

# Product-Service Systems or Service Design ‘By-Products’? A Systems Thinking Approach

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**Abstract:** Service Design has developed, in the last two decades, to be an autonomous multi/interdisciplinary paradigm of a complex domain affecting Design Thinking. Product-Service Systems (PSS) is a representative model of designing through services related to existing products. Terms such as ‘servitising’ are used to declare that, for instance, inventing and adding services based around existing products will increase the value of any related intervention. This paper posits that Service Design should follow a Systems Thinking approach, without the presupposition of related products, allowing for these products to emerge as ‘by-products’ of the process. It is also claimed that, in order to positively utilise the inherent complexity of Service Design, thinking tools such as Systems Thinking are required to capture the design space. This should be a primary concern in such a human centred complex domain as Service Design. Design methodologies and approaches can then be used to continue with the design process

**Keywords:** Service Design, Product-Service Systems, Systems Thinking, Design Thinking

## 1. Introduction

The design of services, under the label of ‘Service Design’ has developed, in the last two decades, to be an autonomous multi/interdisciplinary paradigm of a complex domain. It has obviously affected design thinking and praxis.

Traditionally used taxonomies of design, as far as frameworks, methodologies, methods and their interventions are concerned, include Industrial Design and Product Design. There is, in addition, an array of design areas of application and praxis at a higher resolution such as Human-Computer Interaction. Service Design appears nowadays to be accepted as a major generic paradigm of the design domain. It has been influencing the modelling, the choice and evolution of design methodologies and approaches at all levels of design praxis. One



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basic reason for these changes is the acknowledging of the complexity of design problems due mainly to the realisation that most of these problems should be characterised as 'human-centric'.

The work of grounding Service Design through theoretical frameworks could be said to still be in its infancy. Yet it should be noted that, in the multi/interdisciplinary sense, there is much knowledge to draw from (from Management, Operational Research, Design Thinking and others). In addition, the evolving Service Science (Maglio et al, 2010) is expected to offer substantial theoretical hospitality (Darzentas & Darzentas, 2014b). However, the acknowledging of its human-centric nature and the need to welcome and utilise the inherent complexity are the two main requirements for successfully designing services, and at the same time, the requirements that will probably, at the very least, strongly influence design thinking and praxis.

An important and influential model in the designing of services is that of Product-Service Systems (PSSs). It is a model of designing through services and characterises the design intervention by considering the product with the service and using both of them for adding value to the end result. Terms such as 'servitising' (Gray, 2013) are used to declare that, for instance, inventing and adding services onto existing products will increase the value of any related intervention. It is considered here as a representative model which has produced very interesting results and remains an important design paradigm in service design.

In this paper, PSSs are used to examine a number of issues about Service Design and to speculate on possible directions for structuring methodologies and methods for designing services and forming a theoretical attitude towards design.

Open issues which drive the main themes of the paper include:

- the availability of frameworks and tools to deal with the increased complexity of Service Design in general and of PSSs in particular.
- the hypothesis that: Service Design interventions should be delivered using the design problem space considered as a holon<sup>1</sup>, and not subscribed to a PSS paradigm where product(s) are from the beginning part of the problematique.
- the above hypothesis has a major creative consequence in that any product(s) emerging and added to the design intervention will actually be 'by-product(s)' of the design praxis
- the hypothesis also implies that the complexity of the design space will probably increase even more by considering holistically a larger one with less restrictions. As a result that will demand a range of tools capable of dealing with that inherent complexity.

This paper introduces the use of Systems Thinking in the designing of services as a thinking tool that can capture and utilise complexity without being constrained by the need to

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<sup>1</sup> A holon (Greek: ὅλον, holon neuter form of ὅλος, holos) "whole"

servitise any pre-existing products. This then allows for having any emerging products to be established as part of the design praxis.

## **2. Background**

### *2.1 Services and the need for Service Design*

Traditionally, 'Services' is the name given to economic activities that cannot be classified as agriculture or manufacturing. The service sector includes services such as those provided by government, healthcare, education, retail, financial, business and professional activities, as well as services providing communications, transportation and utilities. It currently accounts for the bulk of a developed nation's economy: as much as 80% compared with 15–25% in the manufacturing sector, and about 5% in the agricultural sector (Maglio et al., 2010, Maglio et al., 2006). This is also reflected in employment figures, with more people employed in the service sector than in other sectors. Newer, less resourced manufacturing economies are also growing their service sectors, especially taking advantage of travel and tourism industries (UNCTD, 2013).

As a sector, services required a new framing to understand them. Two established frameworks are the older IHIP model (Regan, 1963; Rathmell, 1966; Shostack, 1977; Zeithaml et al. 1985) that characterises services as being intangible, heterogeneous, inseparable and perishable. That is, services cannot be perceived with senses, they are non-standard (heterogeneous); it is impossible to separate the production from the consumption of a service (inseparable); and that services cannot be stored (perishable). Other guidance is offered by the model of Service Dominant Logic as opposed to Goods Dominant Logic (Vargo & Lusch, 2004, 2008) which holds that service (as a process) rather than goods, should be the basis of economic and social exchange where value is co-created, and goods are something for the service to deliver.

The occupation of designers with services is fairly recent. In the past it has been the remit of academic disciplines such as Management and Marketing, Operational Research and Engineering, (Bitner et al., 2008). With the move to increasing automation, self-services and online services, Information Systems and Computer Science disciplines are also now heavily involved. Services are currently understood and promoted as representing problem spaces that are complex and require multi/interdisciplinary input. Indeed, recently, IBM, understanding that its core business is no longer in hardware manufacture, but in services, has championed the understanding of services as 'complex systems' (Maglio et al, 2006). These complex systems are defined as specific arrangements of people and technologies which take actions that provide value for others. In this way, the idea of a 'service science' has been advanced (Maglio et al., 2010).

It is against this background that the role of designers in service design can best be understood. For the last two decades, designers have been engaged in realising the shift in working practices from product to systems design: that is, understanding the wider context

of use in which the designed product is to function (Brown, 2008). This incorporates the users, producers, (including the designers themselves) the activities and functions expected, as well as and constraints and freedoms offered by the technologies used in the product. Such work has recently been undertaken under other labels, such as 'Interaction Design' and/or 'User Experience Design' (UX). Lately, this wider context has begun to incorporate services, and Service Design has taken hold, as evidenced by a number of researcher<sup>1</sup> and practitioner<sup>2</sup> networks and courses in Universities, as well as other research activities (Glushko, 2010, 2012; Gotzen et al., 2014).

Given this, what do these services look like; what are their common features and how do designers design them? A striking characteristic of the movement from product to services is the emphasis on service outcomes or what the customer wants from a product or a service: "A customer does not want a drilling machine, he wants a hole in the wall ". An example is that of Rolls Royce's "Power-by-the-hour<sup>®</sup>" the continuous maintenance and servicing of the engines is paid by how many hours the customer obtains power from the engine, rather than by paying for spares and repairs (Ng et al., 2009). This outcome-based understanding is very interesting and is understood as a particular class of Product-Service Systems (PSSs).

## 2.2 *Product-Service Systems (PSSs)*

PSSs are convenient vehicles that serve the interests of different actors and lobbies. For example, the manufacturing industries that have seen that they must move on from only producing products because:

- it is a means of differentiating their offerings
- they need to move to sustainability models as worldwide resources shrink
- recycling responsibilities are becoming a major part of the product lifecycle
- consumer markets are saturated
- owning goods is becoming less fashionable among consumers

These incentives are also based in new models of business relations with customers, as consumers begin to exercise power with brand loyalty and valuing customer relations and other support mechanisms. Thus PSSs can provide customers values and functionalities, as well as physical products, to fulfil economic, social and environmental goals (Tran & Park, 2015).

Studies on PSSs have distinguished three categories: the first is intensely product-based and is also known as 'servitising'. This represents the move from manufacturing to creating other types of consumer offerings based around the product, an example being cars and car maintenance services. The second revolves around ownership, and offers services to provide

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<sup>1</sup> Service Design Research <http://www.servicedesignresearch.com/> [Design for Social Innovation and Sustainability](http://www.desis-network.org/)  
<http://www.desis-network.org/>

<sup>2</sup> Service Design Network gmbh <http://www.service-design-network.org/>

the outcome provided by the product without the necessity for the consumer to purchase and own the product. For instance, there is no need to own a car for the times one might need it, but rather one can use renting or leasing services. The third category focuses only on the results that someone would expect from the product, for instance, lighting from bulbs (Ellen MacArthur Foundation, 2015); a painted wall from a can of paint (Tran & Park, 2015). Within these three main distinctions, it is possible to make more sub categorisations (Tukker, 2004). For instance, the first category of servitising can include advice and consultancy, while the ownership category can include models such as resource sharing by renting and leasing, and the results or outcome based category can look to mechanisms such as 'pay per use'.

Industry experts calculate that manufacturers now depend upon services. A third of large manufacturing firms globally are now 'servitised,' according to research from the Advanced Institute of Management Research (AIM, 2010). The figure stands at 60% in the USA, while in the UK, the figure is estimated at around 40% of manufacturing companies (Gray, 2013). For designers, this means their roles as product designers in industrial design contexts has been changing. The role of designers in the design of services is variously seen as: facilitators in the co-designing process (Vargo et al, 2008); or as active innovators in the co-designing process (Vosinakis et al., 2008), but it is still new ground. More specifically, with PSSs, as Morelli (2003) has noted, designers need new understandings of their role and its extent and new tools.

"Designers, who have usually focused their activity on material products, have rarely been involved in the debate about the development of [PSSs]. The shift to PSS therefore, represents a challenge for designers, who now need to extend their traditional logical domain and to develop new methodological tools" (Morelli, 2003, p1).

In the search for the fundamentals of design methodologies for PSSs, designers have recognised the need for planning at a wider level and that the involvement of the consumer in the creation process is critical (Beuren et al., 2013). Going even further, Morelli (2006) claims that what is needed are methodologies and methods for the identification of the actors involved; for possible scenarios, real use cases, roles and actions of involved actors; for a means of defining requirements for the PSSs and its logical and organisational structure; and tools to represent all these.

Faced with this state of affairs, we observe changes in design praxis (Darzentas & Darzentas, 2014c). Design praxis follows, but also influences, changes in Design. For example, in traditional industrial design, it can be said that the designer and the manufacturer did collaborate in as much as they each performed a part of a process, with one carrying out design work and the other accepting or not the resultant designs. Currently, it is clear that in activities like service design the nature of the design work is highly interactive, using participative co-designing methodologies and tools (Binder et al. 2009; Holmlid, 2009). The service thus designed and produced is enriched by incorporating results from the involvement of the various stakeholders who are collaborating to co-produce the outcome. In addition, the designing of a product may encompass much more than the artefact. It may

include related aspects such as its packaging and the way it will be distributed, which reach back to influence the artefact at the heart of the design effort. It is also not uncommon that these aspects become more important than the artefact in terms of influence. In this way the usability of a product, becomes more important than the product itself. This is because it is touching on the dynamics of the interaction between the user and the product. (Darzentas & Darzentas, 2014a)

### 2.3 *Systems Thinking*

Complexity is now accepted as an expected feature that characterises most design praxis (Sevaldson, 2009; Norman, 2010; Ryan 2014; Darzentas & Darzentas, 2012). That is, a large part of the design effort is concerned with complex human-centric problems that require to be understood so that design interventions may take place. Given this, Design should seek complexity in its grounding and application. Complexity should be encouraged as it enriches the process of design and necessitates that Design considers a larger variety in its definition and its understanding of the problem space. However, thinking tools to help to deal with complexity are needed, and Systems Thinking is put forward as a main contributor.

Historically, Systems Thinking as an approach appeared more than half a century ago, in response to the failure of mechanistic thinking to solve problems. A 'system' is a complex and highly interconnected network of parts, which exhibit synergistic properties, where the whole exceeds the sum of its parts. In its trajectory through time, Systems Thinking has been applied in disciplines such as Biology, Information Theory, Management, Engineering and Cybernetics.

Systems Thinking requires a perspective shift from traditional classical decomposition or reductionist ways of doing things. It looks at relationships (rather than unrelated objects) and 'connectedness'; at process (rather than structure): at the whole (rather than just its parts), at the patterns (rather than at the contents) of a system, as well as looking at context. It offers a perspective which provides tools for understanding relationships between things and does not look for a single answer to a problem within the confines of a single discipline (Moore & Kearsley, 2005, Cameron & Mengler, 2009). One of the most striking features of Systems Thinking is that it accepts that some properties will emerge from a system, and that these (emergent) properties cannot be deduced from a system's component parts and are therefore 'invisible' in a reductionist perspective.

When applied to the high complexity of ill-structured problems, which are normally those which are human-centric, Systems Thinking helps to understand and learn about the situation of concern. The connection between such kinds of problems and design is strong since design is often called upon to address "intractable human centred 'wicked problems'" (Buchanan, 1992). A growing number of designers and design researchers have been using Systems Thinking in their research, teaching and practice (Nelson & Stolterman, 2012; Jonas, 2007, 2011; Valtonen, 2010; Sevaldson, 2009, 2011, Mugadza, 2014; Ryan, 2014; Jones, 2014a,b Darzentas & Darzentas, 2015) and have formed a thriving community around the



theme of Relating Systems to Design (RSD<sup>1</sup>). Other design oriented Systems approaches have been applied to organisational design, (Pourdehnad et al., 2011) and sustainable design (Charnley & Lemon, 2011).

### **3. Approach**

#### *3.1 The 'by-product' hypothesis and increased complexity*

So far in the tackling of design problems there is the tendency to accept that reductionism is possible. In other words holistic views of the problem space are not necessary. In the case of PSSs, the product(s) are considered or remain part of the service design problem space right from the start. In the case of servitising, for example, the added value is generated mainly by devising new services provided by the same products.

However, this means, according to the hypothesis presented in this paper, that the complexity which very usefully characterises the services to be designed is 'damaged' by the assumptions that products associated with those services pre-exist, and are not emerging as part of the design process. Capturing as much as possible of the design problem space obviously provides a more robust description of it. Imposing a major constraint on the problem space such as the retaining of the product(s) and assuming that, by default, the product is associated to the service does exactly the 'damage' mentioned above to the manufacturers, the customers and more generally, the stakeholders. In other words the hypothesis here is that the product(s) are 'by-products' of the service design process. PSS models obviously are not to be removed from the tools of service design. However if one has the luxury of not having to include pre-existing products then, it is claimed, the results may be more robust.

In existing examples of services, and of PSSs, the shadow of the product is present to a greater or lesser extent in all types of service offerings. For example, in the case of car manufacturing: services such as maintenance, insurance, financial assistance to purchase a vehicle, (product oriented PSSs) or services such as renting, leasing or car sharing that remove the onus of ownership (user oriented- PSSs). The shadow of the product is also present in outcome-based PSSs such as subscription services to car pools. This is a service for people who want to get from A to B. The subscription service gives users access to cars that are variously located so that the subscriber can pick up a car from the most convenient car pool and carry out the journeys he wishes and simply return the car when he has finished. This car pool model is an approximate description of actual services such as ZipCar<sup>2</sup>.

Such outcome based PSSs are the least vulnerable to disruptions. The locus of disruptions is often technology based. For instance, the interest in new forms of transport, such as intelligent or automated cars, have the potential to have a serious negative impact upon product oriented PSSs, causing them to have to shift their product and service offerings. In

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<sup>1</sup> <http://systemic-design.net/>

<sup>2</sup> <http://www.zipcar.com/>

order to have more stable or robust offerings, it is important to shift from the product base to the whole system based enquiry to understand the present, and as much as possible, anticipate, future needs. A pertinent recent example is that of the music industry, where the product has shifted from aiming at the purchase and customer ownership of records, tapes and CDs to downloading music, and now to streaming music.

### *3.2 Capturing the 'System' of the Service to be designed. A System Thinking approach for Service Design*

A real problem emerging from the above is that new tools for Design Thinking and praxis are required that are capable of taking on and tackling the richness and complexity of the design problem space. A main assumption here is that theory and praxis must aim at capturing, understanding and learning about the design space. Naturally the more complex the problem is, the more important this is.

The design problem space that is grounded through Systems Thinking is expected in its turn to produce a systemic view of the problem space, in as far as it can. Accepting that when designing in complex human centric situations, such as Service Design, the primary concern of the designer(s) is the capturing, understanding, and learning as much as possible, of and about the design problem space (the 'System'), with which and for which they design. In other words, they will encapsulate as much as possible in the System from the beginning of the design 'journey'.

An example to demonstrate the three main facets of the design problem space considered here can have the following descriptions:

- The design of an accessible cash card for blind users (product design).
- The design of a number of accessible bank services based on the existing accessible cash card for blind users (PSS).
- The design of accessible bank services for blind customers (By-product(s)? (Systems Thinking)).

Systems Thinking is not suggested as a complete methodology for service design or design in general, but as the core of a grounding framework that can act as a platform to be used to capture, understand and learn about the design problem space, or 'situation of concern' since problem solving is not necessarily the aim of the activity. Once this is achieved to a practical level, a number of approaches and methodologies from the relevant multi/interdisciplinary spectrum of tools can help us to utilise the System that representing the situation of concern since they are passed the 'baton', and take over to deliver designed interventions.

As has been mentioned (Darzentas & Darzentas, 2014b; Sevaldson, 2009; Ryan, 2014) the acknowledged complexity of design problems is continuously increasing. This can be seen by the move away from strict engineering approaches to ones that blend the human element, and thereby recognise the human-centric character of the design problems. These problem



must be operationally and usefully expressed and understood by the stakeholders, including the designers.

Systems Thinking, as presented in the previous section, possesses the appropriate properties and nature for encapsulating the holistic thinking necessary for containing the holon of the problem area, i.e. the relevant components and the relations amongst them. It is very important to create and retain as rich as possible a picture of that holon when designing with it and for it.

There are two main questions:

5. How does one acquire a useful and as-representative-as-possible picture of the holon of the design problem space?
6. How does one use that picture to produce an intervention? Or what does one do with it?

The Systemic description of a design problem space will emerge with the use and application of a number of approaches, methodologies and tools from a wide range of related domains (ethnography, participatory design, etc.). In addition, methodologies and tools (such as customer journeys, blueprints, rich pictures) already proven in related domains such as Management, Operational Research, Psychology, Sociology and others can be used to feed the creation of the System as well as to plug into it and carry on towards an added value point of intervention.

Furthermore, an important range of tenets and principles become available once a 'Systemic' view of the design problem space is established and accepted. These can guide the understanding and the discovery of a representative System of the design space. These are principles (Darzentas & Darzentas, 2014a, 2015) of Systems Thinking such as: '*emerging properties*', '*variety*', '*self reference*', '*organisation*' and '*self organisation*' (*autopoiesis*), '*distinction*', which would guide the representation of the problem space as a System in terms of its parts (components) and the relationships amongst and between them. Notional tools such as '*structure*', '*states*', '*control*', '*attractors*', '*code*', etc. can aid the forming of the System of the problem space, mainly in terms of its dynamic characteristics and processes. The result would be a System that would represent as faithfully as possible the problem space, in its parts, the interconnections between and amongst those parts, and their 'life'.

The proposal for concentrating on the building of a System that is representative of the design problem space derives from our hypothesis that this is the 'main door' to successful design interventions. A range of methodologies such as those coming from the Management domain could complement those commonly used in design currently, especially as this already happens in service design, for example with 'Service Blueprints' (Bitner, 2008) and aid the design praxis. Although it could be claimed that these methodologies can be directly applied to design, the ideas of Systems Thinking have special distinct ways of supporting Design praxis which should be picked up and utilised accordingly.

## 4 Summary and Conclusions

The paper does not claim the offering of theoretical grounding for design and especially Service Design. It does not present a complete method or methodology for Service Design or for tackling complex design problems. It offers the notion of a Design Thinking tool based on Systems Thinking with the main purpose to produce System(s) which capture, understand and learn about the design concern, called here the design problem space. The paper remains focused on the notion of the System and the design problem space seen and considered as a System.

The paradigm of service design is the main vehicle because of its rapid emergence and influence on the general domain of design and its inherent complexity. The model of Product-Service Systems (PSSs) is used to emphasise the fact that the 'System' of the design problem space should be understood and created as free as possible from suppositions and restrictions such as pre-accepted constraints in the form of products.

It is understood here that the Systemic description of such a problem space offers itself, by its grounding, to productive alliances with methodologies and tools already proven in relative domains such as Management, Operational Research, Psychology, Sociology and others. Those can be used to feed the creation of the 'System' as well as to plug on to it and carry on towards an added value point of intervention.

Thankfully, there remain open questions. While PSSs remain a staple feature in Service Design and servitising appears as be a natural extension of product design, with Systems Thinking considering the design problem space as a system and not being constrained in this by pre-existing products, will ensure that important creative complexity will be included in the systemically expressed design problem space allowing for by-products to emerge.

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