

«DIGITAL TWINS OF PLASTIC-BASED AM PROCESS FOR PROCESS MONITORING AND CONNECTION TO PRODUCTION PLANNING»

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#### Abstract

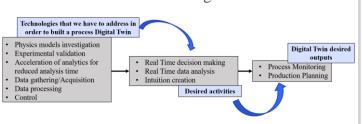
Professor Dimitris MOURTZIS

The current Diploma thesis focuses on the integration of theoretical and empirical process models on a software platform that act as a Digital Twin of the FDM process. The software platform undertakes the production scheduling as well as aims to optimize the process performance and efficiency. During this work, several theoretical models have been investigated. The selected models calculate the Build Time, the Energy Consumption as well as the Extrusion Forces. These models have been implemented on MATLAB. Apart from the theoretical process models, an experimental work has been done in order to study how the different process parameters affect the product quality and the process efficiency. A monitoring system has been integrated in order to find out how the process parameters affect performance indicators such as energy consumption, surface roughness and dimensional accuracy. The acquired knowledge is going to be integrated on a platform that undertakes the production planning and ERP scheduling.

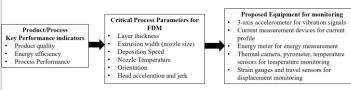
#### Diploma Thesis Goals

- Brief Description of AM processes, critical process parameters and post processing
- FDM process monitoring
- Development of a software platform that can act as a Digital Twin
- Integration of FDM theoretical /empirical models
- Connection to production and EPR scheduler

## Digital Twin Involved Technologies



### FDM Process Monitoring



#### FDM Theoretical Models Integration G-Code Material Properties Printer characteristics Input Prediction of: Measurements: Process Build Time Printer warm up time Printing speed 2.Energy Consumption Product mass and support Bed lowering time Head acceleration Cool down time structure mass Acceleration time Energy consumption G-Code Material properties Measurements: Prediction of: Machine internal distance 3.Pressure Drop Pressure drop on each Rheological properties 1. Printing speed 4.Extrusion force extrusion zone Filament mean diameter Total pressure drop Extruder and nozzle Extrusion forces dimensions Intuition Accelerometer Data visualization DAQ

# FDM: Integration of Empirical models and connection to production planning

Ampere

Clamp

- Step by step guide for the proper set up of the printer as well as guidelines for the initialization of the experimental work in order to take meaningful results.
- Description of the experimental set up and the monitoring system
- Detailed analysis of the design of experiment procedure.
- Presentation of the results and discussion. Correlation between the process parameters (acceleration, printing speed, orientation and layer height) with the surface quality (roughness), energy consumption (efficiency) and dimensional accuracy.
- Development of a software that can act as a Digital Twin in order to undertake the production planning based on the integrated theoretical and empirical process models.

