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Enhancing Service Requirements of Technical Product-Service Systems

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Abstract

Due to the integration of product and services as a new business model, product reliability and strategies for cost reduction at the early design stage have become important factors for many manufacturing firms. It is, therefore, critical at this phase to analyse the risk involved with Service Requirements noncompliance in order to help designers make informed decisions; as these decisions have a large impact on the Product Life Cycle (PLC).

An investigation has been performed into how Service Requirements are analysed in a service orientated business to achieve reduced Life Cycle Cost (LCC) and improvements of existing Service Requirements. Weibull distribution and Monte Carlo principle have been proposed to do so; as they are considered as the most widely used in product reliability studies in the industry sector. A generic methodology for risk evaluation of failure to deliver a new product against Service Requirements is presented in this paper. This is part of the ongoing research project which aims to, apart from comparing current and targeted Service Requirements, it also facilitates an optimisation of them at the minimum risk of nonconformity.

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1. Overview of Product Service Systems

Worldwide, a change towards more service-oriented thinking has recently been taking place. This goes along with a structural change from a product-centric to a service-centric society, which affects private life as well as industry. The reason for this approach is related to three main triggers. The first, there are economic arguments; as services in general have higher margins than products and provide more stable source of revenue. Secondly, customers are demanding more services with higher specialisation and flexibility and with lower and more predictable operating costs. This is directly linked with prolonged life-cycles with continuous product updates, resource efficiency and contribution to environmental sustainability that the service orientated approach provides [1]. Finally, there is a competitive argument as services are more

difficult to imitate, obtaining premium and unique products and differentiating them from the ones created in product markets [2].

Companies in mechanical engineering and plant manufacturing have recognised the great potential which lies in the paradigm shift of providing customer value instead of selling products. This is the case of Rolls-Royce which was originally set up as a product seller to become now one of the most high value businesses worldwide providing their customers with services. The company is using the Design for Service approach as a procedure to first design the service and then, the product that supports it. With this, there is a strong focus on two main aspects: to minimise the cost of providing the service by the reduction of the LCC and to increase the customer value of the service provided.

For all this, the delivery of services has become more difficult to understand and analyse than the traditional model; mainly for the complete responsibility of service providers to extend the PLC through services and so, reduce the overall cost avoiding the cost of redesign [3]. Here is where this research takes relevance; as it aims to assess the main challenges of PSS and the existing alternatives used in companies to manage the complexity at the preliminary design stage and therefore, obtain a generic methodology to integrate and analyse Service Requirements with design concepts to make better choices.

Nomenclature	
PSS	Product Service Systems
WLC	Whole Life Cost
LCC	Life Cycle Cost
PLC	Product Life Cycle
CDF	Cumulative Distribution Function

2. Challenges of Product Service Systems

The change in the business model towards a more service orientated one has increased the necessity of reconsidering new areas of investigation. Moreover, the trend to agree fixed price contracts in PSS has post even higher risk for the solution provider who has to carefully select adequate measures to reduce cost and control service delivery.

This section summarised the main challenges that companies face at the conceptual stage when a service wants to be delivered.

2.1. Uncertainty

One of the subjects whose interest has drastically increased in recent years is uncertainty. It can be defined as “A random behaviour of any physical phenomenon that causes the indefiniteness of outcomes” [4]. Figure 1 summarised the main sources of uncertainty in PSS:



Fig. 1. Key Uncertainties in PSS [4].

As [5] states the role of reliability and availability have become the two most explored uncertainty drivers of all of them. They are considered as parameters that if properly estimated can guarantee more long-term contracts. All this has considerably increased the responsibility of the solution providers who have to take advanced consideration of availability and reliability of the equipment before signing any contract with the customer. Besides, service complexity and urgent delivery contribute even more to the increase of those uncertainties.

2.2. Cost reduction

Focusing in a manufacturing organisation, the estimation of the main uncertainty parameters is highly desirable at the early design stage; as it is considered the phase where almost the 70% of the production cost is determined [6]. Figure 2 illustrates this statement: when 8% of the total PLC cost is reached in the concept phase, 70% of the total PLC has been already fixed [7].

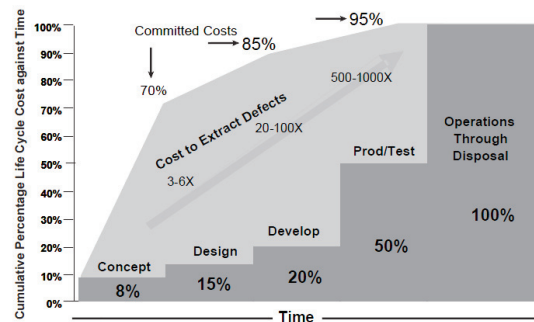


Fig. 2. Committed Life Cycle Cost against Time [6].

Figure 2 also proves that decisions regarding the costs and quality of the PLC at this conceptual design stage are crucial. Thus, the emerging challenge in uncertainty estimation is posting defiance in LCC prediction and reduction; as designers must scope the production solution and service solution concurrently [8].

Therefore, one of the main challenges for the PLC cost reduction is for designers, who have to understand and know the impact of their design decisions at the preliminary design stage in order to reduce cost in the life cycle.

2.3. Identification of Service Requirements

Another growing challenge experienced when delivering integrated product and service solutions is the identification of the top level Service Requirements that a customer is willing to pay for. The difficulty arises due to the variability of uncertainties over time and the unclear definition of the behaviour and performance of a new desired service. Moreover, due to the customised delivery of Service Requirements to the client, the challenge of relating those requirements with their associated uncertainties increases.

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