Applications of the Particle Finite-Element Method (PFEM) in modelling manufacturing processes.

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ABSTRACT

At present, every process employed in the elaboration of a manufactured piece is the result of a lot of acquired experience during years. This means that it is difficult to improve them and usually challenging to suggest changes, as for any enhancement, each manufacturing stage has to be carefully analysed. New modelling and simulation techniques can speed up the product development cycle and at the end improve quality of system and components. Some standard methodologies based on the FEM are nowadays the best way to do it. However, some processes demand other techniques that are still matter of research.

In this work, the Particle Finite Element Method (PFEM) is used to supply solutions for processes that have a lack of numerical prediction. The presented work is focussed on non-linear processes like metal forming, metal cutting processes and processes involving material flow. This covers a wide range of relevant cases of study that occur during an industrial production cycle.

The PFEM is based in the Lagrangian description of the continuum. The main frame is a cloud of particles that define the domain characteristics. Those particles will be reconnected, via automatic remeshing techniques, to compute the governing equations in a continuum domain. The governing equations, together with the constitutive modelling, will resolve the mechanical or thermo-mechanical behaviour of a hyper or hypo-elastoplasticity material in finite strains. In the modelling of cutting processes the contact mechanics problem play an important role and in the modelling of material flows, the disgregation and the recognition of the free-surfaces plays an important role that the proposed method has to deal with.

In order to show the virtues of the method in the modelling of the exposed manufacturing processes, several examples of application are presented. The capabilities of the method as well as the accuracy of the solutions compared with the experimentally tested cases are discussed.

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