



**Transilvania  
University  
of Brasov**

# **HABILITATION THESIS**

## **SUMMARY**

**Title: CONCEPTUAL AND APPLICABLE DEVELOPMENT OF SPEED INCREASERS  
USED IN THE CONVERSION OF WIND OR HYDRO ENERGY INTO ELECTRICAL  
ENERGY**

**Domain: Mechanical Engineering, Mechatronics and Robotics**

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## A. Summary

The habilitation thesis entitled *Conceptual and applicable development of speed increasers used in the conversion of wind or hydro energy into electrical energy* is part of the author's research activity carried out during 2005-2018, after obtaining the PhD degree in February 2005 in Mechanical Engineering at Transilvania University of Brasov.

The habilitation thesis approaches a research topic in the field of *mechanical engineering* by referring directly to mechanical speed increasers used in wind turbines / hydropower plants. The interest in the implementation of renewable energy systems has significantly increased over the past decades due to the high prices, low stocks and the negative environmental impact of using fossil fuels. Among the renewable energy sources, the use of wind / hydro power to generate electricity is distributed worldwide as a feasible and affordable alternative to conventional solutions.

The reason for choosing this topic is based on *the need to have a compatible connection between the wind rotors / hydro turbines, which have increased efficiency at low speeds, and the electric generators, which have higher efficiency at higher speeds*, therefore, loss reduction, weight, cost, and the increased conversion efficiency of the wind / hydro system are challenges in designing the speed increaser.

*The main objective of the thesis* is the conceptual development of speed increasers by elaborating, under certain conditions / requirements, of some *principle solutions materialized by optimal kinematic schemes*, on which is further based the embodiment design.

My own scientific research direction refers to speed increaser with gears or chain, used to convert wind / hydro power into electricity. This implies the development of new types of speed increasers based on the expansion of existing solutions to enable their manufacturing, testing and patenting, as well as the development of kinematic models for the considered transmissions, which poses particular problems. Following these goals, the work is structured on *two research directions*, these directions contain scientific, theoretical and / or experimental own scientific contributions, referring to: I. The conceptual design of planetary speed increasers with gears and / or chain and II. Research on the kinematics of chain transmissions, concerning the contact point between the chain and the sprocket.

In case of speed increasers with gears, 22 conceptual solutions have been obtained through the combination of the technical solutions identified in the state of the art, from which,

based on multi-criteria evaluations, eight innovative solutions have been identified for which the kinematic and static modeling is performed for the evaluation process; some of them are already the subject of patent applications and others are in the process of drafting the patent documents. The study of planetary speed increasers used in renewable energy systems that are generated by reversing the energy flow in gear transmissions was the subject of the research grant *no. 4GR28052007 / 28.05.2007*, in which the author was part of the team. The research on chain speed increasers allowed two patents to be obtained, one of which was manufactured to be implemented in a microhydropower plant, as the outcome of the PNII research contract *no. ID 140 / 2007-2010*. The study of these types of chain speed increasers has led to the *second research direction* which deals with the problem of transmitting forces between the chain and sprocket for each contact point; thus, a first step consisted in choosing a bush-type transmission for which the *point of contact between the bushing and the sprocket* was kinematically analysed by varying the significant parameters. This kinematic study is part of a research grant in which the author is *scientific manager - responsible for chain testing (Chain Drive Systems - Dynamic Tribology, Contract with Schaeffler, No. 4029 / 26.03.2008, Act No. 3 / 01.02.2012)*; in this study, different types of chains and wheels geometries are addressed, which can significantly influence the transmission dynamics and the friction losses.

The results presented in this habilitation thesis represent the scientific research carried out by the author after obtaining of the PhD degree and are gathered within **4** research grants, **2** patents and **4** patent applications, **11** papers indexed in ISI journals, **22** ISI / BDI indexed articles and **31** other articles published in non-indexed conferences.

These results supported the elaboration of **6** monographs (for the monograph *The Role of Mechanisms in Sustainable Energy Systems* received, together with the other authors, the "Constantin Budeanu" Romanian Academy Award) and of **2** textbooks; these materials are used as reference in the disciplines of *Mechanisms, Conceptual Design, Product Design Basics and Wind Systems*.

Although these directions seem to be covered in deep, they open new horizons for innovative research by implementing them in the conversion of wind / hydro power into electricity; thus, the following new directions can be mentioned: *The expansion of the base of speed increasers that allow extra power input, by increasing the output torques with counter-*

*rotation transmissions, Dynamic developments regarding the influence of the static torques at the speed increasers starting, Study and dynamic behavior of the chain transmissions concerning the distribution of forces on each tooth etc.*

In the end, the habilitation thesis is presenting synthetically the evolution and development plan of the author's teaching, scientific and academic career, in which he emphasizes the way he will continue his activity in the specified research topics; the extension of the research methodology for the development of the ideas previously formulated is envisaged in *future developments*, which will allow teaching and research activity involving bachelor, master and PhD students from the Faculty of Product Design and Environment. The expected results will be disseminated in ISI / BDI indexed articles, enriching the base used in the periodic updating of the teaching courses.

The sustainability of the professional development plan is based on the acquired and proven skills and abilities (as author or coauthor) through: 8 monographs, 3 book chapters in foreign publishing houses, 2 textbooks, 3 laboratory guides / 149 articles (28 of them published in ISI indexed volumes / journals, 17 indexed by SCOPUS), 22 research grants (2 of them as coordinator and 1 as scientific manager), 8 patents, 11 patent applications and 1 industrial model protection.