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 2025/26 we propose to continue activities carried out under following title::

Metronet - network for novel measuring and manufacturing technologies

2. Project coordinator and the partner universities.

The project will be coordinated by Prof. Krzysztof Stępień from the Kielce University of Technology. Prof. Krzysztof Stępień is the Head of the Department of Metrology and Modern Manufacturing. The coordinator is going to make every effort to ensure that the operation of the network is satisfactory for all participants. The academic exchange plan will be developed taking into account the preferences of each partner university. Regular, bi-monthly coordination meetings are planned to coordinate the activities. Thanks to coordination meetings, each of the network participants will have the opportunity to actively participate in planning teaching courses and other activities of a scientific and didactic nature.

List of planned 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. Catholic University of Zagreb (Croatia), Faculty of Engineering.

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

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

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.

23. University of Novi Sad (Serbia). Faculty of Technical Sciences, Department of Production Engineering.

24. University of East Sarajevo (Bosnia), Faculty of Mechanical Engineering.

25. The Higher Education Technical School of Professional Studies in Novi Sad (Serbia)

Note: The list of network participants may be shortened if the proposed network participant does not provide the required documents, i.e. Letter of Intent and Letter of Endorsement by 15 December 2024.

3. Project aims

3.1. Basic objectives of the Project:

1. improving the quality of education of undergraduates and PhD students in the field of metrology and manufacturing techniques,
   - 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,
- long-term exchange of undergraduates and PhD students,
- 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.
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 2025/2026

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 (scholarship holders) 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 2026).

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 2025/2026 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 2026 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

When planning the number of scholarships for each partner university, it was assumed that each partner is going to host approximately equal number of scholarship holders. Only in a few cases proposed number of incoming mobilities was increased.

In the case of an increase in the number of incoming mobilities, the proposed number of scholarships was assumed on the basis of the number of scholarships used by the participant in the previous academic year.

In the framework of the Project exchange of students, teachers and university staff 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:

1) Kielce University of Technology is going to host 5 students for 4-month scholarships, 5 students for 1-month scholarships, 7 teachers for 1-month scholarships, and three representatives of the university staff (1-month scholarship).
2) Vienna University of Technology is going to host 3 students for 4-month scholarships, 4 students for 1-month scholarships and 7 teachers for 1-month scholarships.
3) University of Zilina is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
4) VSB Ostrava is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 8 teachers for 1-month scholarships.
5) Cracow University of Technology is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 5 teachers for 5-month scholarships.
6) University of Maribor is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
7) Czech Technical University is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
8) Technical University of Kosice is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
9) Technical University of Kosice (the branch in Presov) is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
10) Slovak Technical University in Bratislava (the branch in Trnava) is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
11) Ss. Ciril and Methodius University in Skopje is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
12) University of Galati is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
13) University of Cluj-Napoca is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
14) Catholic University of Zagreb is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
15) University of Belgrade is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
16) University of Sarajevo is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
17) Technical University of Sofia (Faculty of Industrial Technology) is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships..

18) Technical University of Sofia (Faculty of Mechanical Engineering) is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
19) University in Budapest is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
20) University of Ljubljana is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
21) University of Slavonski Brod is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
22) University of Montenegro is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
23) University of Novi Sad is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
24) University of East Sarajevo is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.
25) The Higher Education Technical School of Professional Studies in Novi Sad is going to host 2 students for 4-month scholarships, 2 students for 1-month scholarships and 2 teachers for 1-month scholarships.

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: dwukrotne uzyskanie tytułu “the CEEPUS Ministers' Prize of Excellence (in 2009 and 2016), obtaining the title of professor and university professor by dozens scholarship holders, publishing of eight scientific books, organizing scholarships for participants from Ukraine in June 2013, in September 2015, September 2016 and September 2017. joint research project proposals, joint publications in internationally recognized journals and many more.

We believe that the acceptance of our project will allow for further development of the universities participating in the network in the area of teaching and research and will improve the quality of education for undergraduates and PhD students in STEM.