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Industry 4.0, Artificial Intelligence, and Mechanical Engineering towards Industry 5.0

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Editorial
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This issue contains ten papers carefully reviewed and selected through a rigorous peer-review process at three international conferences. These high-quality articles consolidate research findings highlighting the crucial role of Industry 4.0, artificial intelligence and mechanical engineering in the sustainability of our industries in the next era. The technology-based paradigm of Industry 4.0 combined with human-centered, sustainability, and resilience creates the Industry 5.0 paradigm, providing support for the workforce and society. The transition to the Industry 5.0 era may face many challenges, as the application and readiness of Industry 4.0 solutions still need to be well discussed in the literature (Gladysz et al., 2023). In this issue, papers have examined relevant aspects of this transitional paradigm in different contexts. As exemplified by the work of Ejsmont et al. (2020) and Gladysz et al. (2021), research is needed to adapt new developments and concepts to the fifth industrial revolution.

The paper by S.R. Mane and R.V. Kale contributes to renewable energy sources and the rise of solar panels as a non-conventional energy source. Urban agglomeration poses a challenge for installing solar water heaters in every household because roof space is limited. Space reduction can be achieved by reducing the collector area by changing the diameter of the vacuum tubes. The results include a single tube and tank arrangement model with a fixed inclination and thermal evaluation of a thermosyphon-based vacuum tube-solar water heater using ANSYS CFD simulation software, including temperature measurements at three different positions in the tank. A model of Industry 4.0 based on sensors to save on water heating was presented. Thote S.A. and Singh N.P. have identified a gap in the search for directions to improve heat transfer and heat exchangers' performance. They proposed a new heat exchanger model with a trapezoidal cut-out insert on both sides of the insert and using different twist ratios. Tests were conducted, and the results were compared with previous studies using different fluids or phase change materials as the fluid to maximize heat transfer efficiency.

V. Miriyala et al. have investigated the issue of machining hard materials. The authors of this study conducted a comprehensive assessment of the literature on machining steels using nanofluids with/without minimum quantity lubrication (MQL). This research aims to investigate the performance of nanofluids (n-Al_2O_3, n-MoS_2, and n-graphene) mixed with coconut oil in various proportions and injected into the tool–work interface using the MQL mist system. Experimental results showed that nanofluids outperformed pure coconut oil. Nano-Al_2O_3 combined with coconut oil provided a better surface finish, lowered the cutting temperatures, and ensured minimal chip thickness. D. K. Bhise et al. have concluded that micro-lubrication (MQL) is a better cooling method than traditional cooling. MQL can be used in machines with high metal removal rates, such as those used for turning, milling, drilling and boring. MQL has lower lubrication consumption, higher cooling rates and cleaner production than conventional flood lubrication. The costs and benefits of MQL compared to conventional flood cooling methods were analyzed. The results indicate that MQL is more economical than conventional cooling, and the break-even point (BEP) for both cooling systems showed differences. BEP can be achieved faster for MQL than flood cooling lubricant.

The paper by Y. Karanjavkar et al. contributes to complex metamaterial structures. It was explained how new material structures could better absorb impacts, which is incredibly important in areas strongly related to Industry 4.0 – aerospace and aerodynamics. The authors designed, modeled and analyzed a feasible, more sustainable impact-absorbing structure based on Origami. The authors created tessellations using the Miura ori fold to obtain a repeatable TCO (Triangulated Cylindrical Origami) structure to create a general-purpose design for impact-absorbing applications. The results show that Origami TCO sheets outperform traditional honeycomb and corrugated sheets. Since the model developed is a general-purpose design, it can be scaled up or down depending on the required application, ranging from nanotechnology to space technology.

The world is moving towards ubiquitous connectivity, with many devices connected and sending information over the Internet. To solve this problem, A. Barik et al. have proposed Unmanned Aerial Vehicles (UAVs). The paper discusses various issues related to data logging and analysis in the Internet of Things (IoT) network supported by UAVs. According to the authors, UAVs are a good solution because they can reach remote locations while using fewer resources to provide connectivity and collect data from remote devices.

X. Li and G. Tian presented how Internet technology can be used in finance. They presented the Internet financing model supported by financing functions. This model represents a significant deconstruction of the traditional financial intermediary function, with high financing flexibility and is of great importance for solving the financial difficulties of micro, small and medium enterprises. Experimental results obtained based on the application in a selected company confirmed the correctness of the model.

F. Wei discusses the issue of increasing green space in urban areas. Using the example of China, urban garden designs were examined. The author applies the PDCA cycle to the engineering of urban gardens and the boundary design method using multiple linear regression analysis and its testing. The results showed that the method can optimize the design and better management of urban landscape engineering.

The last two papers concern the construction sector. J. Yang and S. Yin have discussed risk management issues for housing and construction projects. Considering the complexity and nonlinearity of risk factors in engineering construction projects, the authors propose a feedforward model (BP) to solve the risk management model and achieve project risk prediction. Sparse Search Algorithm (SSA) was used to optimize the construction of the SSA-BP engineering risk prediction model to achieve project risk management and assessment. The results suggest that the proposed approach allows for better risk management capabilities. The SSA-BP model has greater precision and accuracy, improving the risk management capabilities of engineering projects. In turn, Z. Huang and J. Wang present the application of the Random Forest (RF) machine learning algorithm in civil engineering. The primary purpose of the research was to improve tunnel design by accurately predicting and controlling the vertical displacements of pillar foundations. The study proposed combining RF with a Particle Swarm Optimization (PSO) algorithm to improve shield tunneling technology by introducing Bayes' principle to statistical analysis and optimizing various main design variables. PSO was used to optimize the parameters and structure of the RF model. In this way, the ability of the model to predict the accuracy of the vertical displacement of the pillar can be improved. Experimental results allowed to confirm the good predictive performance of the model.

I want to express my sincere gratitude to all the Members of the International Scientific Committees for taking their time and effort to help uphold the quality of all papers through the peer-review process. I hope the papers will be of interest and value to researchers and practitioners across multiple industries seeking to update their knowledge in Industry 4.0 technologies, artificial intelligence and mechanical engineering applications for sustainable growth and transition into the era of Industry 5.0.

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