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HABILITATION THESIS
– ABSTRACT –

Development of manufacturing methods for composite materials structures ...
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The habilitation thesis entitled "**Development of manufacturing methods for composite materials structures"** presents a synthesis of the didactic and scientific results developed after presenting the doctoral thesis.

The thesis includes new materials and manufacturing methods used in the composite industry with interdisciplinary applications. Considered the materials of the future, Fiber Reinforced Polymer (FRP) have migrated from frontier domains such as aerospace or military industry, to industrial area or various fields of activity. The thesis presents new materials, methods, or manufacturing concepts of FRP with applications in various fields such as medicine, the electric vehicle manufacturing industry, sports equipment, or wind energy production. Important aspects of the sustainable development of the composite industry using different polymers as matrices are also addressed.

The habilitation thesis is structured in three sections and included seven chapters. The first section presents the scientific, professional, and academic achievements of the candidate. The second section briefly deals with the most important scientific results obtained, and the third section contains the plans for the evolution and development of the university career.

Chapter one presents the scientific, professional, and academic achievements obtained in the activity carried out at the Technical University of Cluj-Napoca. The main scientific achievements are briefly presented, indicating both the most important scientific papers and published patents. The research projects in which I participated as a director, manager or team member are also highlighted. The most remarkable contributions regarding the didactic activity carried out at the Department of Manufacturing Engineering (IF) at the Faculty of Industrial Engineering, Robotics and Production Management within the Technical University of Cluj-Napoca (TUCN) are marked.

Chapter two presents the most significant scientific achievements in the field of using FRP in the manufacture of electric vehicle components. A new monobloc vehicle chassis concept is presented, made mainly of Carbon Fiber Reinforced Polymer (CFRP), using different Sandwich structures. The chapter also deals with the manufacture of a front hood made of CFRP in two variants. The first one is manufactured using the Black Metal Design (BMD) concept. The second one uses the concept of design and manufacture using the full properties of FRP. Applying this concept, the properties of FRP and its design methodology are demonstrated and highlighted. Starting from the concept phase, design, fabrication of CFRP molds, and hoods, evaluation of results and mechanical testing of hoods, the results show the main differences between the two concepts approached. New solutions for the interior elements of a new electric vehicle concept are also presented. These are made of CFRP and feature a minimalist design with complex shapes tailored to modern automotive design trends. The presented research is a result of some projects between UTCN and the company Belco Avia SRL from Bistrita.

Chapter three discusses the use of Glass Fiber Reinforced Polymer (GFRP) in medicine. New original biocompatible materials are being researched and applied to the manufacture of cranial implants. These are tested in VIVO on animal models. This study used modern and original GFRP manufacturing methods using rapid prototyping (RP) techniques and modern Computer Tomography (CT), scanning techniques. All these new methods applied in the medical field have led to outstanding results in the field of medical implantology. The research was carried out in the project "Customized craniofacial implants obtained by innovative 3D prototyping of composite materials reinforced with fiberglass, UTCN responsible Prof. Dr. Eng. Nicolae Bâlc.

Chapter four deals with MC applications in the field of performance sports. The introductory part presents research on the manufacture of bent and variable section tubes

made of CFRP. The methodology can be extended to other landmarks with complex tubular geometry.

Another application presented in this chapter is the rapid manufacture of CFRP components using modern manufacturing methods. AM and RP techniques are used to manufacture complex CFRP components. A new method of rapid mold manufacturing is proposed using a biopolymer, namely Polylactic Acid (PLA). The results of the new method are validated by obtained matrices and parts from CFRP using this new concept.

This chapter concludes with an overview of the process of making a nose for a Formula One (F1) car. Starting from the concept, design and manufacturing phase, a methodology is proposed which is validated through a dimensional evaluation of the obtained results. This research led to the realization of some CFRP components mounted on the first F1 car assembled at the university in the country.

Chapter five embrace the issue of waste from the production of FRP components. Using this waste, a new patented material is made and used in the manufacture of ornamental tiles for cladding buildings. A method of recycling waste from the production process of FRP components is proposed. The study is intended for companies producing FRP benchmarks that are generating significant amounts of waste.

Moreover, in the context of sustainable development, the chapter cover the research on the development of blades for vertical axis wind turbines (TEAV). This study presents the design and realization of the blades necessary for the TEAV generator. Modern manufacturing techniques are used to make the blades. This study is carried out together with the Technical University of Moldova in Chisinau and the Institute of Hydraulic and Pneumatic Research in Bucharest.

Chapter six presents plans for the evolution and development of the university career. Issues regarding the priorities for the development of scientific and didactic activity and the new research directions that will be addressed are discussed.

From a scientific point of view, the methods of short and medium term development of the future activity as well as the future research directions in the field of FRP are treated.

The didactic activity that presents a special role in our activity of teacher must be focused on the student, to create specific competences to the industrial field. The modern methods of improving the educational act and the perspectives of personal development in this context are exposed.

Chapter seven presents the final conclusions of the habilitation thesis. The most important aspects of the scientific and didactic activity covered in the habilitation thesis are briefly presented. The most representative results obtained in the field of Industrial Engineering applied in different fields are highlighted.

The habilitation thesis falls within the field of Industrial Engineering and deals with modern materials and methods of manufacturing advanced composite materials applied in various fields.