Editorial

Institution of MECHANICAL ENGINEERS
Journal of MECHANICAL ENGINEERING SCIENCE

Proc IMechE Part C:
J Mechanical Engineering Science
2022, Vol. 236(21) 10633–10635

DOI: 10.1177/09544062221128135
journals.sagepub.com/home/pic
SAGE

Special issue on new trends in mechanical design and product development

Dario Croccolo, Massimiliano De Agostinis, Stefano Fini and Giorgio Olmi

This special issue is devoted to a special selection of the best papers presented at the Mechanics and Materials in Design International Conference (M2D 2019) held in Bologna (Italy) in 2019. The M2D 2019 was the eighth international meeting of the M2D series, gathering hundreds of scientists and engineers interested in the fields of mechanics, engineering design, advanced materials, energy harvesting, reliability, quality, and safety engineering. It was held between 4th and 6th of September 2019. Almost 160 contributions in the fields of Mechanics, Materials and Design at varied length scales, as well as Biomechanics and Experimental and Computational Mechanics applied to Mechanical, Aeronautical, Automotive, Biomedical, Environmental, and Nuclear Engineering were submitted to the Scientific board. The best 100 of those papers were selected for an oral presentation with the goal to enable engineers, researchers and scientists to exchange ideas on the following and other derivative topics.

Computational Mechanics: FEM, BEM, MD, DFT, Micromechanics, Monte Carlo, and Hybrid Methods, Optimum Design Techniques, Noise and Vibration, Structural Dynamics.

Experimental Mechanics: Condition Monitoring, Destructive and Nondestructive Testing, Optical Techniques, Damage Mechanics and Assessment, Prototyping and Full-Scale Testing, Vibration Monitoring, Residual Stresses, Laser Treatment.

Fatigue and Fracture Mechanics: Fatigue, Corrosion, Stress Corrosion Cracking, Fatigue Creep Interaction, Environmentally Assisted Failures, Brittle Fracture, Buckling, Impact Failure, Failure of Nanostructured Materials.

Composite and Cellular Materials: Fiber, Matrices and Interfaces, Polymer/Ceramic/Carbon/Metal Composites, Multi-functional Composites, Smart Structures and Materials, Processing/Fabrication/Recycling, Durability/Damage/Fracture, Health Monitoring and Reparability, nanocomposites.

Nanoengineering and Nanomaterials: NEMS and MEMS Technologies, Nanocomposites, Nanodevices, Diagnostics and Control, Nanosensors, Molecular Devices, Applications of Nanocomposites in Industry.

Tribology and Surface Engineering: Lubrication, lubricants and additives, Surface coatings and treatments, Gears and bearings, Micro-pitting, pitting, scuffing and wear, Surface integrity, Adhesive bonding, superhydrophobicity.

Mechanical Design and Prototyping: Mechanical Design, Product Development, Additive Manufacturing and Prototyping, Design for Manufacturing, Eco-design, Conversion Technologies.

Advanced Metal Forming and Metal Cutting: Advanced Forming, Cutting, Casting, micromachining, automation, sustainability, Virtual Manufacturing, reliability engineering.

Biomechanics: Mechanics and Design of Prostheses, Biomaterials and Biocompatibility, Stress Monitoring, Dental implants Orthopedic Biomechanics, Sports and Rehabilitation Biomechanics, Biofluid Mechanics, Medical Devices, Case Studies.

Impact and Crashworthiness: Modeling, Testing Techniques, Measurement in Dynamics, Earthquake Engineering, Crash-worthiness, Ballistic Studies, Energetic Materials, Impact Behaviur of Materials, Case Studies.

Energy and Thermo-Fluid Systems: Design of Advanced Energy Systems, Plasma and Plasma Coatings, Heat and Mass Transfer in Design, Experimental Fluid Dynamics, FSI, Interfacial Dynamics, Large Scale Eddy and Turbulence Analysis.

Manufacturing Engineering: Systems Engineering, Manufacturing Engineering, Safety Engineering, Sustainable Technologies and Processes, Risk Assessment, Product Reliability, Operations Management, Case Studies.

After a preliminary selection carried out by the Chairmen of the sessions dedicated to the new trends in mechanical design and product development, eighteen papers have been processed through *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science's* standard

Corresponding author:
Dario Croccolo
Email: dario.croccolo@unibo.it

peer review procedure. Ten papers were, eventually, accepted for publication, and then collected in this special issue. They are reported in the following order.

The first paper is dedicated to collaborative product development. The paper determines the characteristics of collaborative engineering, which have an influence on the quality of distributed product development. The derived quality attributes were condensed and adapted to collaborative product development in the four key areas of organization and processes, data/artifacts, information technology systems and infrastructure, and social factors. This enables product developers to examine their collaborative engineering environment and to identify room for improvement and to enhance quality. A case example of an engineering change order shows a collaborative data flow process, in which the quality attributes may indicate improvement measures.

The second paper concerns the development of functionally graded lattice structures produced by Additive Manufacturing (AM) technologies. The paper presents three AM-oriented numerical optimization methods, aimed at optimizing components made of: (i) bulk material, (ii) a combination of bulk material and graded lattice structures; (iii) an integration of solid, lattice and thin walled structures. The optimization methods were validated by considering the steering column support of a mid-rear engine sports car, involving complex loading conditions and shape. The results of the three methods are compared, and the advantages and disadvantages of the solutions are discussed.

The third paper investigates the damping properties of a commercial polymer concrete and its suitability as a filler of machine bed components to limit vibrations arising in machine tools and automatic machines working at high dynamics. Two main goals are targeted: (i) quantitative evaluation of the elastodynamic effects, due to the polymer concrete insertion into typical components of machine beds, in order to effectively assess its practical potential and (ii) determination of reliable models of the material. These are needed to simulate the dynamic response of new design solutions of machines featuring structural components filled with polymer concrete.

The fourth paper investigates the use of blast loadings and inverse modeling for the identification of the strain rate hardening model parameters of fiber reinforced polymers. An experimental setup allowing the generation of known and predictable blast waves, leading to repeatable dynamic response in composite plates and the measurement of the displacement and strain fields, is developed. The dynamic response of the plates is measured by means of high-speed cameras and a 3D digital image correlation technique. A suitable numerical model that is able to reproduce the experimental conditions and predict the blast response of the plates is developed.

The fifth paper deals with a probabilistic approach to the finite element modeling of dynamic fracture problems. It is proposed to model internal structural defects and inhomogeneities using the spatial distribution of strength characteristics, according to the normal distribution law. The probabilistic approach to modeling dynamic fracture is provided by the introduction of one additional parameter – the dispersion in the distribution of strength material properties. This approach provides the probabilistic nature to the initiation and development of cracks in the material at any scale level: macro, meso, and micro level.

The sixth paper deals with a new crawler hydraulic excavator designed for the purpose of energy saving, which contains an accumulator as a reversible energy storage component and a variable displacement pump/motor as an energy conversion element. This scheme belongs to the excavator boom potential energy regeneration method. When the boom is lowered, part of the hydraulic fluid contained in its rodless cavity is supplied to the accumulator and/or the rod cavity of the cylinder, thus recovering fluid energy. If the accumulator is full, part of the hydraulic fluid can be diverted directly into the motor to assist the engine operation.

The seventh paper investigates the influence of the thermal spray coating thickness on the evolution of residual stresses in layered materials. Therefore, thick stainless-steel coatings (ASTM 301) of different thicknesses are manufactured by wire arc spraying on aluminum alloy substrates (ASTM 2017A). For a better bond strength, a Ni–Al bond coat is first deposited. Furthermore, a numerically supported hole drilling strain gage method for residual stress field evaluation is proposed. Required calibration coefficients for the strain–stress transformation formalism, based on the integral method, are computed through finite element calculations using Abaqus software.

The eighth paper deals with the effects of thin hard film deposition on the strength of AA7075 under cyclic loading. Uncoated samples and samples with a DLC (Diamond-Like Carbon) surface layer were tested by a rotating bending fatigue machine within the range of 10^5–10^7 cycles. Two regression models were tested to study the relationship between fatigue strength and number of cycles within the range considered.

The ninth paper presents the technical analysis and results of an inquiry carried out by General Directorate For Railway And Maritime Investigations (DiGIFeMa) belonging to Infrastructure and Transportation Italian Minister. The target of this study is drawing how the prognostic theory can be applied to railway maintenance, in order to optimize procedures and operational features addressing railway safety. The case of study points on a HS railway vehicle derailment event, which has been analyzed in an Official Investigation Report drawn by Italian Transportation and Infrastructure Ministry.

Eventually, the tenth paper is devoted to the study of a solid circular plate being unilaterally supported along two antipodal edge arcs and deflected by a static central transverse concentrated force. It is clarified that two distinct mechanical responses are possible, depending on the angular extent of the supports; in the first kind of response, valid for small support angular widths, the plate rotates around the support lateral sides, lifting from the supports along their central zone. The plate deflection is analytically expressed together with the transitional value of the support angular width that describes the passage from the first to the second mechanical response.