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Improving cost analysis by generating dynamic factory simulations from CAD geometry

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Abstract

Analysis of a design is required to determine if the design meets specification. The cost analysis process requires information from multiple sources including results from other analysis. A framework is presented that combines component CAD geometry, dynamic factory simulation, manufacturing and cost knowledge, to reduce the time and improve the accuracy of cost analysis.

Introduction

In early design stages it is required to develop many different designs in a short space of time. To aid the design process multi-disciplinary teams are assembled to develop designs for groups of interlinked components. Designs are developed by the team, by analysing and improving on design iterations. Analysis of the designs are completed by utilising tools and techniques developed by specialised groups. Figure 1 shows the current process for an engine project in a large aerospace company. The engine project creates a component specification which the multi-disciplinary team will fulfil. Each specialised group will analyse the design, but an analysis has multiple attributes that require consideration.

In terms of cost analysis the design forms only part of the information required. Static information such as the amount and cost of material required can be retrieved from design and databases of information. Dynamic information such as the time taken to manufacture a component needs to be simulated or modified from similar designs. Figure 1 shows analysing departments share information to complete their own analysis, but the information being shared takes time to be generated.

The cost analysis is conducted by experienced engineers who have cost and manufacturing experience combined. The engineering experience combined with modelling techniques [1] helps reduce the need to receive information from other departments such as manufacturing engineering. But the requirement of skilled engineers to conduct the analysis results in capacity issues, which manifests itself as time required generating the analysis results.

Modelling techniques and historical information can reduce the need for generating dynamic information via simulation. But these are no substitute for a simulation to provide a prediction of the resources required and the time taken to manufacture a component [2, 3]. Here a framework is described that automatically generates a dynamic factory simulation to improve the accuracy and reduce the time to conduct cost analysis of a component, by combining CAD geometry, dynamic factory simulation, manufacturing and cost knowledge.

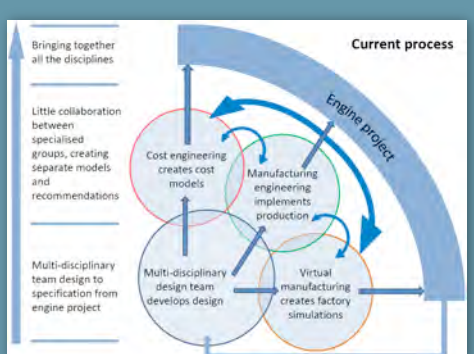

Figure 1: Flow of information through a project

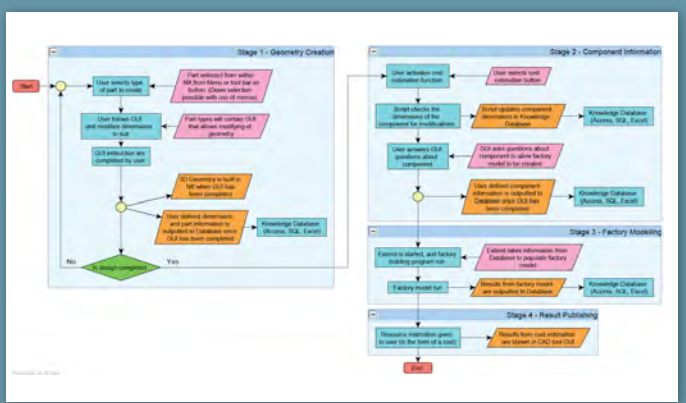

Figure 2: Framework flow diagram

The proposed frame work

The proposed framework reduces the time and improves the accuracy of resource prediction required for cost estimation, by automatically generating a factory simulation from component geometry directly from a CAD tool. Figure 2 shows a flow chart of the framework. The framework is split into 4 stages; geometry creation, component information, factory modelling and result publishing.

Stage 1 – geometry creation, consists of the user selecting a component part by navigating through the CAD tool menus; a GUI prompts the user for information about the dimensions of the part. The user is then allowed to modify the part within the CAD tool. When the user is happy with the design geometry the user starts stage 2 – component information, by selecting a command button within the CAD tool. Stage 2 checks the geometry and any additions to the part; the data from the CAD tool is sent to and stored within a database, which links to extra information about the part and manufacturing process stored within the database. The user is then prompted for information concerning the manufacture of the component. Stage 3 – factory modelling, starts the simulation environment and a factory model is built to comply with the information in the database. The simulation is run and the results are sent to the database. Stage 4 – results publishing, uses the results from the simulation to create a cost model and estimate the unit cost of the component. The unit cost is shown in the CAD tool for the user to review. If necessary the user is able to review a breakdown of the cost and manufacturing process to determine the design drivers.

A system to implement the framework is in preliminary construction. The system is being designed with a powder Hot Isostatic Pressing (HIP) process case study in mind. This process can manufacture components in a Near Net Shape (NNS) form, thus keeping machining and waste material to a minimum. The NNS attributes of this process pose significant benefits in terms of cost for components. A case study driven by the REMAC project will be utilising a component manufactured by the HIP process (Figure 3) that will prove the fundamentals of the framework.

Figure 3: A full sized combustor casing (front case) manufactured by the Powder Hot Isotatic Pressing process

Summary

A framework that combines CAD, and factory simulation, to reduce the time required to analyse the cost of a component in a production environment is presented. A case study is being implemented for a cylindrical component manufactured using the powder HIP process. The case study will show how the user interacts with the system and how the tools are interlinked. The case study will prove the system can implement the framework, which will allow the system to be extended to a real component case study.

References

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