Habilitation Thesys

Theoretical and Experimental Contributions Regarding the Evolution from Mechanical Engineering to Industry 4.0

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HABILITATION THESIS SUMMARY

Theoretical and Experimental Contributions Regarding the Evolution from Mechanical Engineering to Industry 4.0 is the title of my Habilitation Thesis. It presents my professional evolution over 33 years of engineering activity (in a private technical company, research, and academics). It also highlights the original scientific results I obtained while working with several generations of students, engineers, and teachers. The scientific field addressed is transitory, going through the stages of technological development, from mechanical engineering to mechatronics and to the new concepts triggered by the innovative engineering of Industry 4.0. The thesis presents my activity after the conferment of the title of Doctor of Engineering (July 1999), namely the period July 1999 - July 2023.

During all this time, I carried out my activity within the Department of Machines-Tools and Cutting Tools / Department of Machines and Production Systems (currently Robots and Production Systems dept.) from the Faculty of Technology of Machine Building, which became the Faculty of Engineering and Management of Technological Systems (presently called Industrial Engineering and Robotics) from the University POLITEHNICA of Bucharest (UPB). I started this activity on October 1, 1990, with the completion of my studies, first as a research engineer (period 1990-2000) and continuing as a university lecturer (period 2000 - 2016) and associate professor (from 2016 to the present).

In the Habilitation Thesis, I presented the evolution of **my professional, academic, and scientific activities**. Its final chapter lists some guidelines for my future career to consider in the context of industrial globalization and the scientific and technological innovations triggered by Industrial Engineering by the concepts of Industry 4.0.

I also highlighted my capacity to:

• coordinate a teaching and research laboratory, Smart Pneumatics Lab, from 2021 (former BIBUS Technology Centre, between 2008 - 2021), located in room CB110 of the Robots and Production Systems department of the Faculty of Industrial Engineering and Robotics;

• work together with colleagues from different generations within the department that I am a part of respectively:

- in the team led by Professor Nicolae Predincea, that I have been part of since my fifth year of faculty;

- in the team led by Professor Constantin Ispas (former dean of the faculty);

- in the team led by Professor Constantin Dogariu, with whom I developed many engineering projects applicable to industry, thus leaving the "ivory tower" of the university professor and learning about the importance of collaboration with the industry;

- in Professor George Darie's team, where I learnt how international relations trigger high-level academic and professional openness, etc.

- raise the students' and young colleagues' interest in the research activity;
- organize and manage didactic activities within the faculty;
- explain and facilitate learning and research through modern means (through a public-private partnership, we created our own e-learning platform – TIMV, but also the AVRENG project - Augmented and Virtual Reality for ENGineering);
- work in collaboration with other Romanian research teams (Institutul de Chimie Fizică Bucharest, Impromedia Bucharest, with more than 30 other small, medium and large companies) and abroad (Consiglio Nazionale delle Ricerche, Rome, Politecnico di Torino, Italy, ENSAM Cluny, Institute Image de Salon sur Saone, France, Aventics Eger, Hungary, etc.), collaborations that triggered joint research and educational projects and publications in highly-ranked journals.

The Habilitation Thesis unfolds into four main parts:

After the chapter dedicated to the motivation of the Habilitation request and the summary of the Thesis, I presented:

I) In the first part, professional, academic, and scientific achievements since the defense of the Ph.D. thesis (the period July 1999 - June 2023) are briefly structured;

II) In the second part, there are some of my professional and academic competencies and the research areas in which I run my activity;

III) In the third part, one can find personal objectives for the future development of my university career as a Ph.D. supervisor;

IV) In the last part, one can find the list of my scientific articles (only those presented and published since the defense of the Ph.D. thesis) and some international scientific papers citing my works.

The first part of the Habilitation Thesis includes three chapters: *the evolution of the professional, academic, and scientific career and the contributions to the field of Industrial Engineering*. Each chapter contains two subchapters: **the period before** and **after my Ph.D. thesis defense**. In addition to the didactic, professional, and research activity run, these three chapters highlight my responsibilities in the field of education and as a scientific contribution to the development of Romanian engineering and research. They also emphasize my work of guiding

students (enrolled in undergraduate and master's study programs in the fields of Industrial Machines-Tools and Robots) in curricular and extra-curricular research activities. Some aspects of my collaboration with industry specialists, many of whom are our former students, were also presented.

Part two - *Professional and academic competencies and research areas* refer primarily to the specialist's ability to acquire theoretical information at the highest level and, where necessary, the development of practical skills in accordance with theoretical notions. The last paragraphs briefly introduce the research areas I have prepared for and that I have been active in during the 33 years of professional activities.

I divided the professional skills into general (soft skills) and basic skills (hard skills), which were the basis of my entire technical-scientific activity in academic engineering. The research areas refer to the needs of the Romanian and international labor market, but also to what the evolution of technology triggered in mechanics and electromechanics, and lastly to Industry 4.0 and the sustainability of the engineering activity. Therefore, aiming to be well-prepared for these ongoing challenges, I correlated my training and field of expertise.

Part three - *From Mechanical Engineering to Industry 4.0 – The most important result of the research activity* is the most extensive part of the habilitation thesis. It contains results presented into technical-scientific categories approached over the years, maintaining the "Mechanical Engineering - Mechatronics - Industry 4.0" axis. I also introduced my research outcomes as follows:

- **the field of Machine Tools** (the dynamic behavior of the main shaft of the machine tools in different stages of machining),

- **the use of oxidic materials (technical ceramics) in mechanical fields** (the quality of ceramic materials obtained by classic technologies, the behavior of ceramic products in various mechanical assemblies, the comparative, static, dynamic, and thermal analysis of the use of classic bearings and those made of technical ceramics, etc.);

- **the use of computer simulation in industrial engineering** (mathematical modeling and simulation of the operation of stepper motors, the use of computer applications for the analysis of pneumatic systems, etc.);

- **the use of virtual reality in industrial engineering** (the perception of absolute distances using various VR technologies, the use of virtual reality in industrial training, and the use of virtual immersion technology in the design of industrial systems, etc.).

Part four - *Career development plans* - refers to the continuation of the activity within the Smart Pneumatics Lab., of the Robots and Production Systems department. This part of the thesis presents some ideas for the continuation of the already started projects, as well as new research ideas

that will take into account the new priority of the European Commission in the context of imposing sustainability in all fields using the UN strategy - Sustainable Development Goals.

I truly believe that my Habilitation Thesis will give me the opportunity to carry out my activity even more dynamically within the Industrial Engineering Doctoral School of the Faculty of Industrial Engineering and Robotics. I will continue to focus, as a Ph.D. coordinator, on the following three directions: **research activity** (including dissemination/utilization of results at the highest national and international level), **educational activity, and professional collaboration activity with the industrial and academic environment internationally**.

Together with students and future Ph.D. students, I will strive to give even greater importance to the development of the Smart Pneumatics Lab (www.smartpneumaticslab.eu) so as to accredit it for integrating it into the national and international circuit of technical-scientific research.