Metronet - network for novel measuring and manufacturing technologies

1. Introduction

To produce goods or provide services companies need standards. Standardization is applied to achieve a certain level of orderliness that is optimal under specific circumstances by formulating procedures for general and repeated use and providing solutions to the existing or possible problems. In industry standards are necessary, for example, to specify the ways of communication and preparation of documents at the particular stages of product design and construction. They are responsible for process smoothness and the quality of semi- and finished goods. Of significance are also the quality assessment and control methods.

Standardization plays a vital role in the engineering industry, particularly in the production of machinery and mechanical systems. It has been reported that the quality of machine parts is frequently dependent on the level of standardization. As it is extremely important to assure the accuracy of form, dimensions and surface texture, manufacturers of machine parts are required to follow the requirements known as Geometrical Product Specifications (GPS). Set by the International Standardization Organization (ISO), the documents provide guidelines for dimensioning, geometrical tolerancing and measurement of geometric quantities at each stage of machine part generation, from design to assembly. Geometrical Product Specifications define the requirements concerning, for instance, the product functionality, safety, reliability and interchangeability. They need to be followed to obtain the required dimensional properties of ready products. Procedures are given to achieve the dimensional tolerance and that of geometric surface structure parameters, the latter including the geometric tolerance and the surface parameters tolerance.

Taking into account above given problems in academic year 2024/25 we propose to continue activities carried out under following title::

Metronet - network for novel measuring and manufacturing technologies

2. Partner universities:

1. Kielce University of Technology (Poland), Faculty of Mechanical Engineering, Prof. Krzysztof Stępień – Project coordinator.

2. Technical University of Vienna (Austria), Faculty of Mechanical Engineering.

3. Žilina University (Slovakia), Faculty of Mechanical Engineering.

4. Technical University of Košice (Slovakia), Faculty of Mechanical Engineering.

5. Presov Branch of the Technical University of Košice (Slovakia), Faculty of Production Technologies.

6. Technical University of Ostrava (Czech Republic), Faculty of Mechanical Engineering.

7. University of Maribor (Slovenia), Faculty of Mechanical Engineering.

8. Czech Technical University of Prague (Czech Republic), Faculty of Mechanical Engineering.

9. Cracow University of Technology (Poland), Faculty of Mechanical Engineering.

10. University of Galati (Romania), Faculty of Mechanical Engineering.

11. University "Sv. Kiril i Metodij"-Skopje (Macedonia), Faculty of Mechanical Engineering.

12. Technical University of Bratislava (Slovakia), Faculty of Materials Science and Production Technology in Trnava.

13. Technical University in Cluj-Napoca (Romania), Faculty of Mechanical Engineering.

14. University of Rijeka (Croatia), Faculty of Mechanical Engineering.

15. University of Sarajevo (Bosnia), Faculty of Mechanical Engineering, Faculty of Mechanical Engineering.

16. Technical University of Sofia (Bulgaria), Faculty of Industrial Technology Faculty of Mechanical Engineering.

17. Technical University of Sofia (Bulgaria), Faculty of Mechanical Engineering.

18. Budapest University of Technology and Economics (Hungary), Department of Manufacturing Engineering.

19. University of Belgrade (Serbia), Faculty of Mechanical Engineering.

20. University of Ljubljana (Slovenia), Faculty of Natural Sciences and Engineering.

21. University of Slavonski Brod (Croatia), Mechanical Engineering Faculty in Slavonski Brod.

22. University of Montenegro (Montenegro), Faculty of Mechanical Engineering.

3. Project aims

3.1. Basic objectives of the Project:

- supporting further development of the universities participating in the project
- expansion of activities within other international (DAAAM, TEMPUS) and national (SIMP, PAN) programmes
- further involvement of collaborating universities in national and international research projects; also the development of research potentials of universities in the field of cooperation with economic entities.

3.2. Detailed objectives

A. To secure a higher international position of collaborating universities through the organization of:

- long-term exchange of outstanding scientists
- short-term exchange of well-known experts representing universities
- international conferences on measurement technologies and their application in machine manufacture systems
- publishing activities presenting scientific output of collaborating universities

B. To upgrade the qualifications of young scientists from collaborating universities through:

- their participation in international research teams work
- the organization of short and long -term visits to collaborating universities

- the organization of a laboratory base, which will make it possible to conduct research work on a high international level

C. To develop cooperation with research institutions and economic entities through:

- the development of joint research projects closely connected with industry
- the popularisation and introduction of modern measurement technology into industrial plants
- the realisation of industry-oriented research and development projects
- the presentation of engineering output of industrial technical base through its popularisation among scientific centres

The following are expected advantages resulting from the implementation of the project:

a) Directing the scientific and research potential in the field of measurement technologies towards advanced manufacturing technologies; research on the durability and reliability of machines and devices.
b) Following the latest research trends.
c) Developing joint research projects (within the networks) for the forthcoming years in view of future national and international grants.
d) Integrating the universities at home and abroad concerned with the same scientific problems.
e) Establishing close co-operation with various companies at home and abroad in view of future joint research or implementation of results.
f) Creating favourite conditions for further development of research staff (post-graduate courses).
g) Establishing scientific contacts with Ukraine, Russia and other states of the former USSR.
h) Exchanging experience in the field of university education; training engineers and other research staff; preparing new university courses; developing syllabuses for new subjects and modifying the existing ones.
i) Optimising technological parameters to increase the efficiency of economical manufacturing technologies (using as little power and material as possible).
j) Utilising measuring technologies in the protection of the natural environment.
k) Introducing more effective and innovative machines and devices.
l) Analysing the existing methods of measurement and evaluation of dimension and shape accuracy of machine elements to increase their reliability.
m) Developing new methods of measurement and evaluation of geometrical surface structure.
n) Introducing co-ordinate measuring techniques.

4. Main research areas of the project:

A. Fundamentals of metrology

- theory of measurement,

- experimental designs and statistical data analysis,

- theory of design for sensors employed in transducers and measuring equipment,

- metrology in quality systems.

B. Measuring devices and systems

- design and properties of sensors, transducers, and instruments for length and angle measurement,
- measuring sensors and probes,
- intelligent apparatus,
- laser sensors,
- computer-aided laser systems.

C. Measuring devices in quality control systems

- structure of measurement-control systems,
- digital processing of measured signals,
- measurement procedures,
- computer software,
- automation of measuring processes,
- diagnosis apparatus.

D. Surface metrology

- methods and apparatus for surface microgeometry measurement,
- methods and apparatus for form profile and position measurement.

E. Measurement of complex workpieces

- measurement of threaded elements
- measurement of gear wheels,
- measurement of curvilinear structures.

F. Coordinate measurement

- design and properties of coordinate measuring machines,
- scanning,
- robots, automata, and measurement centres,
- methods for attestation of measuring machines and robots.

G. Methods for inspecting tools and machine tools

- control and management of measurement and monitoring means,
- inspecting cutting tools,
- measuring apparatus for machine positioning,
- inspecting machine tools.

H. Laser interferometry

- lasers in interferometers and their properties,

- interferometry in length and angle measurement and in positioning processes.

I. Quality assurance systems

- national and international standards,

- statistical methods in quality control (SPC,SQC),

- examples of industrial quality systems,

- quality control and acceptance of testing laboratories,

- metrology in product and process quality control systems.

J. Application of Geometrical Product Specifications within contemporary manufacturing systems:

- Quality management by application of Geometrical Product Specifications (GPS).

- Geometrical model applied in GPS.

- General concept of dimensioning regarding inner, outer and complex dimensions.

- Modern principles of tolerancing and fitting of machine parts.

- Principles of tolerancing of parameters of surface geometrical structure regarding tolerances of form, waviness and roughness.

- Problems of datums and associated features.

- Principles of tolerancing of orientation and location.

- Principles of tolerancing of free surfaces and complex deviations, for example screw threads.

- Principles of tolerancing of cones and angles.

- Problems of functional selection, denotation and interpretation of geometrical tolerances.

- Problems of tolerancing in different technological processes.

- Principles of tolerancing of complex geometrical features (screw threads, gears).

- Fundamentals of statistical tolerancing in manufacturing processes.

- Problems of dimensional analysis and synthesis in mechanical technology.

- Analysis and synthesis of measurement errors in the aspect of establishing uncertainty of measuring instruments.

5. Planned activities - realization of the programme in year 2024/2025

A. Assistance in research and assessment of dissertations for the highest university degrees and senior university grades:

B. Organisation of short scientific visits for senior students.

C. Delivering lectures by university teachers (grantholders) doing their research at other universities.

D. Familiarisation with an exchange of computer programs concerning the measurement in mechanical engineering worked out by each of the collaborating universities.

E. Participation in the organisation of the International Fair of the Industrial Measuring Technology "Control-Tech" to be held in Kielce, Poland (March 2025).

F. Participation at domestic and international conferences and congresses through publishing and presentation of papers on the problems investigated within the project.

G. Strengthening the connections with Danube Adria Association for Automation and Manufacture (DAAAM).

6. Joint programs

In the academic year 2024/2025 it is proposed to implement following joint programs:

A. "Science Report of the Network". The Science Report will be a book containing scientific papers written by the representatives of the universities cooperating within the network.

B. "Summer School of the network". "The Summer School" is the summer school for undergraduates and PhD students that will be held in September 2025 at Kielce University of Technology. The participants of the Summer School will be undergraduates, PhD students and academic teachers from the universities participating in the network.

7. Planned mobility actions

In the framework of the Project exchange of students and teachers is planned. The details of this exchange are given in the next clause and in the traffic sheet.

7.1. Mobility: Special contribution of each institution:

A. Kielce University of Technology will host students from the universities in Sofia (Faculty of Industrial Technology), Sofia (Faculty of Mechanical Engineering), Prague, Ostrava, Zilina, Kosice and Presov (total number of scholarship months: long-term scholarships: 32, short-term scholarships: 8) and teachers from the universities in Vienna, Sofia (Faculty of Industrial Technology), Sofia (Faculty of Mechanical Engineering), Ostrava, Cluj, Maribor and Zilina (total number of scholarship months: 10).

B. Vienna University of Technology will host students from the universities in Kielce, Cracow, Belgrade and Maribor (total number of scholarship months: long-term scholarships: 16, short-term scholarships: 4) and teachers from the universities in Kielce, Slavonski Brod, Budapest, Cracow, Cluj, Belgrade (total number of scholarship months: 7).

C. University of Zilina will host students from the universities in and Cracow (total number of scholarship months: long-term scholarships: 8, short-term scholarships: 2) and teachers from the university in Kielce (total number of scholarship months: 2).

D. VSB Ostrava will host students from the universities in Kielce, Cracow, Belgrade and Ljubljana (total number of scholarship months: long-term scholarships: 20, short-term scholarships: 4) and teachers from the universities in Kielce, Slavonski Brod, Budapest, Cracow, Galati (total number of scholarship months: 8).

E. Cracow University of Technology will host students from the universities in Vienna, , Prague and Bratislava (total number of scholarship months: long-term scholarships: 24, short-term scholarships: 3) and teachers from the universities in Vienna, Praha and Bratislava (total number of scholarship months: 5).

F. University of Maribor will host students from the universities in Vienna (total number of scholarship months: long-term scholarships: 4, short-term scholarships: 1) and teachers from the universities in Ostrava and Skopje (total number of scholarship months: 2).

G. Czech Technical University in Prague will host students from the universities in Vienna and Kielce (total number of scholarship months: long-term scholarships: 8, short-term scholarships: 1) and teachers from the university in Cracow (total number of scholarship months: 2).

H. Technical University of Kosice will host students from the universities in Kielce and Ostrava (total number of scholarship months: long-term scholarships: 12, short-term scholarships: 3) and teachers from the university in Ostrava (total number of scholarship months: 2).

I. Technical University of Kosice (the branch in Presov) will host students from the university in Kielce (total number of scholarship months: long-term scholarships: 4, short-term scholarships: 1) and teachers from the university in Ostrava (total number of scholarship months: 2).

J. Slovak Technical University in Bratislava (the branch in Trnava) will host students from the universities in Cracow and Maribor (total number of scholarship months: long-term scholarships: 8, short-term scholarships: 2) and teachers from the university in Skopje (total number of scholarship months: 2).

L. Ss. Ciril and Methodius University in Skopje will host students from the universities in Cluj and Galati (total number of scholarship months: long-term scholarships: 8, short-term scholarships: 2) and teachers from the university in Trnava (total number of scholarship months: 2).

M. University of Galati will host students from the universities in Skopje, Kosice and Presov (total number of scholarship months: long-term scholarships: 12, short-term scholarships: 3) and teachers from the university in Rijeka (total number of scholarship months: 2).

N. University of Cluj-Napoca will host students from the universities in Skopje and Rijeka (total number of scholarship months: long-term scholarships: 8, short-term scholarships: 2) and teachers from the university in Vienna (total number of scholarship months: 2).

O. University of Rijeka will host students from the universities in Galati and Sarajevo (total number of scholarship months: long-term scholarships: 8, short-term scholarships: 2) and teachers from the university in Galati (total number of scholarship months: 2).

Q. University of Belgrade will host students from the university in Vienna (total number of scholarship months: long-term scholarships: 8, short-term scholarships: 2) and teachers from the universities in Vienna and in Maribor (total number of scholarship months: 2).

R. University of Sarajevo will host students from the university in Sofia (Faculty of Industrial Technology and Faculty of Mechanical Engineering) (total number of scholarship months: long-term scholarships: 8, short-term scholarships: 2) and teachers from the universities in Sofia (Faculty of Industrial Technology and Faculty of Mechanical Engineering) and in Lubljana (total number of scholarship months: 2).

S. Technical University of Sofia (Faculty of Industrial Technology) will host students from the universities in Sarajevo, Podgorica, Slavonski Brod, Budapest, Galati and (total number of scholarship months: long-

term scholarships: 20, short-term scholarships: 5) and teachers from the universities in Sarajevo and in Podgorica (total number of scholarship months: 2).

T. Technical University of Sofia (Faculty of Mechanical Engineering) will host students from the universities in Podgorica, Budapest and Cluj (total number of scholarship months: long-term scholarships: 12, short-term scholarships: 3) and teachers from the universities in Kielce Vienna and in Podgorica (total number of scholarship months: 3).

U. University in Budapest will host students from universities in Kielce and Ljubljana (total number of scholarship months: long-term scholarships: 8, short-term scholarships: 2) and teachers from the University of Ljubljana (total number of scholarship months: 3).

V. University of Ljubljana will host students from universities in Kielce, Slavonski Brod and Budapest (total number of scholarship months: long-term scholarships: 8, short-term scholarships: 2 and teachers from universities in Slavonski Brod and in Budapest (total number of scholarship months: 4).

W. University of Slavonski Brod will host students from the university in Sofia (Faculty of Industrial Technology and Faculty of Mechanical Engineering) (total number of scholarship months: long-term scholarships: 8, short-term scholarships: 2) and teachers from the universities in Sofia (Faculty of Industrial Technology and Faculty of Mechanical Engineering) (total number of scholarship months: 2).

X. University of Montenegro will host students from the university in Sofia (Faculty of Industrial Technology and Faculty of Mechanical Engineering) (total number of scholarship months: long-term scholarships: 8, short-term scholarships: 2) and teachers from the universities in Sofia (Faculty of Industrial Technology and Faculty of Mechanical Engineering) (total number of scholarship months: 2).

8. Additional information. Recommendations.

The universities participating in the network have been collaborating, though not always formally, for a number of years, and the achievements of this collaboration include:

- Granting "Perfection award", which was established for the best University network by the Joint Committee of Ministers of the Central European Exchange Program for University Studies (CEEPUS) in 2009 and in 2016.

- granting the degree of habilitated doctor to the Project Coordinator, Stanislaw Adamczak, DrEng, representing the Kielce University of Technology; the dissertation was presented and defended in front of an international committee at the Technical University of Bratislava; the research work for the degree was conducted in collaboration with Slovak, Austrian, and other Polish scientific centres;

- reviewing and recommending thesis and dissertations;

- obtaining the title of the professor by Doc. Dr. Ing. Robert Cep (VSB Ostrava) and by Doc. Dr Ing. Marek Sadilek (VSB Ostrava)

- completing the research for the degree of a reader by U. Zuperl (University of Maribor), K. Stępień (TU Kielce), W. Makieła (TU Kielce), S. Spadło (TU Kielce), L. Radziszewski (TU Kielce), S. Turek (TU Zilina), R. Dvorak (CVUT Prague), Durakbasa (TU Vienna), T. Orzechowski (TU Kielce), L. Radziszewski (TU Kielce), J. Zajac (TU Kosice), J. Jurko (TU Kosice), Edward Miko (TU Kielce), V. Modrak (TU

Kosice/Presov), R. Čep (VSB Ostrava), Michal Hatala (TU Kosice), Marek Sadilek (VSB Ostrava), Marta harnicarova (VSB Ostrava).

- completing the doctoral research by Michał Skrzyniarz (TU Kielce), Tomasz Kozior (TU Kielce), Damian Gogolewski (TU Kielce), Paweł Zmarzły (TU Kielce), Łukasz Nowakowski (TU Kielce), Gordan Starcevic, Barabara Juras, Ingrid Danielicova, Anna Macurova, Šarka Ticha, Michal Hatala, Robert Cep, Marek Sadilek, Roman Chrappa, Marcin Krawczyk, Artur Wójcik, Grzegorz Sokal, Adam Janusiewicz, Krzysztof Stepien, Lenka Ocenasova (VSB Ostrava), Lenka Petrkovska (VSB Ostrava), Jana Petru (VSB Ostrava), Jiri Kratochvil (VSB Ostrava), Marketa Gregusova (VSB Ostrava), Ryszard Konderla (VSB Ostrava), Maria Kickova (TU Kosice) undertaken during the previous editions of Projects PL-1, Project PL-127 and CII-PL-0007 of the CEEPUS programme;

- joint publications and conference presentations;

- assistance in research;

- achieving the objectives of Project PL-1 of the CEEPUS programme in the academic year 1995/96, Project PL-001/9697 in the academic year 1996/97 concerning Methods for Measurement and Assessment of Selected Geometrical Parameters of Machine Parts in the Aspects of Automation and Robotisation of Production, Project PL-1 in the academic years 1997/98 and 1998/99 on Metrology in Quality Assurance Systems; Project PL-1 in the academic years 1999-2000 and 2000-2001 on Geometrical Surface Structure of Machine Parts. Constitution. Methods for Measurement and Evaluation. Influence on the Operational Capacity of Mating Elements; Project PL-1 in 2001/2002 on Computer-Aided Systems for Manufacture and Measurement of Machine Elements, Project-127 in the academic years 2003/2004, 2004/05 on Measuring technology in Advanced Machine Manufacturing Systems (stage I and II) the project Modern Metrology in Quality Management Systems (stage I and II) in the academic years 2005/06 and 2006/07, the project CII-PL-0007 on Geometrical Product Specifications – a new tendency in the design and realization of technological processes in 2007/08 and 2008/09, the project CII-PL-0007 on Computer-Aided Systems for Manufacture and Measurement of Machine Elements in 2009/10 in 2010/11, the project CIII-PL-0007 on Modern Methods of the Constitution and Measurement of Geometrical Surface Structure – stage I in 2011/12, the project CIII-PL-0007 on Modern Methods of the Constitution and Measurement of Geometrical Surface Structure – stage II in 2012/13, the project CIII-PL-0007 on Novel methods of manufacturing and measurement of machine parts in 2013/14, the project CIII-PL-0007 on Novel methods of manufacturing and measurement of machine parts - stage II in 2014/15, the project CIII-PL-0007 on Research on modern systems for manufacture and measurement of components of machines and devices, in 2016/17 the project CIII-PL-0007 on Research on modern systems for manufacture and measurement of components of machines and devices – stage II, in 2017/18 the project CIII-PL-0007 on Contemporary manufacturing and measuring technologies of machine parts in quality management systems, in 2018/19 the project CIII-PL-0007 on Contemporary manufacturing and measuring technologies of machine parts in quality management systems-stage II, in 2019/2020 the project on Contemporary manufacturing and measuring technologies of machine parts in quality management systems-stage III and in years 2020/2021, 2021/2022, 2022/23 and 2023/2024 the project Metronet - network for novel measuring and manufacturing technologies.

- organizing summer schools at Kielce University of Technology in years 2002 2011, 2013-2019 and 2021-2022.

- organizing scholarships for participants from Ukraine in June 2013, in September 2015, September 2016 and September 2017.

- organizing IV. International Congress on Precision Machining – ICPM 2007 in Sandomierz and Kielce from 25.09.2007 till 28.09.2007. The Congress sessions were coordinated to the Summer School of the network CII-PL-0007 and the National CEEPUS Office Poland in Warsaw was the honorary patron of the Congress;

- organizing 11th International Symposium on Measurement and Quality Control – ISMQC 2013 in Cracow and Kielce from 11.09.2013 till 13.09.2013. The Symposium sessions were coordinated to the Summer School of the network CII-PL-0007 and the National CEEPUS Office Poland in Warsaw was the honorary patron of the event;

- publishing eleven Science Reports.