

Habilitation Thesis

**EXPERIMENTAL AND NUMERICAL  
FLOW INVESTIGATIONS  
IN HYDRAULIC MACHINES**

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2017

In memoriam  
Prof. Dr. Eng. Doc. Dr.H.C. Ioan M. Anton,  
member of the Romanian Academy  
(1924 - 2011)

## **(a) ABSTRACT**

The habilitation thesis summarizes my research activity after public defending the PhD Thesis at Politehnica University of Timișoara and received the confirmation no. 4189/29.07.2002 from Ministry of Education and Research. The scientific, professional and academic achievements included in the habilitation thesis cover the period from 2003 to 2017.

I am full time senior researcher (1st degree since 2008; 2nd degree during 2002 – 2008) at Hydrodynamics and Cavitation Laboratory from Romanian Academy – Timisoara Branch, Center of Advanced Research in Engineering Sciences, Hydrodynamics, Cavitation and Magnetic Liquid Division. Also, I am associate senior researcher at Numerical Simulation and Parallel Computing Laboratory from Politehnica University of Timișoara, National Center for Engineering of Systems with Complex Fluids since 2002.

My research activity is definitely application driven, with a constant focus on relating the problems in design, analysis and optimization of the turbomachines and the hydraulic systems associated to hydro power stations and pumping stations. Two main fields associated to hydrodynamic of the turbines and pumps are covered in my research. My research is focused on the influence of geometrical and kinematical parameters on the efficiency, cavitation and dynamic characteristics. Several numerical investigations of the flow have been performed to Francis and Kaplan turbines in order to assess its characteristics. Also, the numerical investigations of the fluid flow have been applied to the large storage pumps in order to assess its performances.

Two additional research fields have been developed to support main topics. The first additional research topic corresponds to the mathematical models, numerical algorithms and computational fluid dynamics. This topic has supported my numerical investigations in order to understand the hydrodynamic phenomena associated to the turbomachines. The second additional research topic is associated to the swirling flows and the flow control techniques to mitigate the self-induce instabilities and its effects. These phenomena occur in hydraulic turbines operated far from the best efficiency point, and it hinders the turbine normal operation through severe pressure fluctuations leading to vibrations, damage of the bearings, blade rupture and power swing. An experimental test rig with a swirl generator was designed and manufactured by our group to explore the unsteady phenomena encounter in the hydraulic turbines as well as to investigate several innovative control techniques (e.g. axial water jet, flow feedback, pulsating jet, adjustable diaphragm, and magneto-rheological speed control) to mitigate its effects.

A synopsis view of my publications in the field of the habilitation thesis covering 2003 - 2017 is quantified in 63 journal papers (21 ISI, 12 BDI and 30 other journals), 79 proceeding papers (31 ISI and 48 international conferences), 3 patents, 3 books, 7 chapters and 9 proceedings as editor. These results were supported by 4 programs of the Hydrodynamics and Cavitation Laboratory from Hydrodynamics, Cavitation and Liquid Magnetic Division, Center for Advanced Research in Engineering Sciences, Romanian Academy – Timisoara Branch, 16 projects (14 national and 2 international) and 20 contracts with industrial partners (17 national and 3 international) during 2003 – 2017.

I have developed a special connection with several industrial partners (e.g. Hidroelectrica SA - Romanian Hydropower Company and its subsidiary), UCMR SA and HydroEngineering SA Resita and AQUATIM SA Timișoara (Regional Water Supplier). I have been manager or partner responsible

in several projects with industrial partners who have investigated the problems arising from the operation of hydraulic machines. Also, I want to highlight two events with industrial partners organized as chairman of the organizing committee that have debated the issues raised by them.

It is well known that each hydropower/pumping plant is unique. I have visited more than 40 hydraulic machinery laboratories and hydropower/pumping plants all around the world. I have organized the training course entitled “Numerical Methods in Fluid Dynamics and FLUENT applications” at Politehnica University of Timisoara with 40 participants. I have contributed as member of the scientific committee of 4 international conferences while as member of the organizing committee at 13 conferences/symposiums/workshops and I have been chairman of the one IAHR workshop, respectively. I have contributed as reviewer at 11 journals. I have participated to 14 events (8 symposia: IAHR2016, Grenoble, France; IAHR2014, Montreal, Canada; IAHR2012, Beijing, China, IAHR2010, Timisoara, Romania; IAHR2008, Foz do Iguaçu, Brazil; IAHR2006, Yokohama, Japan; IAHR2004, Stockholm, Sweden; IAHR2002, Lausanne, Switzerland; and 6 workgroups: IAHRWG2017, Porto, Portugal; IAHRWG2015, Ljubljana, Slovenia; IAHRWG2013, Lausanne, Switzerland; IAHRWG2011, Belgrade, Republic of Serbia; IAHRWG2009, Brno, Czech Republic; IAHRWG2007, Timisoara, Romania) organized by International Association on Hydraulic Research (IAHR), Section: Hydraulic Machinery and Systems and more than 10 other international conferences (MDA2016, Porto, Portugal; WREC2015, Bucharest, Romania; ViennaHydro2014, Vienna, Austria; CIEM2011, Bucharest, Romania; CMFF’09, Budapest, Hungary; CIEM2009, Bucharest, Romania; ISFMFE2008, Beijing, China; HME2008, Timisoara, Romania; CIEM2007, Bucharest, Romania; CMFF’06 and CMFF’03, Budapest, Hungary).

I have consolidated and extended my knowledge in field of research management and administration participating to 10 training courses organized by European Association of Research Managers and Administrators (EARMA).

I have worked with several students to prepare their diploma theses (10), dissertation theses (5) and doctoral theses (more than 10) in which they designed different parts of the turbomachines (turbine or pump) and/or they perform in-depth numerical and/or experimental flow investigations. I have supported 4 students at Bachelor level to develop their own research and to present their results at Student Technical Days. I have been appointed of 20 times as member of the PhD committee (19 in Romania and 1 in Sweden).

My teaching career has started in 2016, when I joined as associate professor at the Hydraulic Machinery group from Mechanical Machinery, Equipment and Transport Department, Mechanical Faculty, Politehnica University of Timișoara. My teaching activities are focused on hydraulic turbines course, hydropower plants and pumping stations course which are part in the curriculum in mechanical engineering at Bachelor and master levels, respectively.

I would like to emphasize my membership to Timișoara School on Hydraulic Machines and Cavitation founded by Prof. Aurel Bărglăzan, member of the Romanian Academy and promoted at national and international levels by Prof. Ioan M. Anton, member of the Romanian Academy. I was formed in this school and I continued to develop its research directions together with my colleagues based on what we inherited. My future scientific plan is directly connected with the requirements imposed by the energy market. As a result, the following research topics would be further investigated to support the operation of the hydraulic turbomachines (turbines and pumps) in the energy market and to extend its lifetime. Also, the investigations would be extended to the large pumps installed in the wastewater systems and flood protection systems.