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Near-net shape manufacturing costs

UTC for Computational Engineering

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Introduction

This research concerns near-net shape manufacturing costs and environmental assessments of the processes. Part of the Resource Efficient Manufacture of high performance hybrid Aerospace Components (REMAC) project is to complete a cost, energy and environmental assessment on a powder hipping process to manufacture a component. Other near-net shape manufacturing technologies will be looked at such as Selective laser sintering.

This research will use Vanguard Studio to model the cost and ExtendSim to model the process times, and activity rates to be supplied to Vanguard Studio. ExtendSim will also be used to complete the environmental assessment for the manufacturing processes.

Background

Resource Efficient Manufacture of high performance hybrid Aerospace Components is a Department for Business Enterprise and Regulatory Reform (BERR) (formally the Department of Trade and Industry (DTI)) project. Members of the group are Rolls-Royce plc, Birmingham University, Bodycote plc and Sandvik Osprey Ltd.

The scope of REMAC is to manufacture a high performance Nickel-based alloy component via net-shape powder hipping to maximise material usage and minimise energy consumption. The target component is the combustor casing for a current gas turbine development programme, **Fig.1**. Part of the REMAC remit is to complete a cost, energy and environmental impact assessment.

Fig.1 Combustor casing

Most manufacturing processes such as machining are subtractive, meaning that raw material is removed to produce a component. Near net-shape or net-shape manufacturing such as powder hipping is an additive process, meaning that raw material is added together to produce a component, with little or no finishing processes required.

Other near net shape manufacturing processes will also be looked at, such as Selective Laser Sintering (SLS). This process builds components in 20μm layers; it completes this by applying a thin layer of powder on top of a base plate and fusing the powder together with a laser in the required 2D geometry. The base plate then moves down the required layer thickness and the process repeats until the complete 3D geometry has been completed.

Aim

The aim of this research is to investigate the costs and environmental impact of powder hipping, and compare it to the current methods of manufacture for a combustor casing. Novel methods of simulating the process times and activity rates will also be investigated, to give a deeper depth and understanding to the models. This forms part of the Cost Modelling Strategy being developed in the Research and Technology costing team at Rolls-Royce plc.

Method

A cost model will be produced so that the design inputs are entered into a software package called Vanguard studio. These design inputs will then be converted into feature parameters within Vanguard then automatically entered into a software package called ExtendSim. ExtendSim will then calculate the process times or activity rates using a physical mathematical approach from the process parameters and feature parameters. ExtendSim will then enter the answer to the calculation into Vanguard which will update the cost model. **Fig.2** shows a flow chart for the operation of how the cost of a component will be derived.

Vanguard studio

To produce a cost model for the combustor casing, Vanguard Studio is the preferred software because of its hierarchical structure, graphical interface and ease of use. **Fig.3** shows the top level model layout for the combustor casing.

ExtendSim

ExtendSim has been chosen because of the graphical interface, ease of use and open source code. ExtendSim will be used to calculate the process times or activity rates by the logistics of the process. This could be done within Vanguard for simple processes, but for complex processes such as the atomisation of powder or powder encapsulation ExtendSim is better suited.

ExtendSim utilises two forms of simulation, continuous and discrete event. Continuous simulation is used for when "time advances in equal steps and model values are recalculated at each time step". In discrete event simulation the "system changes state as events occur and only when those events occur". **Fig. 4** shows a transmitter-receiver system, an example of a continuous simulation model.

ExtendSim uses blocks as the main building components, each block represents some part of the process being modelled and are all linked together with lines. Each block contains procedural information for each part of the process, and blocks can be put into hierarchical groups to aid in visual representation. There are a large number of blocks within ExtendSim or custom blocks can be created to for fill a specific role.

Environmental assessment

The environmental assessment will be carried out by comparing the current method of manufacture for a combustor casing to the proposed powder hipping method. The type of information to be compared is waste material for each process, disposal methods for waste material, recycling methods of consumable and processed material, and energy consumption. ExtendSim could also be used to simulate the environmental aspects of the different processes.

Future work

Process models within ExtendSim need to be created, and information to populate the models needs to be gathered from the relevant sources. The Environmental assessment needs to be started, but information gathering for this can be completed in parallel with the process model information gathering.

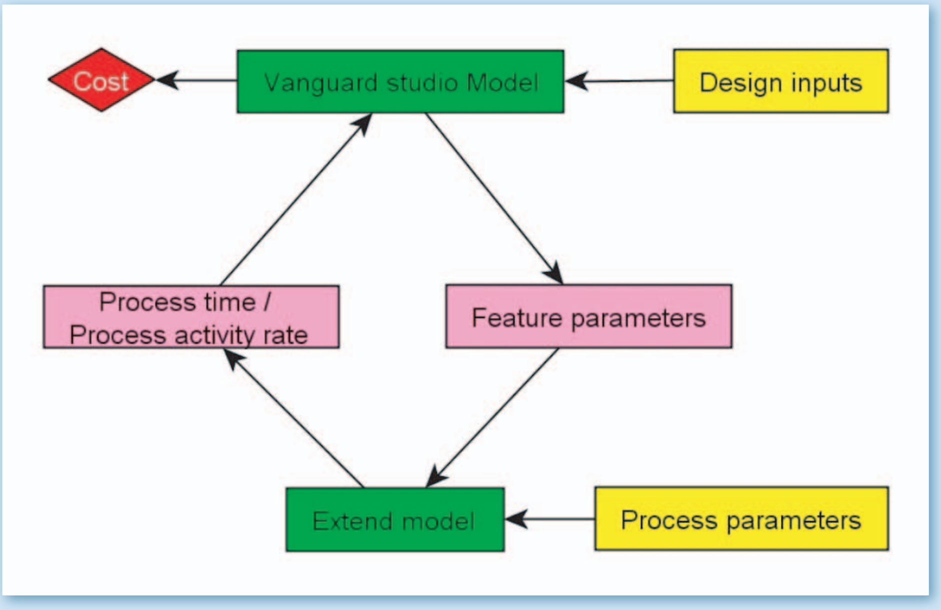

Fig.2 A flow chart showing how a cost will be derived

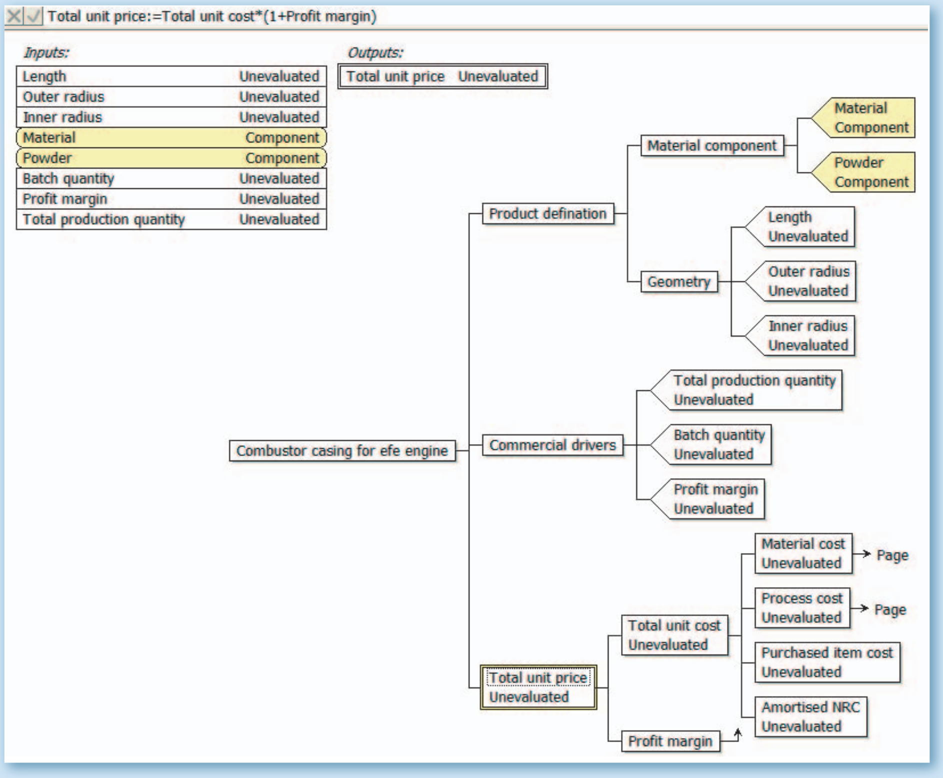

Fig.3 Shows the top level model of the Combustor casing

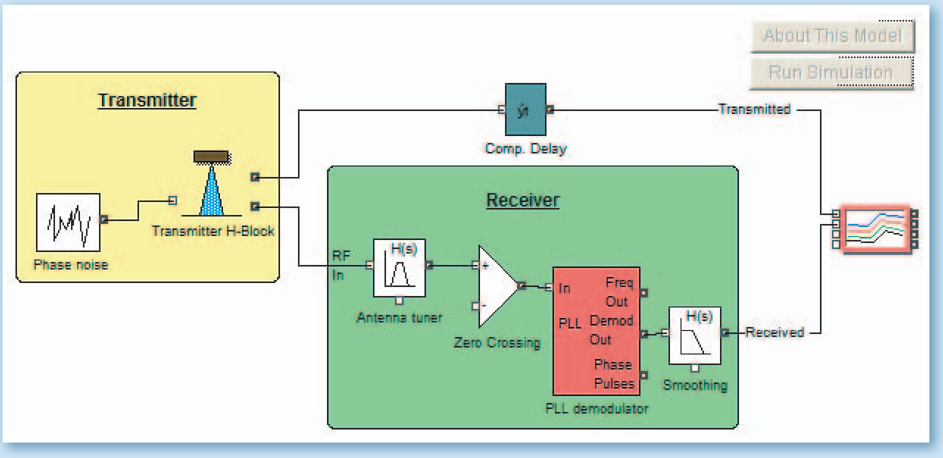

Fig.4 Shows a transmitter-receiver system[3]

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