Preface from the Guest Editors to the Special Issue

"Improvements in Materials and Power Transmissions"

Dear readers,

The main task of modern engineering science is to provide improved performance and reduced manufacturing costs while at the same time reducing the environmental impact of both the manufacturing and the utilisation of the engineering product. This can only be achieved by developing innovative solutions within these constraints as the human population continues to grow and demands placed on engineering products increase from day to day.

Optimization procedures are critical for efficient resource utilisation and product longevity. The application of optimisation techniques can result in cost-effective, resilient, and environmentally sustainable products. Currently, the optimisation of engineering products may be performed only through new and improved materials, by devising new and improved designs and solutions, or by applying new optimization techniques. An overview of these improvements has been gathered, and it is presented to the reader though the articles presented in this Special Issue.

The introductory article **"Product Design and Development according to the Project of Equipping the Summer Kitchen and Bar using Sheet Metal Bending Tools"** deals with the basics of sheet metal forming as applied to improved materials such as austenitic stainless steel X5CrNi18-10. An overview of the sheet metal forming process is provided (CNC based nesting, laser cutting and bending), complete with the modelling and application of CAD/CAM based design and manufacturing, together with advanced welding techniques such as TIG. Extra attention is given to the two modelling principles - bottom-up and top-down for the manufacture of parts. The article has proven that the application of modern engineering approaches and materials in combination with contemporary CAD/CAM programs significantly reduces the time required for product design, creation of product documentation, and preparation of the manufacturing process.

The article **"The corrosion behaviour of low-alloy steel 51CrV4"** deals with the corrosion resistance of another improved material, low-alloy steel 51CrV4. The material was put through a series of electrochemical tests to estimate the corrosion rate of the steel samples. The tests were performed in a sodium chloride solution bath both before and after subjecting the steel to specific heat treatment procedures, including quenching, as well as quenching and tempering. Furthermore, an additional set of electrochemical tests was performed on samples that had previously undergone the quenching and tempering process. These tests were designed to evaluate the corrosion rate under various environmental conditions. A separate electrochemical test was conducted to test the efficiency of two distinct corrosion inhibitors, glycerol and sodium thiosulfate pentahydrate. It was shown that sodium thiosulfate pentahydrate may be applied as an effective corrosion inhibitor, unlike glycerol which actually increases the corrosion rate.

The article **"Planetary Gear Trains Design Parameters Selection"** shifts the focus to power transmissions. It discusses the benefits that are inherent to the application of planetary gear trains (PGTs) as the superior replacement for conventional gear trains, notably because they provide a considerable reduction of size and mass while keeping or improving the torque rating, resulting in an ever-expanding area of applications. PGTs, especially complex multi-carrier PGTs, cover vast areas of technical knowledge. The selection of the various design parameters of the gear train is discussed, complete with the multicriteria optimisation protocol adjusted for basic types of planetary gear trains.

The diagnosis of rolling bearing failures is covered in the article **"Application of the VIBROT software for the diagnosis of rolling bearing failures"**. As manual analysis of vibrational failure data is tedious, the VIBROT software was developed to diagnose rolling bearing failure and rotary machines in general at the Faculty of Mechanical Engineering in Podgorica. The software is LabVIEW™ based, with some functions using MATLAB® support. Tests have shown that the VIBROT software can detect actual vibrations coming from failing or failed rolling bearings, and that its signal processing capabilities are more than adequate for have been used to test the efficiency of the developed software. The obtained results suggest that vibration diagnostics of rolling element bearings can be efficiently performed by means of the signal processing techniques of VIBROT software.

The article **"Application of Two-Carrier Planetary Gear Trains to Shifting Gearboxes"** explores the operation of two-carrier planetary gearsets having two connecting and two external shafts, which may operate as two-speed gearboxes when brakes are placed on two external shafts. The article introduces the torque method as a convenient method for the analysis of the S16WN(S/E) gearbox, after which all specific torques are determined, and the transmission ratios calculated. Kinematic analysis of the gearbox has been performed, the relative power flows identified, and efficiency functions calculated for both gear ratios. The diagram of the shifting capabilities of the S16WN(S/E) gearbox has been developed, and the importance and utility of such diagrams and the relevant equations explained. It was concluded that the S16WN(S/E) gearbox has a wide area of possible applications, and that two-carrier gear trains may experience an expanded area of application as an improved variant of planetary gear train.

The final article **"Analysis of the Shifting Capabilities of Planetary Gear Trains with Coplanar Planet Gearsets"** deals with a relatively unknown type of planetary gearset having coplanar paired planets, combined with a conventional simple planetary gearset. Methods for the kinematic synthesis of both gear trains are explored, and the achievable range of transmission ratios that can be achieved by the gearsets is analysed. The gear trains are checked whether they can operate as a reversing gear train within their design limitations. The geartrain with paired planets is of particular interest, as it can be built in a configuration that will have a transmission ratio of -1, enabling the design of complex gear trains having equal transmission ratios in both directions of rotation of the output shaft, especially useful for clean hydrogen-based rail transport.

As a final word, the Guest Editors believe that the improvements have been properly introduced, and that the readers will be encouraged to explore the areas covered in this special issue even further. We would like to extend our appreciation to all the authors that contributed to this Special Issue and shared the fruits of their research with the Proceedings of the Technical University of Sofia.

One special thanks from the Guest Editors is reserved for Prof. Rosen Mitrev without whose help and support this Special Issue would not have been possible.

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