

Teza de abilitare
Cercetări privind soluții integrate de creștere a productivității prin modelarea și simularea fabricației

Summary

The habilitation thesis includes my professional achievements and scientific contributions over 20 years from obtaining my PHD in the Industrial Engineering field with the title: *Theoretical and experimental research through the optimisation of the machine tool-elastic devices-foundation system*.

The first chapter of the thesis focuses on a short description of the achievements both from the academic and scientific research point of view.

Academically I have lectured, led projects and laboratory work in the following courses: *Machine Tools Vibrations, Robots vibrations*. Additionally, I have introduced, improved and taught new topics in Machines and Production Systems department programmes of studies like: *Modelling and simulation of technological systems, Machine-Tools Dynamics, Simulation of production, Machine-Tools Retrofitting, The virtual design of manufacturing systems, Simulation des systèmes intégrées* (in French), *Equipment for assistive therapies* .

I have led bachelor projects (over 50 projects), dissertations (over 60) and I have taken part as committee member in 17 PHD panels, mostly in the Industrial Engineering area. I had carried out research activities leading fifteen doctoral students who finalised their PHDs during this period.

From 2009 I have developed as coordinator the master programme *Conception Intégrée des Systèmes Technologiques* (in French), within Engineering and Management of Technological System Faculty and in 2011, I have founded a new specialisation, the master programme *Echitera - Equipment for Rehabilitation Therapies*. I have led the team which studied at that point the curriculum of various universities in Europe in order to propose an appropriate European curriculum for the ECHITERA master programme.

With the focus on providing quality study materials for students I have published 7 books, 4 courses books, 3 laboratory reference books (leading author for 2 of each category).

In terms of research I have obtained significant results based on scientific research and implementation of grants / research projects on three main topics with interdisciplinary themes:

1. Researches on the learning content development dedicated to online and collaborative training environment (Chapter 1).
2. Optimisation by modelling and simulation of the manufacturing processes (Chapter 2);
3. Researches to improve technical performance of machine-tools and equipment against shocks and vibrations (Chapter 3).

The research activity objective was to improve productivity by manufacturing modelling and simulation, beginning with the technical performances of the machine tool or other components of the production process and ending with research made on the material flow. Those themes are justifying the title of my habilitation thesis: *Research on integrated solutions to improve productivity by manufacturing modelling and simulation*.

I have consistently participated at research activities ever since starting the employment with UPB.

I have been selected to lead 7 international educational projects (4 as director and 3 as project lead from my university), like: Leonardo da Vinci project “*Formation des formateurs dans l’implémentation des nouvelles technologies*” - 1998, Leonardo da Vinci project “*An internet-based education/training platform in the field of supply chain management, for students,*

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teachers and industrial employees” (2004-2007), the project Socrates thematic networks - 109881 - CP -1-2003 -1- ES- ERASMUS- TNPP “THENEXOM – European thematic network for the excellence in operations and supply chain management education, research and practice” (2003-2005) and Socrates – MINERVA project: CP 71206 – 2000 – 2- MINERVA – ODL: “FAVIR- ODL International virtual network for Future enterprises” (2000-2002).

I lead also 11 national research grants (8 as director, 3 as project lead) like : CEEEX 41/2006 “*Research of the design and technologies of industrial products, taking in account the environmental sustainability*”, the Research of Excellence Programme 2005-2008, INFOSOC, 2005-2007, CEEEX 257/2006 “*Technical and performant devices to reduce the shocks and vibration in order to improve the equipment’s performances*”, Module 1, 2006 – 2008 – AMCSIT and CEEEX 241/2006 “*The virtual techniques implementation to generate and improve the industrial sector*”, AMCSIT, 2006 – 2008. I participated also in research activities as member in 31 research contracts.

All the research grants are awarded through national and international selection.

I have published 29 articles (24 proceeding ISI and 5 in ISI journals) as well as 26 articles in International Databases and 73 in national and international Proceedings. Most of the articles have been focused on the latest research findings. The recognition and the impact of my scientific activity have also led to being selected and taking part to the editorial board or the scientific committees of 4 journals and 10 national and international scientific conferences.

The expertise developed in my academic career led to being selected and involved like expert evaluator in the national assessment of research projects in CNCSIS, AMCSIT, and ANCPDEF as well as international assessment with the European Commission.

Chapters 2 and 3 covers the evolution plan of the scientific research developed during the recent period, starting with 1997. The research has been focused on 2 areas: integrated solutions to improve the productivity by manufacturing modelling and simulation and the design of high performing technological systems through mechanical signature.

The simulation is defined as the process of design and implementation of a new model, or to diagnose an existing system behaviour and to evaluate a large number of possible strategies to improve it. In this case, the model could operate in parallel with the production and be used as a performance model or algorithm or an optimization strategy aiming to increase system performance. In the chapter 2 I had analysed the manufacturing systems taking in account the input data, the constraints, the statics studies and to establish the cycle time for the machines tools and equipment, by presenting the principal contributions resulted from the researches and the studies of manufacturing systems. I presented the modelling and simulation advantages, and also the alternatives to improve the manufacturing processes taking in account the applied constraints.

The chapter presents some elements of the queue theory, technique of modelling of the material flow, taking in account: material flow, the manufacturing time, the exponential distribution, the buffer’s characteristics and the continuous supply with material of the first machine existing in the flow. The theoretical details and the practical examples lead to the optimisation of manufacturing systems by applying modelling and simulation techniques. Optimization algorithms usually allow the functions decreasing, an example being the cost of final products. For existing products, the simulation process could improve their performance and quality.

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All of the research has been developed in collaboration with researchers, colleagues included as co-authors in the scientific papers mentioned in the bibliography as well as specialists from target companies. In both chapters, my research approach was also to promote and integrate the concept of industrial products sustainable development.

In the chapter 3, we have designed and realized the prototypes for some alternatives of elastic couplings that may overtake and transfer axial forces simultaneously with torque moments; can be installed and disassembled without affecting the equipment; the coupling does not generate overloads and vibrations on large radial or angular deviations between the driving shaft and the resistant shaft; the coupling may be installed and operational upon reliable and safety conditions including high explosion risk environments; the coupling does not require special technologies and machining for its fabrication since the coupling is robust and reliable.

In order to minimise the negative effects generated by the shocks and vibrations, another subject of research was to find a new solution in the passive isolation on the foundation, by means of some special devices capable to damp the entire frequency range during the cutting process. In the chapter 3 are presented also some new devices with controlled elasticity and dumping to increase the dynamic behaviour of the equipment and machines, realised by means of sandwich structures adaptable to stress and non-linear behaviour. The devices are studied in some research contracts beginning with the theoretical model, the simulation and experimental research activity through the prototypes finalised also in those contracts. There are presented also the results obtained in two industrial societies where we made experimental research with the new devices.

We made also a research activity through new materials that we could use to make elastic devices to improve the dynamic behaviour of machine-tools and equipment. We established the value of Young's modulus for three specimens at different span lengths in order to have a more accurate value. The specimens used were laminated composite carbon fibre oriented unidirectional made in Italy and tested on an Instron 3367 using the three point bending method. The research results are published in 24 ISI proceedings articles, 5 ISI journal articles and 25 articles in BDI.

The concluding chapter of the thesis, chapter 4, covers my planned future activities. The activities follow academical (educational activities) and scientific research (focused on future developments). The future research activities will be developed in close collaboration with the master programmes (these will represent possibility to select prospective PHD students) as well as Bachelor ones.

The curriculum of these 2 types of programmes will be adapted to the PHD one. The methodology of integrating these educational pillars for providing high quality educational services based on research activities is also covered in this chapter.

The research directions developed so far will be pursued further in depth in accordance with the current trends imposed by Industry 4.0. I am also proposing the expansion of the research in the area of customised assistive equipment in collaboration with the master programme I am coordinating. The applied research will be channelled to the local and national socio-economical users.

The last section of this paper includes a selection of bibliographic references. The purpose of this section is to showcase my ability of leading research activities in the presented research areas. All of the scientific contributions and innovative solutions are supported by clear references and public info related to the professional activity since obtaining my PHD.

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