Product biographies in servitization and the circular economy

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Keywords: products, service, servitization, product biography, circular economy, Internet of things

Abstract

This paper questions the assumption in much of the product-service literature that products can be treated as stable platforms for the delivery of services. Instead, it uses the notion of the product biography to argue that products are chronically unstable, both physically and institutionally, and focusses on the managerial and institutional effort required to temporarily stabilise products for exchange or service value-creation. It applies this perspective to typical servitized dyadic relationships, arguing that service opportunities arise precisely from the instability of products, not their stability. It then extends the analysis to the circular economy, in the form of closed-loop supply chains and the still wider inter-linked networks that characterise the journeys of products in their often eventful lives. Against this backdrop, it also considers the potential of the Internet of Things to provide a basis for service-led growth and in achieving the environmentally-desirable aims of the circular economy.
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1. Introduction
The pursuit of service-led growth by product firms has been an increasingly important issue for practice, research and policy over the past ten to fifteen years. ‘Servitisation’, claimed Vandermerwe and Rada (1988), could add value and differentiate the business; an early call to arms in manufacturing came from Wise and Baumgartner (1999), exhorting manufacturers to ‘go downstream’ to capture more value in the ‘aftermarket’. Since then, several themes have emerged in the product-service literature, in marketing, operations, technology management and innovation studies. In marketing and operations management, the particular interest in product firms shifting into service has taken place alongside a more general resurgence of interest in, and rethinking of, services.
The embracing of services has certainly presented new challenges in practice and in theory. Product-led firms have had to develop or access new capabilities; researchers have had to think again about what services are, often without the aid of the conventional, externally-imposed categorisations of ‘service sectors’ that had defined the scope of most service research hitherto. But in this search for insight into what services are, why that matters, and, especially, how it matters to product-led firms, we suggest that the product has been neglected. Products have been treated as the stable, unproblematic element in the mix, as vehicles for the delivery of service, as the part of the business that is relatively familiar and easy to manage.

We suggest, first of all, that this is not the case, nor ever was; furthermore, we suggest that the intimate entangling of products and services in many forms of servitization means that we must reflect as intensively on the nature, role and identity of products as we do on those of services. Further still, as the conventional take-make-dispose model of product supply chains is superseded by what is increasingly known as the ‘circular economy’, the identity and stability of products is challenged even more, as they undergo refurbishment, remanufacturing, dismantling, re-use and recycling, as well as being subject to new forms of valuation and exchange. Add to this the potential of the ‘Internet of things’ to allow constant monitoring, adjustment and redefinition of products and their relationships to other actors and artefacts in a network, and it becomes apparent that the product is by no means as straightforward a proposition as we might have thought.

In this paper, we use the central idea of the product biography to examine products in relation to services, to other products, and in processes of production, re-production, valuation, exchange and use. We begin by considering products in typical dyadic servitization settings, but then develop our analysis into the more extended networks and processes of the circular economy and closed-loop supply chains. We also consider the impact of the Internet of Things on the evolving relationships between products and services. We address theoretical and managerial issues. First, we challenge the assumption that products are relatively stable elements, developing the notion that products, like services, are institutional achievements as much as they are material objects, and that they are subject to chronic instability, both institutionally and materially. Second, we suggest that managers in product-led and other firms must be alert to the entrepreneurial opportunities that arise from the mutability of products in product-service combinations. Third, we begin to map out the challenges in building the institutional scaffolding with which the environmentally-desirable aims of the circular economy and collaborative consumption can be turned into a reality, and the role of the Internet of Things in achieving this.
2. Servitization challenges and the implied stability of products

2.1 Key themes in the servitization literature

A number of themes have emerged in the literature on the shift to services, or ‘servitization’. Early research was largely conceptual, arguing for servitization as such (Vandermerwe and Rada, 1988), and in manufacturing in particular (Wise and Baumgartner, 1999), as a way to differentiate and to create and/or capture extra value. An extensive literature has grown around the categorisation of different forms of service-led growth in product firms (Mathieu, 2001, Tukker, 2004, MatthysSENS and Vandenbempt, 2010, Kindström and Kowalkowski, 2014), often centring on whether and how service activities should be related to the associated products and, in some cases, examining alternative forms of ownership structure and their effects (Snir, 2001, Stoughton and Votta, 2003). Manufacturing firms venturing into service provision face challenges in terms of organisational structure (Galbraith, 2002, Fisk et al., 2011, Gebauer et al., 2010) and in functional strategies, for example in marketing and operations (MatthysSENS and Vandenbempt, 2008, Baines et al., 2009). An enduring question is the extent to which service should be provided from the same organisational unit as production, or delivered from a separate one (Oliva and Kallenberg, 2003, Oliva et al., 2012). Others have examined the role of capabilities in enabling firms to put servitization strategies into effect (Uлага and Reinartz, 2011, Spring and Araujo, 2013), identifying how existing capabilities can be mobilised, and what additional capabilities may need to be developed or accessed from other firms in the network.

As servitization has become increasingly widely adopted, researchers have turned their attention to its financial and performance implications (Neely, 2008, Visnjic-Kastalli and Van Looy, 2013, Eggert et al., 2014). The so-called ‘servitization paradox’ has emerged, which suggests that firms who adopt servitization may grow their revenue, but not their profit (Neely, 2008). More specifically, studies have begun to show that firms perform better when they add a large proportion of service offerings to their manufacturing product offering, rather than adding services only in a very incremental fashion (Fang et al., 2008). Some forms of servitization entail a shift from the transfer of product ownership to the customer, to various forms of lease, rental or payment for access. This is also examined in the systems integration and ‘solutions’ literature (Prencipe et al., 2003, Nordin and Kowalkowski, 2010). As such, another strand of literature has examined the different forms these arrangements may take, using, for example, property rights theory (Lay et al., 2009) and agency theory (Kim et al., 2007) to understand how the change in ownership structure alters incentives in the ‘servitized’ relationship.
2.2. The problem with services

Throughout these developments, not surprisingly, the service activities have been treated as the new, unfamiliar, and more difficult-to-understand element in the story. For product firms, services require new ways to organise, and new capabilities; they present problems or at least new dynamics in incentivising the behaviour of both provider and customer, and seem to result in mixed performance outcomes for the servitizing firm. Meanwhile, the product is treated as a relatively stable and unproblematic part of the picture: we know how to make products, we have existing and successful organisation structures and strategies for production and distribution of products to be sold, and we know how to price and sell them.

In some ways, this echoes the initial emergence of service management as such: for example, the Harvard Business School introduced its first course on Managing Service Operations in 1972, ‘operating on the hypothesis that the tasks of managing service firms differ significantly enough from those of manufacturing firms to justify separate (or at least special) treatment’ (Sasser et al., 1978). The defining characteristics of services that Sasser and his colleagues identified were what have become known as ‘IHIP’: intangibility, heterogeneity, inseparability 1 simultaneity and perishability, and these were considered to ‘make the management tasks of service executives different from their counterparts in manufacturing firms’ (Sasser et al., 1978: 15). In the past ten years, these defining characteristics have been called into question (Vargo and Lusch, 2004a, Lovelock and Gummesson, 2004). But the result has been either (a) to reframe the ‘problem’ of services from one arising from the IHIP characteristics to one of organisational design or of contracting, based on the ‘rental/access paradigm’ (Lovelock and Gummesson, 2004), treating the product as the non-problematic element or (b) as in Service-Dominant Logic, to treat products not only as non-problematic, but also as mere bit-players in the service drama:

“the creation of tangible objects is of secondary importance: after all, such goods have little value in and of themselves; they are important only to the extent that they serve as the equipment and supplies for the extraction o[f] service production processes” (Vargo and Lusch, 2004: 328)

Our contention here is that, while many challenges doubtless arise from product-led firms moving into the less familiar activities that have been characterised as services, we should not assume that products are as stable and unproblematic as might be inferred from the servitization literature. Indeed, the main argument of the paper is that a fuller consideration of products and their existence

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1 In Sasser et al., ‘inseparability’ was ‘simultaneity’.
in networks of production, service, valuation, exchange and use can shed new light on the sources of service-led competition and growth.

3. The stabilities and instabilities of products

3.1 Products

What is a product? Marketing and economic theory more generally have struggled to conceptualise products beyond commonsense notions. At the risk of over-generalising, products have usually been equated to goods and their essential properties contrasted with those of services.

In economic theory, Lancaster (1966) conceptualised goods as bundles of characteristics that consumers value in different ways. Utility is derived from these characteristics rather than the good as a whole, with characteristics perceived as objective attributes by all consumers. As Lancaster (1966: 134) noted: “...the personal element in consumer choice arises in the choice between collections of characteristics only, not in the allocation of characteristics to the goods”.

In marketing, Kotler (1967: 289) defined a product as “a bundle of physical, service and symbolic particulars expected to yield satisfaction or benefits to the buyer”. Similarly, for Corey (1975: 121) “...the product is what the product does: it is the total package of benefits the customer receives when he buys”. And the total package can comprise anything from the functional characteristics of the products, to technical assistance and after-sales service, implying that material artefacts are just one independent component and, in some cases, the least important one. Later, Kotler (1980: 352) simplified this definition to a product being “...simply the packaging of a problem-solving service”. Riddle (1986: 4), following the Kotlerian vein, noted that: “tangible objects... have little value in and of themselves; they are important only to the extent that they serve as the equipment and supplies for the extraction or service production processes”. Grönroos (1998: 352) defined a product as a “...more or less preproduced package of resources and features that is ready to be exchanged.” In their quest to move away from a product-centred logic, Vargo and Lusch (2004b: 9) similarly claim that products are “... best viewed as distribution mechanisms for services”, or “carriers of competence” (Michel et al., 2008).

These views share a number of points in common. First, products are seen as stabilised bundles of attributes that have been packaged together through manufacturing processes. Secondly, products present themselves as sets of objective characteristics that may be differentially valued by different potential buyers. And finally, once purchased, products acquire value through use, as platforms for
delivering services to users. The product, as a stabilised artefact binding together a set of heterogeneous materials that can also be unravelled and reused, is hardly a matter of concern to those who prefer to see it as a service-in-waiting.

3.2 Product biographies

We suggest that, rather than being stable, unproblematic objects, around which the comparatively ephemeral and slippery services are conceived and delivered, products too are less stable than we might think. We propose to see products as evolving sets of characteristics obtained through distributed qualification processes that straddle design, production, circulation, use and, at the end of the product’s life as a stabilised, material entity. Put differently, products have biographies. Kopytoff (1986) argues that if economists and, we might add, marketers see commodities as self-evident material things, circulating within economic systems by virtue of having use and exchange values, for anthropologists things have a material as well as a cultural dimension. They must be produced but also categorised, qualified as being a particular object. As a corollary, Kopytoff (1986: 90) suggests that we should attend to the: “…eventful biography of a thing [which] becomes the story of the various singularisations of it, of classifications and reclassifications in an uncertain world of categories whose importance shifts with every minor change in context”.

The notion of product biographies allows Callon et al. (2002) to make a helpful distinction between products and goods. In the course of its biography, encompassing design, production, circulation, consumption or use, and end of life, a product undergoes a multitude of operations that transform its characteristics. The concept of a good, on the other hand, implies the stabilisation of the characteristics associated with the product, which allows it to be traded. It applies to services as well as products – as argued elsewhere (Author, date; Author, date), and each stabilisation depends on the specific institutional context of the exchange. This takes us away from the notion that products are injected with characteristics and value through manufacturing processes, those characteristics remaining unchanged save for wear and tear as well as the odd breakdown (Crang et al., 2013). As Callon et al (2002) note, the product, looked upon as a trajectory of transformations, describes the different networks that coordinate the actors involved in its design, production, distribution and use. This is a reciprocal relationship. The product identifies the agents involved in its transformations tracing a specific network, whilst those same agents through mutual adjustments and iterations, gradually establish the product’s qualities. Products’ qualities are thus always open and liable to revision, as they are detached from one network and attached to another.
Callon et al (2002) use the example of a car model. It starts life as a set of drawings and specifications, then a complete design and a prototype, before it is ready for road and other tests (e.g. safety). If successful, it becomes a bill of materials, a set of system and component specifications to be passed on to suppliers and manufacturing plants, before a whole assembly line and supply chain are put together. Only then does it appear in catalogues, with a stabilised set of specifications for each variant, ready to be ordered from dealerships. Each individual new car is given a specific identity (e.g. chassis and engine number, property title, license plates) which allows it to be singularised and traced as a unique entity. At each stage, the characteristics of the car as a good are being defined and refined, qualified through a battery of tests, measurement instruments, certifications and so on. The salient characteristics change: for example, those established through road tests do not migrate to sales brochures untouched even if the two are obviously related. The process of qualification involves significant investments in a socio-technical infrastructure, some external to the car assembler (e.g. crash tests by independent laboratories). And, qualification continues beyond this point (e.g. car journalists, consumer reports).

Once a new car is on the road, it accumulates miles on the clock and routine wear and tear, as well as undergoing both routine and emergency repairs. These are important parts of its biography. When the first owner comes to sell it as a used car, it is necessary to stabilise it and change it into a good, by defining its mileage, taxation status, condition, maintenance history and so on, in order that prospective owners can compare it with other used cars for sale, and thereby value it accordingly.

3.3 Continuity and change in the product biography

In our example, there is an interesting contrast between the car’s enduring identity, conferred on it institutionally by, in particular, its registration number, its ever-changing material condition, and the occasional ‘stabilisations’, brought about by rounds of qualifications to make it tradeable. There is an old story about a caretaker and his favourite broom:

‘The caretaker insists that he has had the same broom for the past twenty years; in fact, it’s the best broom he’s ever had, he says. He has only had to change the head three times and the handle twice!’ (Smith, 2012: 176)

Were it a more significant capital asset, the broom might be identified in an organisation’s asset register, allowing it to be scheduled for routine maintenance, costed and valued in, say, an enterprise system. If, over the years, every part of it had been replaced, as with the broom, it would
still be asset #1234. In this sense there is a continuity of identity. Continuity may also, for some actors, be constructed through practices. The caretaker thinks the broom is always the same broom because it is entangled in his daily routine in exactly the same way every day: he puts it in the same locker when he goes home, and cleans the same floors with it. It might also be said that the broom is a broom because the caretaker classifies it as such.

The continuities in the biography of the broom are of interest precisely because of the simultaneous fundamental changes in its physical condition. Our point here is that, far from being stable and unchanging platforms for the provision of service, products are, as in Callon’s example of the car, and in the case of the broom, changing all the time. Degradation, wear, maintenance, damage, and repair are the norm, not the exception. To return to our earlier example, the contemporary socio-technical infrastructure around the car was built slowly. Borg (2007: 1) starts his book Auto Mechanics with a suggestive scene-setting:

“Cars break down. They always have. On a warm spring day in 1901, a man named Robin Damon expected to enjoy the new freedom of automobility – swift individual travel without rails, without schedule, and free of wilful horses. Instead, he and his friends spent six hours in the hot sun replacing spark plug gaskets, putting in new ignition points, and replacing a broken battery wire in the friend’s stranded ‘gasoline carriage’. The promises of the new technology, it turned out, were conditional”.

Modern cars have become more reliable. The range of distances people were prepared to travel expanded as more and better roads were built, and as filling stations and maintenance networks gradually grew. Mobile roadside repair organisations such as the Automobile Association in the UK are an intrinsic part of the motoring infrastructure, using patrol vehicles equipped with satellite technologies to speed up response times and even laptop computers for fault diagnostics (Graham and Thrift, 2007).

More generally, the activity of repair is fundamental to the continuous reproduction of socio-technical order, notably in the form of vital infrastructures such as roads, water, electricity and telecommunications (Graham and Thrift, 2007), as well as a major source of employment in developed societies. Yet, while there is a general pre-occupation with original manufacture, repair and re-use are still unsung activities. Graham and Thrift argue that they could usefully take a more central role in our analysis:

“...perhaps we have been looking in the wrong place. Perhaps we should have been looking at breakdown and failure as no longer atypical and therefore only worth addressing if they
result in catastrophe and, instead, as breakdown and failure as the means by which societies learn and learn to re-produce.” (Graham and Thrift, 2007: 5)

Various forms of repair, improvisation and systemic engagement with and between manufactured artefacts - cars, bridges, roads, buildings, computer networks and so forth – therefore constitute opportunities for learning, development and long-term value creation. Products or whole infrastructures can be repaired and upgraded to make them contemporary. They can be cannibalised for parts and materials recycled so that parts of objects live on in different systems. Or, restoration can lead to complete rebuild which will allow something to live on in next-to-new condition. In this sense, products can have colourful biographies.

4. Servitization and the unstable product: the case of gas turbines

The typical characterisation of product firms moving into services, especially in the context of capital equipment, is one of providing services to support an ‘installed base’. The challenge is to work out if and how the product firm’s organisational structure and capabilities can be adapted and exploited to provide such services against the backdrop of a stable ‘fleet’ of installed equipment. Thinking in terms of product biographies and the pervasiveness of repair allows us to see such dyadic product-service or servitized relationships in a new light. We explore some illustrative examples taken from the gas turbine sector, mostly drawn from our own empirical research.

4.1 Value in biographical specificity

AirCo design and make components for gas turbines, used in aerospace and other applications such as power generation. Turbine fan-blades are machined to achieve the necessary geometry to very tight tolerances: nevertheless, although within tolerance, each one is slightly different. AirCo capture each blade’s distinctiveness by subjecting it to a mechanical impulse\(^2\) and then recording its distinctive vibration signature. These data are captured and passed on to the OEM, who assembles its turbine using, say, 24 blades. Using the data about each individual blade, the OEM is able to dispose the blades around the annulus in the turbine in such a way as to optimise the balance of the assembled whole.

In this sense, the blade is qualified several times in different ways. First, it is qualified as being an example of blade XYZ that conforms to the tolerances required. Then, it is qualified as blade XYZ with vibration signature ABC – blade plus data represents a new qualification in absolute terms.

\(^2\) Someone hits it with a nylon hammer
Finally, blade XYZ-ABC, by virtue of being alongside blades XYZ-DEF, XYZ-GHI etc, becomes qualified relative to the other blades and to the pre-existing annulus assembly (with its own idiosyncratic balance properties) as blade XYZ-that-is-fitted-at-the-two-o’clock-position, so to speak. In this way, the biography of each specimen has diverged from the original blueprint specification, by virtue of the inevitable variability of the production process. Measuring, qualifying and inscribing (in this sense it truly is a biography) this stage in each individual blade’s transformation thus provides a service to the customer that could be described as a ‘relieving’ service (Normann, 2001: 73), in that it relieves the customer from having to do the detailed balancing of the assemblies themselves.

4.2 Value in repair: restoration beyond the original specification

TurbineCo produce turbines for various uses. From their Service Division, they provide a range of service offerings, from simple supply of spares through to availability-based integrated maintenance packages. Retrieval, refurbishment and re-supply of fan blades are important parts of most of these offerings. The durability and other performance characteristics of the blades directly affect the customer’s costs and uptime, and so TurbineCo seek to improve the technology of the repair and coating processes on a continual basis. As discussed by Graham and Thrift, then, repair goes beyond basic restoration and is an important site of innovation and value-creation for TurbineCo and their customers. TurbineCo spend a quarter of their corporate product R&D on product innovation in the Service Division, such is the importance of the product technology to the provision of maintenance services that keep them ahead of their competitors.

4.3 Value in frequent qualification

The cause célèbre of servitization, Rolls-Royce’s “Power-by-the-hour”, is one of many that involve remote monitoring of the installed base using advanced diagnostic and prognostic technology (Björkdahl, 2009, Grubic et al., 2011). Under such arrangements, the products in use by the customer are equipped with instrumentation that monitors their condition and operation, and collects and transmits data about this to the supplier and/or the customer. Depending on the contractual and ownership arrangements in force, such data are then used to inform maintenance activities, repairs, user training (e.g. if a vehicle is consistently driven badly) and subsequent product improvements. The data may directly or indirectly have a bearing on the payments made to the supplier. In this way, qualification of the product, at least in technical terms, is something that happens, if not constantly, certainly very frequently. This contrasts with arrangements whereby the state of the product is only determined during a periodic maintenance inspection or when it breaks down. Value is thus created by being able to anticipate maintenance needs and hence schedule such
service activities more effectively, as well as in the longer-term improvement in the product and the way it is used in the customer’s operations. However, although the analyses of such arrangements necessarily assume that the product’s state changes, the focus is nevertheless on the need to change business models (Björkdahl, 2009) or on how to re-construe the process as a service value proposition (Ng et al., 2012), rather than on the fundamental nature, role and construction of the product involved.

4.4 Implications for service-led growth in product firms

Our vignettes from the gas turbine industry have wider implications. Each example demonstrates that service value is created, and entrepreneurial opportunities arise, from divergence, change and innovation in products. Products are not the stable platform on which service value is created; rather, the changes in the product create uncertainty that can either be tamed by providing data to enable the customer to act intelligently in view of the inevitable degradation or variance in the physical state of products, or can be pro-actively engineered to turn routine repairs into opportunities for better performance and value enhancement. As Loasby puts it: ‘Uncertainty can be exploited as well as endured’ (Loasby, 2002). As such, product firms must consider each site of qualification or repair as also a potential site for value creation.

5. Products in the circular economy

Although we have suggested that products have extended biographies, so far, most of our examples and discussion have been concerned with one-stage, dyadic relationships. The product biography concept can, however, be taken further in the analysis of service-led growth in product firms. As the perspective is extended beyond the dyad, the biography of a product, rather than being largely hidden within the boundaries of the firm that owns it, uses it, maintains it and disposes of it, is potentially written in a series of exchanges: a product is owned by one firm, used by another, possibly maintained by a third. Many permutations are possible. In short, some forms of servitization see the product entangled in complex inter-organizational relationships involving a multiplicity of contracts that may change over the product’s life-span.

These considerations are becoming much more relevant, as environmental pressures and material scarcity stimulate interest among industry, policy and academic communities in what is becoming known as the circular economy (Mulgan, 2013, Nguyen et al., 2014, Yuan et al., 2006, WEF, 2014). Rather than a linear ‘take-make-dispose’ model of production and consumption, ‘a circular economy is one that is restorative by design, and which aims to keep products, components and materials at
their highest utility and value at all times’ (Ellen MacArthur Foundation, 2015). The practical implementation of a circular economy requires technological change but also institutional innovation (cf Mont, 2004). This is required to allow: products to be accessed and shared as well as sold outright; products, components and materials to be categorized, sorted and treated accordingly when they are returned from a context of use; and in various other ways to handle the unfamiliar reverse flows, re-manufacturings and repairings, and non-ownership-based usage models that are part and parcel of the circular economy concept. Here, we suggest that considering the implications of the circular economy in the extended - and possibly very varied - biographies of products can add significantly to our understanding of service-led growth in product firms.

5.1 The circular economy concept

The World Economic Forum (WEF) report (2014), “Towards the Circular Economy: Accelerating the scale-up across global supply chains”, remarks that the linear model of take, make, and dispose has been dominant since the early days of industrialisation. This is replicated in academic models such as value or supply chains, which regard all stages of a chain as adding value while the endpoint, consumption, is a “value sink” (Normann, 2001). The circular economy is designed to eliminate waste through cycles of assembly, use, disassembly and re-use, with virtually no leakages from the system in terms of disposal or even recycling (see Figure 1), and replaces the habitual notion of a consumer, who owns things and destroys value, with that of a user. The concept was set out by Walter Stahel almost 40 years ago (Stahel and Reday, 1976/1981), but has recently been given added impetus by think-tanks such as the Ellen MacArthur Foundation, consultancies (Nguyen et al., 2014) and, increasingly, policy initiatives (Yuan et al., 2006, Spring, 2013).

Some aspects of the circular economy model, especially the shift to paying for performance and access rather than ownership, will be familiar to servitization scholars. Indeed, the strand of management literature examining access-based servitization (Baines et al., 2007) used the term ‘product-service systems’ (PSS), taken explicitly from earlier studies in industrial ecology (Mont, 2002); these, in turn, drew on Stahel (1976/1981). But the managerial literature has played down the environmental motivation, instead seeing the product-service-system label as a useful one to apply to the emerging technical and institutional arrangements that had sprung up for largely commercial and strategic reasons. The interest shown recently in the circular economy by the consultants McKinsey (Nguyen et al., 2014) suggests that there is more than a little consistency between environmental and business motivations: as such, we re-unite the environmentally-inspired PSS strand in the form of the circular economy with the managerial emphasis on service-led growth, in order to gain insights into the managerial implications for product firms.
5.2 Institutions, qualification and networks in the circular economy

Product-service systems, as we have signalled, require institutional as well as technological change. In some respects, the two are inseparable, especially if we take seriously the claim that products are themselves institutionally-shaped (Araujo and Spring, 2006). Many contemporary products are deliberately designed so that the possibilities of maintenance and repair are foreclosed or strictly controlled. Even simple products such as electrical plugs and power adapters are tightly sealed and display warnings of “warranty void” if seals are broken, and many passenger cars can only be worked on in a dealership’s garage by using proprietary electronic diagnostic programs (Graham and Thrift, 2007). So, once again, the institutional shaping of products in terms of property rights and liabilities comes into the picture. Servitisation strategies for the aftermarket (Wise and Baumgartner, 1990) are facilitated by product designs that tightly control liabilities, all but compelling users to rely on manufacturers’ maintenance and repair services.
The reverse flows that are the essence of the circular economy require additional processes of qualification, either of intact products or of sub-assemblies and components. Qualification is required first to determine that a product or component is in need of repair or replacement, and then to determine what courses of action to take at each stage, as products are recovered from end-users, moved to points of disposal, and the most economically attractive and technically feasible reuse option determined. Qualification is also essential to the creation of markets for refurbished or remanufactured goods. Products’ biographies may be forgotten, unmentioned and unproblematised, until reaching critical points where they ‘come to the surface’, presenting a problem of categorisation, qualification, classification: ‘What is this?’ ‘What can/can’t I do with it? Who owns it? Who is liable?’ It is still an electric motor, a piece of wood, or platinum, but, having journeyed so far from its original incorporation into a product and, presented at the point of dismantling, repair or recycling, its provenance may be lost, the effects of its journey unknown, and the implications for what to do next, consequently, unclear. The risk – environmentally speaking if nothing else – is that, absent effective qualification processes, the ‘safe’ option of disposal will be favoured over re-use or other ‘circular’ options: in other words, quality uncertainty (cf. Akerlof, 1970) will cause failure in the processes that constitute the circular flow.

Of course, many products could be designed for ease of maintenance, repair and upgrading (Cooper, 2012). Technological paradigms tending to generate accelerating waves of quick disposal, such as consumer electronics, could be reorganized around longer-term and sustainable systems of service delivery, designed from the outset to be easily and continually upgraded. But this requires a major effort of technological and institutional reconfiguration, extending across the wider network. For example, the WEF (2014) report examines Renault’s remanufacturing plant near Paris, where 325 people are employed to examine, test and recover mechanical subassemblies (e.g. water pumps). These remanufactured parts are then sold at a fraction of their original price, with a one-year warranty. The company also redesigns assemblies such as gearboxes to boost the component reuse ratio and facilitate the sorting of components from returned assemblies. But, to make this work, Renault has had to alter relationships with key suppliers. For example, through collaboration with recyclers and waste management companies, raw material streams are now controlled differently, to ensure technical and economic value throughout the product’s life cycle, and to incorporate provision for a product’s end-of-life in its initial design. In other areas such as the use of cutting fluids, Renault have moved away from product-based transactions to service-based models in order to provide incentives for the supplier to reduce usage levels. In the case of electric cars, Renault has been actively promoting access over ownership, by leasing batteries for electric cars to boost the
residual value of electric vehicles and keep track of the life of electrical batteries, to improve collection rates and close the remanufacturing/reuse loop.

5.3 Constructing and managing the circle: the case of IT equipment

These issues are central to a study of product recovery in the IT equipment industry by Insanic and Gadde (2014). Focusing on logistics firms who specialise in the recovery of IT equipment, they apply the concept of ‘transvection’ from early channels literature (Alderson, 1965) to the reverse flow of recovered items. The transvection approach draws attention to the alternating stages of transformation (collection, processing, transportation) and ‘sorting’. The logistics firm is concerned to organise activities for economies of scale in transportation and processing. But Insanic and Gadde’s study also reveals the critical role of the sorting rules that are applied at each sorting stage and by the various firms in the network. Products need to be tested for their condition and eventually disassembled, with their component parts being assigned to different recovery paths – some will be good enough to be reused, some will be repaired, some will be recycled and others will be disposed of. All these operations require important investments in socio-technical infrastructures, namely testing and diagnostic equipment, facilities for separating out materials and directing them to appropriate recovery paths (Insanic, 2014). In other words, products are qualified at these critical junctures in their biographies. Furthermore, Insanic and Gadde find that these sorting rules become manifest ‘through the interaction among actors’ (Insanic and Gadde, 2014: 276).

More generally, although the firms in Insanic and Gadde’s study developed sorting rules of their own, categories and classification regimes often do not spring up solely through bottom-up, mutual adjustment of activities amongst private actors, but are also shaped by governments and supranational institutions. Kama (2015) suggests the theory of the circular economy has been instrumental in establishing the EU’s Waste Electronic and Electrical Equipment (2012/19/EU) or e-waste directive. Through this initiative, the EU has made the circulation of electronic products traceable and monitored within the territorial confines of the Union as well as making electronic waste a source of raw materials. This initiative aimed to create a market in which electronic waste can be classified, valued and traded, and in which material flows could be tracked and accounted for within a self-contained space. As Neyland and Simakova (2012) and Kama (2015) remark, determining what could be valuable to whom and in what circumstances did not prove easy. It turns out that e-waste is, as the WEF (2013) report would put it, still locked in the powerful grip of the technical, economic and legal logic of linear chains where value disappears with use or consumption.
6. A broader concept of the circular economy: closed-loop and not-so-closed-loop supply chains

In most of the examples we have examined, products and components either stay within the dyad or somewhat longer chain of manufacture, supply, use, recovery, repair and re-supply. Indeed, representations of the circular economy like the one shown in Figure 1 tend to reinforce the ‘closed loop’ conception. Guide and van Wassenhove (2009: 10) define closed-loop supply chain management “...as the design, control, and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time”. But this raises two separate issues regarding the feasibility of this approach: first, closing loops assumes that firms are able to keep close control of their linear supply chains, in the forward and reverse directions. As the case of Renault indicates, closing loops requires significant investments in redesigning products as well as recalibrating relationships with key suppliers. Secondly, the notion of extracting value from a product’s life cycle implies that products are containers of value that can be successively unlocked as they circulate through pre-determined stages (e.g. use, recovery). However, circulation doesn’t occur independently of valuation. As Çalışkan and Callon (2009: 389) noted: “Nothing moves on its own. If a good is produced it is because it has a value for its producer; if it is distributed it is because it is a source of value for its distributor; and if it is consumed it is because it has a value in its consumer’s eyes. The forces that explain the circulation-transformation of things are the same forces that give things value.” Understanding these sites and processes of valuation in the extended and variously-governed circuits of the circular economy is vital, we suggest, to creating and delivering product-related services.

6.1 The case of end-of-life ships

Such wider understandings of how products are valued and revalued as they are qualified and potentially attach themselves to new networks and chains are revealing. For example, Gregson et al (2010) study the breaking of end-of-life ships on the beaches around Sitakunda in Bangladesh. This loop is far from closed: steel plate from the ships provides 90% of the steel used in Bangladesh; ship’s chandlery is re-used by the country’s fishing fleet; electric motors, compressors and ship’s boilers are reconditioned and used in various land-based industries, notably the burgeoning Bangladeshi clothing export sector. It is claimed that 99% of a typical ship is ‘recycled’ (Gregson et
al., 2010: 484). The seemingly chaotic, laborious and dangerous dismantling of large ships reminds us that although we are witnessing the destruction of the ship as a valued, integral object, we are also catching a glimpse of the dying ship as a composite of materials with their own values and further circulation potential. Instead of valuing ships as objects performing a function, we can now see ships for the value of scrap metal that can be recovered, furniture that can be re-used or reprocessed, and so on.

Such systems of recovery and re-use require new modes of qualification-valuation which are not restricted to linear supply chains, much less closed-loop ones. Rather, they mean finding ways to insert materials into economic circuits and frame them in novel ways. As Gregson et al. (2010: 853) comment:

“Animating materials anew, rekindling them is curtailed not just by limits of the imagination, by knowledge or indeed by ways of seeing, it is framed too by the categories and classifications that surround stuff in particular parts of the world – particularly discarded objects declared to be ‘end-of-life’ – and by the markets that are available to goods fabricated from secondary materials.”

These observations suggest a move away from linear value chains to multiple, enmeshed networks of circulation and exchange (Lepawsky and Mather, 2011), and re-conceptualising products as assemblages of materials that have been brought together and stabilised as particular forms, that are always liable to stop working as a unit, or to fall apart altogether (Gregson et al., 2010). This brings us back to the importance of maintenance and repair (Graham and Thrift, 2007) as well as the trajectory of the materials that go into products such as ships, after their useful life has ended. For example, the dismembering of ships leads to the recovery of furniture that is valued by particular types of consumers in Bangladesh, but also to the recovery of wood that is then used through secondary manufacturing to produce a range of ‘chock-chocky’ furniture that is valued by a portion of Bangladeshi middle classes. Around the beaches of Sitakunda have emerged auctions for furniture and wooden materials, workshops where furniture is reconditioned and upgraded, and retail shops where it is sold to private households, as well as a re-rolling mill to process the recovered steel from the ships’ hulls. In other words, the institutional and socio-technical infrastructure to enable the recovery, valuation and re-use of the materials from broken ships has gradually been constructed.

6.2 Products + data: the Internet of Things in the circular economy

The extended biographies of products have hitherto been either theoretical abstractions or the product of considerable effort by researchers (as in Gregson et al. (2010)) to piece together the
otherwise disconnected fragments of industrial activity by ‘following things’ through their life-course. However, the growth in ubiquitous computing has given rise to the Internet of Things, which makes it feasible to follow things – products – in great detail, from afar. Kevin Ashton, credited with originating the term in 1999, argues as follows:

“If we had computers that knew everything there was to know about things—using data they gathered without any help from us—we would be able to track and count everything, and greatly reduce waste, loss and cost. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best” (Ashton, 2009).

The first tentative steps of the Internet of Things are already familiar to us – e.g. packages can be tracked through logistic circuits using radio-frequency identification (RFID) or barcodes as they pass through dedicated reading devices (e.g. Delen et al., 2007, Hozak and Collier, 2008). RFID and analogous technologies have the potential not only to closely track transformations, but also can provide the means to create new transactions. Zipkin (2006) shows how RFID can greatly reduce the cost of clearly demarcating process stages, enabling transactions to be introduced where none previously existed. Thus inserting RFID in an object such as a car body allows it to be tracked accurately in a production line and makes it possible to set up transactions where the object shifts from one operation to another (e.g. when the car body moves in and out of a paint shop owned and run by an independent contractor). In other words, RFID can shape the institutions of production as well as simply reporting on the passage of objects through them.

However, RFID technology is largely limited to reading passive tags in restricted locales such as warehouses, often using idiosyncratic protocols (Kortuem et al., 2010). In contrast, the Internet of Things is based on “small intelligent devices ubiquitously embedded in the physical world and connected to the Internet” (Kleinrock, 2003: 7), hence providing a robust and efficient means to collect and transmit product-related data. As Gershenfeld and Vasseur (2014: 67) point out:

“The Internet’s defining attribute is its interoperability; information can cross geographic and technological boundaries. With the Internet of Things, it can now leap out of the desktop and data center and merge with the rest of the world. As the technology becomes more finely integrated into daily life, it will become, paradoxically, less visible. The future of the Internet is to literally disappear into the woodwork”.

Hence, the Internet of Things promises to greatly expand the quantity and quality of information about product biographies but also to open up access to this information through public channels (e.g. using smartphone scanner apps) that are already in place. It opens up the possibility that every
object that is manufactured can be tracked from cradle to grave – not just through the linear supply chain that takes it from manufacturer to end-user, but to every single user it comes into contact with, as well as the reverse chains that lead to dismantling, recycling and disposal. And, as the costs of embedded technology drops (cf. Zipkin, 2006), it can be applied to toothbrushes and running shoes as well as ships and aircraft engines. This has huge implications for the circular economy, as products’ biographies can be made manifest and data not only about current location, but also about condition, provenance, ownership, and so forth can potentially solve many of the problems of qualification that stand in the way of the practical operation of circular economy ideals. The interoperability of the Internet can help sidestep the shortcomings of RFID technologies, that have limited their use in reverse flows (WEF, 2014). Just as the sociotechnical infrastructure that has emerged in and around ship-breaking in Sitakunda allows once-integral products to be dismantled, and their component parts to be qualified, valued, attached to new networks and hence re-used, so the capabilities of the Internet of Things can be harnessed to allow a more distributed governance of circular flows, freed from the limitations of the reach and coordinating capacities of any one firm.

6.3 Data-enabled services and the strategies of product firms

For many of the products that move through supply chains, tracking information is currently only of interest to those organisations that are directly involved in manufacturing or transport (Speed, 2011). However, another key feature of the Internet of Things is that products will gather data about themselves and their surroundings ceaselessly:

‘Unlike the old adage ”a rolling stone gathers no moss”, artifacts within the Internet of Things will gather moss. As they move from one place to the next, they will gather locative data; as people interact with them, they will gather social data; and even as they sit idly on a shelf, they may well be gathering data about the objects that are around them. This data will exist in virtual form even when the actual object has been broken, lost, or thrown away. Stored safely in the cloud and accessible for eternity, the object lives on as a ghost in the machine, waiting for a chance to be exorcised’ (Speed, 2011: 19).

The collection and analysis of large amounts of product data will create novel technological and economic opportunities linked to the circular economy that go far beyond product-based servitization initiatives in forward supply chains. Iansiti and Lakhani (2014) and Porter and Heppelman (2014) have recently speculated on how the Internet of Things may impact on firms, industries and business models. Their common concern is how biographical data on products,
especially capital goods, are going to be amassed, analysed and commercially exploited and for whose benefit. Iansiti and Lakhani (2014) use the example of General Electric as illustrative of the trend towards new forms of value creation and capture. Whereas GE has long since shifted its emphasis from selling capital equipment to contract service agreements, covering the operational management of assets, the connectivity afforded by embedded sensors, microprocessors and software opens up new business opportunities. Connectivity allows GE to amass and analyse large amounts of data on its customer’s operations and constantly think of new ways to improve performance. This required significant development of a unified set of software solutions, as well as new ways to design and sell offerings. Performance data on the customer’s operation generates value through the ‘optimisation’ of its equipment set-up and maintenance. GE are then paid according to the customer’s incremental performance improvements, often as part of outcome-based contracts. These novel opportunities raise questions about how value is measured, the monetisation of performance improvements, as well as risk-sharing between GE and its clients. The shift to an outcome-based contract – a shift to service – is only feasible because of the technological development of the product and the wider data-collection infrastructure.

For Porter and Heppelman (2014), data about a product’s operating characteristics and history lead to a better understanding of how a product is actually used. These data have important implications for product design (potentially reducing the need for excessive product features or design products for ease of repair), marketing (by creating usage segments to be matched to customer types), and maintenance (by allowing service engineers to learn the nature of breakdowns before they visit a site). Porter and Heppelman (2014) also point to the substantial investments required to construct what they call a product cloud, comprising a product database as well as application platforms (e.g. allowing visualisation), analytics/rules engines (e.g. the algorithms involved in monitoring product operation) and smart product applications (e.g. software that monitors the autonomous operation of product functions). Developing these requires significant investment in technologies and infrastructure that are hardly widespread in the IT sectors, never mind in traditional manufacturing companies. If the solution is to rely on outside partners, many of the benefits as well as the risks that Iansiti and Lakhani (2014) allude to will have to be shared between the manufacturer, the customer and the intermediaries that construct product clouds. If the decision is to develop these skills internally, companies are faced with the prospect of how to reap returns from amassing large amounts of data and being able to construct business models in which data is monetised in a multiplicity of ways – including selling data to other providers or to other intermediaries.
7. Implications for service-led growth in product firms

7.1 Theoretical implications

Various theoretical implications of our argument are developed and discussed throughout the foregoing sections. However, it is perhaps useful to return to our starting-point in the servitization and related literatures, and to attempt to identify an overarching theoretical implication of our analysis. In sum, rather than being the basis for service-led growth because of their stability, as these literatures might suggest, products are the basis for service-led growth precisely because of the various forms of *instability* that we have identified. As we have previously argued (Author, date; Author, date), what have been termed products and services are both institutional achievements: to be traded, at least, both have to be qualified and temporarily stabilised as goods. Likewise within firms, qualification is necessary to make products and services into manageable objects (Czarniawska and Mouritsen, 2009). Many forms of servitization see customers unwilling to own ‘products’, preferring to pay for access to them; in the circular economy, ownership, if contemplated at all by customers, is seen as a more temporary state of affairs: customers own products in the expectation and anticipation that they will eventually return them, upgrade them, have them repaired, sell them on, part-exchange them, etc. Institutionally, there is both continuity and change through the product biography: a product may change physically a great deal (the broom) and yet retain its identity according to systems of registration; on the other hand, products are frequently re-qualified and redefined in the network as they attach themselves to and detach themselves from actors and other artefacts – a truck used by a logistics firm under a ‘servitized’ access-based contract is defined by each use by a different driver, journey on a particular route, etc. The product is formed and redefined by each episode of service in which it is implicated, rather than the service being delivered on the stable ‘platform’ or ‘vehicle’ of the product.

7.2 Managerial implications

How does this affect the perspective of a manager in a product firm? In the take-make-dispose model, the problem is making and selling things – a crueller version of take-make dispose as it relates to the immediate customer relationship is ‘Design, deliver, abandon’. Moving onto servitized models, with or without transfer of product ownership to the customer, and we have the basic notion of the ‘installed base’, especially in capital equipment settings. The product firm manager then looks out onto world of installed specimens of her product, of various vintages and models, perhaps, in various user contexts. The problem is one of attaching and delivering service elements to
the ‘installed’ products, based on the idea that the expertise of the product firm in some way can be translated into the delivery of service activities that are valued by the customers and can be designed and contracted for effectively. What about the manager looking out onto the world of the circular economy? Compared to the basic servitization setting, there are many more and more varied sites where products raise questions, and generate opportunities for entrepreneurial action. This may extend beyond the initial customer to those organisations that buy used products, adapt them for other purposes, dismantle them for spares etc. Given the increasing reach of concerns about provenance and product liability, product firms, far from being able to ‘abandon’ their products at the point of sale, may never be able to relinquish responsibility for them, even if they do not retain direct control through a conventional closed-loop supply chain. The product firm, then, needs not only be aware of the increased opportunities arising from the more extended scope of the product’s biography, but also be alert to the ways in which the product, in its journey through the circular economy may, like a boomerang, return to cause problems.

With the advent of the Internet of Things (IoT), business models focusing on servitization and intent on extracting value from installed bases will need to explore how to create value by accessing copious amounts of data on products, components and materials during usage and post-usage. The IoT opens up the possibility of creating connected, rich biographies of products going down to specific parts and components that can be exploited in a variety of ways. Allmendinger and Lombreglia (2005: 145) neatly summarised this argument: “A device that can report back to its maker on its status and usage represents the foundation for a much richer and longer-term customer relationship”.

At the most basic level, the availability of data can enable companies to better plan and deploy their service capabilities in routine maintenance, for example. A connected product may also open up business opportunities adjacent to maintenance – e.g. management of spare parts inventories. In short, connected products may enable servitization activities to move to another level of efficiency as well as unlock further opportunities centred on the product as a gateway to service delivery (Allmendinger and Lombreglia, 2005). Moving the focus from products in dyadic, buyer-supplier relationships to products in a circular economy, the IoT can help firms add value in relative closed-loop settings, as well as solving some of the critical qualification, classification and categorisation problems that stand in the way of achieving circular economy ideals in settings where products circulate beyond the direct governance of one coordinating firm.

For example, firms can explore opportunities for capacity utilisation of resources as when forward and reverse logistics loops can be made to overlap – e.g. IT firms can deliver new computer systems
as well as collect disposed machines using the same logistics infrastructure (Insanic, 2014). Better knowledge of the state of products and their components allow firms to set up, by themselves or in collaboration with selected partners, network paths to deal with different recovery options (e.g. refurbish or dismantle and dispose). Firms may thus offer not just to sell or rent equipment but provide a broad range of services around the product, including maintenance, disposal and replacement of equipment. Results-oriented servitization models based on the circular economy notion will also allow for a change in how products themselves are designed (e.g. design for maintainability) as well as incentivizing firms to use refurbished parts, recycle materials and so on.

Smart, connected products not only enhance efforts to develop a circular economy but can also potentially allow different approaches to markets. A traditional marketing tool such as segmentation may be rethought along the lines of usage patterns rather than customer characteristics. As companies gather usage data, they can gain novel insights on usage patterns by customer, and configure offerings in terms of products, services or product-service systems to different customers in much finer-grained fashion (Porter and Heppelman, 2014). Kortuem et al. (2010) study of the use of smart objects to monitor usage of rental equipment suggests the potential for the yield management of rental assets and fine-tuned pricing policies in line with actual usage, not just the rental period.

Finally, there are also potential business opportunities to be considered from the perspective of who owns, controls and integrates the data streams stemming from the development of the IoT. Companies may find that the data they collect far exceeds their own requirements and might be useful to others. Data about a fleet of trucks, for example, might be useful to other fleet operators, insurance companies or road assistance companies (Porter and Heppelman, 2014). In other cases, firms need to develop strong data analytics, actuarial as well as the financial capabilities to absorb the risks that go with results-based servitization models (Iansiti and Lakhani, 2014). The key question here is who is best placed to develop and maintain the requisite capabilities to operate these business models.

8. Conclusions

This paper has made a number of contributions to the literature regarding the transition from products to services, or servitization. Rather than seeing it as a one-way street, where product-centric firms gradually move into services, we regard the boundaries between products and services as porous and shifting. Whereas the servitization literature has assumed that the base case, product-
centricity, is well understood, this paper has questioned this assumption. The notion of products that pervades much of the servitization literature is far too narrow and incomplete.

Our first contribution is thus to conceive of products as stabilised assemblages of materials often with complex biographies that undergo multiple qualifications and valuations through their life cycle. Each qualification point provides opportunities for turning products into goods (e.g. second hand cars) or for associating services with a product (e.g. maintenance). As we have argued, products are not stable entities acting as gateways to service income streams. Rather, changes in products (e.g. their status or condition) create entrepreneurial opportunities for service value-creation that go well beyond restoring products to their original status (e.g. turning repair activities into opportunities for improved performance).

Our second contribution takes a broader view of the product life cycle, which is traditionally seen as ending with abandonment or disposal. Based on the notion of the circular economy, we have argued that products’ biographies should be seen as a composite of trajectories rather than following a linear path from design to manufacture and disposal. Products get repaired, refurbished, upgraded, tinkered with, dismantled, reassembled and discarded. Their enduring integrity should not blind us to the changes that many products undergo during their often long lifecycle. We have pushed these arguments further by showing how the reverse loops of the circular economy, the post-usage stage, offer further opportunities for entrepreneurial service creation. Whereas the literature on closed loop supply chains has focused on opportunities for remanufacturing, we have argued that closing loops in reverse supply chains often requires the creation of novel network relationships involved in multiple activities such as reverse logistics, the dismantling of products, the classification and sorting of product components, the recycling of materials and so on.

Finally, we have highlighted the growing importance of the IoT and the possibilities it affords for rethinking the traditional notion of product biographies. The ability to gather, store and analyse vast amounts of data on products opens up new entrepreneurial opportunities not just around products but also around the broader systems in which products are embedded. More specifically, we highlighted the development of capabilities associated with data collection and analytics in IoT-based systems, as well as the financial and actuarial capabilities needed to deal with risk in performance-based contracts.

In brief, our argument is that the servitization has gone both too far and not far enough in its attempt to address the product versus service debate. On one hand, it has assumed that conversion from product to service-centricity is intrinsically desirable from a financial perspective. In reality,
firms may follow servitization as well de-servitization paths, depending on a host of economic and technological factors. On the other hand, by adopting an unnecessarily simplistic view of products, the literature has so far dealt with a nominal range of services associated with the product life-cycle. The notion of product biography we advanced in this paper is a necessary, if modest first step to eliminate these blind spots.

References


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