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Computational simulation of manufacturing processes

Foreword

In the face of increasingly fierce global competition, industrial companies must develop products more and more quickly and cheaply. In such a context, the numerical simulation of manufacturing processes is a big challenge and a key factor for success. Indeed, numerical simulation enables the control of manufacturing processes and of the consequences that they induce on the manufactured parts in terms of material modifications, geometrical changes or residual stresses, each of them playing an important role in the lifetime of the component.

Numerous manufacturing processes are used in industry. Depending on the part to be produced, the loadings that it must support or the proposed materials, several processes can be considered among the following:

- processes leading to the direct elaboration of parts such as casting, additive manufacturing or liquid composite molding,
- forming processes such as stamping or forging,
- machining processes such as turning or grinding,
- assembling processes such as welding, riveting or bonding,
- surface finishing processes such as carburizing, nitriding, cladding, polishing, or shot peening.

Whatever the manufacturing process, the main objectives of the numerical simulation are:

- to better understand the role of the process parameters in order to optimize the operating conditions,
- to predict the final state of the component, thus allowing more accurate lifetime analyses.

But to do so, characterizing and modeling the physical phenomena involved and their coupling at the suitable scales must be performed and adequate numerical methods must be developed to solve the strongly non-linear resulting problem. For example, coupling between fluid mechanics, heat transfer, metallurgy and solid mechanics must be taken into account in the numerical simulation of welding or additive manufacturing processes. In the same way, large strains and large strain rates must be coupled to damage, to heat transfer and to metallurgy to simulate cutting processes.

The modeling and numerical simulation of manufacturing processes have thus generated numerous research axes over the last years, including:

- the elaboration of dedicated models coupling several physics problems for particular manufacturing processes, including the development of constitutive equations for materials submitted to extreme thermomechanical loading conditions such as large strains and large strain rates or high temperatures, and taking into account microstructure evolution, phase changes or damage;
- the development of efficient modeling methodologies and of robust numerical methods specifically adapted to the resolution of very strongly non-linear problems and to the coupling of several physical phenomena;
- the elaboration of dedicated meshing procedures for the representation of the micro or meso-structure of materials.

Many international conferences such as ESAFORM, NUMIFORM, NUMISHEET or ICOMP have been dealing with these subjects. The technological and scientific importance of “Computational simulation of manufacturing processes” justifies that the *Comptes rendus Mecanique* devotes a thematic issue to this topic. The present issue compiles ten peer-reviewed contributions giving an overview of the work performed in this area. We hope that this issue will bring to the readers’ knowledge new points of view and advances in the field and lead to further contributions to the journal on this topic.

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