



DOTTORATO DI RICERCA IN TECHNOLOGY, INNOVATION AND MANAGEMENT (DTIM)



PHD PROFILE, II YEAR STUDENTS, A.A. 2018/2019

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- *Title of the research: Sviluppo di ontologie multi livello per la realizzazione di sistemi di ottimizzazione strutturale (Development of multi-level ontologies for the implementation of structural topology optimization applications)*
- *Tutor: Prof. Davide Russo*

OUTLINE OF THE RESEARCH

- **Contribution of the Research.**

New technologies, such as Additive Manufacturing, and the digital factory paradigm require rethinking the product design process. Consequently, it is necessary to develop new software solutions, inspired by brand new approaches. The focus of the present research is the design of tools supporting the design for additive manufacturing.

This topic is relevant because the use of evolved working methodologies and innovative informatics applications, in the early stages of the concept of the products, is expected to be a great advantage. In fact, the input for the new machining and rapid prototyping technologies may be drastically improved (better models, object which may be produced in an easier way, lighter and stronger structures), and the control of the productive means itself may benefit by the optimization of the controls (less energy required for the production, lighter and more rigid machines).

- **Research Objectives.**

The goals of the research are: i) the development of a novel topology optimization software, and ii) the improvement of the input models and control of the productive means, such as CNC machine tools and 3D printers. More specifically, the main inspiration is the biomimetic paradigm in order to develop design fundamentals, procedures, algorithms, etc. To do this, the focus is on extrapolating some main principles, such as the redundancy of the natural structures, or the multi-level organization of the living matter, and implementing these high-level concepts in the new tools. This goal is not trivial, and for this reason, it is required to develop a number of ontological instruments for the management of the knowledge coming from biomimicry studies.

The outputs of the research may be different. At present, an ontology is under development which allows the application of multilevel approach in engineering problems. As first result, a preliminary version of an optimization software engine has been realized.

Moreover, while carrying out studies about the application of redundancy in the topology optimization of the structures, a novel methodology for the design and the control CNC machine tools and 3D printers has been disclosed, and, at the moment, it is under patenting process.



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- **Prior literature and innovative contribution.**

There are a great number of scientific publications concerning biomimetic. Most of them propose the study of a particular biological structure, trying to understand the reason of some extraordinary skills of the living beings, or to present a technical solution to artificially replicate these features.

Also the structural topology optimization is an important research topic, and a large quantity of research works concerns computational and mathematical aspects of this particular engineering task; on the other hand, even if the number of solution methodologies is rather high, the number of starting conceptual frameworks is limited.

In this scenario, the present research aims to make a synthesis of some results of both research areas for the creation of new software tools, and organize information from different sources in order to create a wide framework to use for structural topology optimization problems, and the mechanisms synthesis (multibody and compliant mechanisms).

- **Collaboration between institutions.**

The present research is developed on three thematic areas, biomimetic, topology structural optimization and ontological management of knowledge, and, consequently, a number of different competences are required.

This means that the collaboration of different institutions would be particularly proficient. At the moment, two articles regarding the most theoretical aspects of the new optimization software have been presented in collaboration with an Israeli University. Moreover, in future, the collaboration with the University Federico II seems to be particular convenient, in order to test the outcomes of the project.