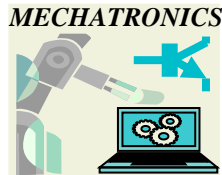Politehnica University Timişoara
Mechanical Engineering Faculty
Mechatronics Department

MECHATRONICS

HABILITATION THESIS

Modeling, simulation and experimental research

on technical and biological systems

Argeșanu Veronica

Abstract

2016

Abstract

The current thesis is the consequence of the author's research efforts during the 2000-2016 period at Politehnica University Timișoara, being focused on: 1. Constructive and functional optimization of the mechanical face seals through modeling, simulation and experimental work; 2. Constructive and functional analysis of machine parts used in road vehicles; 3. Modeling, simulation and experimental work on biological systems.

This holds only a part of the research in mechanical systems design, road vehicles design and ergonomics during the time mentioned, research that embedded diverse areas from analytical modeling, finite model modeling and experimental work to application fields such as road vehicles ergonomics and medicine and maxillofacial ergonomics.

In the recent years it has become more clear that the technical systems evolution is strongly influenced by the outbreak from materials science domain, advanced technologies, information technology and electronics and mechatronics.

This allows the increase of research and optimizations in mechanical construction domain.

Since the *Phd* thesis elaborated in 1998 the professional activities in the field of research and education had the topics related to mechanical engineering, flow and heat transfer in mechanical face seals and ergonomics. Until 2007 the topics were mostly in the field of mechanical engineering, specifically mechanical face seals, joints, clutches, gears as a result of research contracts from the national level (CEEX 21 I 03/07.10.2005/, *Research about the possibilities of using robotic systems with the ai of increasing Romanian industry*; 36/1999 cod CNCSU 204/1999, *Means and methods for mechanical transmissions and its components research :Results implementation in education units and economic units with industrial profile*, 36/1998 cod CNCSU 280/1998, *Means and methods for mechanical transmissions and its components research Experimental research),* international -FP7 250485/2010 ThinkMotion or with private partners. - S.C. ROSEAL S.A and because the activity was oriented in the machine design field –applications and teaching, construction and design of road vehicles teaching.

So, this was the reason for making the experimental research. The research results were published in 6 ISI Journals, 16 ISI Proceedings and IEEE Explore papers, 39 in Scopus database, 53 in other database-Google (Scholar) Academic.

The issues that were considered were

1. *Constructive and functional optimization of the mechanical face seals through modeling, simulation and experimental work*;

1.1. Argeșanu,V.;Popa,A., The elastohydrodynamics (EHD) lubrification of a mechanical face seal , The revue of Tribology Fascicle VIII, „The Annals of University Dunărea de Jos of Galați", ISSN 1221-4590, 2004, pp.   136 – 139.

1.2. Argeșanu,V.;Mădăras,L., Model and analysis of a Mechanical seal by Finit Element Method. Interface Tension Distribution, Facta universitatis-series Mechanics; Automatic control and robots, ISSN 0354-2009, 2003, Vol. 3, no. 15

1.3. Argeşanu,V.;Popa,A., Interface contact pressure distribution in Dynamic contact face seals, analyzed by FEM, 3rd International Conference With International Scientific Comitee Research and Development in Mechanical Industry,RaDMI, ISBN   86-83803-10-4, 2003

1.4. Argeşanu, V. ; Kulcsar, R.M.; Borozan, I.S., Automotive Mechanical Face Seals Tribological Simulation, Journal of the Balkan Tribological Association, ISSN 1310-4772,   2011, Vol. 17, no. 1, pp. 1 -12.

1.5. Argeşanu, V.; Kulcsar, R.M.;Farkaş, I.A., Calculation by Finite Element Method(FEM) of Temperature Distribution in the Components of a Mechanical Face Seal, Journal of the Balkan Tribological Association, ISSN 1310-4772, 2011, vol. 17, no.1, pp.13-20.

2. *Constructive and functional analysis of machine parts used in road vehicles;*

2.1. Argeşanu, V.; Luchin, M.; Jula, M.; Mărgineanu, D., Considerations Upon the Circular Section Circlips/Retaining Rings Axial Load-Carrying Capacity, ANNALS of DAAAM for 2008 & Proceedings of the 19th International DAAAM Symposium, ISBN 978-3-901509-68-1, 2008, pp. 33-34.

2.2. Argeşanu, V.; Jula, M.; Cărăbas, I., Determination of the Optimum Variant of Shaft-Hub Joint for Gears, ANNALS of DAAAM for 2009 & Proceedings of the 20th international DAAAM Symposium, ISBN   978-3-901509-70-4, 2009, vol. 20, pp. 1881-1882.

3. *Modeling, simulation and experimental work on biological systems;*

3.1. Argeşanu,V.;Kulcsar R.M.;Borozan I.S., The drivers spine analytical model   International Journal of Biology and Biomedical Engineering, ISSN 19984510, 2014, vol. 8, pp. 172-178

3.2. Kulcsar R.M.; Borozan I.S.; Argeşanu V., Experimental determination of the intervertebral stress, 12th IEEE International Symposium on Inteligent Systems and Informatics (SISY), 2014, pp. 303-307.

3.3. Streian, F.; Argeşanu, V.; Kulcsar, R.M.; Borozan, I.S.; Jula, M.; Talpoș-Niculescu, C., Human Body Posture before and after Maxillofacial Surgery, Procedia Engineering,   ISBN   1877-7058, 2014,Vol. 69, 508-511.

The first part refers to the optimization of the mechanical face seals from the point of view of construction criteria and functioning, the specific conditions concerning the environment and the durability have a great impact on the construction of the mechanical equipment. The complete adjustment of all the types of mechanical seals implies additional anticorrosive and calorific protection of the elastic pre-tensioned component, the cooling of the surface, which are in contact, and recirculation and/or the evacuation of the discharge flow.

A great diversity of contact-seals designs, materials, operating conditions, and factor that affect their performance have not yet allowed the general conclusions on friction and wear of these seals to be drawn.

The simple model of the complex friction between the surfaces in contact, when taking into account the hydrostatic theory of lubrication, is functional both for convergent surfaces and for divergent ones, with the necessary particularities. If the hydrostatic effect of lubrication is combined with the mechanical effect of the solid contact with friction, the problem of mixed friction that appears at mechanical face seals can be solved. Afterwards, the hydrodynamic effect of lubrication can also be introduced.

There are various causes for face seal leaks. Leakage normally takes place through the radial seal gap formed by the two sliding surfaces. Calculations are based on the assumption that a hydrodynamic film exists in face seals and that the leakage can be calculated in accordance with the known equations for laminar flow through a radial annular gap. The form of the surfaces can, however. Be altered by heating and wear, for instance.

Modeling to access solutions is the goal of predictive engineering. The research deals with the boundary element analysis or the numerical simulation of the behavior of a mechanical face seal. The present boundary element analysis is a particularly one for it contains the nonlinear effect due to changes in boundary conditions resulting from the contact of the static ring and the sealing head of the face seal. These all have significant influence on the behavior of the system. The results can be used for optimizing designs, predicting limits or investigating failures.

In the second part the focus is on the constructive and functional analysis of machine parts used in road vehicles:

Some interesting aspects about the strength of helical gears are presented: the beam strength and the surface strength. A ''minimum modulus'' that guarantees the resistance of the gear at both strength, the beam strength and the contact strength as a ''remedy'' is proposed. The PC is utilized in order to ensure the arguments;

The analysis is devoted primarily to the design of helical gears to resist bending failure of the teeth and to resist pitting of failure of the tooth surface;

the evolution of the constructive solutions of the joint that form the cylindrical fitting specific to the gears determined the occurrence of some typified families whose carrying capacity tend to equal the performances obtained by the joint by shrinking joints;

Experimental data regarding operational stats and thermal stats of an automatic gearbox are presented. Experimental data regarding the operating pressure and the command of the solenoid actuators is being expressed in percentage and current, is being recorded on the hydraulic test rig for establishment and optimization of the clutches, and brakes operations from an automatic gearbox;

The purpose of the research is to point out a controlled vibration quarter car model of a human body in seated position. Its importance is mostly due to the vertical accelerations impact of the human body and be able to control these vibrations. It marks these vertical accelerations based on a concentrated mass mathematical damped model. This is first established mathematically and then simulated in Matlab software, its results clarifying the differences between accelerations at different parts of the model and their range.

The third part is about ergonomics as a human centered design and presents the candidate contributions in the biological systems area. This is the main area in which the candidate has made the latest research as a result of research contracts at the national level- Manager- Contract CNMP/PNCDI 2, Nr 91-022/18.09.2007 – 2010: *Workplace ergoengineering. Dental medicine applications,* or with enterprise partners-Honeywell, researcher key-expert researcher, in contract AMPOSDRU 1477/24.03.2010, ID 55651- *Ergonomics, prevention and performant management in dental medicine by alignment to European standards*, CNMP/ PNCDI 2 no 41-034/14.09.2007 MICRODENT-*Clinical protocols in dental microscopy applications*, CEEX 116/04.08.2006 with Medical Science Academy Bucharest – *Studies regarding the modular dental equipment based on mechatronics systems; ergonomic solutions for the double prevention of medical diseases*, CEEX 88/2006 –*Development and implement of*

performant systems of spine deformities on school population and professional categories with sedentary lifestyle investigation and recovery, the great collaboration on national and international scale with SRED (*Romanian Dental Ergonomics Society- Societatea Română de Ergonomie Dentară*) – founding member and vicepresident, ESDE (*European Society of Dental Ergonomics*), specially with Prof. Rotgans Jerome from Medical Faculty, RWTH Aachen University –the president of ESDE and Chairman of the Study Group 'Dental Ergonomics' of the German Dental Association, founding member and president of SRE (*Ergonomic Romanian Society* -Societatea Română de Ergonomie-) and material base development through personal effort.

Another contribution has been the involvement in POSDRU contract-Potebntial future PhD leaders, Contract AMPOSDRU/21/1,5/G/13798 *Doctoral school in research aid through European context* "*Școala doctorală în sprijinul cercetării în context european*" in which I guided two doctorate students, As. Dr. Eng. Kulcsar Raul–Miklos (*Ergonomic research regarding the spine behaviour during the drive*) and As. Dr. Eng. Borozan Ion-Silviu (*Automatic gearboxes parametric quality analysis regarding the improvement of the technical and functional characteristics*).