HABILITATION THESIS

ENVIRONMENT-FRIENDLY MANUFACTURING PROCESSES IN CONTEXT OF TRANSITION TO SUSTAINABLE PRODUCTION

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Abstract

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This work presents my scientific and professional concerns and results of the researches published after obtaining the PhD degree in 2003 on the subject of ecological manufacturing techniques, with the work named ***Research on the ecological machining processes in manufacturing engineering*** (Supervisor: Acad. Prof.dr.ing. Csaba Gyenge).

The habilitation thesis, ***Environment-Friendly Manufacturing Processes in Context of Transition to Sustainable Production,*** focuses on the achievements that prove the author's ability to conduct a scientific activity in the industrial engineering, and specifically in the green manufacturing area. The personal achievements are integrated in a larger area of the current status of the scientific research in the domain.

The work is structured in ***three sections***. ***The first one*** presents the evolution of my professional and academic career. ***The second one*** comprises a sum of research results, representing the core of my scientific work done over the last years. ***Chapters 1-3*** of thesis present the recent developments in the field of environment-friendly techniques and sustainable production, highlighting the importance of the sustainable manufacturing technologies in achieving sustainable development objectives. Particularly, the machining processes constitute an important manufacturing activity that contributes to the growth of the global economy. Research and new developments in machining processes have improved manufacturing performances through higher process productivity, greater parts quality, advanced tool materials, while environmentally and health-friendly technologies are becoming increasingly important for achieving cleaner, healthier, and safer manufacturing processes.

One of the main environmental pollution sources related to machine building industry is the huge amount of cutting fluids which are supplied during the machining processes. In order to avoid the problems induced by cutting fluids usage, considerable progress has been recently made in the field of *Near Dry Machining (NDM),* called also *Minimal Quantity Lubrication (MQL).* Converting conventional processes to MQL method imposes new tasks classification within the tribological system in order to guarantee the process safety and product quality.

Chapter 4-8 are focused on investigating various aspects of machining process from an ecological perspective and concern the evaluation of *Dry Cutting (DC)* and *Near Dry Machining (NDM)* effects on gear milling, turning and milling efficiency, while machining several materials (AISI 1045, 42CrMo4, stainless steel AISI 314L, aluminum alloy $AlMg_3$) and give an overview on some requirements to be considered for successful application of

these environmental-friendly methods into industrial practice. Therefore, the research is mainly focused on evaluation of *DC* and *NDM* effects on process efficiency, with respect to surface quality, cooling effect, cutting forces, chips' shape and environment damage by comparing them with conventional *Flood Cooling (FC).*

Furthermore, the comparative analysis of environmental performance of DC, NDM and FC is performed using *Sima Pro 7.1.5 software* and the *EcoInvent1.5 database*, including combined *Life Cycle Assessment (LCA)*. Taguchi method for mixed level parameter design was used for the experiments' design to optimize cutting parameters. Analysis of variance *ANOVA* was used to determine the effect of machining parameters on process responses.

Chapter 9 gives a survey on sustainability issues related to *Additive Manufacturing* (*AM*). AM technologies allow developing and manufacturing very complex shaped parts and functional products with a high level of customization, being a great alternative to *Traditional Manufacturing (TM)* methods like injection moulding, die-casting or machining. Due to the importance of cleaner production in the field of manufacturing processes, sustainability of *AM* processes needs to be assessed in order to make easier its acceptance and implementation in the industry. Thus, the manufacturers can improve their competitiveness and profitability by considering the ecological aspects during the manufacturing step of a product.

The third section of habilitation thesis describes the career development and evolution plan for short and medium term, taking into consideration three main directions: the *professional, scientific* and *academic activity*. I am going to continue the research-development-scientific innovation activity through an interdisciplinary approach of sustainable production domain, aiming to establish academic and industrial partnerships. In the educational area, the purpose is to improve the teaching tools and the editorial visibility, to increase the quality of teaching-learning process, to adapt the teaching demand to the work market evolution, to improve the delivering and learning process by focusing it on the student through interactive activities.