An exploration of vertical integrations and facilities practices within servitized operations

Tim Baines, (t.baines@aston.ac.uk)
Aston Business School
Howard Lightfoot,
Cranfield University

Palie Smart,
Cranfield University

Abstract
The debate about services-led competitive strategies continues with much interest emerging around the differences between leading production and servitized operations. This paper contributes to this discussion by presenting the vertical integration and facilities practices that are common to four manufacturers which are leading in their successful adoption of servitization. Furthermore, we present the rationale that is emerging as to why these practices are being adopted, and so why they differ to those of production-centric manufacturers. Hence, in this paper we seek to both contribute to the debate within the research community and make practitioners better aware of the consequences of servitization.

Keywords: Servitization, Vertical integration, Facilities practices

Introduction

There is a growing interest amongst both the research community and manufacturers delivering advanced services linked to products (Baines et al, 2010). Examples are frequently given of companies such as Rolls-Royce Aerospace, who now generating a large portion of their business revenues through availability and capability based maintenance contracts with clients. Supporting such services demands, however, that the manufacturer adopts new and alternative practices and technologies to those traditionally associated with production operations (Baines et al, 2009). A prevailing challenge is to understand these differences and their underpinning rationale.

Our research programme has therefore set out to explore how the pursuit of a services-led competitive strategy impacts the broader operations of a manufacturer. To achieve this we have investigated a cross-section of companies who are successfully delivering advanced services coupled to their products. These case companies include Caterpillar, Xerox, MAN and Alstom. Our initial results indicate that several areas of operations are indeed impacted, and these include, information and communication technologies, performance measurement systems, organisational processes, and human resources. Differing practices have also become apparent in the areas of vertical integration, along with the associated form and location of facilities. Here, we are concerned with micro-vertical integration which is otherwise known as supply chain positioning (Baines et al, 2005).

In this paper we report on the vertical integration and facilities practices that are common to our case companies. We explore the rationale underpinning these, and propose an hypothesis for the impact on vertical integration and facilities practice of successful servitization. To realise the purpose of this paper we first reflect on the topics of vertical integration and facilities within the context of conventional production operations. We subsequently describe the design of our study. The main body of the paper then deals with the practices we have observed in situ and the factors that appear to explain them. Finally we conclude and set out a programme for further work.

Background: Vertical integration and facilities practices within conventional production operations

The term vertical integration is usually taken as the extent to which a firm owns and takes responsibility for its upstream suppliers and its downstream customers. Modern manufacturers appear significantly less vertically integrated than their predecessors. Evidence is apparent in the practices of Henry Ford with his production of the Model T in the early 20th Century. Ford chose extensive vertical integration to control quality conformance which in turn helped to minimise the overall cost of vehicle production (Womack et al, 1990). Since then improvements in capabilities within the supply base have relaxed the need for such vertical integration, and concepts such as core competences have motivated manufacturers to divest and relinquish such integration.

Choosing the appropriate position and extent of vertical integration is a complex decision making activity. Within the context of more conventional manufacture (which we refer to as production-centric operations) a wide range of studies have taken place. For example, research that specifically targets the in-bound material supply chain is addressed under make-versus-buy (cf: Probert, 1996), outsourcing (cf: Lonsdale and Cox, 1998) and strategic sourcing (cf: Greaver, 1999). Similarly the out-bound customer interface tends to be covered in the marketing literature (cf: Jones and Clark, 1990; Christopher, 1998).

The concepts of servitization and vertical integration are closely related (Schmenner, 2009). This is especially the case with advanced services which are closely coupled to manufacturer's products. Such product-centric services, such as availability contracts, require the provider to take on maintenance activities that were otherwise performed by the customer and this can be thought of as forwards integration of the manufacturer. However, questions then arise as to whether or not such forwards integration is reflected in the relaxing of backwards integration, or if the extent of vertical integration actually increases with the effective execution of a servitization strategy?

In attempting to generalise the practices in terms of the location and structure of production operation facilities, clearly there are many forms that such operations can take. However, clues do exist as to the popular characteristics of such facilities (see for example; Ford (1922), Skinner (1985), Womack (1990) and Baines et al (2009)). Such authors highlight that although production operations can take differing forms (usually based around the volume and variety of products they produce, eg: project, Jobbing, Batch, Mass, and Process) there are strong similarities in facilities practices. They all seek to exploit economies of scale and resource availability. Hence, the over-ridding tendency is for centralised facilities, where people and equipment are located in one place, and production materials are transferred to the location.

This rationale is illustrated in the practices of manufacturing off shoring. The literature gives a number of examples where companies have relocated their facilities to exploit low labour cost in less developed economies. Such decisions are influenced by factors such as availability of natural resources (eg, materials and energy), market access, political

environment and government incentives. However, the overriding concern appears as access to labour, and leads to the development of large and centralised factories that exploit scale and resources. The question that then arises, is how are such practices impacted when manufacturers seek to compete through a portfolio of advanced services which are coupled to their products?

Research methodology

Our exploration of vertical integration has taken place as part of a larger study to understand the impact of successful servitization on the operations of the manufacturer. In brief, our research methodology has been to carry out in-depth and multi-disciplinary case-studies of manufacturers leading in delivery of advanced product-centric services. Our targeted companies have included Alstom, Caterpillar, Xerox and MAN. Data has been collected over a 15 month period through semi-structured interviews with a wide range of personnel in such companies. Typically these have been interviews with maintenance technicians, customer services personnel, through to marketing, technical, and managing directors.

Analysis has then been conducted by systematically searching for data clusters where our case companies coincide in terms of the practices they follow. For each cluster we have then sought to rationalise the data as a prevailing practice, along with the underlying logic that explains its adoption. Once this has been completed for each data cluster, we have then set out to describe and disseminate these preliminary findings as technical notes and short communications. Thus heightening our engagement with both communities of practice and research, and through their feedback helping to strengthening the validity of our results.

Following this approach, preliminary results have indicated that the adoption of servitization strategies will impact facilities, information and communication technologies (Lightfoot et al, 2011), performance measurement systems, organisational processes, human resources, and vertical integration. The remainder of this paper describes our findings for vertical integration and facilities practices and concludes by summarising why these appear to occur for successfully servitizing manufacturers.

Vertical integration and facilities practices within servitizing operations

Rather than the largely limited extent of vertical integration that is now apparent in many production-centric operations, it appears that those manufacturers delivering product-centric services successfully retain a somewhat unexpected tail of design and production capabilities.

The vertical integration of a conventional manufacturer tends to be arranged around design and production capabilities. Often basic services are offered, such as spare parts, but typically these are produced alongside normal production and delivered to the customer through a relatively independent network of dealers and distributors. Such distributors are themselves conventional service providers and offer a channel to the market for the manufacturer. Typically they will be entirely focused on services such as show-rooms, demonstrations and sales.

Manufacturers such as Rolls-Royce Aerospace initially appear as having extensive vertical integration. In practice, much of this is because the company is active in both original equipment manufacture and product-centric services such as maintenance, repair and overhaul. A more clinical picture of vertical integration supporting product-centric servitization is apparent in those companies that have focused entirely on servicing their existing installed asset base. Although rare, such businesses do exist (Alstom train-life services being one example). As mentioned earlier, forward vertical integration occurs as the manufacturer takes over operations that would have otherwise been carried out by the customer. However, our study indicates that these companies also set out to retain a tail of

design and production capabilities. Such integration exists even when conventional manufacture and product-centric servitization occur in one company (as per the case with Rolls-Royce). Here, there is both close integration and some duplication in activities. For example, both functions of such an organisation may have assembly and test facilities. The extent of this penetration is however reduced, partly because some activities may be shared, and partly because of stronger supply chain leverage held by such a larger organisation.

Moving on to examine facilities themselves. It appears that Facilities are located in close physically proximity to the customers operations and distributed geographically throughout these. Evidence of this appears in the operations across the organisations studied. For example, Caterpillar has an extensive geographic network of autonomous dealers, and these dealers themselves may have strategically placed depots close to the customer base. MAN is somewhat similar, again facilities are carefully located geographically such that they are physically close to their principal customer base. In the London region, for example, facilities are typically within a ten mile radius of the customer.

This situation is further demonstrated by Alstom who have designed and now support the Pendolino trains operated by Virgin Trains on the West Coast mainline routes in the UK. As part of supporting this advanced service, they subsequently took over the existing rail side maintenance and repair facilities which are regionally distributed across the network. They also have a similar contract for advanced services associated with the Northern Line of the London Underground. Here, they again they took over maintenance and repair facilities located at either end of the tube line and were previously owned by the underground operator. This is similar to Rolls-Royce Aerospace who has established facilities for Maintenance and Repair Operations (MRO), through joint ventures with major customers such as American, Singapore and Cathay, which are located close to the operational hubs of these airline customers.

The extent to which a manufacturer decentralises facilities appears dependent on the balance between delivering products and delivering services. If the company retains Original Equipment Manufacture then they may also retain a centralised production hub, as is the case with companies such as Rolls-Royce and Caterpillar. Such a hub appears to be less sustainable as the balance of the company's business moves towards advanced services.

Rationale underpinning the vertical integration practice

Our case work has also illustrated that where a manufacturer sets out to adopt advanced services two sets of macro business pressures are incurred. Understanding these is key to understanding the practices. One set reflects the direct customer demands of a service offering and, in the case of advanced services, is typically concerned with measures of performance, availability and reliability. Performance is concerned with the extent to which the full capability of equipment is accessible, for example the power delivered by a gas-turbine as a percentage of that specified. Availability is typically measured as the extent of time that a product or asset is available for use, as a proportion of the scheduled availability. Reliability is taken as a measure of mean-time between in-service failures. The second principle pressure is from the host manufacturer, and is concerned with the resources required to deliver the service offering, and is typically measured as contract delivery cost. Figure 1 sets out to illustrate how the practice of extended vertical integration (shown to the left of figure 1) translates into an overall positive impact in the light of the business pressures associated with an advanced service contract (shown to the right of figure 1). The underlying logic has two purposes, firstly to maximise the speed and effectiveness of response, and secondly to minimise the cost of response.

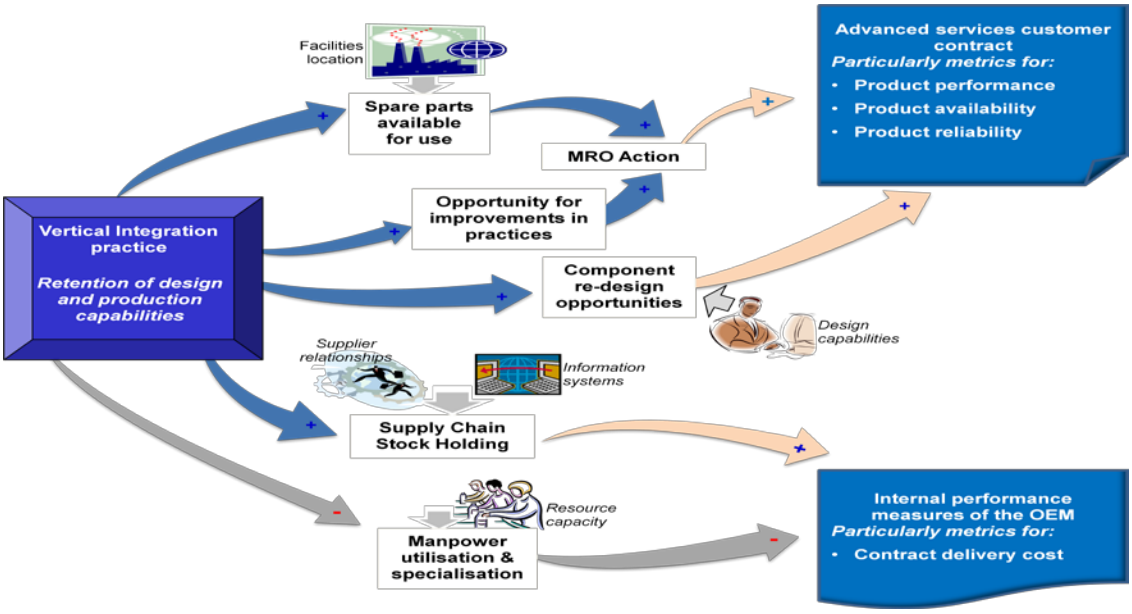

Figure 1: Illustrating the rationale for the vertical integration practices

Supporting advanced services contracts demands an ability to provide a rapid and effective response should an asset fail when in-service. For example, if an Alstom train breaks down then reliability penalties will be incurred immediately by the manufacturer (Alstom), and they are closely followed by escalating penalties for lack of availability or 'up-time'. Rapid maintenance action is aided by the readiness of spare and replacement parts. Some commodity parts and consumables (such as hydraulic oils, filters, fasteners, and brake components) can be readily held in stock and used on a call-off basis. However, with high value subsystems, economics demand that these are overhauled and re-manufactured. Retention of a production capability helps to ensure that such subsystems will be dealt with as quickly as possible, along with buffering the manufacturer from any issues they may encounter with their own suppliers. Retaining design authority also aids continuous improvements in asset design. For example, equipment can be readily re-engineered to improve reliability and maintainability (such as improving access to inspection points, lubrication, and serviceable items). Likewise, many improvements in working practices (such as those achieved through Lean techniques) have originated from the production environment. Adoption of such techniques in maintenance activities is likely to be assisted if the organisation already has expertise of implementing them in production.

Extended design and production capabilities also provide the manufacturer with greater control over the cost of responding. As mentioned above, improvements in working practices and component design impact both the effectiveness and cost of delivering an advanced service. Likewise, the cost of stock holding in the supply chain is reduced. Finally, as maintenance operations are notoriously unpredictable, demanding high levels of buffer capacity in order to deal with unpredictable events, in sourcing provides opportunities to better exploit such capacity. A practical example of this is with Alstom on the Northern Line, where the maintenance depots have chosen to in source the refurbishment of door actuators. A relatively low skilled and labour intensive activity that immediately appears as a candidate for outsourcing if not off shoring. Yet, carrying out such activities internally provides useful employment of standby maintenance staff and also helps to reduce stock holding costs of such items. The downside of this integration is that the business will invariably need to increase investment in management and resources, and this can negatively impact the cost of delivering an advanced services contract.

Investments in design and production capabilities are of course also influenced by the facilities decisions. The relationship between facilities practice and business pressures is captured in figure 2. This illustrates that there are three principal routes through which the practice has an impact. When facilities are located in physically close to a customer's operations, and distributed geographically throughout these, then product/asset performance and availability is positively impacted because the manufacturer can respond faster. This may occur as both faster fault diagnostics and response to a problem. This is achieved because staff are more likely to be on-hand when or as a failure occurs, possibly witnessing a failure themselves, and so taking corrective actions more quickly and precisely. Examples of this in practice include Caterpillar, who is likely to hold maintenance personnel and critical spare parts for quarry trucks, on-site and in reserve and at large customer mines.

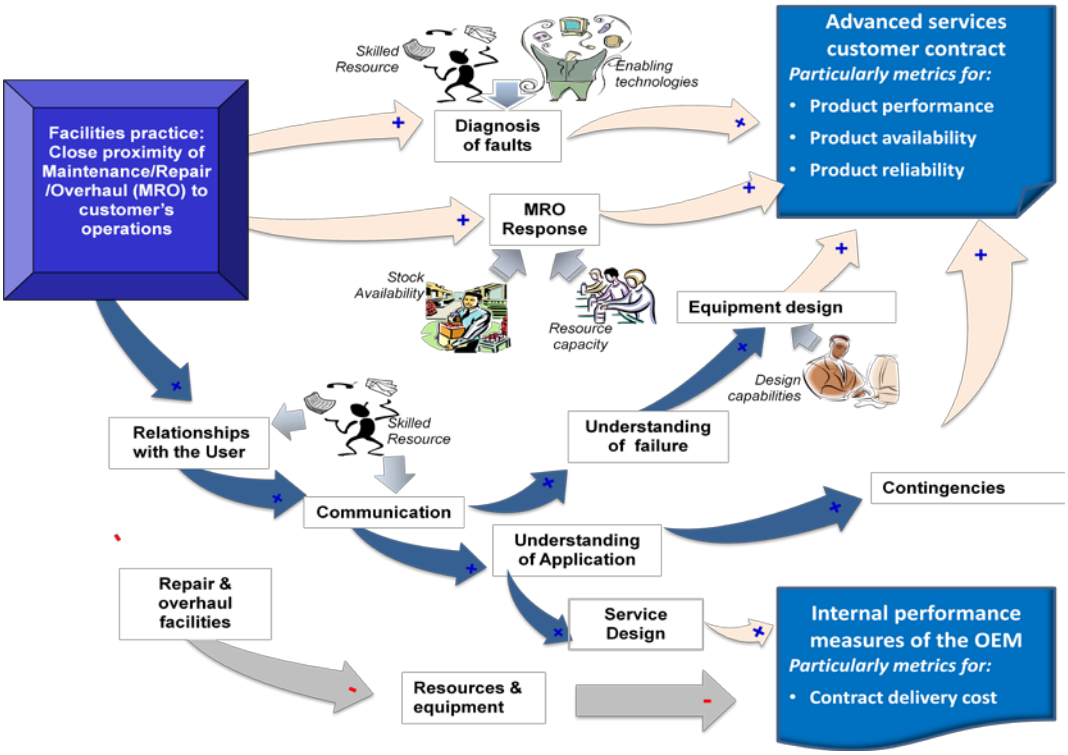

Figure 2: Illustrating the rationale for the facilities integration practices

The proximity of facilities also positively impacts reliability, though principally through a process that centred on building strong relationships between the manufacturer and customer at the level of day-to-day operations. This is critical to a healthy communication process, which itself enables the manufacturer to witness and directly improve their understanding of the application and the way in which the user operates their product. This knowledge can be used to either arrange appropriate contingencies should failure occur (for e.g. knowing precisely where to locate stock reserves and so improving availability), and subsequently modifying the design of products so that they become more reliable. Indeed, it is this capability to improve product designs that provides manufacturers with a significant advantage over competitors who are more conventional service providers.

Although positioning facilities throughout the customers operations positively impacts performance, availability and reliability, the downside is that contract delivery costs also increase. Replicating facilities throughout a customer's network of operations is expensive and invariably means that manpower and equipment are duplicated and cannot be utilised to their fullest extent. For example, Froude Hofmann, faced an increase of costs in setting up a

series of in-country MRO facilities to deliver its customer's service response requirements, which had to be offset by the generation of increase revenues from customers.

These facilities practices, and their implications on business performance, are moderated by other practices within the broader service delivery system. Keys here are stock-holding policies, available resource capacity, capabilities in remote product sensing technologies, and design capabilities. As illustrated in Figure 1, decisions about these other practices impact the consequences of the facilities practices in a number of ways. For example, large amounts of capacity and stock can help to compensate for a poorly located facility, similarly predictive technologies can give the manufacturer advanced warning of an impending issue with an assets performance.

Concluding remarks and future research

This paper, reports on our work to understand the vertical integration and facilities practices of a cross-section of manufacturers who have embraced the servitization trend. In particular, it highlights that such companies retain capabilities in design and production, and do so because this benefits their speed, effectiveness and costs of supporting assets on advanced services contracts. We have captured these findings in the following hypotheses:

For vertical integration:

Delivery of an advanced service contract is positively impacted by the vertical integration into capabilities for sub-system design and production, as this ensures speed and effectiveness of response while minimising costs.

For facilities:

'Facilities that are located in close physically proximity to the customers operations and distributed geographically throughout these'.

These practices differ to those in production fundamentally because, the business pressures associated with advanced services differ to those in original equipment manufacture. Production tends to focus on cost, quality and delivery, where as advanced services contracts centre on performance, availability, reliability and cost. These demand that a manufacturer is responsive. Such pressures are mitigated by the a range of other contextual factors, such are the form of the contractual relationship with the manufacturers own suppliers, the location and structure of facilities, and the sophistication of technology systems monitoring the asset condition in service. All such factors interact to determine the operations strategy that is most appropriate to an individual manufacturer. Our future work will continue to explore these other factors in greater detail.

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