is participating in a collaborative R&D project. There is a great pressure to find *the* solution and discuss the results of its impact. On the other hand, the research team believes that better results and a better knowledge of the process can be withdrawn if a scientific approach or method is followed. A balance must be found to merge these two concepts. It should be used a scientific approach or method that the SME can understand and be involved in. If not possible, the results of the scientific work should produce several alternatives solutions that can be analysed by the SME to support the decision process.

## 2. TOOLS AND METHODS FOR PRODUCT DEVELOPMENT

While design is a key of product development, it is subsidiary in inventing new values and functions or renovating existing ones, is related to their systematization or integration, or to organize its process. Since design is an inherent activity of mankind, discussion of frameworks and methods for improving or rationalizing design process had not been an explicit major issue in engineering. However, as the contents of artifacts, such as machines, products, have become more complicated and massive, allocation and enforcement of design knowledge and process have become unavoidable issues in manufacturing industry. Additionally, as various digital engineering tools such as CAD systems have becomes widely available under the progress of information technology, their utilization has become an important issue for enhancing product development performance.

Figure 2 roughly shows a map of tools and methods for product development over the design process and product life-cycle. While some of them originated in 1970s, others were formed in 1990s or later under the movement of concurrent engineering. The coverage of tools and methods has been gradually spread so as to support a series of phases and aspects more widely and in more integrated way. When considering that product development is an integrated activity, it should be an essentially important view not only to utilize respective ones, each of which was developed independently from the others, individually but also to systematically organize the overall process of product development by selectively utilizes ones, which are necessary and effective for a specific project, from available ones.

## 3. PRODUCT DEVELOPMENT AN THE FACULTY OF MECHANICAL ENGINEERING IN NIŠ

University of Niš, Faculty of Mechanical Engineering in Niš (UNFME) is je educational – scientific institution accredited to educate bachelor, master and doctoral students. UNFME does basic, applied and development researches in interdisciplinary areas of science.

Cooperation with SME is achieved over the Institute for Mechanical Engineering. Institute consists of several research centers:

- Centre for the applied mathematics,
- Centre for the nonlinear dynamics and active structures,
- Centre for logistics,

– Centre for machine design and product development,
– Centre for welding and welded structures and
– Centre for motors and motor vehicles.

Spectrum of competences and capabilities of UNFME are huge and local industrial complex relies on the UNFME as a knowledge Centrum in the region.

Centre for machine design and product development (CERP) is capable to develop various products from the area of power transmissions and various designing challenges. Significant amount of the knowledge in product development is priceless basis for the knowledge sharing and further expansion.

Centre is one of the foundations of novel product development concept – virtual product development applied on power transmissions.

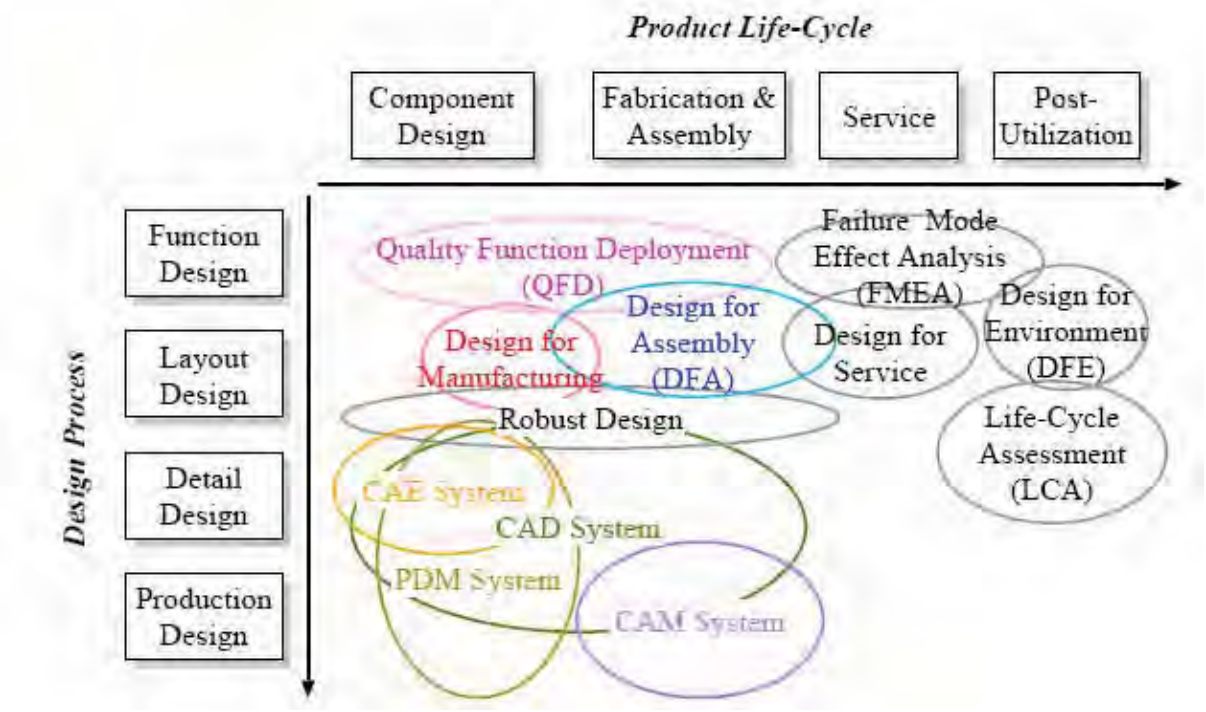



*Fig. 2: Design process and Product Life - Cycle*

## 4. VIRTUAL PRODUCT DESIGN ON EXAMPLE POWER TRANSMISSION AT FACULTY OF MECHANICAL ENGINEERING

New product development – NPD consist of 6 phases (Figure 1). Presently and a decade in the past, UNFME has numerous undergraduate / graduate subjects (Mechanical Parts, CAD, CAE, CAx, Design Theory, Industrial Design, Product Design, Systems for Design, Virtual Product Design etc.) which pay special attention on the phase no. 3 – Detailed design. Detailed design consists of:

- Product Shaping (modeling, documentation development etc.),
- Simulations and Calculations,
- Virtual Prototyping
- Computer Aided Visualization (CAV).

Product shaping is very important phase of product design process. Shaping theory is scientific discipline which studies methods and acts of parts, machine assemblies and machines shaping. Shaping tools, hardware and software for visualization of shapes by computer applications are parts of shaping theory, also.

Application of computers in product shaping process includes Computer Aided (CAx) technologies – Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), and Computer Aided Engineering (CAE). Software applications, used for shaping in this phase of design have to enable and ease:

– Static and dynamic calculations,
– Element modeling, including complex shapes and three dimensional (3D) curves or faces,
– Elements assembling into precisely defined relations and shapes,
– Application of standard elements, generated from adequate databases or part libraries (springs, bolts, bearings etc.),
– Automatic development of technical documentation as product of modeling and assembling,
– Automatic creation part lists,
– Simulation of movements and monitoring in working condition,
– CNC code generation, in order to automate manufacturing process,
– Sheet metal design support, mold base, for metals and plastics etc.,
– IGES i STEP database generation and usage in other CAD and CAM systems,
– Constructive optimization,
– Mechanism analysis,
– Analysis of experimental data derived from prototype testing,

– Marketing support – easy presentation making, realistic rendering, animation.
– Virtual product development enables high speed innovations and manufacturing, high quality products and economic production.
– Corporation's concurrence and quick accommodation to market requests require software for calculations of mechanical parts and tools which will enable easy 3D modeling and other automatisation (CAD, CAD/CAM or CAD/CAM/CAE tools).

University of Niš, Faculty of Mechanical Engineering - UNFME is working long time period on development of integrated computer program for complete design of power transmitters – Power Transmitter Design Software (PTD). Integrated program system PTD, shown in Figure 3, has three main parts:

– Program modules for power transmission element's calculation,
– Program modules for calculation of rotation elements,
– Program modules for calculations of mechanical connections.

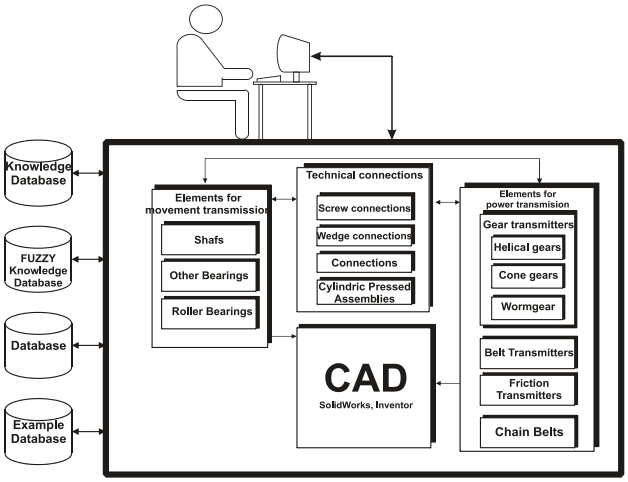



*Fig. 3: Integrated system for power transmitters design PTD*

PTD is developed by UNFME stuff and undergraduate/graduate students of UNFME and it is used for further education of engineers or students and for projects realization – product development processes.

Examples of projects realized by PTD are numerous: worm gear power transmissions, combined power transmission – worm gears and helical gears, helical gears and bevel gears, finite elements analyses – FEA, virtual prototyping, CAV etc (Figures 5 to 11). Developed product are mentioned for the students' education, as well as for the local small and medium enterprises of the Niš region.

*Fig. 4: Worm gear power transmission, variant 1*

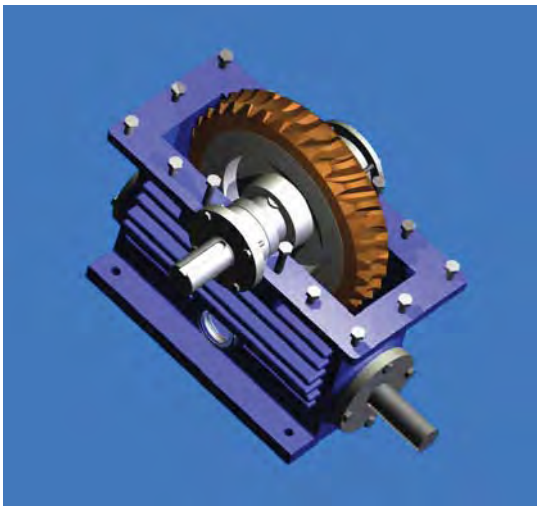


*Fig. 5: Worm gear power transmission, variant 2*

*Fig. 6: Combined power transmission - worm gear pair and bevel gear pair*

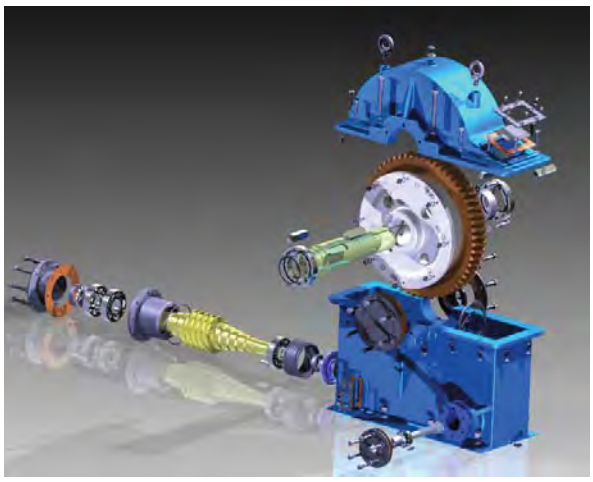


*Fig. 7: Combined power transmission - worm gear pair and bevel gear pair (exploded view)*

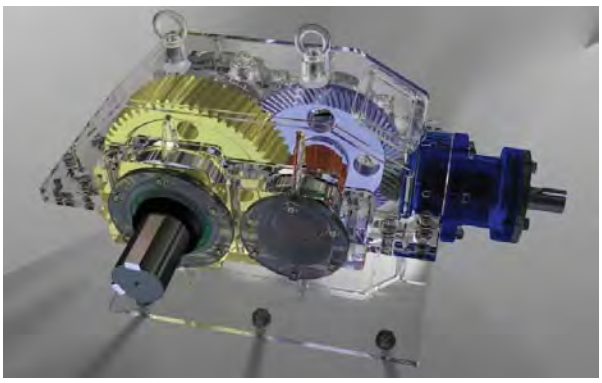


*Fig. 8: Combined power transmission - helical gear pair and bevel gear pair ("Osa računarski inženjering" Company has awarded prestige prize "Petar Damjanović" to Marko Ristić for the best graduate thesis in Product Development)*

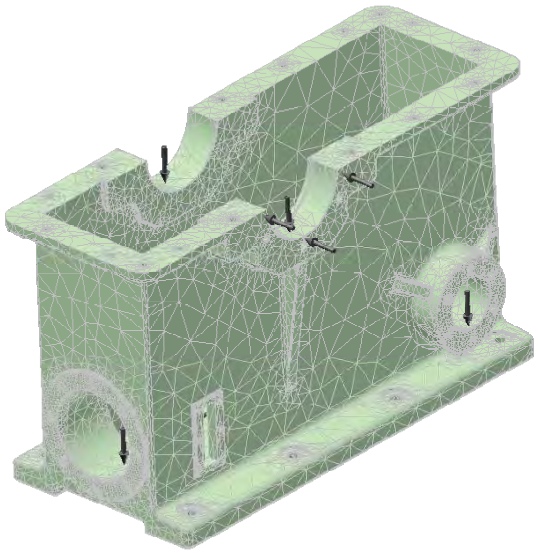


*Fig. 9: Finite elements analysis –discrete model of the power reducer's case*

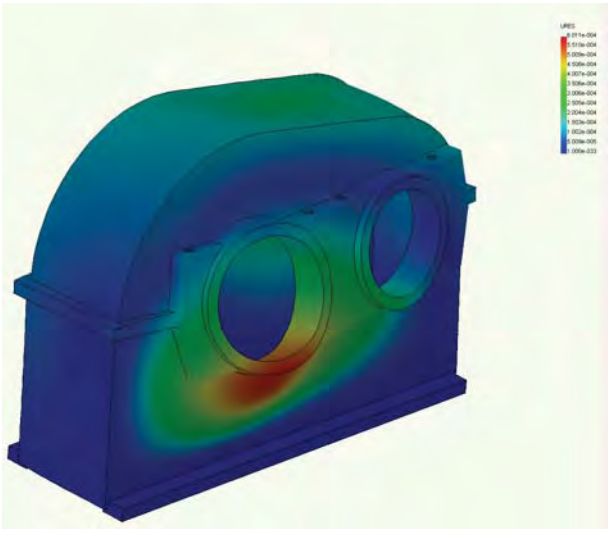


*Fig. 10: Finite elements analysis –deformations on the power reducer's case*

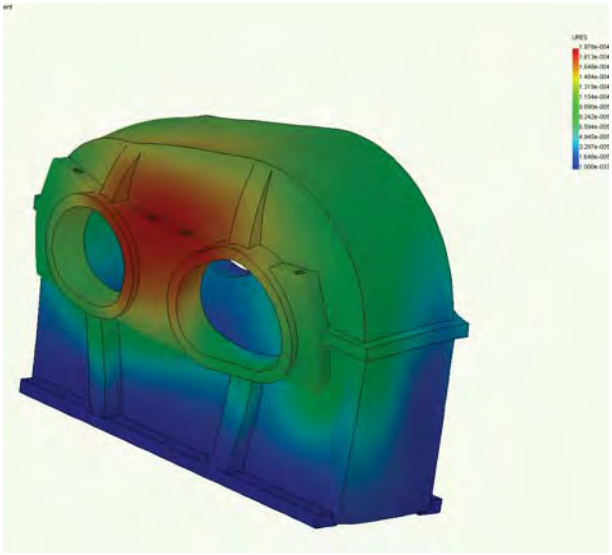


*Fig. 11: Finite elements analysis –stress distribution on the power reducer's case*

## 5. CONCLUSION

UNFME is creating an excellent bond with the small and medium enterprises in the region around the UNFME. Modern industrial age delivered new demands to the enterprises on product development:
- need for the fast product development,
- reduction of time and costs in order to stay competitive
- on the market, and
- increase of quality.

Developed systems for design at UNFME directly help these enterprises in achievement of several mentioned demands. Other demands can and are fullfield in cooperation with the staff of the UNFME at Institute and Centres for various engineering tasks. Synergy of the University, as an example of science and knowledge centre, and the industrial complex is the only possible solution for modern challenges in engineering overcoming.

## REFERENCES


[1] Miltenović, V., Milčić, D.: Intelligent integrated system for the gear power transmitters design. 4th World Congress on Gearing and Power Transmission, Paris, 16-18. mart 1999., pp.143-155.

[2] Miltenović, V., Milčić, D., Stamenković, N.: Architecture of intelligent integrated system for the gear power transmitters design. International Conference on COMPUTER INTEGRATED MANUFACTURUNG - CIM '99, Zakopane, POLAND, 9-12. mart 1999.

[3] Milčić, D., Miltenović, V.: Aplication of artifical intelligence methods in gear transmitters conceptual design. The Scientific Journal FACTA UNIVERSITATIS, Series: Mechanical Engineering Vol. 1, No 6, 1999, pp. 721-734.

[4] Milčić, D., Janošević, D., Jovanović, M.: Primena CA - tehnologija u razvoju proizvoda. IMK-14 Istraživanje i razvoj, Časopis instituta IMK "14. Oktobar" Kruševac, Godina VIII, Broj (14-15), 1-2. 2002., s. 55-60.

[5] Milčić, D.: CAx alati u procesu oblikovanja proizvoda. Zbornik radova drugog skupa o konstruisanju, oblikovanju i dizajnu KOD 2002, Novi Kneževac, 22. maj 2002., s. 25-30.

[6] Milčić, D., Marković, B., Mijajlović, M.: KONSTRUISANJE UNIVERZALNIH ZUPČASTIH PRENOSNIKA KAO VIRTUELNI PROCES, Zbornik radova devetog SEVER-ovog simpozijuma o mehaničkim prenosnicima, Subotica, 10.oktobar 2003., str. 23-28.

[7] Janošević, D., Milčić, D.: Virtualni razvoj proizvoda, VIII Međunarodna konferencija fleksibilne tehnologije, Novi Sad, 2003, str.89-90.

[8] Milčić, D.: Virtuelno konstruisanje, Seminar CAD/CAE '04 "RAČUNAROM PODRŽANO KONSTRUISANJE", 11. februar 2004., Niš, CD.

[9] Milčić, D., Mijajlović, M.: Parametarsko modeliranje delova zupčastog prenosnika snage, Treći skup o konstruisanju, oblikovanju i dizajnu 3. KOD 2004, 19.5.2004., Novi Sad, str. 67-72.

[10] Milčić, D., Živković, D.: Konstruisanje kao virtuelni proces, Zbornik radova sa naučno-stručnog skupa IRMES '04, Kragujevac, 2004, str. 123-128.

[11] Milčić, D., Miltenović, V.: Design of Gear Drives as Virtual Process, The International Conference on Gears 2005, September 14th to 16th, 2005, Garching near Munich, Germany, VDI-Berichte Nr. 1904, 2005, s.399-415.

[12] D., Milčić, Mijajlović, M.: Parametarsko modeliranje elemenata. 4. Simpozijum sa međunarodnim učešćem „Konstruisanje, oblikovanje i dizajn", Palić, 30-31. maj 2006., s. 41-44.

[13] Milčić, D., Anđelković, B., Mijajlović, M.: Automatisation of power transmitter's design process within ZPS system, Machine design, The editor of the monograph prof. phd. Siniša Kuzmanović, On the occasion of the 48th anniversary of the Faculty of Technical Sciences, Novi Sad, 2008., pp 1-8.

[14] Milčić, D.: Integrisani programski sistem za konstruisanje prenosnika snage – veza sa CAD sistemom, IMK-14 Istraživanje i razvoj, Časopis instituta IMK "14. Oktobar" Kruševac, Godina XIV , Broj (28-29), 1-2. 2008., s. 91-98.

[15] Milčić, D., Nikolić, M., Mijajlović, M.: AUTOMATISATION OF BELTED POWER TRANSNISSION'S DESIGN PROCESS, The International conference Mechanical Engineering in XXI century, Niš, 2010, pp 129-132.

[16] Ristić, M.: Virtuelno konstruisanje reduktora sa ukrštenim osama ulaznog i izlaznog vratila, Diplomski rad, Univerzitet u Nišu, Mašinski fakultet Niš, 2009.

[17] Kikuo, F., Takahiro, M.: UTILIZATION OF PRODUCT DEVELOPMENT TOOLS AND METHODS: JAPANESE SURVEY AND INTERNATIONAL COMPARISON, International Conference on Engineering Design ICED 05, Melbourne, 2005


## CORRESPONDENCE


Dragan MILČIĆ, Prof. D.Sc. Eng.
University of Niš
Faculty of Mechanical Engineering
Aleksandra Medvedeva 14
18000 Niš, Serbia
milcic@masfak.ni.ac.rs



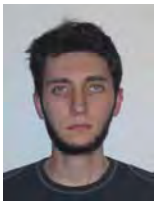
Miroslav MIJAJLOVIĆ, M.Sc. Eng, IWE
University of Niš
Faculty of Mechanical Engineering
Aleksandra Medvedeva 14
18000 Niš, Serbia
mijajlom@masfak.ni.ac.rs



Marko RISTIĆ, M.Sc. Eng.
University of Niš
Faculty of Mechanical Engineering
Aleksandra Medvedeva 14
18000 Niš, Serbia
marko.a.ristic@gmail.com



Dalibor STEVANOVIĆ, M.Sc. Eng.
University of Niš
Faculty of Mechanical Engineering
Aleksandra Medvedeva 14
18000 Niš, Serbia
dalibor.stevanovic85@gmail.com


Miodrag MILČIĆ, Student.
University of Niš
Faculty of Mechanical Engineering
Aleksandra Medvedeva 14
18000 Niš, Serbia
miodrag21@gmail.com

The 7th INTERNATIONAL SCIENTIFIC CONFERENCE

# RESEARCH AND DEVELOPMENT OF MECHANICAL ELEMENTS AND SYSTEMS

**27th & 28th of April, 2011, Zlatibor, Serbia**

**ISBN 978-86-6055-012-7**