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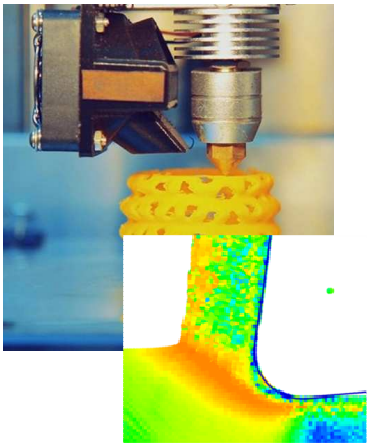
PROPOSAL FOR A THESIS IN HYBRID MANUFACTURING AT THE FEMTO-ST INSTITUTE

Start : September or October 2022 (3 years)

Hybrid PolyCut (HPC)

Title of work: Sequencing of additive-subtractive processes for the production of precision components in filled polymers



. Scope of work: Research strategy of the PRISM team of the Applied Mechanics department of the FEMTO-ST institute on the sequencing of manufacturing processes in the context of Industry 5.0.

Management : Michael Fontaine
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Issues :

The "Manufacturing Processes and Surfaces and Materials Interactions" (PRISM) team is currently focusing its research on two very complementary manufacturing processes: 3D printing and precision machining. 1/ For 3D printing, the aim is to master the entire process, combining experimentation with digital simulations, in order to explore new innovative materials. 2/ In precision machining, the aim is to understand the difference in thermomechanical phenomena of chip formation during the macro/micro scale change, to study the tool/material interfaces, with the aim of controlling the life of the tools, the quality and integrity of the surfaces produced and the economic and ecological impact. Thus, additive/subtractive process chains combine many technical and scientific obstacles that must be overcome depending on the materials studied and the processes linked together. This is of major interest for the precision mechanical parts industry, which must develop its manufacturing techniques, especially for raw parts, in order to remain agile and competitive. Indeed, these companies have to diversify more and more and to meet the demands of very specific parts in small and medium series. Filled polymers have been studied at the DMA for more than 10 years with a strong academic focus and numerous industrial collaborations. Their production is approached from the manufacturing of the feedstock to the obtaining of a dense solid part with the requested geometry, integrating fillers such as fibers, natural or not, or metallic powders. In machining, all the means and know-how are available to study the machinability of a material, both experimentally and through semi-empirical or thermomechanical modeling. The MIFHySTO mechanical manufacturing platform in Bisontine gathers all the necessary experimental means. The AMETISTE and MIMENTO platforms will provide the necessary complementary observation means

(topomicroscopy, SEM). The idea is therefore to go to the end of the production chain of high value-added parts (with a geometric tolerance of 10 microns or less) by characterizing the material at all stages of manufacture in order to determine the optimal process sequence and the machinability of the target materials, i.e. polymers (PP and PLA) loaded with short vegetable fibers and magnetocaloric metal powder.

Expected work :

The expected work consists in studying each step of the manufacturing process of a specific part made of filled polymer and to identify the technical and scientific barriers allowing to optimize the sequence of processes. The performance criteria to be considered are the quality of the final part (material and surface integrity, cutting tool life, but also the time, cost and environmental impact of manufacturing). All the data collected will be fed into a database that can be exploited by artificial intelligence in order to lay the foundations for a heuristic or meta-heuristic approach to process selection based on artificial intelligence.

Additive and subtractive manufacturing methods (FDM/EAM 3D printing, 3 to 5 axis milling, micro-milling) will be implemented, but also characterization methods (polymer rheology, mechanical tests, pressure and temperature instrumented printing, stress and temperature instrumented machining, friction tests, tomography, topomicroscopy, 3D reconstruction, dimensional, geometric and surface metrology). Numerical models will also be updated and used to study the physical phenomena involved in printing and cutting. Finally, the various tests on the machine will be the object of measurement of electric currents and pneumatic flow in order to evaluate the energy consumption of each stage and approach.

Added value of this thesis for the PhD :

This work will greatly enrich the student's technical-scientific skills in scientific instrumentation, characterization and numerically resolved thermomechanical modeling. These skills are highly sought after at the academic level in the field of processes and will allow for rapid publication of results. Moreover, this work is an ideal prerequisite for professional insertion in the field of academic research in processes, in higher education or in a position of R&D engineer in companies specializing in the shaping of precision parts, which are very well represented in Burgundy Franche-Comté and in Switzerland, particularly in the luxury goods, connector and biomedical industries.

It will be possible to carry out teaching hours at the Ecole Nationale Supérieure de Mécanique et des Microtechniques de Besançon or at the Université de Franche-Comté in the following fields, related to the thesis work

- Mechanical and micromechanical design
- Mechanical and micromechanical manufacturing
- Metrology
- Materials and surfaces

Profile and skills required:

We are looking for a motivated, curious person with a Master's degree in mechanical engineering or general engineering (ideally research oriented), interested in the field of industrial manufacturing and materials. Minimum knowledge and skills related to additive manufacturing, machining and polymers are required, with minimal experience in the application of finite element software. Knowledge and skills related to machine tool operation, force measurement, non-contact metrology, micrographic analysis of materials and numerical modeling would be a plus. A good command of English is essential and a good command of French is preferable, in particular if the candidate plans to train as a teacher in parallel with the thesis.

Documents to be provided and recruitment procedure:

- The applicant will be required to provide the following:
- A CV.
- A copy of an identity document.
- A letter of motivation presenting the professional project and the skills related to the project.
- A transcript of grades from the master's program and/or engineering program, and a copy of the diploma if available.
- 1 or 2 letters of recommendation from people who have followed the candidate in a project.
- A schedule of availability for interviews to be considered between May 17 and 25, 2022.
- A copy of the ZRR authorization (access to restricted areas granted by a CNRS agent) already obtained beforehand if applicable (in master for example).

Complete applications must be sent by email in pdf format before May 16, 2022 (midnight May 15). Based on the analysis of the applications, interviews will be offered to a selection of candidates between May 17 and 25, 2022. The oral interview will consist of a quick presentation of your CV with a presentation of the adequacy of your application with the thesis project (10 min in total). Then the supervisors will ask questions (allow a minimum of 1 hour). The decision will be made and sent to the SPIM doctoral school of UBFC by May 28, 2022.

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