

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

First page

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Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

- **Purpose** - The purpose of this paper is to underpin the phenomenon of service from a system theoretical perspective the law of requisite variety in particular. The paper unfolds three realms of service: Mutualism as service in nature, ecosystems service as service **from** nature and service between humans. The law of requisite Variety serves as a basis for all three realms and hence offers a broader perspective to explain the phenomenon of service.
- **Design/methodology/approach** - The law of requisite variety is explained and connected to service. Mutualism as service **in** nature and ecosystem service as service **from** nature is described and also connected to the law of requisite variety. The variety perspective is applied to service networks.
- **Findings** – The law of requisite variety serves as a basis showing that service in all three realms emerge as flows of variety. Service networks are not only C2C or B2C. Applying the law of requisite variety shows much more variety rendering and hence service rendering entities like public goods/services and one's own properties and of course nature. Thus a service network embeds also C/B2P (C to Public goods) relationships, C/B2O (C to own properties) relationships and finally C/B2N (C to nature) relationships. Variety is exchanged in these relationships. A service networks unfolds by a variety flow between different entities.
- **Research limitations/implications** - A lot of service rendering entities are taken for granted. A service science has to have a solid theoretical underpinning which can't be service itself. This paper tries to offer a system theoretical basis for service. This basis is by no means fully explored here but it offers an important research agenda for service science not only in business, marketing of information systems but also beyond.
- **Practical implications** – It has been stated that 'There is nothing so practical as a good theory' (Lewin, 1951: 169). To understand the basis of service can very much improve service quality.
- **Social implications** - Service is not only seen in a business world but in the society as a whole which is embedded in nature. Although the term service is used in the public domain the quality of this service can often be improved.
- **Originality/value** - The paper offers a theoretical underpinning of the phenomenon of service and applies it to service networks. Service can't be explained by service. Here service is explained form a variety flow perspective base on the law of requisite variety.

Introduction

It has been written a lot about service and services. It has been tried to understand *what* service is in different disciplines and most of the work is important and helpful. Here I want to address a different question. I don't want to ask *what* service is but: *why* does service exist? *Why* does it happen to be? This question may appear curious since service is a very common phenomenon in human coexistence and everybody has experienced service and services so that one may take the phenomenon of service for granted. But one may think a moment about the word of human coexistence without

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

service. Unimaginable isn't it? It's just like a world without gravity – unimaginable. But like gravity service may not be fully understood if we don't ask why it happens. This was exactly what Isaac Newton did: He asked *why* does an apple fall to the ground? The story of Newton and the apple was first published by William Stukeley in 1752:

"After dinner, the weather being warm, we went into the garden, and drank tea under the shade of some apple trees, only he, & myself. Amidst other discourse, he told me, he was just in the same situation, as when formerly; the notion of gravitation came into his mind. "Why should that apple always descend perpendicularly to the ground," thought he to himself: occasioned by the fall of an apple, as he sat in a contemplative mood: "why should it not go sideways, or upwards? But constantly to the earth's centre? Assuredly, the reason is, that the earth draws it. There must be a drawing power in matter. And the sum of the drawing power in the matter of the earth must be in the earth's center, not in any side of the earth. Therefore does this apple fall perpendicularly, or toward the center? If matter thus draws matter; it must be in proportion of its quantity. Therefore the apple draws the earth, as well as the earth draws the apple."

Newton did not ask *what* happened but *why* it happened. The reasons for a phenomenon to exist allow a deeper understanding of the phenomenon itself. This is not only true for down falling things explained by gravitation but it's also true for service. So this article tries to understand service from the perspective of a world without service.

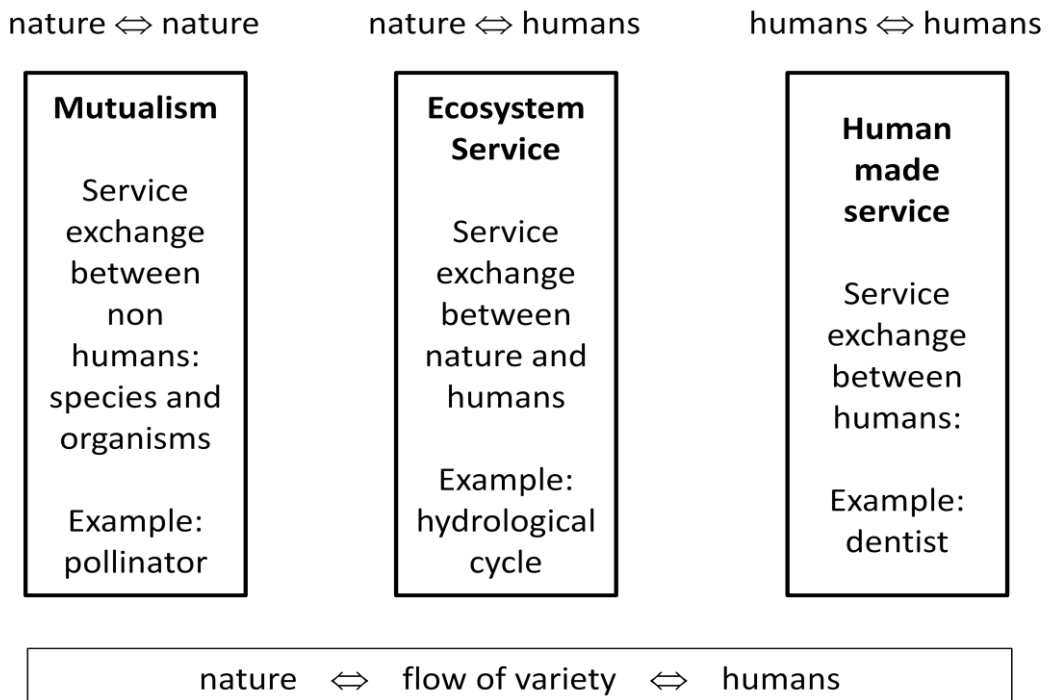
One may think that service exists because people want to have it and hence the wants (wishes, needs etc.) are the explanation for service existence which may be true for service between human beings. One could ask why people want to have it. And even if one knows why people want to have it the wants, wishes or needs are not enough to really have the execution of service, it has to be

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

“done”. It took millions of years until the great wish of flying was fulfilled. Hence wants, wishes and needs may be part of an explanation of service in a world of human coexistence. This article follows an agenda which was recently given by Vargo and Lusch (2011, 186): “we can draw on our understanding of the nature of value creation through systemic, networked, service exchange relationships from all of the marketing sub-disciplines, as well as often untapped streams of research outside of marketing.” It integrates two untapped streams of research outside of marketing. These two streams open a second and third realm of service: service is not only a phenomenon in the world of human beings it also happens between organisms and low and high developed species. It is addressed in biology and ecology under the umbrella term of mutualism. Mutualism addresses the question why “different kinds of organisms help each other out” (Boucher, 1985, 1) and it has been argued in the journal of service science to understand service as mutualism (Metcalf, 2010). In addition to these two realms of service (mutualism and service between humans) a third realm of service can be identified as ecosystem service (Boyd, Banzhaf, 2007) (not to be confused with service ecosystems Vargo & Lusch 2011). People everywhere depend on nature for value creation and their well-being. Not only food and fresh water are coming from nature. Its ecosystems also provide less obvious service such as storm protection and pollination. The natural world provides spiritual and recreational benefits as well. These and other benefits of nature’s ecosystems have supported the extraordinary growth and progress of the human population. “Ignoring these services in public and private decision making threatens our ways of living and impedes our ability to achieve our aspirations for the future.” (JANET RANGANATHAN et al. , 2008, 2)

Figure 1 Three Realms of Service

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.



Hence wants, needs and wishes cannot be understood as an ultimate reason for the existence of service because one may doubt whether organisms and ecosystems have wishes, wants and needs and notably whether these organisms and ecosystems try and intend to fulfill them. One wouldn't assume an *intention* to fulfill the wants, wishes and needs in organisms like in human beings. Since service exists in a world without human beings it can't be explained with characteristics of a human world only. Hence this article refers to biological mutualism and to ecosystems service as two additional realms of service. In this sense this article doesn't restrict service to the human or man-made world as service science does: "Service science restricts its attention to artificial, in the sense of being real human-made, worlds, and is thus a specialization of systems science" (Spohrer, 2009, p. 13) In the co-creation of value and wellbeing nature plays an important role and hence is not excluded here as an important part of service and notably of resources.

Insights from cybernetics, the law of requisite variety in particular (Ashby, 1957, 1958) will be used.

From the perspective of the law of requisite variety it is argued here that entities need variety

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

(requisite variety) to survive in a changing environment and in case they don't have it they get (or "learn") it from other entities or will die out. For too many human beings in today's world survival is still a purpose to need help (variety, options etc.) from other humans. For those who are not fighting for survival requisite variety comes into play when they want to live their life in their own special way and can't do it without any kind of support. Hence the flow of variety from one entity to another and so forth is seen as the basis for service exchange; it also shows how networks of service work when different entities (organisms, humans etc.) coexist. The article unfolds as follows: in the next section the law of requisite variety is introduced and connected to service by using an example in a human being context. Then mutualism is explained, connected to the law of requisite variety and examples are given for service between different kinds of species and organisms which are not human beings. After discussing mutualism the special case of "exploitation" as a non-reciprocal "service" is reconsidered and connected to the public service domain. Hereafter ecosystem service is explained and described as an important source of value creation and well being. Then Ashby's model is integrated into a service network and described unfolding interesting facets of service networks. Finally I draw some conclusions for further research.

Requisite Variety and Service

Ashby's law of requisite variety has been recently linked to service (Godsiff, 2010). The law of requisite variety is very general. It supposes an entity getting some kind of disturbances D from its environment and the main question of the law is then how does the entity deal with these disturbances. The entity transforms the disturbance into the desired outcome E (e.g. survival). To do so the entity is composed of a regulator R and a transformation T consisting of a set of relevant transformations the entity is capable to perform. The regulator then chooses the best transformation out of the relevant set to get its outcome E . One also can see R and T together as an entity F : "The organism (or whoever is interested in E), however, has some power of forming another dynamic

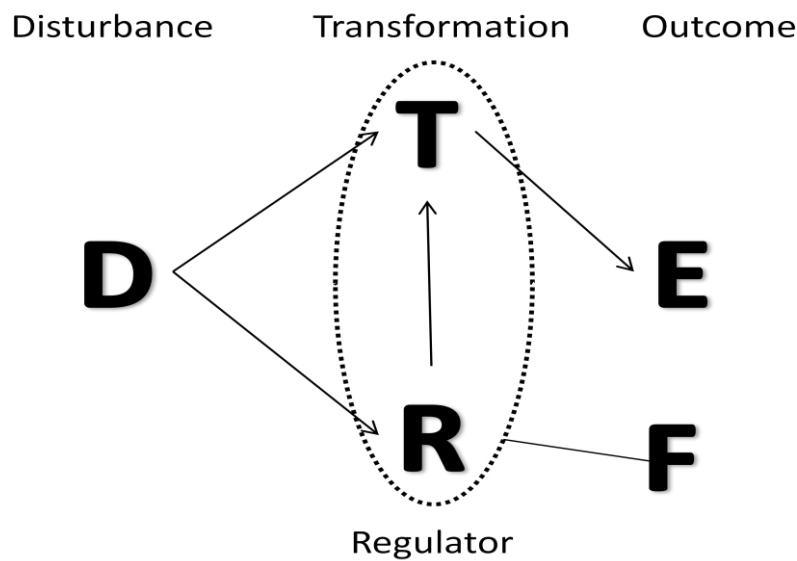
Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

system **R** (e.g. a brain or a servomechanism) which can be coupled to **T** and which, if properly made, will form with **T** a whole, **F**," (Ashby, 1957, 219). It is important to be aware that this description is on a very abstract level. "The word variety, in relation to a set of distinguishable elements, will be used to mean either (i) the number of distinct elements, or (ii) the logarithm to the base 2 of the number, the context indicating the sense used." (Ashby 1957, 126) Here the non logarithm form will be used. It is important to realize that variety in the set of disturbances, in the set of transformations and in the set of outcomes "is not an intrinsic property of the set: the observer and his powers of discrimination may have to be specified if the variety is to be well defined." (Ashby 1957, 126) Hereby the observer is often but not necessarily the entity which has to deal with disturbances' variety in order to keep her preferred outcome **E**. The discrimination of elements of a set is not limited to one dimension. Whatever the measure or scale is the observer use to distinguish elements in a set works for applying the concept of variety.

The outcome **E** for example can be anything what comes out after applying a transformation to a disturbance: it can be a work, it can be a painting, it can be a car, it can be a piano play, it can be playing the piano, it can be enjoying a movie, it can be sleeping, it can be being entertained etc. hence there are no limits for the interpretation of the outcome **E**. There is also no limit to refine the desired outcomes in any dimension. In the same vein the disturbance **D** is a description on a very abstract level and can be anything or any process in an entities' environment which the entity has to deal with as it may disturb the entity's outcome.

Figure 1: Ashby's model

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.



Godsiff as well as Frei following a managerial perspective have thought of the entity **F** to be a company or organization providing service. Hence disturbances were seen as customer inputs (Godsiff, 2010) or customer requirements (Frei, 2006) and the company or organization was the entity to manage requisite variety. Frei argues: “The first step in managing the variability introduced by customers is to understand the forms it can take” (2006, 94). This question focus on the variety the customer brings into a company or organization and then asks how the company can reduce this variety. But from the customer point of view the question in this frame may be: What can the company offer to me the customer to keep my outcome in a desired range? Godsiff suggests the “value/variety proposition from the producer to the customer, acts as a disturbance to the customer” (2010, 98) But why should a company “disturb” a customer? Why should a company confront a customer with more variety she already has to deal with? I think a company should help to reduce the customer’s output variety (by extending her requisite variety) in enabling her to live her way of life and neither raise the customer’s variety which may confuse her nor to limit the variety which would move her out of a desired set. Hence this paper argues that in Ashby’s model neither the company’s value proposition nor the customer’s inputs/requirements are disturbances. To cover with it one can directly follow Ashby. He has introduced a “controller” **C** in addition to the

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

disturbances **D** influencing **R** and **T**. Later in this section it is shown how **C** and **D** work together in service. But first an example how the Law of Requisite Variety and service are connected is given whereby Ashby’s own example is used and adopted:

“A guest is coming to dinner, but the butler does not know who. He knows only that it may be Mr. A, who drinks only sherry or wine, Mrs. B, who drinks only gin or brandy, or Mr. C, who drinks only red wine, brandy or sherry. In the cellar he finds he has only whisky, gin, and sherry. Can he find something acceptable to the guest, whoever comes?” (Ashby, 1957, 11/4/4, 204). Let’s start to analyze the situation by first taking only Mr. A and Mrs. B into account. One can draw the well-known table (Ashby, 1957)

Table 1: Butler’s choice (1)

		Butler’s choice		
		Whisky	Gin	Sherry
Guests	Mr. A	n	n	a
	Mrs. B	n	a	n

a: acceptable; n: not acceptable

Connected to Ashby’s model (see Figure 1) the guests are **D** or more precisely the source of disturbance, the butler is **R**, the set of Transformations is given in the (transformation)-matrix **T** from which **R** can choose and **E** is the result whether the guests accepts the liquor or not.

The butler’s choices are on the top of the table. Mr. A only accepts sherry given the three offers and that Mrs. B only accepts Gin given the three offers. The Whisky column is not necessary to solve the problem so it can be dropped. The remaining table is:

Table 2: Butler’s choice (2)

		Butler’s choice	
		Gin	Sherry
Guests	Mr. A	n	a
	Mrs. B	a	n

a: acceptable; n: not acceptable

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

Since the variety of the guests is two (Mr. A and Mrs. B) and the Butler's choice variety is also two (Gin and Sherry) he can reduce the disturbance's variety to one (acceptable). So the Butler's choice variety is high enough to cover the guests' variety and bring the situation down to variety of one namely acceptable. Now let's assume that instead of Mr. C Mr. D will come, who drinks only red wine, brandy or port. The table now becomes:

Table 3: Butler's choice (3)

		Butler's choice	
		Gin	Sherry
Guests	Mr. A	n	a
	Mrs. B	a	n
	Mr. D	n	n

a: acceptable; n: not acceptable

It is easy to see that the butler now can't get the desired result of a (acceptable) in all cases.

The variety in the last row is only one (n) which is not enough to reduce the overall variety of two. The butler alone cannot reduce it to one with his set of options. So he calls the liquor store to bring him some port and the table becomes:

Table 4: Butler's choice (4)

		Butler's choice		
		Gin	Sherry	Port
Guests	Mr. A	n	a	n
	Mrs. B	a	n	n
	Mr. D	n	n	a

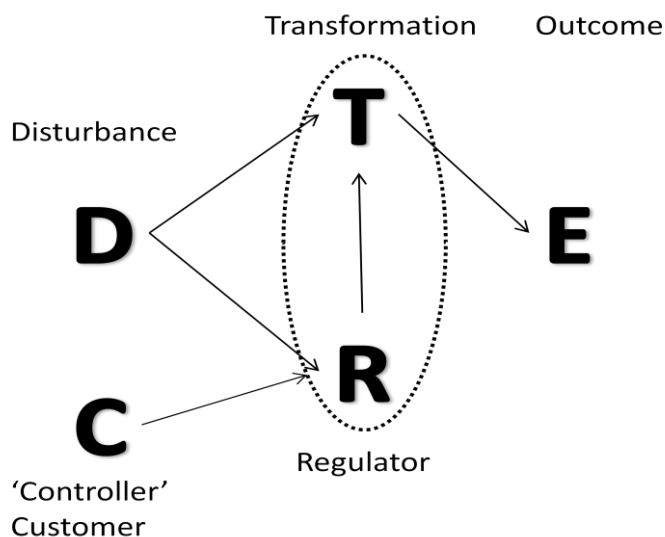
a: acceptable; n: not acceptable

The exchange with the liquor store rose the Butler's variety as indicated in the third row from one (n) to two (a, n) so that he can reduce the result variety to one. Without the liquor store's service the butler does not have the requisite variety to meet the disturbance's variety. Hence the disturbance is neither a service nor a value proposition and vice versa which goes beyond Godsiff's perspective! Each actor is in a specific environment or context

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

(Chandler, Vargo) which may overlap with the others or not. In a broader view one could also think the environment to be influenced or partly created by some actors' output. If for example on Sunday afternoon my neighbor is cutting down a tree with his chainsaw while I try to take a nap the noise is part of my environment and I have to deal with this disturbance D (it is neither a value proposition nor a service and I can't co-create value with it). Maybe I have some earplugs (requisite variety) otherwise I need a value proposition (earplugs) from someone else to transform D into output E the desired set (sleep) in particular. But the desired output of another party is not a disturbance even not in Ashby's concept. "Suppose the decision of what outcome is to be the target is made by some controller, C, whom R must obey. C's decision will affect R's choice of α , β or γ ; so the diagram of immediate effects is (where I put customer for indicating her input), the author)

Figure 2: Ashby's model with "controller"/customer



Thus the whole represents a system with two independent inputs, C and D". (Ashby 1957, 213) The customer "tells" the regulator (representatives of a company) what she desires or

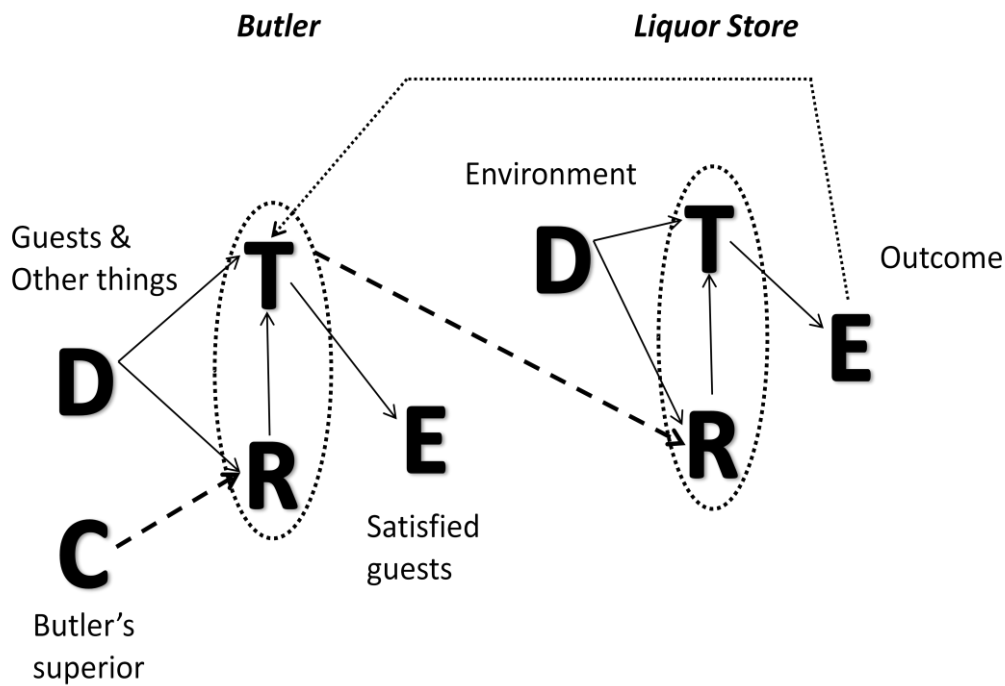
Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

the company asks customers what their wishes are in order to “produce” an outcome E for the customer. The customer is not a disturbance but she tries to influence the regulator to “produce” an outcome preferred by her and the company tries to understand the customer to design and “produce” the right outcome. The disturbances may come from competitors or other parts of the environment (e.g. legislation, politics etc.) and may be understood as part of the context. Companies and other organizations may perceive customers’ wants and needs as disturbances if they don’t have the requisite variety in their own transformation matrix T to deal with them and therefore need variety on their own. If they are prepared for the customers’ wants and needs they have an adequate column in their transformation matrix with an appropriate outcome E for the customers’ transformation matrix.

The better the “regulator” performs C’s desired output the more perfect the regulator is (Ashby 1957) from C’s perspective. Like in the butler example a polite guests would never say “I don’t accept this” but the butler’s superior would perhaps (to regale his guests) and he is the butler’s customer (‘controller’) not the guests, they don’t pay. This is shown in Figure 2. The butler’s superior “works” as a controller C for the regulator R (butler) indicated by the dashed arrow from C to R in the relationship between superior and butler; whereas in the relationship between butler and liquor store the butler “works” as “controller” (here customer by order of his superior) of the liquor store indicated by the dashed arrow from the butler to the liquor store’s R. The liquor store’s result E is the value proposition to the butler as it extends the latter’s transformation matrix T indicated by the dotted arrow from liquor store’s E to the butler’s T.

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

Figure 3: Ashby's model for butler and liquor store



The customer's input affects directly the regulator's intended outcome whereas a disturbance should be seen as a challenge for the regulator to reach the outcome desired by her and her customer.

The service can be interpreted as an extension of the transformation matrix together with the Butler's right choice. If the butler had an extended transformation matrix (which means that he had port from the liquor store) but didn't choose port for Mr. D. he got a value proposition (from the liquor store) but did not co-create value from that value proposition. Hence the value proposition is an extension of the transformation matrix which the regulator **R** in our case the butler can use to meet the disturbance's variety. If the butler expected only Mr. A and Mrs. B. for dinner then he wouldn't need an extension of his transformation matrix which means he wouldn't need service or to be more precise he wouldn't need a value proposition from the liquor store as an extension of **T**.

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

Using the language of the Law of Requisite Variety one conclusion of these considerations is that a value proposition can always be seen as an extension of a transformation matrix. A proposition only is a **value** proposition if it is an extension of someone's transformation capabilities T. An extension means a column containing a desired outcome in row where there was no desired outcome without the extension. If it is not an extension of the entity's own transformation matrix it is not a **value** proposition but just a proposition.

The second conclusion is that the value is co-created if the regulator uses the extension of the transformation matrix (value in use) in his context (value in use in context). If the entity uses the "new" column of the transformation matrix more than once it is still an extension of its own capabilities. Hence the extension and the use/application together make a service what it is. If the variety requiring entity extends her own transformation matrix this can be interpreted as learning or more general as self service since learning is a special case of self service may be or may be not supported by others teachers in particular.

By using the law of requisite variety the idea of service as it is described in the service dominant logic-the application of skills and knowledge-for the human sphere can be extended to the natural world where one wouldn't commonly speak about the "application of skills and knowledge". In general it is the flow of variety which extends the **required** variety of an entity to survive or reaching other goals or living styles. The general principle behind this may be balance since it is a very natural and oldest ecological theory (Egerton, 1976, 323). Differentiation together with balancing or exchange is coexistence of different

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

entities organisms as well as of human beings. Variety is “produced” exchanged and destroyed depending on where it comes from and where it goes to.

Mutualism and Service

The above holds also for mutualism or service between species since “mutualism is an interaction between individual organisms in which the realized or potential genetic fitness of each participant is raised by the actions of the other.” (Janzen 1985, 40). To raise the fitness is to enable the other to react to environmental disturbances with the required variety.

Metcalf (2010) has suggested understanding service as mutualism and one reason for him is the fact that “those deeper aspects of our humanity which connect us to the mutualism found in other species never left us.” (109). In fact mutualism and in connection with it symbiosis are long-standing and essential concepts in biology and ecology (Lewis, 1985, Janzen 1985, Boucher 1985). In general mutualism (in biology not in political economics¹) tries to understand why “different kinds of organisms help each other out” (Boucher, 1985, 1). Different categorical systems have been used to describe and understand mutualism and to distinguish it from symbiosis (Starr, 1975; Lewis, 1985; Conner, 1995). Authors agree that “in mutualistic interactions, one of the species provide some kind of ‘service’ that its partner species cannot provide for itself and receive some kind of ‘rewards’ in return” (Yamamura, et al. 2003, 421). Hence a mutualistic interaction is typically seen as a dyadic interaction in which both participants benefit. Non-mutualistic interactions are interactions in which

¹ With his recently published book “Studies in mutualist political economy” Carson (2007) has brought back the topic at least into political economics. ‘For the most part Carson is a Marxist. But not entirely. He adds to Marxism a large dose of what he calls “individualist anarchism”’. (Reisman, 2006, 47). An impression of the debate is given in the special issue of *The Journal of Libertarian Studies* (2006 Vol. 20,1). Mutualism in political economics doesn’t look at service as constituting element, so this article does not deal with mutualism as it is understood in political economy.

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

at least one participant is harmed or not affected at all by the action of his counterpart (Lewis, 1985; Conner, 1995). However recent research in mutualism has shown that firstly a dyadic approach to mutualism is a too narrow perspective and that research in mutualism networks sheds new light on it and the role of cheaters in particular (Stanton, 2003; Renner, 2007; Basqcompte & Jordano 2007; Rezende et al. 2007; Bastolla et al. 2009; Fortuna et al. 2010) which integrates “cheaters in mutualism networks” (Genini, et al. 2010). Depending on the structure of the network, nested or modular (Fortuna et al. 2010), the impact of cheaters in a mutualism network is quite different (Genini, et al. 2010). But overall it brings new insights into mutualism networks as it shows that these networks exist and survive although not all (dyadic) relationships are win-win relationships. Moreover cheaters “seem to be important to the overall stability and integration of natural systems” (Genini, et al. 2010, 496). In addition a phenomenon called “conditional parasitism” was identified “which basically means that the services of different pollinator are not additive but can interfere with each other” (Thomson 2003, S. 8). So if one thinks of service as mutualism in the world of human coexistence does it include cheaters or conditional parasitism too? Or is the concept of mutualism too broad for service if it includes cheaters and/or conditional parasitism? These questions are discussed at the end of next section.

Moreover the term service has become important in the field (Cushman, J.H. & Whitham, Th. G. 1991; Herre, E.A. et al. 1999; Yamamura, N. et al. 2004; Ollerton, J. 2006). Hereby the exchange of service is distinguished from the exchange of goods: “...mutualisms usually involve the direct exchange of goods and services (e.g. food defense and transport)” (Herre, et al. 1999, 49). This distinction is quite similar to the distinction of goods and services associated with the goods-dominant logic (Vargo& Lusch 2004, 2008) but now can be seen as two forms of service according to the service-dominant logic (Vargo& Lusch 2004, 2008). Although the term service has been used in the mutualism literature it was not defined specifically. But a look at the goods and services (again using the good dominant terminology because biologist use this terminology) show what has been

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

meant by goods and services. Services: dispersal, protection, defense, bioluminescence, cleaning, etc. Goods: Carbohydrate, nitrogen, inorganic components, organic components, water etc. (Ollerton, J. 2006) Following the service dominant logic “goods” are seen as indirect service and the “services” are seen as direct service. It has been recognized that these exchange of service “typically result in the acquisition of novel capabilities” (Herre et al. 1999). This perspective brings in an important point in to focus: novel or additional capabilities are reasons for the service receiver to take this additional variety of her former capabilities. The service receiver gets service and uses it because he doesn't have the required capability (variety) to survive or to achieve whatever is necessary. Hence service offers requisite variety.

Examples:

Example 1: The birds – called Oxpeckers, hanging out on the back of rhinos – are there for the food. Oxpeckers pick blood-sucking ticks and other parasites off the rhinos. Found only in Africa, these coffee-coloured birds also perch on the backs of zebras, buffalo, and giraffes.

The relationship between the oxpecker and the rhinoceros is an example of "mutualism", a relationship in which both organisms benefit. In other words, it's a win/win situation – the rhinos get rid of unwanted pests and the birds get a tasty meal. (Yes Mag, 2005, 8/17)

Example 2: Egyptian plover and the crocodile. In the tropical regions of Africa, the crocodile lies with its mouth open. The plover flies into its mouth and feeds on bits of decaying meat stuck in the crocodile's teeth. The crocodile does not eat the plover. Instead, he appreciates the dental work. The plover eats a meal and the crocodile gets his teeth cleaned.

These examples show how variety is exchanged from one species to another in a reciprocal way. The Oxpecker's transformation matrix is extended by the food it gets from the rhino and the rhino's transformation matrix is extended by getting rid of the parasites. Hence both get requisite variety.

Pollinators and flowers are common examples of mutualists; one could not persist without the other. The strength of this link, however, can be weak. Many mutualisms are "diffuse," meaning that each player may have many alternative species with which it may interact.

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

What about cheaters?

If variety is transferred or exchanged from one entity to another, this sometimes happens in a way that at least one of the entities may not get back something in reward or may even be harmed. For the variety receiver the extension of her transformation matrix cannot harm her if it brings her closer to her requisite variety. Hence any extension of the transformation matrix which brings the matrix owner closer to her requisite variety is a value proposition which can't harm the user of this value proposition (prescinding from accidents or alike). But what if the variety receiver "takes" the variety from another entity without reward? What if she exploits the variety of another party? One should be aware that this is not a unique case but it is ubiquitous. It ranges from robbery over using infrastructure without paying directly for it (e.g. driving on a street, see below) over using information publicly available (e.g. street signs) to simply enjoying neighbor's garden. In accordance to the mutualism terminology the term exploitation is used because it was introduced to avoid "the implications of intent and subterfuge inappropriate for all but the most cognitively advanced organisms" (Bronstein, 2001, 278) which for example terms like "cheater" hold. "An exploiter of a mutualism is an individual that obtains a benefit offered to mutualists, but that does not reciprocate." (Bronstein, 2001, 278).

An example is the Clownfish (Nemo in the movie Finding Nemo) and sea anemones: Clownfish are small, brightly-colored fish found in coral reefs. They are frequently found in the tentacles of sea anemones, which typically capture their prey by paralyzing them with discharged cnidoblasts (nematocysts), and then ingesting the animal within the gastrovascular cavity. Studies have shown that a component of clownfish mucus *inhibits* the discharge of these cnidoblasts. Clownfish and sea anemones present an example of **facultative mutualism**. The clownfish benefits by having a protected home territory. What does the sea anemone gain from this arrangement?

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

“Once a mutualistic relationship has arisen, the appearance of cheaters is highly probable” (Mainero and Martinez del Rio, 1985, 193). In these cases reciprocity may be intermitted and the flow of variety takes a detour until it again reaches variety the offering entity. In this sense exploitation is prevalent not only in nature but also in human societies. Unlike using bridges and paying a fee for it (reciprocal) the use of infrastructure of a city or country is not reciprocal. Though people pay taxes these taxes are not imputable to the expenses for building and maintaining specific parts of the infrastructure. If the infrastructure user’s income is below tax allowance she “co-creates” value without paying for it. The same holds for public defense. People enjoy peace and freedom and they usually don’t even know the people who assure it. These are non-dyadic cases of service and in addition the service is not exchanged on markets it is the domain of public good or better public service (see next section). They are part of a democratic (sometimes non democratic) coexistence of humans. Hence if one accepts these cases as service one has to extend a dyadic market perspective explicitly to two dimensions: First one has to go beyond a dyadic perspective; second one has to go beyond market exchange. The next section describes a service realm beyond market exchange and then all three realms are integrated in service networks by extending Ashby’s model to a network.

Ecosystem service

Humans benefit from a manifold of resources and processes that are offered by natural ecosystems. Overall, these benefits are known as **ecosystem service(s)** (which should not be confused with service eco systems! Vargo and Lusch 2011) and include service like clean drinking water and e.g. the decomposition of wastes. While environmentalists have discussed ecosystem services for decades, these services were popularized and their definitions formalized by the United Nations 2004

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

Millennium Ecosystem Assessment (MA), a four-year study involving more than 1,300 scientists worldwide. Among these ecosystem services one can find *provisioning*, such as the production of food and water; *supporting*, such as nutrient cycles and crop pollination; and *cultural*, such as spiritual and recreational benefits.

The recognition of human dependence on ecosystems of the Earth reaches the beginning of our species' existence. Humans benefited from the products of nature e.g. to nourish their bodies.

Contemporary ideas of the ecosystem by be drawn back to Marsh in 1864, when he got the idea that the earth's natural resources are not inexhaustible by reference to changes in the fertility of soils in the Mediterranean region in question. The Club of Rome with its "Limits of Growth" revitalized the discussion on exhaustible resources in the 70s of the last century. The term "environmental services" was finally introduced in a report of the Study Group of the critical environmental issues. In the following years variations of the term were used, but eventually "ecosystem services" has been the standard in the scientific literature (Daily, 1997, Sagoff, 1997, Boyd & Wainger, 2003, Kremen, 2005,)

Since the Millennium Ecosystem Assessment in 2004 nature as ecosystem service has been readdressed with a focus on measurability. The ecosystem services concept tries not only to explain human-nature-interaction in a holistic way but also provides an opportunity to tackle the issue of non-marketable benefits obtained from ecosystems (Costanza et al. 1997). In general these benefits are an extension of requisite variety of humans to keep their outcome in desired set otherwise humans wouldn't have survived.

"Talking about services inevitably focuses our attention on the receivers of those services. Thus, we argue that ecosystem services need to be identified and discussed in terms related to people's perceptions and needs for services from the environment rather than scientific or economic theory." (Cork et al. 2001) In other terms what is the variety these people need and value?

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

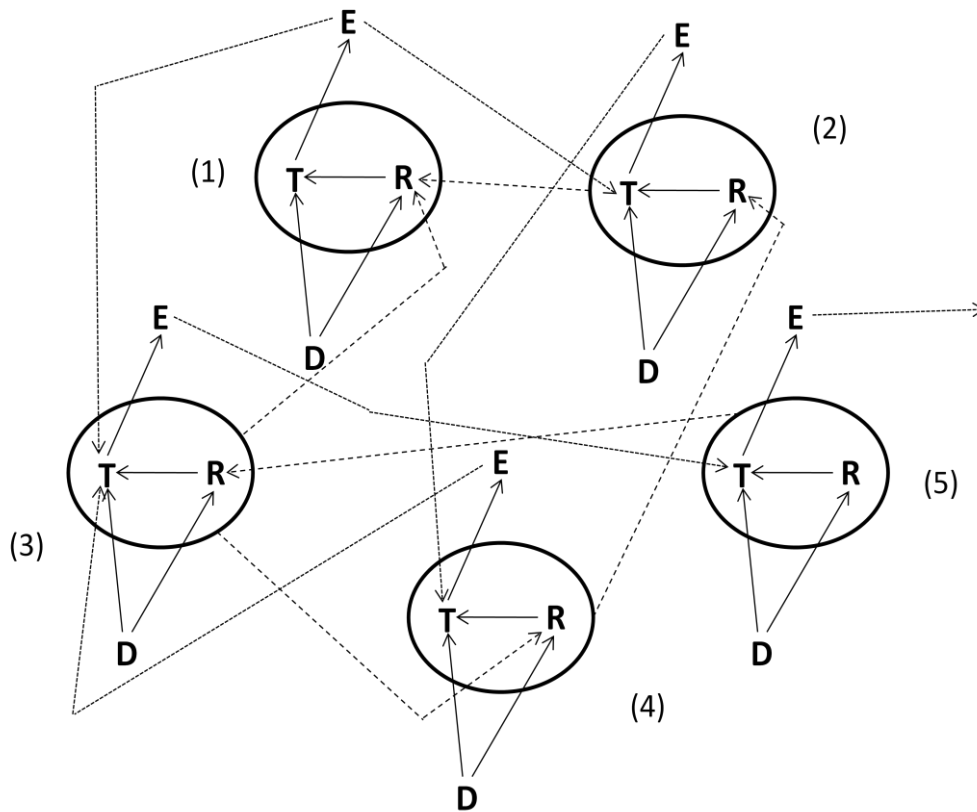
Hau and Bakshi (2004) point out “the crucial role that ecosystems play in sustaining all industrial activity.” Hence ecosystem service does not only extend the requisite variety of single humans but also that of companies, organization and perhaps the society as a whole. De Groot et al. explicitly mention the variety offered by ecosystems for humans’ recreation and gives a typology of ecosystems service (2002). All this service is an extension of variety for their “receivers” and/or users in their specific context. All three service realms discussed above have a flow of variety as a common basis. This flow of variety is not limited to dyadic relationships but attains its full meaning in service networks, integrating the resources relevant to the respective service.

The Law of Requisite Variety and Service Networks

Network theory is by no means new in the area of marketing or service. There is an extended body of literature dealing with networks in these disciplines and it has been argued for a network paradigm in particular in marketing (e.g. Achrol, 1997 and Achrol & Kotler 1999). In service marketing e.g. Gummesson (2007) has argued for networks and network theory with the watchword “many-to-many” (Gummesson, 2008, 2009, 2010). And in service-dominant logic the network perspective is acknowledged not only as many to many but as many within many, “...the context of value creation is networks of networks” (Vargo & Lush 2008, 7) But to my knowledge Ashby’s law of requisite variety has not yet been connected to service networks as Godsiff has put it on the agenda for further research (2010). Figure 3 shows a network of five entities which of course can be seen as a part of a bigger network. In general there is no need to distinguish between a so called producer and consumer (Vargo and Lush 2011).

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

Figure 3: Ashby's model integrated in a service network



In figure 3 there are five actors/reactors encircled. These actors may be people, companies, institutions, governments or even machines as will be discussed below. There is no restriction for the application of Ashby's model. Dotted arrows indicate outputs E which are inputs in another party's transformation matrix T extending the number of columns as described above (value propositions).

All actors "produce" an outcome which can be used to raise other actor's variety to enable them to get their desired outcome E . So there is a variety flow between the actors. The output E can be seen as a value proposition for others as described above. For example actor (1) is offering her outcome to actor (2) while actor (2) is offering her outcome to actor (4) and (5). Actor (5) is offering her outcome E to nobody e.g. (just enjoying her outcome) or

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

somebody unknown or it is an outcome nobody needs which may or may not be part of the environment of others. Dashed arrows are actors' goals or wishes, desires etc. for another party which are inputs for the regulator R. If an outcome E is used in another party's transformation matrix there is (usually) also a dashed arrow from this party back to the output "producer" which can be interpreted as information about the wishes of this party (which can be interpreted as consumer). Continuous arrows like above. The human service network can have double inputs for R.

Let's unfold a specific service network by using Gummesson's "Freezer Case" (2008, 145-146):

"The freezer case

On a Friday night around 8:30, I went down to the basement to pick up food from our big freezer. We do not go there daily as we have a smaller freezer in the kitchen. When I put my hand in the box I felt that it was not cold enough. The thermometer showed minus 10 degrees Celsius whereas it should be minus 20. A crisis was in the making. What do you do? One option is to just leave it and let the insurance cover as much as possible. Still you need to get the freezer out of the house before its content starts to smell. As the freezer was 25 years old – its expected lifetime is rather 10 to 15 years – the idea of having it repaired did not seem attractive. A more compelling option was to try and save the food, especially as much of it was home-made from natural ingredients and could not be replaced in the supermarket. But the salvage had to occur within the next few hours. And it was Friday night.

We could squeeze some of it into our kitchen freezer, but not much. We decided to solicit assistance from our neighbors, starting with Dagmar, the old lady living closest to our house. She could take some but her freezer was not so big. We walked over to two more neighbors, a family of four who I knew had an extra freezer in their garage, and an elderly couple two houses away. Still there was food left. Some of the other houses in the immediate neighbourhood were dark and in some we did not feel that our relationship to the people was strong enough to ask for this kind of help. We phoned our daughter in the city and had to drive for 15 minutes to get rid of the rest.

This was an annoying situation. It was unexpected, there was no script, we had to act quickly and it spoiled our Friday night. I was grateful in a sense. Suppose I had not gone downstairs to pick something up. The freezer did not send a signal to warn us. The breakdown was only indicated by a small red lamp close to the floor and almost invisible. You cannot handle the situation by yourself and your social skills and the benevolence of others have to be activated.

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

There are now four families involved: me, my wife and our daughter, and three neighboring families with seven people, altogether ten people. Though this is an antecedent to a commercial situation of purchasing and marketing, there are only citizens and consumers involved; it is customer-to-customer (C2C) interaction.

Business-to-customer (B2C) interaction came the following morning, Saturday, when my wife went on the internet to find the type of freezer we needed, a retailer and preferably somewhere to go and see it physically. After some telephone calls she found that retailers only had very few of the most common models on display. It costs too much for a retailer to have them; they tie up space and capital, which makes the retailer vulnerable in the highly price-competitive household appliances market. The manufacturer, Electrolux, despite having their world headquarters in our city Stockholm and being market leaders, did not have a showroom. On the internet, however, their product line stood out as the preferred choice. After searching for models through internet pictures and specifications, comparing prices and what was included – transport, installation, removal and scrapping of the old freezer – we chose a retailer. “We deliver on Thursdays,” they said. “Electrolux delivers to us on Wednesdays.”

We now had two networks, the C2C social network of family and neighbors on the customer side, and a commercial retailer and manufacturer network on the supplier side. We had to contact our C2C network asking if they could keep the food until Thursday. As luck would have it they could.

We had not expected the delivery to take so long. It would mean a week in practice if you include a day or so to get the spread out frozen food back. There might have been quicker options but many quality aspects have to be fulfilled – right size, performance, design and delivery conditions – and the price had to be right. You can only investigate so many suppliers. It takes a lot of time, you are forced to do it, and it is not really an enjoyable experience. Checking the physical quality is not possible although the service literature is full of statements like “the customer can easily assess the quality of physical goods because they are tangible but not services because they are intangible” (see, for example, Zeithaml (1981), referred to in every textbook on services marketing) claiming that this shows a difference between goods and services. Unfortunately it does not. You can only check if the specification is met by the physical product as to certain apparent variables such as size. We only knew the quality of the previous box by the fact that it lasted 25 years and kept the food at the right and constant temperature until it suddenly gave up. For a critique of conventional claims of differences between goods and services, see Lovelock and Gummesson (2001) and Vargo and Lusch (2004b).

On Wednesday the retailer phoned and said that Electrolux could not deliver this week so it would have to wait until Thursday next week. The delivery time is now doubled to two weeks. New contact with the neighbors and our daughter.

The transport firm arrived on Thursday and became the third member of our B2C network. They carried the old freezer from the basement and brought in the new one. It was heavy work going downstairs and through narrow doorways. When they unwrapped the new freezer we found three big holes in its front. They had to wrap it again. “We will be back next Thursday,” they said. New contact with our C2C network. They were patient and understanding but we brought each a jar of homemade jam as a token of appreciation.

Next Thursday the transport firm came again and finally plugged it in. Three weeks had passed. We began to recover our food, starting on the Friday. But Gunnar and Ingrid had

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

left for their country house to be back on Tuesday, and Dagmar was gone until Sunday night. Before all the food was back in place, close to four weeks had passed.

During this process we had established a C2C and a B2C network. I would like us to change to B2C/C2B as just B2C implies that the supplier is the leading party doing something to the customer and not the customer doing something to the supplier. In the language of service-dominant logic it means co-creation of value. From our consumer perspective, the supplier side started out as many-headed and was reduced to three-headed during the search process: Electrolux, the retailer and the transport firm.”

If one looks at this case from a requisite variety perspective the broken-down freezer took off a column of Gummesson’s transformation matrix and so they needed variety to reach back the desired outcome(s) of frozen food. The Gummessons wanted to keep food frozen in a usually non freezing environment (D) and they used a transformation (the freezer) to do so. After the freezer broke down the specific transformation was no longer available and the Gummessons had to deal with it differently. Several entities can be identified rendering requisite variety and hence service. In a chronological order one finds: The thermometer rendering information about the temperature of the freezer (**in terms of variety (tov):** the ability of measuring temperature), the kitchen freezer rendering freezing space (**tov:** providing cold space) , the neighbors (Dagmar, and the others) rendering freezing space with their freezers (**tov:** providing additional cold space), the phone rendering the connection to daughter Madelene (**tov:** enabling Mr. Gummesson to talk directly to his daughter), the car rendering mobility (transportation) (**tov:** enabling Mr. Gummesson to bring the food to Madelene fast enough), the streets rendering a plain surface to drive on (**tov:** enabling an easy ride compared to driving on a natural landscape), the fuel rendering “service” for the “car” (**tov:** enabling Mr. Gummesson to drive with the car; the car transforms fuel into motion (T) and is controlled by Mr. Gummesson (C)->(R)), the internet rendering information about new freezers and a retailer (**tov:** enabling Mr. Gummesson to decide about a freezer and to get in touch with the retailer) , the phone again, the retailer rendering information

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

about delivery and organizing delivery (**tov**: ability of organizing delivery of the new freezer and transferring information from Electrolux to Mr. Gummesson), the transportation company rendering the delivery (**tov**: enabling to physically move the freezer from Electrolux to Mr. Gummesson) and finally Electrolux rendering a freezer (**tov**: ability of making a freezer). And the Gummessons themselves managing the whole process. Why didn't a company do all this? Gummesson describes: "There was no alarm. Why not Electrolux? I would have liked her voice to say: 'Hi, my name is Hans and I am the CEO of Electrolux. I'm sorry to inform you that your freezer has given up. If you look on the bright side of life your freezer has served you impeccably for 25 years and 143 days, far longer than can be expected. I am sure you would like to buy a new one quickly. To do so, look at our product line on www.electrolux.se. To make sure you don't miss this alert, I will also send this as an e-mail and text message on your cell phone.'" (Gummesson, 2010, 635) This describes precisely the requisite variety the Gummessons needed but couldn't get. So they had to take care for it on their own and to substitute the described desired requisite variety by other varieties. In this example the requisite variety perspective shows what it means to render requisite variety as a service in a way that not the customer alone has to take care of all the different varieties needed to solve the problem. The identified entities rendering variety also form a service network (see figure 4) and from each entity another service network can be unfolded (Gummesson 2008).

Figure 4: The "freezing" Service Network

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

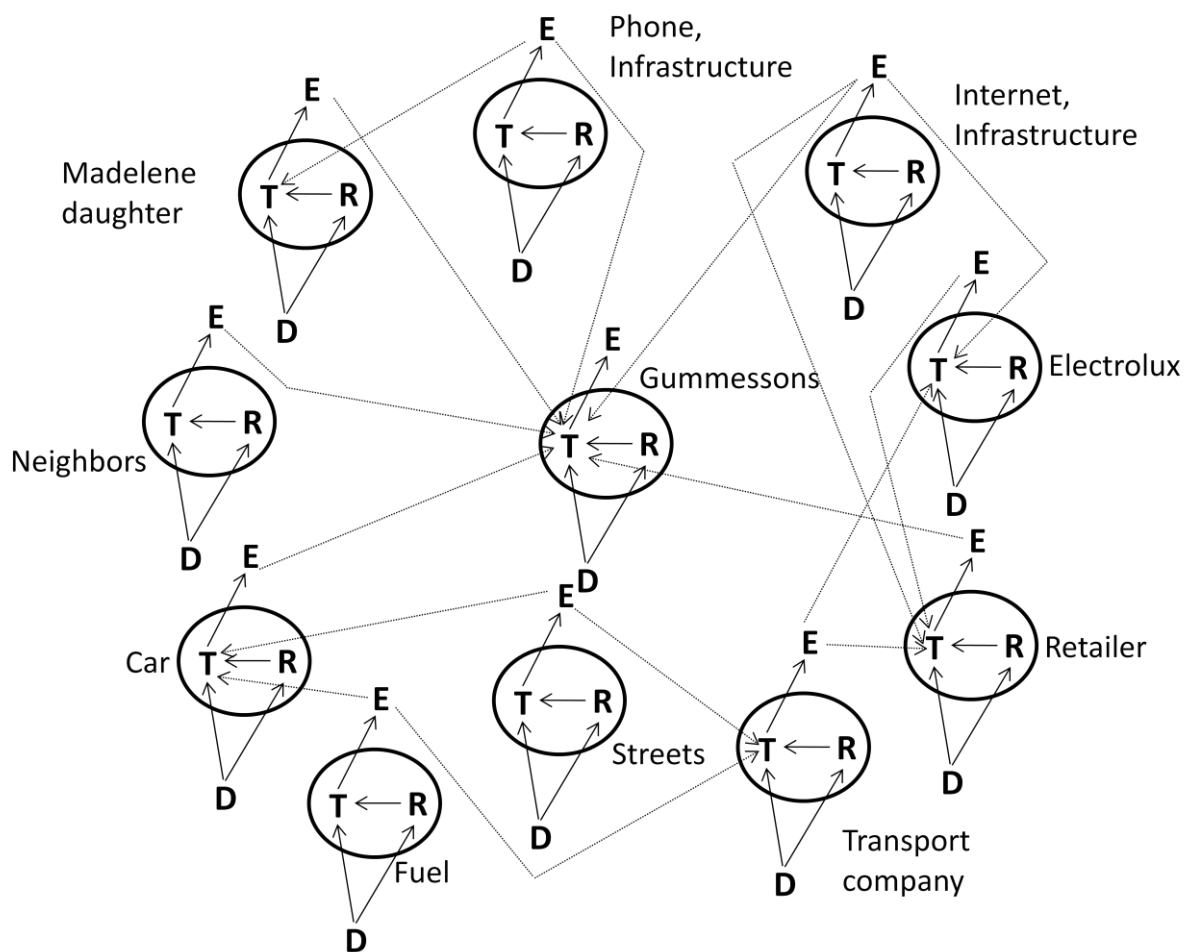
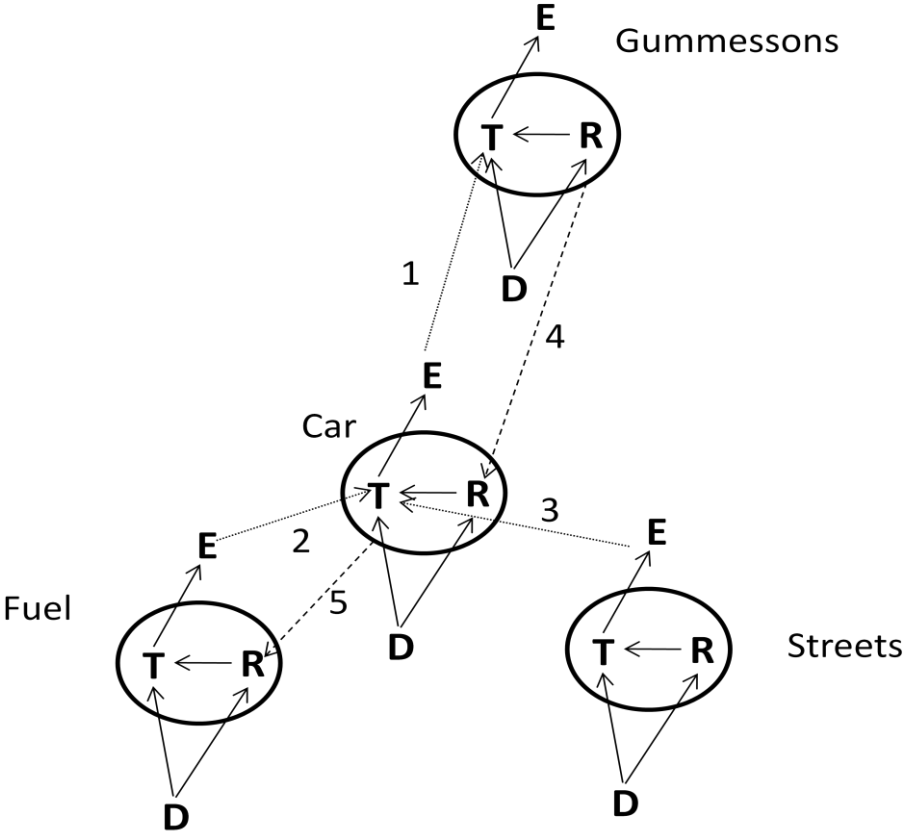


Figure 4 presents the service network. In the center the Gummessons are located. Around them a service network unfolds which is very specific to the case in question. The three neighbors are put together as one entity just to keep the picture clear. All entities are service or (requisite) variety providers of value propositions for the Gummessons. Even the Gummessons provide service for themselves in managing it all. The dotted arrows indicate that the different outcomes extend the Gummesson's transformation matrix.

For clarity all dashed arrows from entities to regulators were dropped. Just two are explained here Arrow 4 and 5 in figure 5: Professor Gummesson is the (customer) controller of his car.

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

Figure 5: Part of the “freezing” service network



He controls the car which then transforms fuel into motion; the outcome of the car is enabling Mr. Gummesson to bring the food fast enough to his daughter. The car controls the fuel to explode precisely at the right time. Table 4 summarizes the components of the partial service network and their connections.

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

Table 4: Components of the partial “freezing” service network*)

Components of the partial network	Fuel	Street	Car	Gummessons
T	Transforms energy into other forms of energy	Transfers uneven surface into plane surface	Transforms explosion into motion (driving) and requires a plane surface	Transforms (locally: transfers) his food to Madelene
R	Car controls fuel's R with its ignition spark (perfect controller)	Network of public authorities and private companies	Mr. Gummesson controls the car's R	Mr. Gummesson
Fuel's E	explosion			
Street's E		Plane surface		
Car's E			driving	
Gummesson's E				Keeping the food frozen

*) Arrows indicate outcomes E extending other entities' transformation matrices T.

Each entity is a variety providing entity and other entities use this outcome as an extension of their own transformation matrix for their own purposes. This network extends Gummesson's original network which was a C2C and B2C/C2B network (Gummesson, 2008, 146) with three additional types of relationships: C/B2P (C/B to Public), C/B2O (C/B to own property) and C/B2N (C to Nature) and now becomes a **many-in-many** network (MiM). This distinction is in line with Vargo and Lusch's distinction of sources for resources (2011): the B2B and C2B as market facing sources, C/B2O private sources, C/B2P public sources and the C/B2N in addition to Vargo et al. as resources as obtained from natural sources.

The streets as a “public good” render service to Professor Gummesson when driving to his daughter and renders service to the transportation company delivering the freezer.

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

Professor Gummesson's car renders service in enabling him to bring food to his daughter. The food if vegetables are part of it depends on natural pollination, a service rendered by ecosystem. The car wouldn't drive without fuel, a service from the ecosystem and from oil "production" however the oil is not produced by humans it is only hoisted by humans it is produced by the ecosystem (Crok et al. 2002, Wallace, K.J. 2007). Hence fuel is itself is an outcome of a service network connecting different operant and operand resources enabling a flow of variety, a variety enabling the car to be driven.

The additional three types of relationships render an enormous service. These types of service-relationships first show that service-relationships can't only exist between human beings or people and organizations (Löbler & Raschpichler, 2009) but between any kinds of service rendering entities as described under the term service system (Vargo et al. 2010, Spohrer, Maglio, 2010, Vargo et al. 2008, Spohrer et al. 2008, Maglio, Spohrer, 2008) but also connect people to nature and the service of ecosystems.

C/B2P: We use a lot of so-called public goods or services (in goods dominant language) "...which all enjoy in common in the sense that each individual's consumption of such a good leads to no subtractions from any other individual's consumption of that good..." (Samuelson, 1954, 387). Typical examples are roads, bridges, services of policemen, civil servants, judges, laws etc. (Samuelson 1976, 157) A public service is characterized by "non-rivalry" which means that consumption of the service by one individual does not reduce availability of the service for consumption by others (Varian, 1992, 415). This article argues to integrate this public service (goods and services) explicitly in to service networks. They

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

render service and they are used in a specific context. The same holds for properties and the service they render.

C/B2O: It is Vargo and Lusch's merit that since S-D logic goods are understood as indirect service. (Vargo & Lusch 2004, 2008, 2011) The service rendering quality of goods is why they are used to co-creating value with. But like Gummesson's car, phone etc. properties only render service in specific situations in time and place (Vargo et al, 2010, Vargo & Lusch 2011)) i.e. in context. And there are times and places i.e. contexts in which the same properties are not rendering service. In the first case they are resources in the second they are part of the environment. "Resources are highly dynamic functional concepts; **they are not, they become** (emphasis added), they evolve out of the triune interaction of nature, man, and culture, in which nature sets outer limits, but man and culture are largely responsible for the portion of physical totality that is made available for human use" (Zimmermann 1951, 814-15, also Vargo & Lusch 2004). Whereas Zimmermann refers to physical entities Vargo et al. extend this view to include non physical entities. "In fact, resources such as time, weather and laws, which are often considered exogenous and uncontrollable by individuals and organizations, are often integrated – if not relied on – in the value creation process by all service systems" Vargo et al. 2010, 148). Here the **C/B2N** is already integrated and as it is focused on in the ecosystem service project (Boyd, J. and S. Banzhaf 2007, Engel, S., S. Pagiola, and S. Wunder (2008) Goldman, R.L., Thompson, B.H. and G.V. Daily (2007, Müller, F. & B. Burkhard (2007) "The billions of species on our planet, including humans, interact with one another in many ways. These interactions among and between species are what define ecosystems. Ecosystems in turn, provide the habitat and life-support functions for each of their component species – and this is also true, of course,

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

for humans. Because ecosystems provide many functions from which humans benefit, the term “Ecosystem Services” has been coined to describe these benefits – the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life. Ecosystem services are the transformation of a set of natural assets (soil, plants and animals, air and water) into things that we value. For example, when fungi, worms and bacteria transform the raw “ingredients” of sunlight, carbon and nitrogen into fertile soil, this transformation is an ecosystem service, as is the capture of the sun’s energy in chemical form by living plants.”(Csiro SUSTAINABILITY NETWORK 2002, 1) A service network doesn’t only connect actors it connects – using the Service-Dominant language – operant and operand resources as soon as they become operant and operand resources. The resources become resources together or simultaneously with the emerging network one can’t have one without the other (no service network without resources and no resources without service network). The network defines what become resources and the connected resources define the network. As soon as one employs some properties, capabilities etc. they become resources as they are connected to a network of operant and operand resources. Unlike some other kinds of networks a service network of operant and operand resources disappears after the resources have been used as resources. Resources that become can also cease to be resources. Whatever can become a resource can cease to be a resource. Since these (operant and operand) resources build the service network the network becomes and ceases with the resources. Finally one can subsidize all relationships in a service network by resource integration (RwR) resources with resources. Whether they are operant resources, like people, organizations or institutions etc or they are operand resources like streets, cars, digitized processes etc. or even nature as they are connected and

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

become resources as they form a service network. From the perspective of requisite variety the relationships in a service network become variety connecting and hence build variety controls variety relationships (VcV). One should be aware that all this can happen even without human beings as it did before humans were on earth. Hence the fundamental principle behind service is not man-made it can be understood as exchange of variety (capabilities). The need of requisite variety unfolds a service network. If variety is employed or used resources become. Everything, every thoughts, every kind of energy hence every entity or process can become a resource but before it becomes a resource it is variety and after it was a resource it can be variety or it can be vanished because it has been transformed by employing or using it. Variety flows extend requisite variety so that the receiving entity can deal with the disturbances' variety. Variety moves from available variety to requisite variety. "The general principle behind this may be balance since it is a very natural and oldest ecological theory" (Egerton, 1976, 323).

Conclusions and further research

This article tries to understand service from the perspective of a world without service, an imaginative world without service. It emphasized that service is not only a man made phenomenon but goes beyond humans. If so all attempts explaining service with human characteristics (wants, needs etc.) must fail. The law of requisite Variety has been used to substantiate the pooling of service in nature (mutualism) service between nature and humans (ecosystem service) and service between humans as flows of variety. Service exchange is seen as rendering requisite variety. This opens a huge potential for further research:

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

- **Going beyond humans.** Looking at service from a variety perspective shows that service networks do not only connect people, organizations or institutions but all potential resources as soon as they become resources. As mentioned by Vargo and Lusch (2011) not only man-made resources contribute to value co-creation, but also others, and therefore it is appropriate to integrate them into a service network as it suggested here.
- **Understanding co-creation of value** without integrating non-man made resources would exclude important contributors to value co-creation and well being. This it is not a human being focused avenue instead it allows to manage and coordinate service in consistency with sustainable development. It recognizes the value contributed by nature which is often taken for granted.
- **The integration of learning** is an important option the variety perspective is open for if learning is understood as a self extension of the transformation matrix. Also self service can be re-integrated into service thinking if understood as self extension of someone's transformation matrix. Learning is a special case of self service which may or may not be supported by others teachers in particular. The variety perspective opens a door for an integrated perspective of learning and service which is off course not worked out here.
- **Service is not always reciprocal.** Some service rendering resources (variety flows) may never be rewarded (e.g. natural resources like rain or sunset) and others may be rewarded through a long service chain in a service network e.g. (public defense) and some may be rewarded reciprocally on markets.
- **Markets are by no means** the only way of service exchange. Service is exchanged with and without markets depending on whether it is reciprocal or not. This holds for public goods and service in particular. Markets may emerge as reciprocal service

Why does service exist? Requisite Variety, Mutualism and the Nature of Service.

exchange institutions depending on how they are (socially) constructed. Reciprocity may be understood as a constituting element of markets. In general they may be seen as coordinated and coordinating signs and practices (Löbler 2010, 2011).

- **Moments of truth** are the moments where requisite variety is needed and unfolds a service network. This net work can disappear after value was co-created by the integration of recourses or use of variety and may become again if requisite variety is needed. Service as well as value co-creation is fugacious. Therefore service networks are dynamic and emerge with the need of requisite variety and disappear after value was co-created. For service providers it is indispensable to understand the fugitive nature of service and the sensitivity of value co-creation on requisite variety and the availability of potential resources.

From a human perspective a holistic understanding of value co-creation is very much supported if service of nature is integrated. Contributors to value and well being are not limited to a man made world. Perhaps one might extend bionics to service?

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