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State of the art in Through-life Engineering Services

L.E. Redding[a,*], B. Tjahjono[b]

[a] School of Aerospace, Transport, and Manufacturing, Cranfield University, Cranfield, MK43 0AL United Kingdom
[b] Faculty Research Centre for Business in Society, Coventry University, Coventry, United Kingdom

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ABSTRACT

Through-life Engineering Services (TES) involve the use of applied technologies in support of complex engineering products. TES are considered to be key enablers of innovative product support strategies and business models achieved by condition-based monitoring, applied prognostic and diagnostic technologies, aligned Maintenance Repair and Overhaul (MRO) strategies, and integrated service delivery systems. This paper presents the findings of a state-of-the-art review of the literature relating to TES. Contributions to the literature are identified by the application of a structured and defined method, which are then collated and analysed. The findings are grouped into a number of themes which include definition, structure, scope and standards that govern TES. Further findings report examples of TES applications, features in the effective design of TES solutions, tools and methodologies for designing TES in support of complex engineering products, and offers discussion of the ongoing and future direction for TES.

Contents

* Corresponding author.
E-mail address: louis.redding@btinternet.com (L.E. Redding).

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1. Introduction

Through-life Engineering Services (TES) are the result of the evolutionary progression in the development of applied technologies which enable the enhanced support of complex engineering products [1–3]. Whilst the emergence of TES is facilitated by developments in technology and innovative applications thereof, two of the underlying drivers for increased levels of product support are Product Service Systems (PSS) [4–7] and the process of *servitization* [8–11]. Underlying the adoption of PSS through increasing levels of *servitization* there lies the issue of increased levels of risk transferred to the product's manufacturers. This manifests itself as the manufacturer adopts risk to the revenue stream caused by the diminishing or loss of a product's design function when offering contracts based upon the availability for use of their products.

Product Service Systems emerged as a result of consideration for the sustainability of resource (predominantly ecological risk) as demand for products continued to increase [12,4,13], whilst *servitization* is seen as a strategic response to business risk [8,14–16] resulting from such commercial pressures as globalisation, low cost economies, and the need for protective operating strategies to maintain and improve on the organisation's competitive position [17]. These two strategies provide increased levels of 'data' which can be used to facilitate continuous product and service improvements, and improved revenue streams in economic downturns. The technical data generated when operating PSS and servitized solutions can also be leveraged to reduce risk by informing advanced engineering service and support strategies one of which is Through-life Engineering Services.

As manufacturing organisations move through Tukker's [18,19] PSS continuum there emerges a fundamental shift in the flow of revenue between the manufacturer and the user of the product, and in the case of high value complex engineering products, the finance house. Baines et al. illustrate this in their work relating to PSS and *servitization* [7,20]. Baines proposes three levels of service that manufacturing organisations move through as they evolve through the servitization process and the authors have sought to illustrate this by adopting and amending Baines's model (Fig. 1).

In Fig. 1, we see that Baines [21] identified three levels of service which move from being centred on product provision, through managing the product's condition, to that of supplying a capability based upon the product's design function. Two typical examples of advanced services being:

- Rolls Royce moving from selling engines to selling the availability to deliver 'thrust' on demand.
- Xerox moving from selling office copying machines to selling managed print solutions

As advanced services evolve the concept of wealth being increasingly co-created emerges [22,23] as organisations seek to become ever closer aligned to the product service offerings of their customers. In so doing the ability of their products to reliably deliver the design function becomes ever more important to their revenue streams. The authors suggest that as organisations enter into availability contracts this risk to the manufacturers revenue due to degradation or failure of the product's design function warrants significant focus. Manufacturing organisations will seek to mitigate potential disruption to their revenue streams and subsequent damage to brand reputation should product performance degrade or fail when in use. It is suggested by the authors that this adopted risk to revenue by the manufacturer over the operational/contract life of the product gives the impetus to the

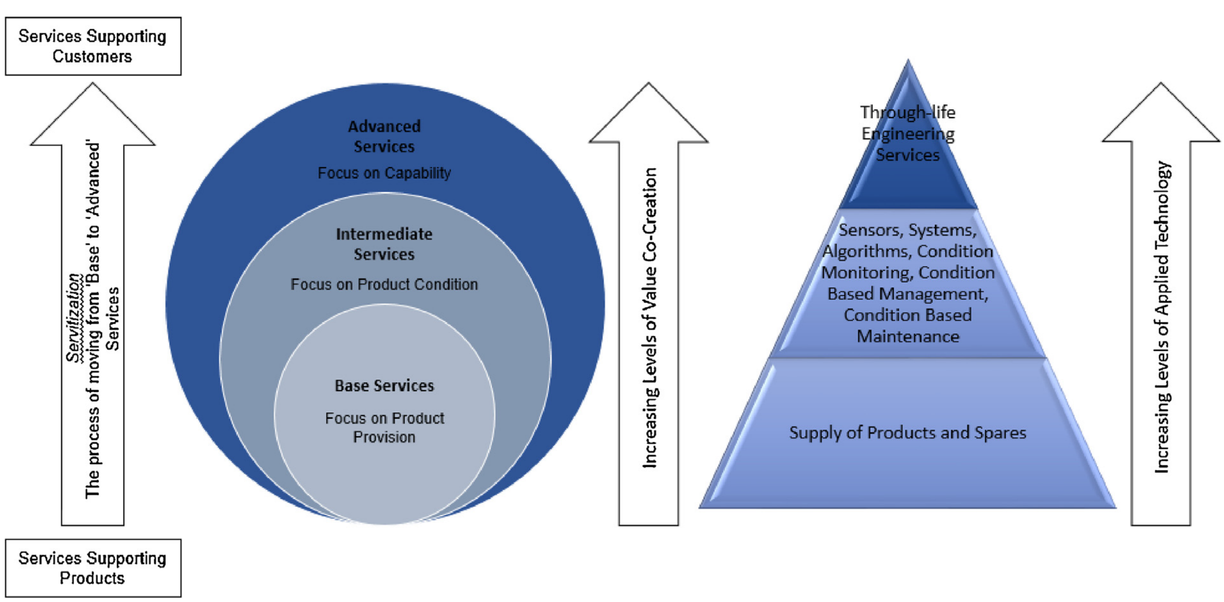

Fig. 1. Applied Enabling Technologies for Differing Levels of Service.

Modified from Baines [21].