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 Research Efficient Manufacturing of High Performance Hybrid Aerospace Components (REMAC) project is to complete a cost, energy and environmental assessment of a powder-hipping process to manufacture a component. Other near-net shape manufacturing techniques will also 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) (formerly the Department of Trade and Industry (DTI)) project. Members of the group are Rolls-Royce plc, Birmingham University, Rolls-Royce plc and Sandwell and Dudley.

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

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 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 ExtendSim and 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 this to the calculator into Vanguard which will update the cost model. Fig 1 shows a flowchart 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 preferred to because of its hierarchical structure, graphical interface and ease of use. Fig 2 shows the top level model layout for the combustor casing.

ExtendSim
ExtendSim has been chosen because of the graphical interface, ease of use and the case study 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 simulation of powder or powder encapsulation ExtendSim is better suited.

ExtendSim utilizes 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. 3 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 code, information for each part of the process, and codes can be put into hierarchical groups to aid visual representation. There are a large number of blocks within ExtendSim or custom blocks can be created for fill a specific role.

Environmental assessment
The environmental assessment will be carried out by computing the current method of manufacture for a combustor casing in the proposed powder hipping method. The type of information to be compared is waste material for each process, disposal method for waste material, recycling methods for consumable and processed material, and energy consumption. ExtendSim can 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.

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