

The habilitation thesis titled **The structural and technological analysis of specific mechanical elements processed using concentrated energies and 3D printing** is the result of research in multiple domains specific to the processing of materials with conventional and unconventional technologies. The research has been gathered and disseminated by the author in books, articles, research contracts, projects and stands built or under construction. The habilitation thesis is comprised of 6 chapters including a bibliographical list which certifies the thesis's preoccupation with the domain under discussion.

1. Summary of the habilitation thesis

The first chapter deals with technological and structural aspects linked to the processing of materials by way of energetically activated fluids when processing metallic and non-metallic materials used in the industrial field. An in depth analysis is provided, of aspects related to both the phenomenological part and the generation of the energetical medium made from water or abrasive suspended in water. In addition, the interaction between the energetic medium and the material undergoing transformation has led to both the study of the elements specific to the impact of processing at the surface level, as well as the impact on the volume of the material undergoing the process of transformation. Part of the study deals with determining major and minor influence factors on the erosive process from the point of view of the material-energy-source ensemble, as well as from the perspective of determining the regression equation, surface curves and, respectively, of tendencies specific to processing. The structural analysis includes solutions of construction, employed by the processing with non-energized-jet installation, with controlled dosing of the quantity of abrasive environment after a new concept of dosage control. Furthermore, the analysis touches upon the electromagnetic activation of the energetic environment at the level of the mixture areas as well as in the output and energy-jet concentration sections.

The second chapter addresses both the new methods of generating the parts, subassemblies or assemblies by FDM 3D printing technology as well as the methods of modifying the structure of a water jet or laser processing plant starting from the aforementioned elements. The analysis covers the creation of the components of the mixing chamber of water with abrasive from elements generated by 3D printing, as well as the creation of the parts for installations applied in engraving, cutting or welding with laser beam of plastic materials, and not only. The water jet and laser processing methods comprise fragments of the author's earlier work, whereas the implementation of the 3D printing technology, at the level of water jet and laser processing, represents a recent addition to the author's research. The thesis covers the construction, modelling and

generating of components for the aforementioned installations, some are in the experimental phase whereas others have reached a finite state.

The third chapter tackles new methods of generating parts and structures using 3D printing, namely the phenomenological one of generating elements through thermoplastics processes and, respectively, the production of elements by photo polymerization methods through the two DLP and SLA procedures. An analysis of the types of constructive solutions provided by the machines used in the generating of parts, as well as a study of cost efficiency in execution, are featured in this chapter. It should be pointed out that, for the FDM process, aspects of modifying the constructive solution of the printing parts were taken into account, by introducing one movement and two rotational movements respectively and performing comparisons between Cartesian printers developed with and without rotation, as well as using delta printers. Part of the study is also oriented towards the ordering of the technological parameters according to their influence, both from the FDM process point of view and from the DLP or SLA process point of view. In addition, a mathematical modelling of the process is performed based on the full or partial factorial experiment and, respectively, analyses of surface quality and dimensional changes to establish the optimum technological conditions for the achievement of the parts.

The fourth chapter revolves around aspects of constructing experimental stands destined for laboratory activity and specific devices. Of these, it is worth highlighting the generation of cogwheels, spiral-type elements, guide-type elements, transmission-type elements or task-take-over parts, coupled with a study of their behaviour both for determined periods of time and at varying orders, so as to ascertain their behaviour, and their areas of use. We consider their 3D modelling as well as their applications in laboratory stands or installations.

In chapter five, some of the activity carried out by the author of the thesis in the field of student activity is presented and analysed. Both on the part of student practice programs and on the part of vocational training programs for teachers or the unemployed. Also featured are the activities carried out on the line of doctoral training of researchers from several fields within the doctoral school of the Polytechnic University of Timisoara, Department of MMUT.

Future directions of professional development are tackled in the sixth and final chapter. Owing to the diversity of the problems analysed, and to the way in which they can be

addressed, one can observe the great number of possibilities of extending and deepening the research into the matter from a process-oriented and didactic point of view. In addition, this last chapter also includes a bibliographic synthesis of the documentation elaborated by the author of the thesis, or that was used in the professional training of the author of the thesis.

The present synthesis highlights both the positive evolution of the activity provided by the author of the thesis, through his involvement in scientific research activity, as well as in the coordination or participation in vocational training programs in areas related to the one which this thesis addresses. It should be mentioned that some of the research programs were carried out by the author's own efforts, often without the support of a team of researchers.

Each of the six chapters included in the thesis comprises a unitary structure starting from an overview of the problem addressed, analysing the concerns and needs that led to the completion of the studies, presenting the scientific and research ensemble from the moment of the research, covering the directions reached by the research over time.