

Knowledge modeling of Design and manufacturing interface for DFM approach during product development process. Application to foundry process.

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Co-directors: L. ROUCOULES and L. MARTIN

Contacts: lionel.roucoules@ensam.eu

Websites: www.aix.ensam.fr, www.lsis.org

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Candidate profile: engineering design and manufacturing, CAD modeling, C/C++ programming, database and inference solver modelling.

Candidature: send CV + motivation letter to the above mentioned contacts.

Background

Currently, the industrial design process is fully focused on the geometric model of the product. This model is clearly created from a design intent outcome of the choice of architecture to meet the structural features of the product. Unfortunately, the geometric model (commonly called CAD model) does structure only the information on the nominal geometry of the product which are then not related to business knowledge of each of the experts involved in the design process.

In order to master the design solution then it is essential to structure the information around an advanced CAD to link information (i.e. knowledge) of business entities geometric product. This thesis is an approach fully in DFM (Design For Manufacturing) for which it is necessary to bind the manufacturing information to geometric data. XAO software tools must then expand to include more data from manufacturing processes. This requires the development of models to integrate in what will be new design tools, expert knowledge data, parameters of manufacturing protocols, their consequences on the mechanical part in terms of geometry, internal stresses, at the material science ... The lock here is to formalize the knowledge to propose models sufficiently general to be useful in different applications while providing practical applications in the short term.

The results of this study offer a new paradigm for creating the CAD model partly generated by "translation" of manufacturing plan selection. This new paradigm fully supports simultaneous engineering approaches for which the activities of "processes selection" are positioned early in the design process even before the CAD model is completely defined. DFM method is then fully seen as a design method.

Objective

This involves developing a method to take into account the manufacturing information to predict the geometric shape of the object, taking into account different levels of product definition (topologies, dimensional tolerances, roughness, and residual stresses) introduced with manufacturing processes. The thesis will provide a demonstrator for computer support this method.

The first scientific objective is to model the various data and links between manufacturing processes, materials and product data. It will be essential to consider the duality between:

- The data structure that can generate a 4D CAD model. This structure is then the value of the DFM approach proposed because it allows to link a given geometric and manufacturing data. This link is then essential to master the impact of a change in upstream solution (functional analysis) and downstream (selection processes).
- Database processes / materials / product that will capitalize on the knowledge and assumptions relating to manufacturing processes. This knowledge base is also a high value of the thesis work to capitalize on information relationships that currently exist in various forms: analytical, numerical, heuristic [Moraru et al. 2004] [Martin et al. 2006] [Moraru et al. 2009] [Martin et al. 2009].

This work is in full continuity of work already framed by L. Roucoules [Roucoules 2007] that have already provided a first demonstration of the DFM approach to create a CAD model into line with the selection process [Skander 2006] [Skander et al. 2008] [Elgueder et al. 2009]. The main issue is to model the global IT system that should be based on inference solver, database, CAD model, FEA solver...

The second objective relates to the management and protocols for exchanging data between the application of DFM and the other applications in the design environment and simulation. Indeed, it will clearly position the demonstrator in the DFM global information system and specifying the exchange of data needed:

- upstream (from the functional analysis - application of functional analysis). Some functional surfaces, viewed as the specification of the choice of manufacturing processes, are in fact derived from the analysis of energy flows [Meyer Klein et al. 2007].
- in the industrialization phase (simulation of manufacturing processes) for the application of DFM to rely on numerical analysis of processes in complex situations [Cochennec et al. 2008]

This integration approach (ie interoperability) software will be based on standards (eg STEP) or approaches the highest level (eg MDA - Model Driven Architecture) [Etienne et al. 2008].

The third objective is to specify new graphic metaphor to represent product information with respect to the design/manufacturing interface (i.e. material flows). That should give a new vision of the information to provide innovative solutions.

With respect to the candidate profile, those objectives will be treated totally or partially.

Method

First year

- Bibliography (manufacturing processes, KBE applications, integration product / process)
- Study of protocols for data exchange within the global information system
- Definition of the work program and digital tools that will be used (Choice of environmental technology and computer interfaces between applications).
- Specification of scenarios and case studies that will highlight the value added of the thesis

Second year

- Implementation of the DFM process-model-product materials
- Development of computer software tool.

Third year

- Implementation of the validation scenarios
- Application to complex parts
- Writing a doctoral thesis.

Progress reports of the thesis will be written once a year. Publications to present the intermediate results will be written and presented in national and international conferences during the first two years. The entire process will be finalized in the form of international conferences and articles in international scientific journals with peer review. A point detailed progress will be made every six months in the presence of different partners.

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Application:

Please send application form and materials to Mr. Yvon VELOT

→ yvon.velot@ensam.eu