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Engineering Power

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EDITOR-IN-CHIEF'S WORD

Dear readers,

Artificial intelligence is rapidly transforming engineering, not only by providing new computational tools but also by changing the way we approach scientific and technological challenges. Its true potential lies in combining data-driven methods with established scientific knowledge, engineering expertise, and a sound understanding of physical principles.

The Croatian Academy of Engineering is committed to promoting scientific excellence, encouraging interdisciplinary cooperation, and fostering the responsible application of emerging technologies. Through Engineering Power, we aim to contribute to the exchange of knowledge and ideas that advance both engineering research and professional practice.

This issue also marks an important moment in the Academy's institutional life, as its 59th Annual General Assembly provided an opportunity to reflect on past achievements, recognize outstanding contributions, and welcome new leadership for the years ahead.

I trust that this issue will provide valuable insights and inspire further research and collaboration.

Editor-in-Chief
Vedran Mornar, President of the Croatian Academy of Engineering



EDITOR'S WORD

Dear readers,

It is a particular pleasure to present new issue of Engineering Power, edited by Marko Čanađija and Lovre Krstulović-Opara, members of the Croatian Academy of Engineering from the Department of Mechanical Engineering and Naval Architecture. This issue contains three papers that demonstrate the integration of artificial intelligence and machine learning with classical methods in experimental and computational mechanics. In addition to these papers, this issue also includes a review of the 59th Annual General Assembly of the Croatian Academy of Engineering, held on June 8, 2026 in Zagreb.

I hope you enjoy reading this issue.

Editor
Bruno Zelić, Vice-President of the Croatian Academy of Engineering





FOREWORD

Artificial intelligence (AI) and machine learning (ML) are becoming increasingly important tools in modern engineering, opening new possibilities for the analysis, modelling, and optimisation of mechanical systems and materials. Their integration with established numerical and experimental methods offers opportunities to address complex problems that are difficult or computationally demanding to solve using conventional approaches alone.

This special issue of Engineering Power, entitled Applications of Artificial Intelligence and Machine Learning in Experimental and Computational Mechanics, presents three contributions that illustrate different aspects of this rapidly developing field. The first paper, by Čanađija, Ivić, and Zlatić, presents a computational framework for the optimal design of metamaterials based on carbon-nanotube nanotrusses. Molecular dynamics simulations are first used to generate a dataset describing the stress–strain behavior of single-walled carbon nanotubes. A neural network augmented with fundamental physical constraints is then trained on this dataset and subsequently employed as a surrogate constitutive model in nonlinear finite element analyses. This approach preserves the high accuracy of molecular dynamics simulations while significantly reducing the associated computational cost. In the final step, the framework is integrated with optimization algorithm, resulting in an efficient computational tool for developing metamaterials with tailored mechanical properties.

The second contribution, by Zlatić and Čanađija, addresses the incorporation of physical constraints into neural-network-based constitutive models for hyperelastic materials undergoing finite deformations. These types of constitutive models are more convenient than conventional models because they do not require a predefined functional form. The paper provides details on the proper enforcement of thermodynamic consistency, objectivity, energy normalisation, and polyconvexity. The resulting neural-network model is then implemented in the finite element software Abaqus as a replacement for a conventional constitutive model. The presented example demonstrates the performance of the proposed procedure in a hyperelastic application relevant to rubber and biological materials.

The third paper, by Grebo and Krstulović-Opara, explores the application of deep learning to experimental mechanics by investigating the relationship between full-field measurements obtained using Digital Image Correlation (DIC) and Infrared Thermography (IRT). Using a U-Net architecture, the authors compare the prediction of thermal fields from measured strain distributions with the reverse mapping from temperature to strain fields. The results highlight both the potential and limitations of neural networks for integrating complementary experimental measurement techniques.

Although addressing different problems, the three contributions share a common objective: combining the capabilities of AI and ML with established physical principles, numerical methods, and experimental observations. They demonstrate that data-driven approaches are particularly valuable when used to complement, rather than replace, conventional methods in mechanics.

Guest Editors
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