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# Society's Grand Challenges: What Role for Services?

**Andy Neely**

This paper is a Working Paper.

## **Why this paper might be of interest to Alliance Partners:**

This paper explores the potential that different forms of service offer in addressing the grand challenges that society faces - overpopulation, slow economic growth and sustainability. The paper identifies five different forms of product-service system (ranging from attempts to vertically integrate to services that completely replace products) and explores how each of these five forms of product-service system might help address the challenges society faces. The paper is deliberately forward looking in style, exploring what the future trends for services might be.

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## Society's Grand Challenges: What Role for Services?

Andy Neely, Cambridge University

### The servitization of manufacturing

Manufacturing's shift to services is not a new phenomenon. For at least twenty years academics have argued that firms should seek to supplement their product revenues with service revenues. In a manufacturing context the term 'servitization' is usually traced back to the work of Vandermerwe and Rada (1988). Their paper is upbeat about the potential for services, arguing that services are sweeping the industrial landscape.

*Servitization is happening in almost all industries on a global scale. Swept up by the forces of deregulation, technology, globalization and fierce competitive pressure, both service companies and manufacturers are moving more dramatically into services. (Vandermerwe and Rada, 1988, p. 315).*

Other authors, however, point out that many manufacturers have been service providers ever since the day they provided their first product. Certainly ever since the day they had their first product breakdown! Manufacturers have long sold spares and offered repairs. They have offered maintenance and overhaul services, in many cases for as long as they have been selling products. In other sectors of the economy we can see an evolution – through periods of service provision to periods of product sales and then back to service provision. In the music industry, for example, before records and tapes were available, music was embodied in the service delivered by live bands. Then we had a period where products – tapes, records and CDs – were widely available. Now we are re-entering a phase where the physical product is becoming obsolete, as it is replaced by a digital asset accessed through a complex service system that involves the internet, electronic banking payments, music access rights and the exchange of digital information. This evolution from service to product, and back again, is apparent, and not just in high-tech industries. In a historical review, Roger Schmenner explains how at one time pineapples were such a rarity that they were rented for dinner parties. The hosts would proudly display their rented pineapple on the dinner table, only to return it to the store the next day for someone else to rent and use that evening (Schmenner, 2009). This has to be one of the earliest and most unusual versions of Lovelock and Gummesson's rental access paradigm (Lovelock and Gummesson, 2004).

So if the servitization of manufacturing is not a new phenomenon, why then is it an important topic to explore now? This chapter argues that there are three broad reasons why we should pay account to the servitization of manufacturing today. First, the changing structure of the global economy – now, more than ever, services may offer opportunities for manufacturers in developed economies to create value. Second, the technological dimension – it seems we are at a technological tipping point, where new sensors and data-capture systems open up new opportunities for service business model innovation. Third, the future – at this time there are some significant stresses and strains on society and these are set to grow. An ageing population, coupled with changing societal expectations, means that we need new service innovations that will help people live the lives they wish to as they age. Environmental pressures and the demand on the earth's resources mean that we have to look for ways of changing notions of ownership and production, especially

as we look forward to an economically active world with a global population of over seven billion inhabitants. Significant economic shifts, with power moving to the East, mean that Western economies are searching for new ways of ensuring they create and capture economic value.

The structure of the chapter is as follows. It starts by reviewing the traditional reasons why manufacturing is servitizing and exploring the technological tipping point. The chapter then offers a framework for thinking about servitization, identifying five options that firms appear to be pursuing. Next the chapter turns to the future, looking at the illustrative challenges that society faces – most notably demographic, economic and environmental – and explores the implications of these challenges for the phenomenon of servitization. Finally the chapter combines the five servitization options with the previously discussed societal challenges, offering some thoughts on what the future might hold.

### **The rationale for servitization**

Before exploring the reasons why firms are servitizing it is worth stepping back and asking what is servitization. The academic literature appears to use the term somewhat loosely. Some authors describe servitization as ‘the shift to services’ (Vandermerwe and Rada, 1988), suggesting that servitization involves a shift in positioning. Others describe servitization as a strategy. Slack (2005) states that servitization is ‘any strategy that seeks to change the way in which product functionality is delivered to its markets’. Some define servitization relatively narrowly, thinking about it solely in terms of repair and overhaul (Cheng et al., 2010). While others think about it broadly, suggesting that servitization is a phrase that describes ‘the bundling or integration of services with products’ (Schmenner, 2009). Further complexity is introduced when one considers related terms in the literature. There is a wide stream of work on product–service systems, much of it exploring issues of sustainability (Mont, 2004; Tukker and Tischner, 2006). Other authors talk about firms ‘going downstream’ (Wise & Baumgartner, 1999), ‘transitioning from products to services’ (Oliva & Kallenberg, 2003) and offering ‘integrated solutions’ (Davies, 2004).

For the purposes of this paper we will distinguish between three related concepts: servitization, a product–service system, and a servitized organization. We define servitization in terms of the transformation journey – hence servitization is a transformation process, which involves a manufacturing firm ‘innovating its capabilities and processes so that it can better create mutual value through the shift from selling products to selling Product–Service Systems’. We draw on the product–service system literature to define product–service systems as ‘integrated product and service offerings that deliver value-in-use’. And we assume that these product–service systems are delivered by servitized organizations that ‘design, build and deliver one or more integrated product and service offerings that deliver value-in-use’ (Neely, 2009).<sup>1</sup>

Why are manufacturing firms choosing to servitize? It appears there are three broad categories of reason: (i) economic, (ii) strategic and (iii) environmental (see Figure 1). In terms of the economic – the first reason for servitization is that manufacturers in developed economies recognize they cannot compete on the basis of cost. Hence they have to innovate and look for new ways of adding value, one of which is by offering services. This theme – service as a means of manufacturing competing in developed economies –

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<sup>1</sup> With thanks to my colleagues at Cranfield University who helped develop the first three of these definitions through the IMRC sponsored Ideas Factories.

features heavily in many government and policy publications (Porter and Ketels, 2003; Sainsbury, 2007). The second economic reason is that of the installed base. This is particularly prevalent in sectors that offer complex, expensive and long-lasting equipment. Estimates suggest that the ratio of installed-base-to-new-sales is 13 to 1 for automobiles, 15 to 1 for civil aircraft, and 22 to 1 for locomotives (Wise and Baumgartner, 1999). With products that have a 30–40 year operating life, it makes economic sense for the manufacturer of the original equipment to seek to offer life support and servicing. The third economic reason for servitization is stability of revenues. This has been particularly important in recent years, with the economic downturn. Manufacturers have recognized that product revenues are often 'lumpy'. When you sell a large product, you receive significant revenues, but you don't make sales all of the time. With service contracts the revenues may be smaller, but they are regular. Hence many firms are searching for a balance between product and service revenues to smooth the peaks and troughs in income.

The second set of reasons why manufacturing firms are servitizing can broadly be categorized as strategic. In some cases firms deliberately adopt business models that seek to lock in customers. They sell the original equipment at, or close to, cost and seek to make their profits through the ongoing sale of associated spares and services. Classic examples include printers and ink cartridges, mobile phones and calling contracts, razors and replacement blades. Interestingly others also recognize the value in these spares and services, so a second reason why some original equipment manufacturers enter into services is to lock out potential competitors, who might otherwise attack the spares market. This strategy is not always successful. Witness the ink cartridge replacement market, where there is now a booming business in recycling and refilling used cartridges. Clearly these new competitors reduce the margins that the original equipment manufacturers are able to demand. Perhaps the most significant strategic rationales for servitizing, however, centre on risk, predictability and customer demand. In terms of risks, many customers – especially those in the public sector – are seeking to shift the balance of risk. Governments across the world are now declaring that they will contract for capability rather than buy specific products (Ministry of Defence, 2005). The UK defence industrial strategy makes it clear that the Ministry of Defence is interested in procuring the capability to carry out operations, rather than the physical equipment itself. Hence the growth in outsourced support services offered by firms such as BAe Systems and Rolls-Royce. As Slack (2005) points out, this trend has advantages for both suppliers and customers. From a supplier perspective, servitization is a way of increasing sales revenues, while from a customer perspective, servitization offers a route of reducing risk and decreasing – or at least stabilizing and making predictable – maintenance and support costs. Interestingly in the public sector, of course, customers are often powerful, not least because of their purchasing spend. Hence the final strategic reason for shifting to services – sometimes the customers of manufacturers demand that they make this shift.

The third broad category of reasons why manufacturers are servitizing is environmental. This is less prevalent today, but one might expect this to change in the future. Indeed there is extensive literature in the environmental arena that highlights the potential for servitization to have a positive impact on environmental performance (Goedkoop et al. 1999). The core thesis is that it is possible to reduce the adverse environmental impact of products if firms change their business models and customers revise their conceptions of ownership. An illustration that is often quoted is the rented washing machine. Customers no longer buy washing machines, but instead they rent them and pay a fixed fee per

washing cycle. The revised business model means that it is in the customers' interest to minimise the number of washes they undertake – they pay less as a consequence. It is also in the provider's interest to maximize the product lifecycle. Once the machine is installed the provider does not want to have to undertake any maintenance. This revised business model changes the incentives for both the customer and provider –encouraging both parties to pursue courses of action that minimize the environmental impact of the product (Mont and Plepys, 2003; Mont, 2004).

Figure 1: The reasons why manufacturing firms are servitizing

Economic rationale	<ol style="list-style-type: none"> <li>1. Manufacturing firms in developed economies cannot compete on the basis of cost (technological developments are enabling them to add innovative services)...</li> <li>2. The installed base argument (e.g. for every new car sold there are already 13 in operation, 15 to 1 for civil aircraft and 22 to 1 for trains)...</li> <li>3. Stability of revenues – services versus products...</li> </ol>
Strategic rationale	<ol style="list-style-type: none"> <li>1. Lock in customers (sell the original equipment at cost, make money on spares &amp; suppliers - razor, printers)...</li> <li>2. Lock out competitors...</li> <li>3. Increase the level of differentiation (e.g. equipment provider offers to take customer's risk and give predictable maintenance costs)...</li> <li>4. Customers demand it (e.g. contracting for capability)...</li> </ol>
Environmental rationale	<ol style="list-style-type: none"> <li>1. Environmental rationale (change notions of ownership and resource use – e.g. Mobility cars)...</li> </ol>

While these three broad categories of reason are important drivers of the shift to service, the related issue is that recent technological developments appear to be speeding up the servitization of manufacturing. This is particularly the case when one considers asset-heavy industries, where there is increasing use of intelligent vehicle-health monitoring technologies. In the construction industry, for example, firms such as Caterpillar use remote asset-management technologies to monitor equipment health. By tracking variables such as engine temperature and oil pressure, Caterpillar is able to identify potential engine failures at an early stage, intervening before a critical equipment failure. The net result is that customers end up replacing \$100 bearings, rather than facing bills for complete engine overhauls. They are also able to achieve higher uptimes for their equipment, a key driver of competitiveness in the construction equipment industry.

Other technological advances open up new opportunities for service. In the agricultural sector, John Deere offers precision farming solutions through its GreenStar solutions. These employ GPS technology to monitor the position of farming equipment in a field. The iGuide system tracks the position of farming equipment – ploughs and harvesting implements – ensuring that the overlap between furrows is minimized and hence wasted effort reduced. Other solutions include automatic steering systems, which allow operators to drive hands-free, by linking steering mechanisms to GPS trackers. The same technology is used to control the application of fertilizer and the process of spreading

seeds. Using GPS technology to monitor the position of farming equipment allows systems to be turned on automatically at the right time. Through the innovative integration of GPS technology and farming equipment, John Deere has been able to develop creative and valuable services and solutions for its customers.

Beyond the asset-heavy industries, advances in information communication technologies and new methods of data collection are creating new opportunities. For example, mobile phones can now double as people-tracking devices. The movement of mobile phones can be used to monitor traffic flows. If on a major motorway all of the mobile phones are only moving along the route of the motorway at five miles per hour, it is safe to assume that there is a traffic jam and the phones are sitting in cars that are stuck in the traffic jam. Google maps uses positioning data from mobile phones to provide real-time updated maps through smart phones. Smart metering systems in the home mean that energy companies can help householders understand, manage and reduce their fuel consumption. The list of innovative services being provided by traditional manufacturers appears endless and is limited primarily by our imagination. Technology plays a crucial enabling role in these developments. Whether it is GPS systems, handheld devices or smart meters, a unifying theme in many services is the creation and integration of data via the Internet. Without these enabling technological platforms, many of the services we see today would simply not be feasible (Gawer, 2009).

### **Five options for servitization**

Traditionally the literature discusses three different forms of product-service system (PSS): product-oriented PSS; use-oriented PSS; and result-oriented PSS (Hockerts and Weaver, 2002). In a product-oriented PSS, ownership of the tangible product is transferred to the customer, but the manufacturer provides additional services that are directly related to the product. For a use-oriented PSS, ownership of the tangible product is retained by the service provider, who sells the functions of the product, via modified distribution and payment systems, such as sharing, pooling, and leasing. While in a result-oriented PSS, the PSS replaces services for products, e.g. voicemail service replacing answering machines. While useful, this categorization is not comprehensive (Neely, 2009), for it misses two additional options for servitization: integration-oriented PSS; and service-oriented PSS. Integration-oriented PSS result when firms seek to add services by going downstream and vertically integrating. Service-oriented PSS result when firms add services to products, by integrating those services into the product, e.g. Intelligent Vehicle Health Monitoring services.

In essence these five options for servitization form a spectrum, ranging from integration-oriented PSS to result-oriented PSS. Major oil companies, for example, have servitized through the integration-oriented PSS route. They have established retail infrastructures, initially to sell their own products – oil and gasoline – and then increasingly to sell the products of others. Indeed many service stations now operate as mini-supermarkets, offering a wide range of consumables.

A classic example of the product-oriented PSS would be automobile servicing and financing services. The consumer still takes physical ownership of the product, but buys additional product-related services from the provider. In the case of financing, the finance is tied directly to the purchase of the product. A model used to great effect in many sectors – just look at the size and scale of GE's financial services business.

The third option – service-orientated PSS – is a subtly different development. Here the service becomes embedded in the product. John Deere’s use of GPS technology, along with Rolls-Royce’s power-by-the-hour, are classic examples of service-orientated PSS. Both involve the use of advanced technologies embedded in the product to enable the service. Often these services involve remote monitoring and predictive maintenance. Data are gathered during the product’s operation and are used by the original equipment provider to advise when maintenance services are required.

In the use-oriented PSS the change lies in ownership. Here legal ownership of the product does not transfer to the user of the product. Instead the user buys the right to use the product as needed. Some of Rolls-Royce’s customers operate this way, paying just for the thrust aero-engines deliver rather than for the engine itself. The use-oriented model, however, is becoming increasingly widespread. ZipCar has adopted a use-oriented PSS, providing customer access to cars only when they need them. Indeed any rental or access-based model is effectively a use-oriented PSS.

The most extreme form of service involves the service completely replacing the product. Sometimes products are made obsolete through these innovations. Take, for example, answering machines. We all used to have answering machines by our phones, but now the technology has developed to such an extent that the answering service is embedded in another product – the telephone itself – or provided as an additional service (e.g. by phone operating companies). Whenever the product (or the functionality it provides) can be digitized, there is scope for result-orientated PSS. This is a particularly important phenomenon in the entertainment and telecommunications industries, where traditional videos and DVDs have been replaced by e-enabled services, such as video on-demand.

These five forms of product–service system offer interesting opportunities for manufacturing firms seeking to servitize. The remainder of this chapter explores how these five forms may offer solutions to some of the grand challenges facing society in the twenty-first century.

### **Society’s grand challenges**

In 2011 the earth’s population surpassed 7 billion. Although the overall rate of population growth is decreasing, the population in developing economies continues to grow at around 2 per cent. In many developed economies the picture is slightly different, in that declining birth rates, couple with increased life expectancy, mean that populations are ageing. The United Nations forecasts that by 2050 the median age of people in developed countries will be 45.5 years, up from 29.0 years in 1950. Increased longevity has particular implications for service, especially public services. In the UK the prediction is that by 2050 one in four people will be over 65. Today the figure is one in six (Cracknell, 2010). Government data suggests that spending by the National Health Service on retired households is nearly double that on non-retired households. And spending on people aged 85 and over is almost three times greater than spending on people aged 65–74. In 2009/10, state benefits and the National Health Service accounted for just under half of all government spending. The financial demands that an ageing population will impose mean that we have to look for new and innovative ways of much more efficiently delivering health-care services in the future (Cracknell, 2010).

Let us turn to a different grand challenge facing society – namely economic growth. Even before the current turmoil in the financial markets, significant questions were being asked

of manufacturing's future in developed economies. The UK and the US have lost swathes of industry to emerging and other developed economies. Consider automotive manufacturing, consumer electronics, computer and IT systems or machine tools. In the UK, with the exception of aerospace and pharmaceuticals, much of the country's manufacturing capacity is foreign owned. Indeed the country's economic strength is founded on financial services – a fact that has increasingly worried commentators, who are now calling for a rebalancing of the economy. How do you rebalance an economy, however, when your labour costs are significantly higher than the competition and, in some cases, you have lost the production capabilities that are needed to support economic activity? Pisano and Shih (2009) neatly summarize this issue in their provocatively entitled article 'Restoring America's Competitiveness'. They argue that the US has lost much of its industrial commons – 'the collective R&D, engineering, and manufacturing capabilities that sustain innovation'. Through decades of outsourcing, the US has decimated its local capabilities, making it almost impossible to re-establish certain industrial activities. If we can't recreate old industries, in order to stimulate growth, developed economies have to innovate new industries – hence the significant interest in novel technologies and exotic materials ranging from electronics to biomedicine. The question is what role will services play in enabling and supporting these developments and the return to growth of many industrialized economies?

A third grand challenge that is often discussed is that of the environment. The Stern Report, published in 2006, outlined some significant challenges that will arise from climate change. Significantly the report claimed that average temperatures could rise by five degrees centigrade from pre-industrial levels if climate change goes unchecked. With rises of three to four degrees centigrade, 200 million people may be permanently displaced because of rising sea levels, heavier floods and drought. Even with a two-degree centigrade warming, between 15 and 40 per cent of species face extinction (Stern, 2006). There are critics of Stern's analysis and ongoing debates about the size of the impact of climate change, but it is clear that climate change poses some significant challenges for society, especially if we continue to consume resources at an increasing rate.

These three grand challenges make an interesting framework to pose the question – what can product-service systems offer in terms of addressing the grand challenges facing society?

### **The demographic challenge: What role for services?**

As previously discussed, the demographic challenge relates to population growth. There are different causes of population growth, although three important factors are birth rates in developing economies, migration (often from developing economies) – a phenomenon that may become more pronounced given the impact of the environmental challenge – and population ageing, which is a consequence of increased life expectancy, because of improvements in medical and health-care provision. Taken together, these factors mean that our health-care systems will come under increasing strain. We don't have enough hospital capacity and cannot afford to create enough capacity as the cost of health care is increasing rapidly. As the low-hanging fruit of drug discovery is picked, it becomes increasingly expensive to create ever-more sophisticated pharmaceuticals. Indeed the pharmaceutical industry also faces a crisis, as many of the traditional 'blockbuster' drugs are coming to the end of their patent and so pharmaceutical firms are also questioning what role they should play in the future.



What do these challenges mean? First, we know that members of the ageing population value their independence and freedom. Many express a preference for living in their own homes. Technology – especially assisted-living technology – makes this more feasible. Remote-patient monitoring and diagnostics are becoming more common. These developments offer a new opportunity for pharmaceutical firms, as they seek to overcome the business challenges they face with their drugs coming off patent. Hence we see more and more pharmaceutical firms redefining themselves as health-care firms, interested not just in the sale of product, but in the provision of a wider range of health-care services.

In terms of integration-oriented PSS, the implication is that pharmaceutical firms will increasingly seek to vertically integrate. They will seek to position themselves as health-care providers offering assisted-living technologies, as well as health-care support. How far this vertical integration will spread is an interesting question? In other manufacturing sectors we have seen firms diversify into providing financial services to support their products. Will the same happen in the pharmaceutical sector? Is there scope for pharmaceutical firms to offer health insurance services or private health care, as we see a shift towards personalized health-care provision? Even more outlandish, how far could pharmaceutical firms expand in terms of product-oriented PSS? Could they start to offer customized and personalized drugs? Or even replacement organs?

In terms of service-oriented PSS, the obvious development lies in remote diagnostics and monitoring technologies. Patient adherence – the requirement for patients to complete courses of prescribed drugs – is a significant issue in health care today. With remote monitoring technologies it may be possible to monitor whether patients are following their proscribed treatment plans. Indeed with remote monitoring technologies it is also possible to remotely track blood-sugar levels in diabetics, irregular heartbeats in patients at risk from heart attacks, and breathing patterns in asthmatics. A particularly interesting recent development is IBM's Watson, a super-computer that recently won the American quiz show Jeopardy. Watson uses complex analytics to answer questions and has the potential to support patient diagnosis. Indeed IBM is now exploring how Watson could be used to support, if not replace, doctors in the patient diagnosis process.

Use-oriented PSS tend to focus on the use of assets without exchange of ownership. Already we have examples of use-oriented PSS when it comes to population ageing – retirement homes, for example, provide access to assets (accommodation, entertainment and sustenance) on an as-needed basis. At a broader level one can consider what other resources an ageing population might need access to on a sporadic basis – transportation services (cars with wheelchair access), health-care services (shared nursing and medical advice), and leisure services are all obvious candidates.

The final category of PSS – result-oriented PSS – poses particular challenges for the demographic challenge. What would outcome-based health care constitute? Is there scope for a lifetime health contract – where individuals pay for support and advice that would increase their life expectancy? Coupling a 'pay per year' model with remote monitoring and diagnostic technologies opens up interesting opportunities to offer dietary and exercise advice designed to maximize an individual's healthy life.

### **The economic challenge: What role for services?**

The economic challenge is clearly topical. Even before the financial crisis and the current turmoil in Europe there was widespread recognition that the economic landscape was

changing. The emergence of the BRIC (Brazil, Russia, India and China) countries as economic powerhouses, coupled with the relative economic lethargy in many developed economies, meant that many commentators were asking how firms in developed economies would compete in the future. Numerous policy reports called for 'Western' firms to compete through innovation and creativity – a call that was especially loud in the manufacturing sector.

There are, of course, numerous ways in which firms can innovate. Some commentators appear to equate innovation with technology, confusing high value with high-tech. It is clear, however, that high-tech is just one opportunity. There are low-tech opportunities to create value for firms that think creatively. Take, for example, recent thinking about two concepts – the last mile and the long tail. The last mile refers to the act of getting products to consumers. The long tail refers to the fact that there is a long tail of products with low individual demand, but which collectively are valuable. Amazon has exploited these two – the last mile and the long tail – to particularly good effect. They have captured significant value simply by retailing products – initially books, but now a much wider range of goods. The long tail is important to Amazon because changes in printing technologies mean that they can economically offer a wide range of products, even if some have very low demand. In a traditional bookstore shelf space is a limiting factor. You can only display the books you can physically hold in store. In a virtual store you have no such constraints; hence you can offer a far wider product range, with effectively no stock holding costs. The implication is clear – in terms of integration-oriented PSS we will see increasing numbers of firms seeking to capture the value created in the last mile, by selling directly to their own (and others) consumers. To do so they will rely on online stores – either self-owned, or created in partnership with others.

When it comes to product-oriented PSS and service-oriented PSS, two major trends that we will see are increased systems and solutions offerings, coupled with innovations in business outsourcing services. The former – systems and solutions offerings – can already be seen in some sectors. In the automotive and aerospace manufacturing sectors, for example, there has been a significant shift to corner or modular engineering, where first-tier suppliers take responsibility for the design and delivery of entire systems or modules that the original equipment manufacturers integrated into the final product. In service-oriented PSS, many manufacturers are offering through-life services for their product and equipment. This is especially the case in asset-heavy industries with a large installed base. As previously discussed, if you operate in a mature sector with a large installed base of capital equipment that has a long operating life, it follows that offering through-life services is a natural extension. A key element of this extension is the alignment of incentives between provider and customer. In the past it was often in the original equipment manufacturer's interest for their equipment to be unreliable. In some sectors – notably aerospace – original equipment was often sold at, or close to, cost and the margin was made on the provision of spares and repairs or time and materials. With the advent of remote product-monitoring equipment, manufacturers and customers can now minimize maintenance, often only intervening when maintenance is needed rather than working to a fixed schedule. This approach can significantly reduce the costs of maintenance, or make them far more predictable, reducing the risk and exposure of the customer.

Use-oriented PSS often involves the shared use of assets. Some firms are seeking to innovate their business model in this way, although interestingly these are often new entrants to the market – consider ZipCar, for example, which offers customers the

opportunity to join a car-sharing club, and Better Place, the Israeli company that offers batteries for Electric Vehicles. One of the challenges in the Electric Vehicle market is the range that cars can travel before they need a battery recharge. The Better Place business model involves sharing batteries. Drivers buy their vehicles, but they borrow Better Place batteries, use them until they run out of charge, drive to a Better Place station, swap their battery and drive off. Better Place recharges the battery to make it ready for another customer to use.

In the most extreme form of PSS – result-oriented PSS – the product is replaced by a service. Again, when responding to the economic challenge, result-oriented PSS often involves significant business model innovation. Frequently this is associated with a shift to outcome-based contracting, where the customer pays for the desired outcome, not the product. The classic example is Rolls-Royce, with its power-by-the-hour contracting model. But other firms have also adopted result-oriented systems – ranging from the provision of men’s and women’s underwear (see [www.manpacks.com](http://www.manpacks.com) and [www.pantybypost.com](http://www.pantybypost.com)) through to a wide variety of drive-through services, including drive-through libraries in Milwaukee and Ottawa.

### **The environmental challenge: What role for services?**

The environmental challenge has multiple dimensions, but at its heart is the pressure on the earth’s limited resources. A pressure that is clearly set to grow as the economies of the BRIC countries, amongst others, develop rapidly. A significant challenge that society faces is that of the consumer economy – we define ourselves as consumers – and yet consumption is at the heart of the environmental challenge that we face. Hence one argues that business models that rely on shared use of, and access to, resources, rather than consumption, may provide a more sustainable future.

In integration-oriented PSS this shift away from consumption implies a shift towards life-cycle management. Considerations of recycling and reuse of resources will become more central, especially as the price of resources increases. There are already some interesting developments in the reuse of resources, especially when a systems’ perspective is taken. Some industrial estates now, for example, take the by-products from one factory and use them as inputs in another. In furniture manufacturing, wood and offcuts are produced as by-products, but these can become inputs to wood-chip mills and used for fuel. Other manufacturing processes, which require significant cooling, produce heat as a by-product that can be captured, stored and reused as thermal energy. In the oil industry, the use of extended well-life technologies has allowed firms such as Cairn Energy to start to efficiently extract additional oil and gas from wells that were uneconomical to the oil majors.

As firms seek to address the environmental challenge from a product-oriented PSS perspective, they will increasingly focus on life-cycle operating costs, not initial manufacturing costs. Design for service and through-life operation will be much more deliberate, with growing attention being paid to end-of-life disposal and reuse. Similar trends will be observed in the service-oriented PSS. Here manufacturers will use technology to offer timely services, rather than scheduled services. We have already mentioned the use of remote product sensors to minimize maintenance. As well as having a cost benefit, remote sensing equipment and predictive maintenance can be used to avoid unnecessary maintenance and repair, hence reducing the use of materials and components. Additionally, remote sensing equipment on vehicles, for example, can be used to give feedback and advice to the asset operators on how to optimize asset

utilization. Accelerating too hard in your car increases fuel consumption unnecessarily. Overheating the engine on your Caterpillar extraction equipment can result in significant damage and the need for a major overhaul. Yet with remote monitoring (and even intervention equipment) these problems can be avoided.

For use-oriented PSS the environmental opportunities are obvious. Sharing product and resources, rather than owning individual assets, has obvious advantages. Consider libraries – both for books and films. In essence these own a stock of assets and make them available to people for the period they need to use them. Hence we do not need to consume as many resources in the original production process. Finally, for result-oriented PSS, the service replaces the product. The environmental impact is again obvious – a reduction in resource consumption. Potentially any product that can be digitized can be eliminated. We don't really need to produce books, newspapers, CDs or DVDs – all of these can be made available digitally. Continued innovation in technology means that we will see increasing numbers of digital assets that exist only in the form data and computer code.

### **Bringing it all together: The potential of services**

Table 2 brings these themes together and illustrates the nature of the challenges facing society, the implications of these challenges and the potential that the five different forms of product–service system offer when addressing these challenges. Clearly the shift to services is not going to overcome all of these grand challenges, but it may help mitigate some of their impact.

	<b>Demographic</b>	<b>Economic</b>	<b>Environmental</b>
<b>Nature of the challenge</b>	<ul style="list-style-type: none"> <li>• Significant growth in population.</li> <li>• Migration resulting in changing population profiles within countries.</li> <li>• Improved health care increasing life expectancy.</li> <li>• Ageing population, especially in developed economies.</li> </ul>	<ul style="list-style-type: none"> <li>• Emergence of new low-cost competitors.</li> <li>• Rapid industrialization of BRIC countries.</li> <li>• Concerns about financial stability and economic growth, particularly in developed economies.</li> </ul>	<ul style="list-style-type: none"> <li>• Growing pressure on earth's resources.</li> <li>• Concerns over the sustainability of the carbon economy.</li> <li>• Food shortages and wastage.</li> <li>• Global water shortages with uneven impacts.</li> </ul>
<b>Implications of the challenge</b>	<ul style="list-style-type: none"> <li>• As the population ages we will see more opportunities for assisted living and remote health care, with older members of society wishing to remain independent.</li> </ul>	<ul style="list-style-type: none"> <li>• Firms in developed economies will look for new ways to differentiate and add value, possibly through service provision.</li> </ul>	<ul style="list-style-type: none"> <li>• Society today is a 'consumer' society. One can question whether consumption is sustainable in the longer term. Business models that encourage shared use of resources may become more popular.</li> </ul>
<b>Opportunities for integration-orientated PSS</b>	<ul style="list-style-type: none"> <li>• Greater vertical integration from pharmaceutical providers. As drugs come off patent, firms may redefine themselves as health-care providers, seeking to offer through-life health-care services.</li> <li>• Other equipment manufacturers will innovate health-care provision, questioning whether we need the same hospital-based health-care structure that we have today.</li> </ul>	<ul style="list-style-type: none"> <li>• It is clear that significant value lies in the last mile: the retail and distribution end of the value chain.</li> <li>• Product manufacturers will increasingly seek to capture more of this value by creating their own distribution channels, especially online.</li> </ul>	<ul style="list-style-type: none"> <li>• Considerations of reuse and recycling will become more dominant.</li> <li>• Exploring the scope for reuse through systems thinking will become prevalent.</li> <li>• We are already seeing examples of industrial parks, where the by-products from one firm become the input to another.</li> <li>• Reuse waste heat, produced as part of a production process, to provide heat input to central</li> </ul>

			heating systems.
<b>Opportunities for product-oriented PSS</b>	<ul style="list-style-type: none"> <li>Pharma companies become health-care companies.</li> <li>Customized and personalized drugs and organs.</li> </ul>	<ul style="list-style-type: none"> <li>Digital printing – product innovation.</li> <li>Systems integration.</li> <li>Design and development.</li> </ul>	<ul style="list-style-type: none"> <li>Efficient design that takes account of through-life operational costs, not short term.</li> </ul>
<b>Opportunities for service-oriented PSS</b>	<ul style="list-style-type: none"> <li>Remote patient monitoring.</li> <li>Patient adherence.</li> </ul>	<ul style="list-style-type: none"> <li>Remote equipment monitoring.</li> <li>Outsourced to reduce cost of operation.</li> </ul>	<ul style="list-style-type: none"> <li>Managed maintenance – as needed, not when scheduled.</li> <li>Advice on equipment utilization based on remote monitoring.</li> </ul>
<b>Opportunities for use-oriented PSS</b>	<ul style="list-style-type: none"> <li>Hotel hospitals, for example, will become more prevalent.</li> </ul>	<ul style="list-style-type: none"> <li>Shared factories.</li> <li>Shared production.</li> <li>Shared design.</li> </ul>	<ul style="list-style-type: none"> <li>Shared resources and assets.</li> </ul>
<b>Opportunities for result-oriented PSS</b>	<ul style="list-style-type: none"> <li>Outcome-based health care.</li> <li>Pay per year of life...</li> <li>Offer remote monitoring and diagnosis (with supplementary dietary and exercise advice).</li> </ul>	<ul style="list-style-type: none"> <li>Outcome-based contracting – provide outcome.</li> </ul>	<ul style="list-style-type: none"> <li>Digitization – replace the product with the service.</li> </ul>

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