Visualising the impact of early design decisions on engineering supply chains

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For industry sectors that design and develop large, complex, engineered products, costs of non-quality are widely reported and on a scale that is unimaginable. For example, the additional development costs for the Rolls-Royce RB211 engine were quoted as £120 million in 1972 which equates to approximately £1.5 billion today[1]. The costs of non-quality are incurred when a design needs to be changed after it has been approved. Design errors can be found during manufacture or when an engine is in service. In the aerospace sector, concessions may be issued that mean the design does not need to change but additional reviews are needed, and in some cases more frequent maintenance operations undertaken, or the design itself may need to be modified. All circumstances use additional resources and result in delays that impact customer satisfaction. If an error is found in service the costs can be colossal. For example, consider a situation where tonight's flight from Singapore to London is cancelled because of a technical issue associated with the aeroplane. The five hundred passengers are likely to be en-route to the airport, immediate costs include accommodation and compensation for these passengers and costs of the aircraft being in the wrong place tomorrow. In addition, there are consequential losses such as reputational damage and disruptions to engineering teams that delay future projects. Comparable situations are reported in other sectors. For example, the UK's Crossrail project had cost overruns of circa £600 million[2] and lessons learnt reports include recommendations for the management of quality in supply chains[3].

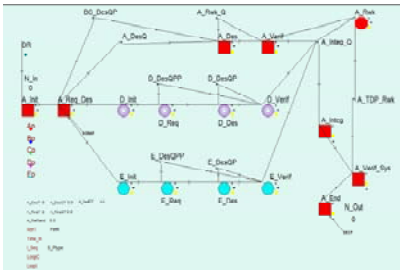
Root causes of costs of non-quality can often be attributed to system-level design decisions, made very early in the product development process, that fix or heavily constrain: (a) key characteristics and requirements of the major sub-systems, and (b) for each of these sub-systems, whether it is to be designed and made in-house or by suppliers. We are currently building an interface for an engineering simulation package (Witness) to enable the visualisation of implications of such early design decisions on supply chain performance. The interface takes as input an indented parts list and an associated make-buy scenario, and uses it to generate a simulation model that can be used to visualise supply chain implications of alternative system architectures and make/buy scenarios. An example dashboard is illustrated in the figure.

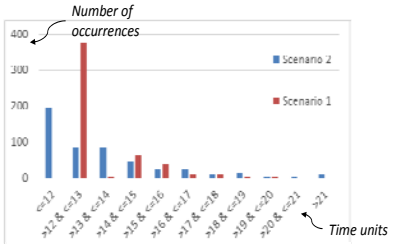
Scenario 1

Parts			Make/buy?	
Level 0	Level 1	Level 2	Design	Make
torch			In-house	In-house
	bulb assembly		External	External
		housing	External	External
		bulb	External	External
		lens	External	External
		retaining ring	External	External
	casing		External	External
		lower body	In-house	External
		upper body	In-house	External
		M6 bolts	External	External
		M6 nuts	External	External

Scenario 2

Parts			Make/buy?	
Level 0	Level 1	Level 2	Design	Make
torch			In-house	In-house
	bulb assembly		In-house	External
		housing	In-house	External
		bulb	In-house	External
		lens	In-house	External
		retaining ring	In-house	External
	casing		In-house	External
		lower body	In-house	External
		upper body	In-house	External
		M6 bolts	External	External
		M6 nuts	External	External





At the Marketplace we propose sharing early results and insights from this on-going projects by providing an interactive demonstration of the software that has been developed and providing opportunities for participants to experiment with alternative scenarios.

[1] Lazonick, W., Prencipe, A. (2013) "Sustaining the Innovation Process: The Case of Rolls-Royce plc" Available from: https://www.bartleby.com/essay/Sustaining-the-Innovation-Process-the-Case-of-Rolls-F3N77JSX7KU4Z

[2] https://www.railway-technology.com/news/uks-crossrail-project-costs-overshoots-nearly-600m/

[3] https://learninglegacy.crossrail.co.uk/documents/supply-chain-quality-requirements/