 

# Editorial

## Special Issue of the Faculty of Mechanical Engineering, University of Maribor — 30 Years of Excellence in Engineering Research

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**Abstract** *This editorial introduces the Special Issue of the Strojniški vestnik - Journal of Mechanical Engineering dedicated to the 30th anniversary of the Faculty of Mechanical Engineering as an independent member of the University of Maribor, and the 50th anniversary of the University of Maribor. The Faculty of Mechanical Engineering is one of the most successful members at the University of Maribor and is recognised for its excellence in education, research and collaboration with industry. Its history of development, from its early beginnings in 1959 to becoming an internationally active and research-driven institution, reflects a continuous commitment to technological progress and societal impact. The Special Issue presents a selection of articles covering applied fluid mechanics, advanced materials and metamaterials, manufacturing science, and biomedical modelling. The collected works combine experimental, numerical, and review-based approaches to address contemporary challenges in mechanical engineering. This publication not only highlights the scientific excellence achieved at the Faculty of Mechanical Engineering, University of Maribor, but also celebrates its enduring mission to connect knowledge, innovation and human creativity in shaping a sustainable and technologically advanced future.*

**Keywords** *applied fluid mechanics, computational fluid dynamics (CFD), hydropower systems, advanced materials, metamaterials, triply periodic minimal surfaces (TPMS), biomedical modelling, inverse bioheat problem, intelligent toolpath generation, artificial intelligence in manufacturing*

**Highlights**

- *Special Issue marks 30 years of Faculty of Mechanical Engineering and 50 years of the University of Maribor.*
- *The contributions cover applied fluid mechanics, materials, manufacturing, and biomedical modelling.*
- *The issue showcases cutting-edge research and technological innovation in mechanical engineering.*
- *It reflects the Faculty's long-standing link between academia and industry and celebrates engineering creativity and multidisciplinary collaboration.*

## 1 INTRODUCTION

The Faculty of Mechanical Engineering is one of the most successful members of the University of Maribor, recognised for its achievements in education, research, professional and artistic endeavours. One of our key priorities is to strengthen the connection between academia and industry, and to co-create technological progress that drives social transformation. With our broad spectrum of knowledge and experience, we continue to preserve tradition while, simultaneously, embracing the trends of modern society. The planned renewal of infrastructure across the technical Faculties will undoubtedly contribute to the highest quality of research and educational activities in the future.

The origins of mechanical and textile engineering studies in Maribor date back to 1959, when the Technical College was established. In 1973, it evolved into the Higher Education Technical Institution, and, in 1975, it became part of the newly founded University of Maribor, which is celebrating its 50th anniversary this year. In 1985, the Higher Education Technical Institution was renamed to the Faculty of Technical Sciences, and in 1995, it was reorganised into four independent Faculties of the University of Maribor, one of which is the Faculty of Mechanical Engineering, celebrating its 30th anniversary this year.

Our Faculty places great emphasis on international cooperation, which we enrich continuously through numerous projects and collaborations with researchers from around the world. We also encourage students to participate actively in various project-based activities, providing them with valuable theoretical knowledge and practical experience, an excellent foundation for their future careers.

We place great importance on collaboration with national institutions, especially the Faculty of Mechanical Engineering, University of Ljubljana. Although both Faculties differ in their dynamics, strengths and challenges, we share a common vision, demonstrating that engineering truly knows no boundaries.

It is an honour to commemorate our anniversary with the publication of this Special Issue of the Journal of Mechanical Engineering, which, for more than 70 years, has shaped and advanced the field of mechanical engineering and related disciplines significantly, while promoting its recognition and excellence continuously.

Looking ahead, our Faculty will continue to embrace modern technologies, development, and unexplored potentials that represent limitless sources of new opportunities for engineering creativity optimistically. The word technology originates from the Greek word »techne«, meaning the art or skill of making and building. At the Faculty of Mechanical Engineering, University of Maribor, we will continue to build ideas that advance technological progress skilfully, while nurturing the art of building and maintaining a positive working environment, and valuing- human relationships — the true added value behind every achievement.

We will foster connectivity and openness, strengthen interdisciplinary academic networks, and encourage diverse

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perspectives that can lead to new insights and innovative solutions. In doing so, we will continue writing stories of success, innovations and progress, bringing science closer to life and creating a better future.

## 2 SELECTED ARTICLES OVERVIEW

This issue brings together a compact but diverse collection of contributions spanning applied fluid mechanics, advanced materials and metamaterials, manufacturing science, and biomedical modelling. The papers collected here share a common thread: rigorous modelling combined with targeted experiments or comprehensive literature synthesis, all aimed at solving pressing engineering problems with practical relevance.

In the area of hydraulic and turbomachinery flows, Vovk and Ravnik [1] compared 1D Euler-based and full 3D Navier–Stokes approaches to the water-hammer problem, showing how simplified models, if validated carefully, remain powerful engineering tools. On the other hand, the 3D viscous simulations reveal detailed cavitation dynamics and interactions with protective devices such as dynamic combination air valves. Complementing this, Kevorkijan et al. [2] presented a CFD study of particle-driven erosion in Pelton turbine runners: using Lagrangian particle tracking and the Finnie abrasion model, they quantify when sediment loading becomes critical, and where real-world wear is likely to occur, offering insights for design and maintenance in sediment-prone hydropower plants.

Fluid and process engineering are also addressed in the contribution by Založnik and Zadravec [3], who investigated gas flow distribution in fluidised beds using both the Two-Fluid Model enhanced by the Kinetic Theory of Granular Flow (TFM-KTGF) and coupled CFD-DEM simulations. Their results, validated against the experimental data, revealed that common geometric assumptions for gas distribution plates underestimate particle effects on flow distribution significantly. While CFD-DEM offers detailed particle-level resolution, the TFM-KTGF approach emerged as a computationally efficient alternative for large-scale systems

Bridging numerical analysis and healthcare, Horvat and Iljaž [4] addressed an important diagnostic challenge: they solved the inverse dynamic-thermography bioheat problem for skin tumours using a non-Fourier (dual-phase-lag) model and a boundary-element solution strategy coupled with Levenberg–Marquardt optimisation. Their results showed robust retrieval of the tumour parameters (notably the diameter and thermal relaxation time) even with noisy data, pointing to promising improvements in non-invasive early-detection methods.

Materials and structural topics are reported in the paper of Kovačec et al. [5], which presented a systematic industrial trial of rotary flux injection, to remove inclusions and alkali and alkaline-earth trace elements from Al–Mg–Si melts, demonstrating an effective salt-flux formulation that supports higher scrap fractions without compromising cleanliness.

Continuing within the field of metallic materials, Pal et al. [6] investigated the melting behaviour of magnesium during additive manufacturing using experimental testing. The study focused on understanding melt-pool dynamics, solidification characteristics, and potential defect formation mechanisms, which are critical for improving print quality and structural integrity of magnesium components. The results contribute to optimising process parameters and advancing the use of lightweight magnesium alloys in 3D printing applications.

In a materials-oriented review, Žnidarič et al. [7] synthesised the latest knowledge on fatigue behaviour of triply periodic minimal surface (TPMS) metamaterials. The review highlighted why TPMS geometries often outperform conventional lattices under fatigue loading, and clarifies fabrication and material dependent performance trade-offs.

Expanding the metamaterials perspective, the work of Novak et al. [8] provided a comprehensive review of cellular metamaterials, covering two decades of research progress. The article highlights how advanced fabrication methods, such as additive manufacturing and explosive compaction, enable the design of foams, TPMS lattices, and hybrid auxetic structures with tailored mechanical properties. The validated computational models are emphasised as indispensable tools for optimising graded and hybrid designs. Their insights underline the transformative potential of metamaterials for crash absorption, biomedical implants and defence applications.

Manufacturing and process planning received critical attention in Simonič et al [9], a systematic literature review on intelligent toolpath generation. Mapping the evolution from Industry 4.0 towards human-centric Industry 5.0, the authors spotlight AI/ML-driven feature recognition, STEPNC interoperability prospects, and the urgent need to broaden realworld validation and SME-focused adoption strategies.

Finally, the experimental–numerical study by Močilnik et al. [10] examined how pre-setting and deep-rolling sequences affect creep and long-term torque stability in torsion spring bars. Their combined FEM and long-duration tests identified a narrow process window (around moderate pre-setting levels) that balances the enhanced elastic range with acceptable creep. The results can be applicable directly to suspension component design and production.

Taken together, this issue underscores the strength of multidisciplinary engineering in terms of robust numerical tools, thoughtfully designed experiments and careful literature synthesis, which contribute to progress across domains. We thank the authors for their excellent work and the reviewers for their constructive assessments, and hope that the readers will find both inspiration and practical ideas to advance their own projects.

## 3 CONCLUSION

The articles presented in this Special Issue illustrate the broad scope and scientific excellence of the contemporary engineering research conducted at the Faculty of Mechanical Engineering, University of Maribor. They demonstrate collectively how fundamental understanding, advanced modelling, and innovative experimentation contribute to addressing practical challenges in engineering science, from fluid dynamics and materials development to manufacturing intelligence and biomedical applications.

This collection also symbolises the shared values of curiosity, creativity and collaboration that have defined the Faculty of Mechanical Engineering throughout its 30-year history within the University of Maribor. As we celebrate this milestone alongside the University's 50$^{th}$ anniversary, we reaffirm our commitment to advancing engineering knowledge and fostering connections that bridge academia, industry and society. Looking ahead, the Faculty will continue to support multidisciplinary research, collaboration, cultivate new generations of engineers, and contribute to shaping a sustainable and technologically advanced future.

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