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Engineering and the Environment
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Implementation of a Stochastic Maintenance Cost Model

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Background

Future Programmes (FP) works to offer new engine solutions to customers. During the bidding process, FP looks at various options and develops product concepts, business structures and business case including the Life Cycle Cost (LCC) of the proposed solution. In this preliminary stage of the project, FP must be able to incorporate the changing requirements from the airframer and deal with the highly fluid design options.

Currently the traditional whole engine performance attributes, such as thrust, specific fuel consumption (SFC), and weight, are calculated in the Engine Preliminary Design System (EPDS) which successfully integrates and automates various spreadsheet-based and standalone programs by utilising the Isight workflow execution environment. The primary objective of this work is to demonstrate stochastic LCC models that can be incorporated into the EPDS, so that LCC implications of design changes become an integral part of early design decisions.

Vanguard Implementation

A possible system use diagram of the current implementation is presented in Fig.1 below. Each engine component or component set assumes six shop visits (SVs) and their lifing data (Weibull parameters) are used to instantiate separate Vanguard components. These Vanguard components are then automatically embedded into the whole engine level LCC model in order to perform various Monte Carlo (MC) simulations and sensitivity analysis studies.

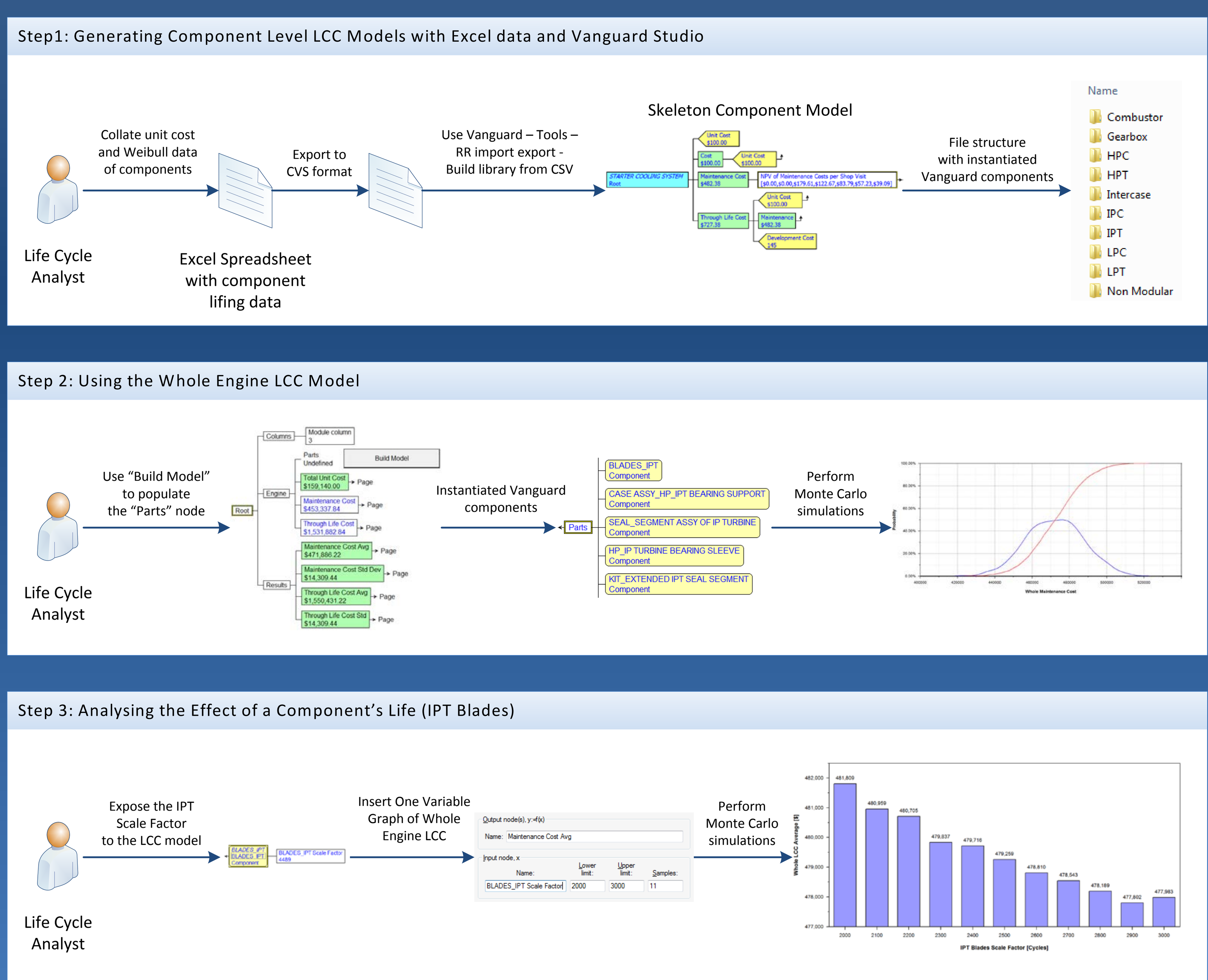

Figure 1: System use diagram of the stochastic LCC model in Vanguard.

Programmatic Monte Carlo Simulations

The LCC model can perform MC simulations programmatically as shown in Fig.2. This allows the analyst to explore the average and standard deviations of any LCC analysis. Additionally, sensitivity analysis studies can be run on average LCC values at the whole engine and module levels.

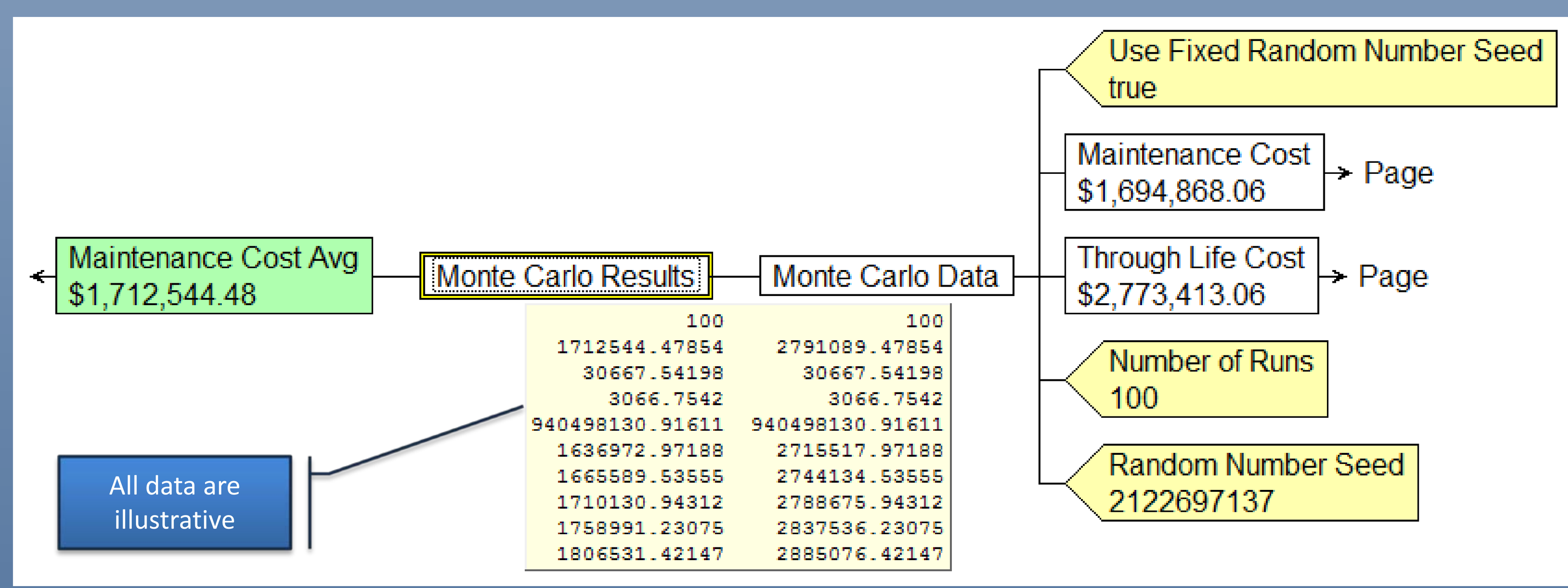

Figure 2: Programmatic access to Monte Carlo simulations in Vanguard.

Two Parameter Design of Experiments in Isight

The Isight integration of any Vanguard model can be done through the web services component, direct batch run, or the Vanguard link component. The results presented in Fig.3 utilises the web services component, and demonstrates the effect of Weibull scale parameters of high pressure turbine (HPT) and intermediate pressure turbine (IPT) blades to the whole engine maintenance cost.

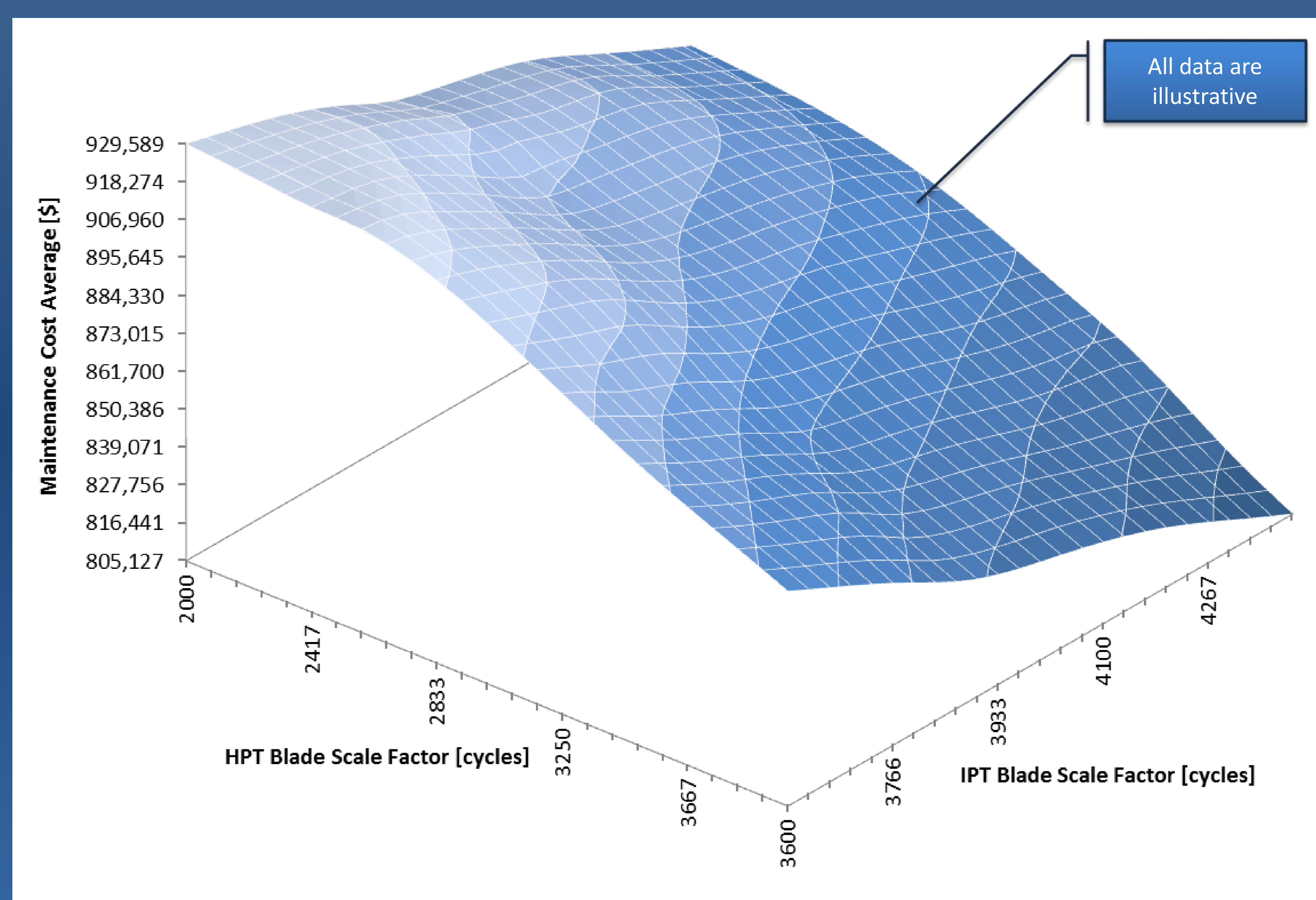

Figure 3: Whole engine LCC implications of HPT and IPT blade scale factors.

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