CV Prof. Francesca Di Puccio

EDUCATION and ACADEMIC CAREER

Prof. Di Puccio got her Master Degree in Mechanical Engineering cum Laude at the University of Pisa in April 1995, discussing a thesis on Elastic Fracture Mechanics. She received her PhD in Mechanical Engineering at the University of Pisa in March 1999, presenting a thesis on numerical and experimental evaluation of residual stresses in large diameter pipes with longitudinal welds.

In 1999 she won a fellowship from Bocconi University (Milano, Italy) for attending a Master course in "R&D Management".

She had a Post-Doc fellowship from 1999 until 2001, on rolling contact fatigue and passive magnetic bearings. She became Researcher in Applied Mechanics in February 2001.

She was Associate Professor in Applied Mechanics from December 2014 to December 2019.

She is coordinator of the PhD curriculum in Mechanical Engineering at the University of Pisa, since 2017.

She is Full Professor in Applied Mechanics since December 2019.

DIDACTICAL ACTIVITIES

Prof. Di Puccio taught several university courses from Theoretical and Applied Mechanics to Biomechanics.

She currently teaches "Applied Mechanics" in the Bachelor Course of Aerospace Engineering and "Mechanics of the Musculoskeletal System" in the Master Course in Biomedical Engineering, University of Pisa.

She has been tutor of many Bachelor and Master students, as well as of six PhD students in Mechanical Engineering.

RESEARCH ACTVITIES

The research activities carried out by Prof. Di Puccio in her academic career spanned many different fields of Mechanical and Biomedical Engineering, from gear generation to cardiovascular biomechanics, from magnetic bearings to biotribology, as is soon evident from the titles in her Scopus profile (http://goo.gl/pb2nPY).

The variety of the topics, mainly is due to the necessity of responding to requests of industries or medical operators. Some long-term activities are worth mentioning:

- 2001-2002, (participation to the) foundation of the Research Centre on Advanced Technology Mechanical Transmissions (CRTM) of the University of Pisa in co-operation with Fiat Avio.
- 2002-2005 (PI) research on direct fuel injectors, in collaboration with Siemens VDO.
- (co-PI) research on comfort assessment related to hand-arm vibration in scooters (Piaggio, 2002-2003) and sportive cars (Ferrari, 2003).

- since 2003, member of the Pisa gear group for a research activity on the theory of Gearing, mainly in collaboration with Fiat Avio (now Avio).

The research activity in the field of biomechanics started as integration and enrichment of the didactical activity for the Mechanics of the Musculoskeletal System course and covered: cardiovascular biomechanics, elastosonography, human movement, earing biomechanics, bone biomechanics and biotribology.

*Cardiovascular Biomechanics

The research in the cardiovascular field began with the participation to a PRIN in 2003 on "Integrated methodologies for the design of endovascular devices." The research led to the realization of three test rigs specially designed for testing arterial tissues and device-artery interactions, together with the development of a software for 3D reconstruction of arterial segments from histological images, of an optical extensometer in Matlab, and to the implementation of advanced constitutive models for the simulation of aneurysms, etc.
In the years 2008-2009 she collaborated with the Dept. Cardiothoracic Cisanello Hospital of Pisa for the validation of a surgical procedure (patented and currently in use) for replacing chordae tendineae.
More recently Prof.Di Puccio managed a research for the characterization of venous catheters (PICC) in collaboration with the Pain Therapy Unit of the Hospital S. Chiara, Pisa, and with Gemelli Hospital, Rome.

*Earing biomechanics

Another line of research was focused on modeling the human ear (outer and middle) and led to the creation of a hybrid model, integrating FEM (tympanic membrane) and multibody (ossicular chain) approaches. The objective of the research in this field is to define a reliable model that can better evaluate the effect of interventions or implants.

*Bone biomechanics

More recently, in collaboration with Cisanello Hospital in Pisa, a research was started on the application of the experimental modal analysis to the assessment of the healing of bone fractures treated with an external fixator. The aim of the research is to define a procedure for monitoring fracture healing, alternative to radiographs, based on mechanical vibrations to estimate variations in bone stiffness. After first feasibility studies on a phantom, some in-vivo tests were carried out with promising results This research is still ongoing, it has aroused the interest and involvement of other Tuscan hospitals and has received funding from the University.

*Biotribology

Since 2008, various research activities have been launched in the field of biotribology, in particular focused on the analysis of wear of hip prostheses. The main aim was to develop

predictive wear models to compare different prostheses design in realistic operative conditions. This last point is important since, the current regulations for the experimental evaluation of wear of prostheses consider fairly simple loading and kinematics conditions (simplified walking style), generally implemented in special simulators. What happens *in vivo* is obviously different for numerous reasons and it is of interest to understand to what extent the regulations are able to evaluate the actual behaviour of the prostheses. We therefore concentrated on the development of predictive wear models, first with analytical formulation, implemented in Mathcad/Mathematica, and more recently based on commercial finite element codes (FEM). The analytical models are quick and efficient but do not take into account the modification of the geometry with wear, so they are suitable for 'small wear' and are used for a first rough estimate. The FEM models are more advanced, they allow updates of the geometry but are quite expensive from a computational point of view. For this reason, we have also recently turned to the search for solutions to reduce calculation times through submodeling techniques. These activities have led to numerous collaborations, particularly with those who conduct experimental tests and make prostheses. These include Dr. Saverio Affatato of the IOR (Bologna, Italy), Prof. Joyce of the Newcastle University for shoulder prostheses, the Ac2t Tribology Center in Vienna, Permedica company.