Modification of semantically enriched FE mesh models : Application to the fast prototyping of alternate solutions in the context of industrial maintenance

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Résumé :

Behaviour analysis is largely performed on the virtual model of the product before its physical manufacturing. The move from the reality to the digital world is gainful since it avoids the high costs in terms of money and time spent on intermediate manufacturing required for performing simulations on real products. Anyhow, the process could be further optimised especially during the product behaviour optimisation phase. This process involves repetition of four main processing steps : CAD design and preparing for meshing, mesh creation, enrichment of the model with physical semantics and Finite Element Analysis (FEA). The product behaviour analysis is performed on the first design solution as well as on the numerous successive product optimisation loops. Each design solution evaluation necessitates the same time as required for the first product design and it is particularly crucial in the context of maintenance and lifecycle assessment.

This thesis proposes a new framework for CAD-less product optimisation through FEA which reduces the mesh preparation and FEA semantics enrichment activities. More concretely, the idea is to directly operate on the firstly created FE mesh, enriched with physical/geometric semantics, to perform the product modifications required to achieve its optimised version. In order to accomplish the proposed CAD-less FE analysis framework, modification operators acting on both the mesh and the associated semantics need to be devised. In this thesis, the underlying concepts and the devised components for the development of such operators are discussed. A high-level operator specification is proposed according to a modular structure that allows an easy realisation of different mesh modification operators. Finally, four instances of this high-level operator are described: merging, cracking, drilling and filleting. These operators are prototyped and validated on academic and industrial FE mesh models, thus clearly showing the feasibility of our approach.