Editorial

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Biographical notes: Aleksandar Subic graduated with a BEng (Hons) Degree in Mechanical Engineering, MEngSci and a PhD from the University of Belgrade. He is currently the Chair in Mechanical Design and Head of Mechanical and Automotive Engineering at RMIT University in Melbourne, and Director of the SAE-Australasia. He is the Editor-in-Chief of the *International Journal of Sustainable Design* and member of the Editorial Board of the *International Journal of Vehicle Design*. He has been the President of the International Sports Engineering Association (ISEA) from 2003 to 2007 and has founded and chaired the Asia Pacific Congress series titled The Impact of Technology on Sport. He is internationally respected for his research in the field of sustainable engineering design focusing on sports and automotive technologies and has published over 130 international peer reviewed publications in the field to date.

Mobility is an essential part of our lives. The ability to move freely is central to meeting our social and economic needs. For this reason we have embraced the car over the past century perhaps more then any other technology or consumer product. Today there are over 600 million vehicles on the world's roads with another 60,000,000 new vehicles produced each year worldwide. The scale of the automotive industry is enormous and far reaching. It is estimated that around two thirds of world's oil output goes to transportation whereby road vehicles alone consume around 40%. The automotive industry uses approximately 15% of the world's steel, 40% of the world's rubber and 25% of the world's glass, with the consumption of raw materials and other resources further growing due to the rapid development of the automotive sector in China and India. In addition, transportation accounts for around 25% of greenhouse emissions worldwide, whereby 90% of transport related emissions come from road vehicles, predominantly cars. Clearly, current levels of consumption and emissions are unsustainable. This in turn suggests that mobility as we know it, based on the traditional vehicle technology, and existing production and consumer practices, is unsustainable.

The challenge of developing new sustainable approaches to mobility confronts our societies. A recent report by the World Business Council for Sustainable Development (WBCSD) titled *Mobility 2030: Meeting the Challenges to Sustainability*, identifies the following 12 indicators that constitute the most important dimensions of sustainable mobility: accessibility, financial outlay required of users, travel time, reliability, safety, security, greenhouse gas emissions, impact on the environment and on public wellbeing, resource use, equity implications, impact on public revenue and expenditures, and prospective rate of return to private business. The concept of sustainable mobility is multidimensional and the challenge of achieving it is quite complex. Based on the current body of knowledge it is becoming painfully clear that there is no ‘silver bullet’ or single technology available at present to address this challenge. To succeed we will most likely have to pursue a range of different technologies and approaches with short-term and long-term gains. This includes improving existing vehicle technology (e.g., by increasing the efficiency of the engine and transmission, reducing weight and size, improving tyres and reducing drag), developing alternative fuels and power-train systems (e.g., electric, hybrid, hydrogen), changing the transportation systems and how vehicles are used.

The special issue of the *International Journal of Vehicle Design* titled *Sustainable Mobility, Vehicle Design and Development* aims to draw attention to the issues raised above and to highlight the need for new sustainable approaches to design and development of road vehicles. It presents eight selected peer reviewed papers from around the world that feature state-of-the-art research in this field.

More specifically, the paper ‘Sustainable management of vehicle design’ by Schmidt and Taylor presents the Ford Europe’s Product Sustainability Index (PSI) that is used as a sustainability management tool for vehicle design and development. The PSI incorporates eight indicators reflecting environmental (Life Cycle Global Warming Potential, Life Cycle Air Quality Potential, Sustainable Materials, Restricted Substances, Drive-by-Exterior-Noise), social (Mobility Capability, Safety) and economic (Life Cycle Cost of Ownership) vehicle attributes. Ford Galaxy and S-MAX were the first vehicles where this tool has been applied from the beginning of their development respectively. This work has been externally reviewed according to ISO14040.

The paper by Schiavone et al. titled ‘Strategy-based approach to eco-design: application to an automotive component’ describes how Rieter Automotive has integrated the environmental considerations into the product development process. The authors present a strategic approach to innovation in automotive design whereby the product strategic vision also includes environmental performance indicators. The developed methodological approach has been successfully applied to the design and development of a panel for the vehicle trunk. Also, an assessment tool for environmental analysis of automotive components is introduced.

Koffler et al. in their paper ‘Volkswagen slimLCI: a procedure for streamlined inventory modelling within Life Cycle Assessment of vehicles’ claim that one of the key prerequisites of environmentally-friendly product design is a continuous, quantitative assessment of the environmental profile of the different product design options. The application of Life Cycle Assessment (LCA) to complex technological systems requires considerable effort and time associated with the collection, interpretation and processing of relevant data. In order to address this problem the authors present a particular methodology developed at Volkswagen for automating the LCA process steps in a way that not only reduces the overall effort of conducting LCA studies, but also that offers advantages in terms of quality of results.

The paper ‘LCA of batteries in the context of the EU directive on end-of-life vehicles’ by Matheys et al. analyses the environmental implications of traction batteries for battery electric and hybrid electric vehicles. The paper presents the results of Life Cycle Assessment of different types of batteries referring to a single score for comparison. This analysis provided policy makers with clear information regarding the environmental impact of different battery technologies. The inclusion of batteries for electric vehicles on the EU exemption list can be interpreted as EU's desire not to restrict the development of clean vehicles despite the environmental impact individual components such as batteries may have. This is the primary reason why in this paper authors discussed in more detail the need for clean transportation, and in particular the role and importance of battery electric, hybrid electric and fuel cell electric vehicles respectively.

Energy control strategy, especially for drive power management, represents one of the main issues in the design of Hybrid Electric Vehicles (HEV). In order to reach the target of simultaneously optimising both fuel consumption and emissions, Chen et al. present an environmentally friendly and efficient fuzzy logic control strategy for a parallel hybrid electric SUV in their paper titled 'Simultaneous optimisation of fuel consumption and emissions for a parallel hybrid electric SUV using fuzzy logic control'. In this control strategy, an optimal torque provided by the internal combustion engine according to the driving conditions is firstly evaluated and then corrected by a fuzzy logic controller. The presented simulation results indicate that the proposed control strategy is more effective than the conventional electric assist control strategy (EACS).

The paper 'Virtual design of efficient twin-screw superchargers for sustainable power management in engines' by Li et al. presents a Computational Fluid Dynamics (CFD) approach to predicting leakage flows in twin-screw superchargers. Internal leakage, especially across the male and female rotor tip sealing lines and the blowhole, has a significant effect on supercharger efficiency. The virtual design approach described in this paper supports the development of efficient twin-screw superchargers for sustainable power management in engines under a wide range of operating conditions. The fact that today's IC engines have around 20% efficiency in urban driving and even less in real-world driving conditions, indicates that there is significant scope for improvement of engine efficiency through efficient turbocharging and/or supercharging.

Aleksendric and Duboka in their paper 'Artifical technologies in sustainable braking system development' present a systems approach to sustainable design of contemporary vehicle braking systems. The authors use virtual reality as the main design medium in conjunction with artificial intelligence. This approach allows for calculation, simulation, testing and/or verification of new brake designs within a virtual environment without the need for physical prototyping. The artificial intelligence tool that was developed for this purpose uses both theoretical and experimental data obtained for braking systems at the Frimeks laboratory.

In the past five years magnetorheological (MR) dampers have been successfully used by the automotive industry in semi-active suspensions. By controlling the current to an electromagnetic coil inside the piston of the damper, the magnetorheological fluid's viscosity can be changed, allowing for continuous change of the damping force in real-time. Paper by Hudha et al. titled 'Non-parametric linearised data driven modelling and force tracking control of a magnetorheological damper' presents a simple and effective modelling approach capable of describing the non-linear dynamic behaviour of MR dampers. The main objective of this method is to help reduce the cost and time associated with the development of this type of device for vehicle suspension systems and other automotive applications.

I gratefully acknowledge the authors and the referees who have made this special issue of the *International Journal of Vehicle Design* possible with their invaluable contributions. I would also like to thank Inderscience for their ongoing support and commitment to promoting contemporary research in vehicle design. I hope that this special issue on the multidisciplinary topic of *Sustainable Mobility, Vehicle Design and Development* will be of interest to the automotive technology researchers and enthusiasts whatever their scientific background or persuasion. Finally, I acknowledge that much remains to be learned, in particular about the ways of engaging all stakeholders around sustainable mobility issues in order to achieve the much needed change.