UNIVERSITY OF Southampton

Engineering and the Environment

Aeronautics, Astronautics and Computational Engineering

Optimal Mean Setting – Maximising Profit

UTC for Computational Engineering

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Introduction

Manufacturing variation can be larger than the tolerance limits imposed on a feature or component. Optimal mean setting is an approach developed to minimise the manufacturing cost and maximise profit when a process the frequently produces scrap and/or rework.

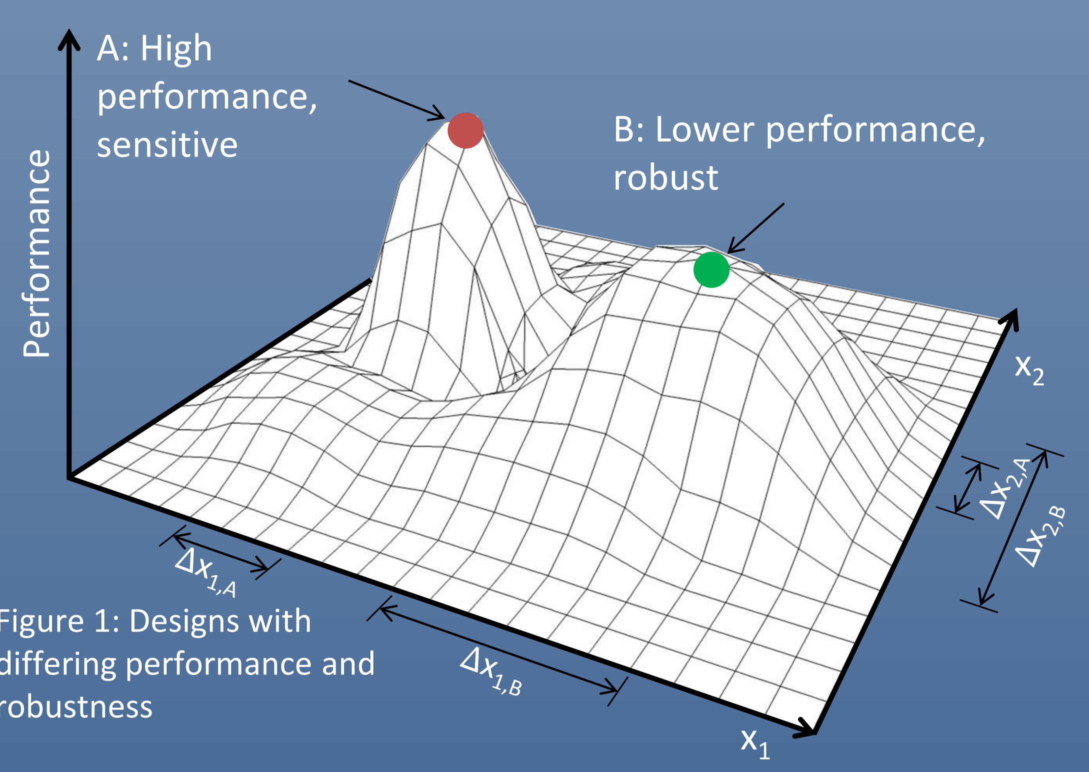

Figure 1: Designs with differing performance and robustness

Methodology

Figure 1 illustrates two design candidates where candidate A has the highest average performance but requires much tighter tolerances (Δx_i) than candidate B. If the range of manufacturing variation is equal to $\Delta x_{i,B}$ then candidate A will be very costly to produce with a conventional manufacturing approach due to scrap and rework. Optimal Mean Setting can be applied to shift the process nominal towards rework to minimise manufacturing cost, since reworking a feature is generally less costly than scrapping a component. How far it is shifted depends on the balance between final conformance, scrap and rework costs (Figure 2).

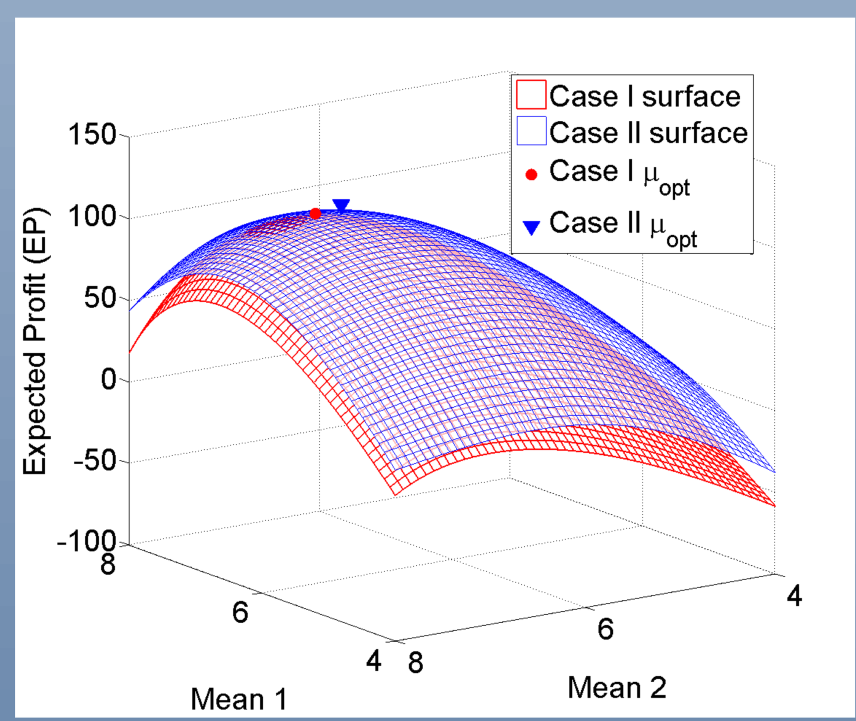

Figure 4: Improvement in expected profit from the new methodology (Case II) over Case I from literature.

Optimal Mean Setting

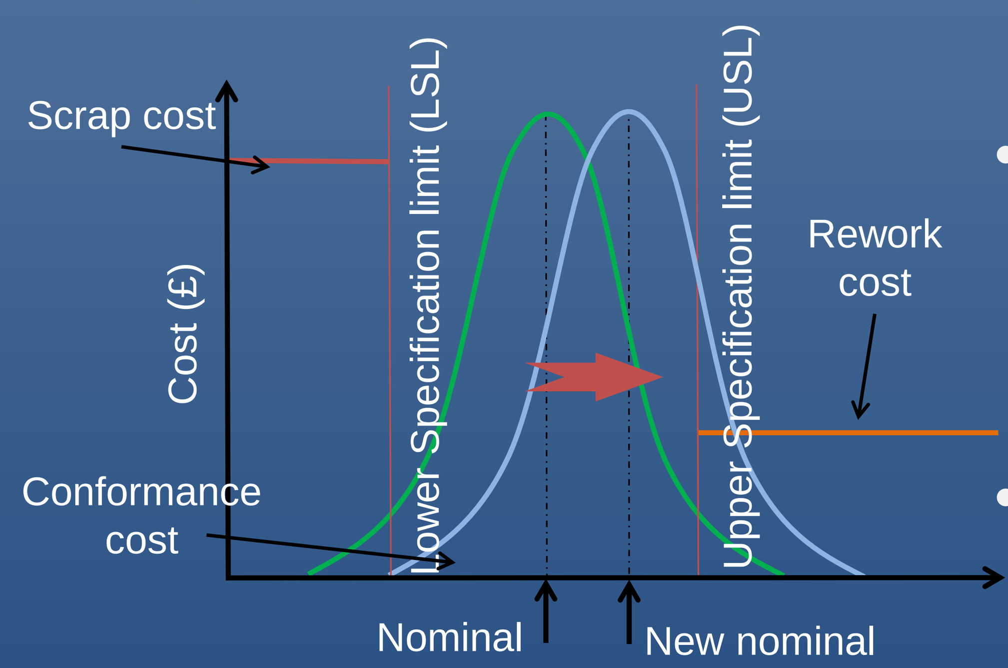

Figure 2: Optimal mean setting principle (shift the process nominal towards rework)

Highlights

- Mathematical modelling of the process revealed errors in the previous literature which were corrected.
- A generalised method was developed to return the expected profit and the final distribution of the manufactured geometry utilising Copula functions.

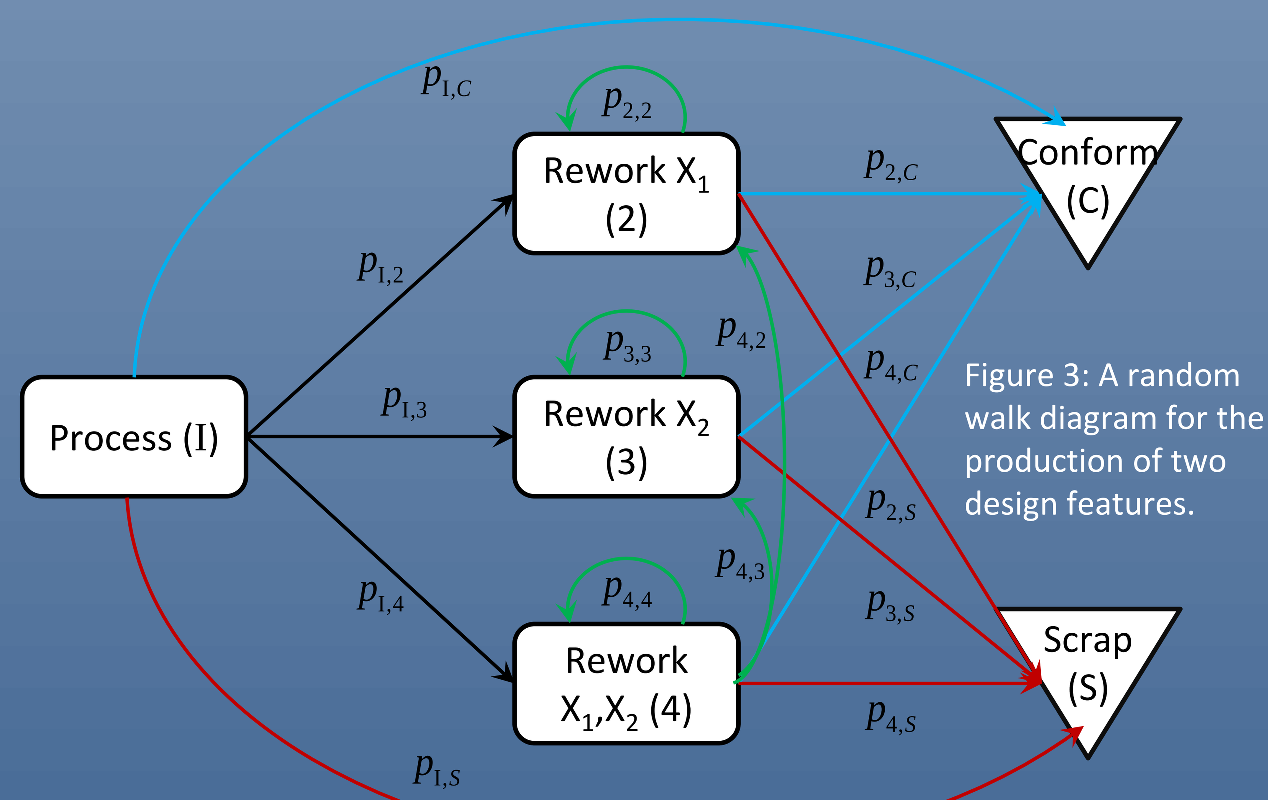

Figure 3: A random walk diagram for the production of two design features.

- The method can be applied to a component with any number of features with any process distribution for a variety of manufacturing sequences.
- The optimisation methodology in Optimal Mean Setting literature was improved upon, gaining higher expected profits (Figure 4).

Case Study and Conclusion

The Optimal Mean Setting principle was applied to the geometry of a film cooling hole (Figure 5). Cooling effectiveness is highly dependent on the hole geometry where tightening tolerances gives rise to improvements in cooling effectiveness. Optimal Mean Setting delivered cost improvements over a conventional manufacturing approach and the mean setting method developed by this research outperformed existing literature.

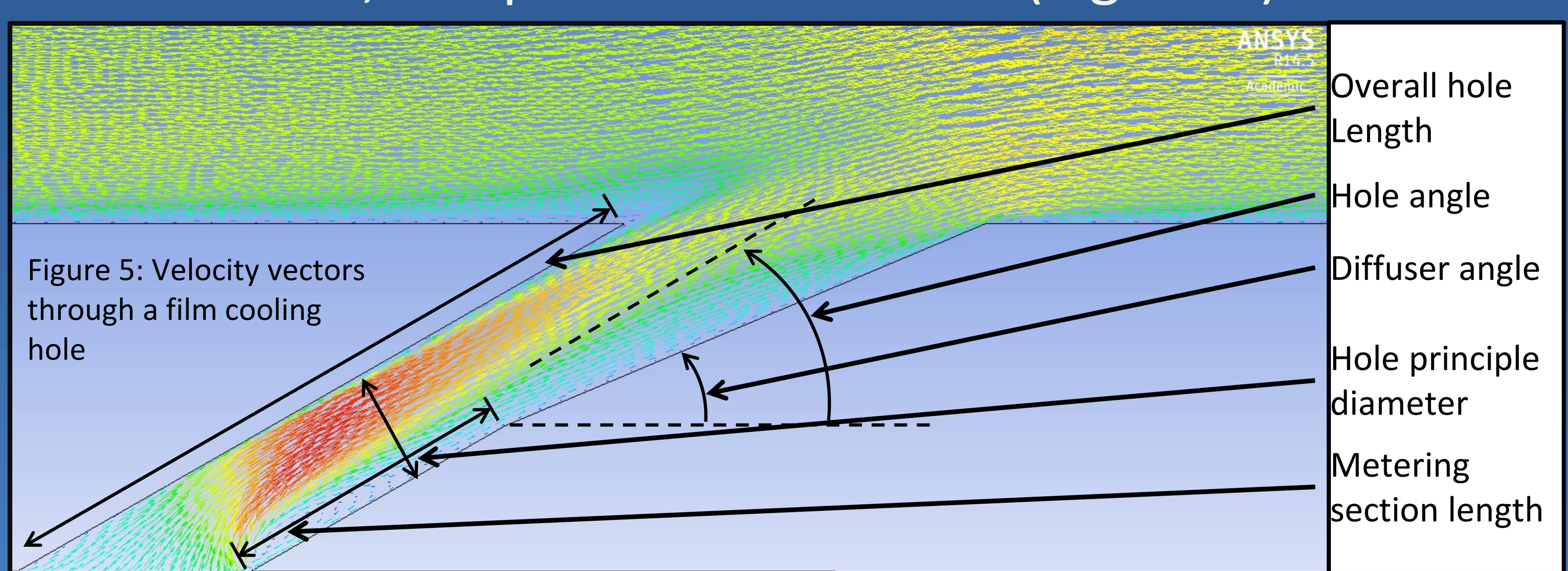

Figure 5: Velocity vectors through a film cooling hole

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