Cost Modelling of UAVs

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http://www.soton.ac.uk/~cedc/posters.html

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UTP for design

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Introduction

This research concerns multidisciplinary design optimisation of an unmanned air vehicle (UAV) with cost as the objective. The total life cycle cost of a UAV includes the recurring and non-recurring costs. The non-recurring cost is the cost of building the aircraft, which includes the material costs and the manufacturing costs. The recurring cost is the cost necessary for operation, maintenance and repair of a fleet of aircraft.

Need

Traditionally, the design process has tended to concentrate on functional parameters such as aerodynamic and structural performance evaluations and cost has generally been neglected. However, cost is a dominating factor for any commercial aerospace organisation.

Even though it is widely accepted that 70-80% of the cost is controllable at the design stage, cost has often not been included during the concept design phase. This is because of a lack of good cost estimation models, particularly for novel technologies such as UAVs, which can be realistically deployed in the design cycle.

Objective

The objective of this project is to develop a life cycle cost model (LCC model) which allows us to calculate the cost of a UAV, given its specifications. The research aims to develop a model which will be simulation-based, easily understandable, easy to populate and clearly structured. It will also aim to perform risk, stochastic and sensitivity analysis. This LCC model will be then integrated with a concept design tool, also developed as part of the FLAVIIR programme, to perform cost-based optimisation.

Plan

A schematic sketch describing the cost model is shown in the flowchart (Figure 1). A brief explanation is given below.

Given any mission objective, we can get an idea of the number and type of aircraft required and the mission profile necessary to achieve that target. From the UAV specifications, the manufacturing and tooling costs can be derived and calculated. The mission profile simulation model gives us an estimate of the necessary resources from which the cost of maintenance, support, operation and repair can be calculated.

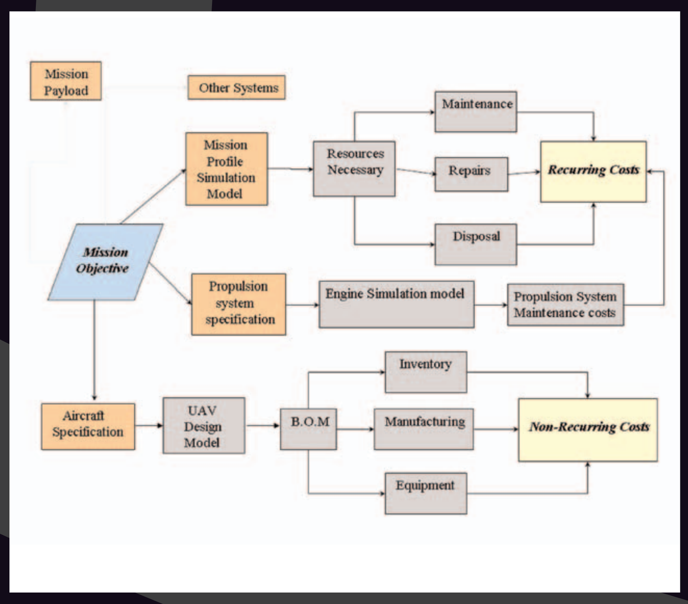

Fig 1

LCC

For the Life cycle cost model, we are planning to use a software language known as DecisionPro because of its hierarchical structure, modular nature, visualisation tools and its ease of use. A particular objective is to use its web server capability as we intend to host the cost model as a web service.

The reason for this is that it enables the access of the cost model from anywhere and by people without any design knowledge which is useful, especially for people from a wide range of disciplines. A sample model of the LCC model using DecisionPro is shown in Figure 2.

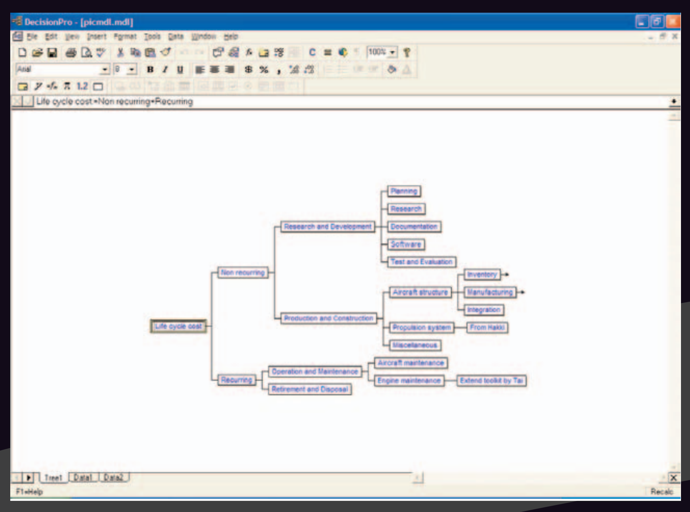

Fig 2: Sample life cycle cost model using DecisionPro software

Geometry

The geometry of the aircraft is modelled in CATIA as part of the University of Southampton's work package on the FLAVIIR programme, as shown in Figure 3. From this model, we can obtain the product data structure which allows us to calculate the cost of raw materials and the manufacturing costs. Clearly, the dominant structural technology is composites and the cost model should be capable of taking this into consideration. We are collaborating with composite experts from Cranfield University in this area to capture the composite manufacturing knowledge.

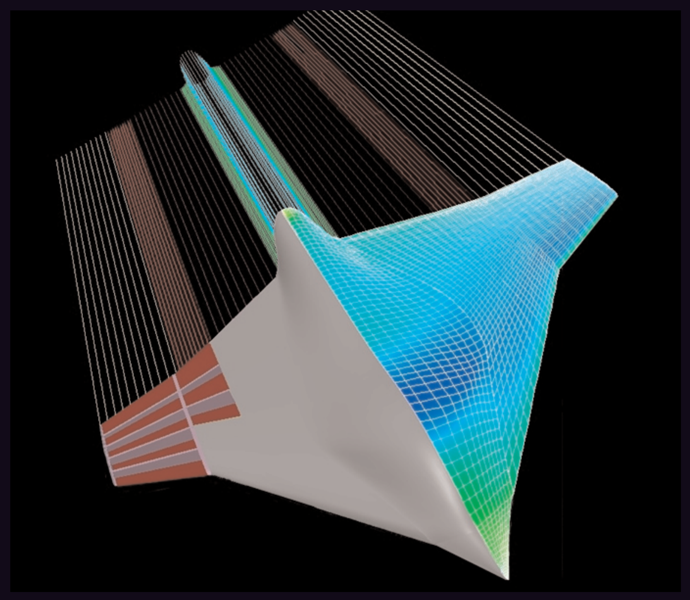

Fig 3: Geometry model of a UAV

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Simulation models

The simulation model gives an estimate of the necessary resources and infrastructure (number of personnel, equipment, etc.), from which we can calculate the cost of maintenance, support, operations and repair. Also, we intend to exploit knowledge the group has in Gas turbine simulation modelling which allows us to estimate the life cycle cost of a propulsion system in an accurate and detailed manner.

For the simulation of mission profile and engine life cycle, we plan to use the EXTEND software. This is because of its good visualisation capability, ease of integration with other software and its effectiveness in modelling complex systems. Also, this tool is capable of modelling both discrete and continuous simulations. A simple civil aircraft simulation model, which is the subject of other research in the group, is shown in Figure 4 for the purpose of illustration.

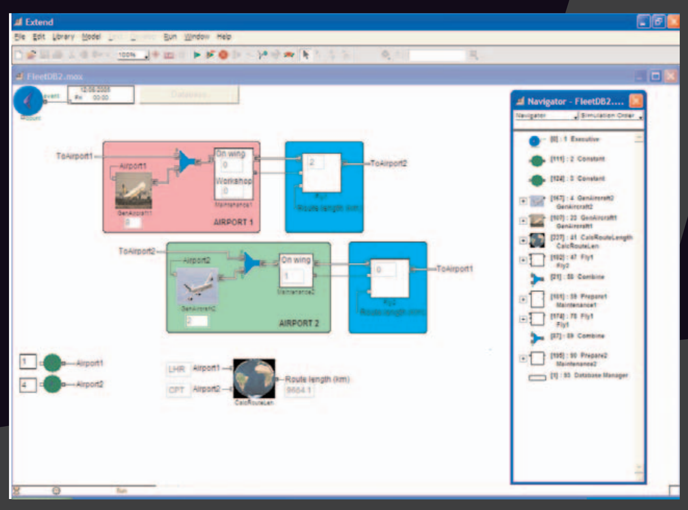

Fig 4: Simple civil aircraft simulation model using EXTEND

Future work

We plan to integrate the cost model with a concept design tool that is being built at the University of Southampton to perform cost-based design optimisation. We plan to perform trade-off studies between cost and performance for the aircraft. Also, we plan to include uncertainty modelling, reconfigurable and hybrid systems in the LCC model as shown in Figure 5.

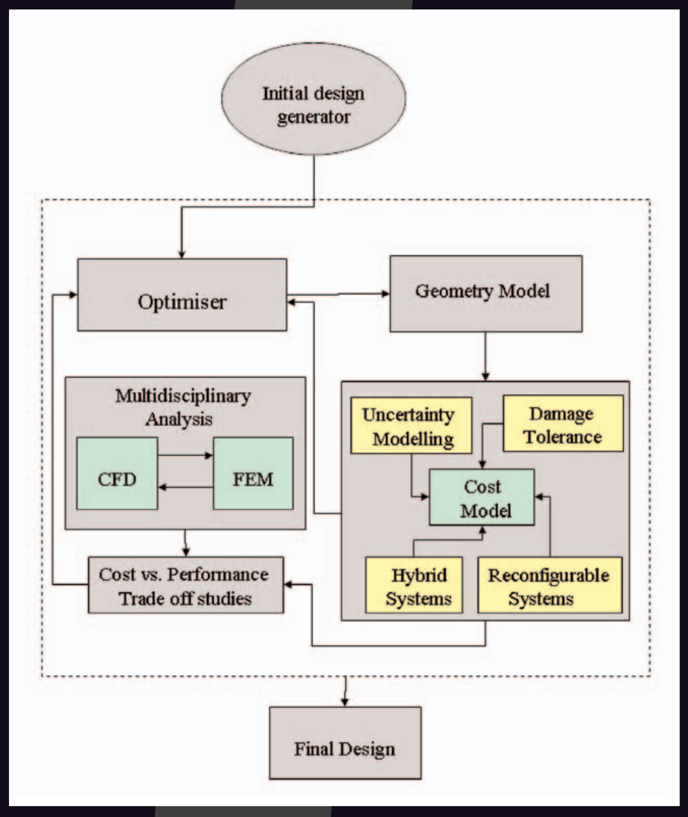

Fig 5

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