

Preliminary remarks on the current challenges facing materials engineering in Industry 4.0 development

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Abstract

Statement of the Problem: From the beginning, the material history of humanity has been based on the use of materials to meet human needs. In general, the approach to the production of products that provide utility functions of products has not changed since primitive times, as symbolically illustrated in Fig. 1. The pursuit of general well-being consisting in the fair satisfaction of people's needs without disturbing the balance of the biosphere can be imagined as one virtual resultant vector of the desired actions of all humanity, including representing various political, economic, educational, scientific, social, health, ecological, military and many other influences. Comprehensive actions ensuring progress and social and territorial cohesion are the essence of an economy based on knowledge and innovation. Innovations understood as valuable, innovative ideas are the basis for economic development regarding the production, distribution and implementation of knowledge, effectively ensuring the transformation of the economy towards sustainable development, and thus lasting progress in meeting the needs of societies. The stream of resources guaranteeing the expected progress of this transformation should be directed towards the most effective fields of science and industries, bringing the greatest added value and ensuring the most important civilization development priorities, taking into account the degree to which people's needs are met, including ensuring peace, improved quality of life and health, food and water, sustainable development, environmental protection, global and secure communication and information exchange, and a high level of education without exclusions. The current civilization challenges can be described by the acronym NIEBO (HEAVEN in English), taking into account nanotechnology, IT support in a very wide scope, ecology with a closed-loop economy, biocompatibility and bio neutrality of all products, and optimization of the functional properties of products and the related economic outlays. A developed information society solves various social challenges, especially those defined as the 17 Sustainable Development Goals (SDG) set by the United Nations and confirmed in the 2030 Agenda document. H. Kagermann's classic model of the current stage of Industry 4.0 contains only nine technologies IT systems referred to as cyber-physical systems, which the creator recognized as IT only after ten years. This model ignores the need for progress in the field of materials, without which no product can be produced, as well as machines and production technologies limited only to additive manufacturing, without taking into account the necessary development of all other technologies. The original Industry Integrated Idea 3x1 4.0 /5/0 model, showing two approaches of producers and consumers focused on the product. They are illustrated by parallel levels:

technological with four determinants, materials and multi-cyber physical factors, and consumer with ecology and economics, considered to be coincident horizontal factors. The model includes the three most important challenges regarding the sustainable development of engineering materials and the ongoing digitalization revolution, as well as ecological challenges related to the need to minimize the environmental footprint for the good of current and future generations.

Conclusions: The aim of the 26th International Scientific Conference AMME & bio is to present a wide range of modern engineering materials and advanced materials processing technologies to achieve contemporary civilization goals, in accordance with the 6 x E paradigm of six expectations that the engineering material meets to ensure the product's functionality.

Image

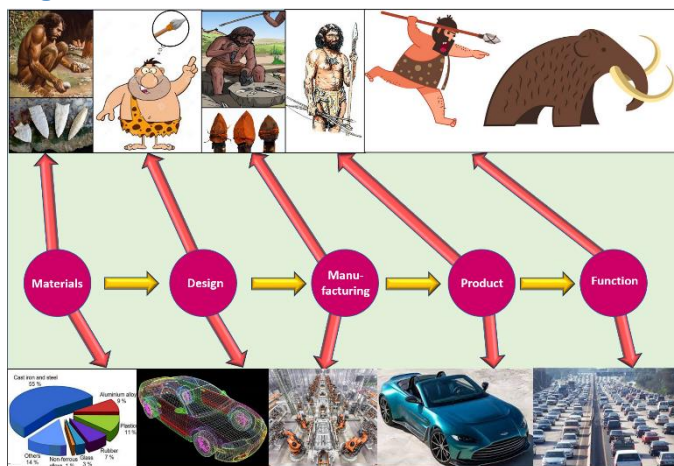


Figure 1. Consistency of the approach to designing and manufacturing products from the dawn of civilization to the present day

Recent Publications

1. Dobrzanski, L.A.; Dobrzanski, L.B. (2020) Dentistry 4.0 concept in the design and manufacturing of prosthetic dental restorations. *Processes*, 8: 525.
2. Dobrzanski, L.B. (2024) Advanced engineering materials and materials processing technologies in dental implant and prosthetic treatment with clinical cases, *Journal of Achievements in Materials and Manufacturing Engineering* 121/1 (2023) 5-43.
3. Dobrzanski, L.A. (2024); *Materials engineering and materials processing technologies fundamentals*; PWN, Warsaw, in Polish (in printing).
4. Kagermann, H.; Wahlster, W. Ten Years of Industry 4.0. *Sci* 2022, 4, 26.

Photography Biography



Prof. DSc, PhD, Eng. Leszek Adam Dobrzański, Honorary Professor, M.Dr HC has been a full Professor and Director of the ASKLEPIOS Science Centre for six years at the Design, Research and Production Center of Medical and Dental Engineering ASKLEPIOS in Gliwice, Poland. He worked in the years 1971 to 2017 at the Silesian University of Technology in Gliwice, Poland, as a full Professor (1995 to 2017), among others Vice-Rector (2012-2013), and Dean of the Faculty (1990-1993, 1999-2005). He is the President of the World Academy of Materials and Manufacturing Engineering WAMME, Vice-President of the Engineering Academy in Poland and a foreign member of the Engineering Academies of Ukraine and Slovakia, Editor-in-Chief of the Journal of Achievements in Materials and Manufacturing Engineering JAMME and Archives of Materials Science and Engineering AMSE. He is a Member of Editorial Boards, including Taylor & Francis, MDPI, ASTM International, and others. The title of Professor was awarded to him by the President of the Republic of Poland in 1995, and abroad second time in 2017 the title of Honorary Professor of the Lviv State University of Technology in Lviv, Ukraine, and three honorary doctoral degrees in 1997 from the University of Ruse, Bulgaria, in 2007 from the State University of Khmel'nitsky, Ukraine and in 2016 at the University of Miskolc (Hungary). His works are cited at least 18,000 times in world journals according to Web of Science, Scopus and Google Scholar, and the numbers of citations are: 16,694 (GS), 5,508 (SC), 3,191 (WS), h index: 54 (GS), 34 (SC), 27 (WS). He is the author of. Approx. 3,000 scientific publications and books (more to be published), including approx. 60 books, approx. 60 chapters in books, 250 papers in the journals referred on the Web of Science Core Collection, and over 120 lectures at the invitation of organizers of international scientific conferences in many countries. Research interests include materials, biomedical and dental engineering, surface engineering, organization and management, manufacturing engineering, nanotechnology and additive manufacturing and technological foresight.