

Value-Driven Condition of Supply Shape Optimisation

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Background

In modern jet engines high pressure turbine (HPT) discs function at high temperatures and stress levels in order to increase overall engine efficiency. The mechanical integrity of HPT discs are of paramount importance to safety as the failure of an HPT disc can cause a total engine loss or even damage to the aircraft. Hence, after the HPT discs are forged and roughly machined by the forging supplier in the form of condition of supply (COS), they are ultrasonically inspected for internal defects that may inhibit the mechanical properties of finished HPT discs.

The profile of the COS determines success rates of the ultrasonic inspection process and its shape highly depends on the final HPT disc shape and features. Therefore an Isight process model has been developed that can accept different disc profiles and automatically generate COS, black forging and heat treatment profiles, calculate ultrasonic inspection success rates, and perform a volume-based manufacturing cost analysis through web services (see Fig.1).

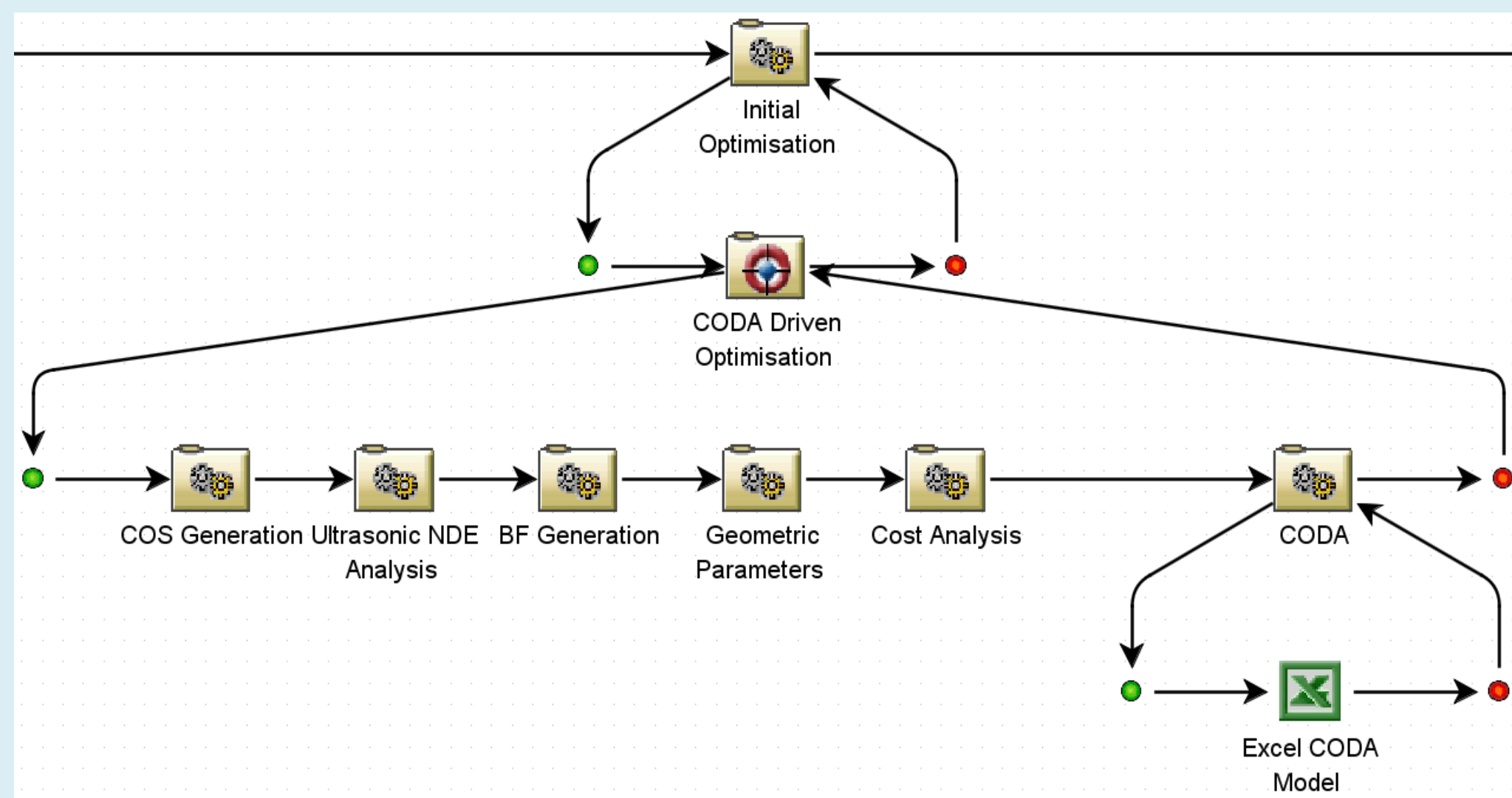


Figure 1: Isight workflow of the initial COS shape optimisation process.

Customer Oriented Design Analysis (CODA)

The CODA method aids the conceptual design and selection phase within new product development. By making the mapping between nebulous customer needs (CNs) and tangible engineering characteristics (ECs) in a design, CODA models the overall customer satisfaction level or design merit of a particular design.

The Excel implementation (see Fig. 2) uses three CNs: 1) Cheap to manufacture; 2) Better scanning rates; and 3) Minimise forging volume. These CNs are analysed by a binary weighting model and their relative weights are used in the CODA model.

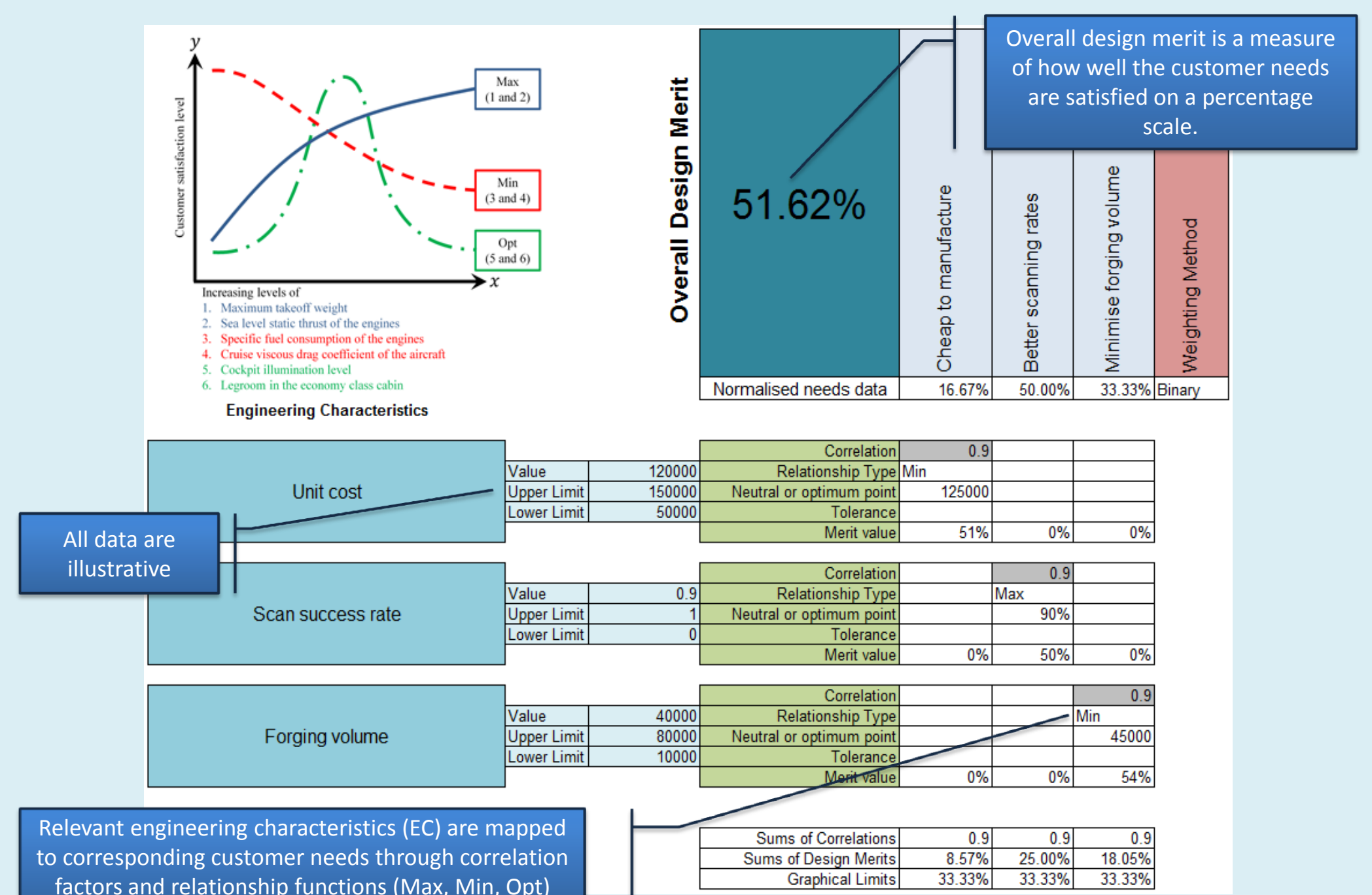


Figure 2: CODA model to link customer needs to engineering characteristics.

Results

The CODA model provides a single objective function, i.e. overall design merit, for the COS shape optimisation process. A Trent 500 disc profile is used to find the optimum number of edges (see Fig. 3 top row). This initial profile is further optimised by perturbing the vertices until an optimum overall design merit value is reached (see Fig. 3 bottom row).

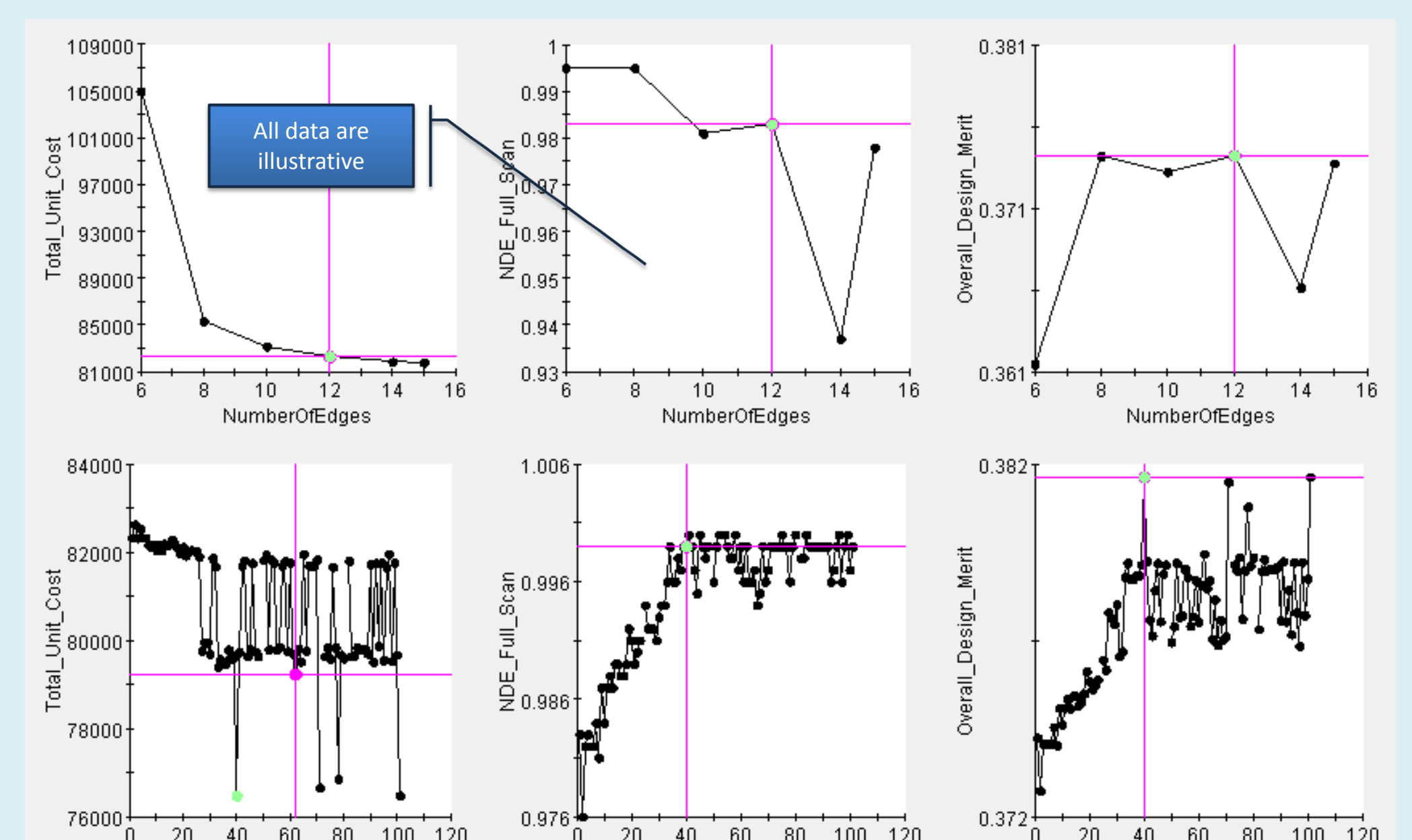


Figure 3: Value-driven initial and further optimisation results.

Acknowledgement

The research leading to the presented results received funding from the Technology Strategy Board's Strategic Affordable Manufacturing in the UK through Leading Environmental Technologies (SAMULET) Programme: Processing Of Advanced Materials Project No: 5 TP No: TP AB265C/5.