# PSS Tool Book

A workbook in the PROTEUS series

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# #4
# PSS TOOL BOOK

A workbook in the PROTEUS series

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# WHAT IS IN THIS BOOK?

The intention with this workbook is to equip the reader for the process of developing actual concepts of successful Product/Service-Systems (PSS). The development of PSS concepts entails many of the activities applied the in general development of technical products, but also some new ways of working and approaching the value creation process. This book contains eleven tools that can be applied both individually and in combination with each other. When applied together in a process, the tools will help to ensure that all relevant users and customers are understood, the key elements of the company's technology offerings are considered, and that a sound value delivery process is ensured, from supplier company to final receiver of the PSS. We propose such a structured PSS concept development process, where we provide recommendations of applicability and dependencies between the eleven tools, which in combination will support the formation of innovative and solid PSS concepts. Finally the book presents recommendations of how to further pursue new business areas, through PSS concept development, which a traditional product development mindset and approach does not support.

**PSS Tool Book**

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# THE PROTEUS INNOVATION CONSORTIUM

# INTRODUCING PROTEUS

## PREFACE

The vast majority of countries in the developed world are now dependent on their service sectors for between 70-80% of their gross domestic product. Even companies with decades of expertise in producing manufactured products are experiencing an increased need to understand before-, during- and after-sales service and have therefore embarked on business development activities that tightly combine product and service offerings in their portfolios. Closer customer contact, commoditisation of goods, total cost of ownership, and product liability are just some of the reasons for this transition. As yet there are only few systematic guidelines and instruments available to aid the development of servitised products. Therefore this series of workbooks. In this fourth workbook we focus on tools. Tools for conceptualisation of PSS solutions that can be used independently, or combined in a systematised way, to build an actual process of PSS development. We've chosen eleven tools, based on a thorough literature review of tools and methods for product development, service development and integrated product/service-system development. One of our main criteria for choosing the tools in this book was their fitness for purpose - so each has been tried out on a number of cases in the PROTEUS project. Whilst some of the tools are sourced from other literature, the majority were created by the PROTEUS team. Although this book is written primarily for our partners on the PROTEUS project, we are sure it can be a source of inspiration to a broad range of practitioners, policy makers, academics and students.

**Professor Tim McAloone, PROTEUS Project Manager**

## WHAT IS PROTEUS?

The Danish Agency for Science, Technology and Innovation (DASTI) promotes and funds so-called innovation consortia, a novel constellation of research and innovation activities, involving industry, technical service companies and research institutions. The idea with innovation consortia is to promote the relationship between research and actual innovation activities in industry, resulting in both enriched research recognitions and applied industrial results. PROTEUS is one of DASTI's current innovation consortia, which focuses on the Danish maritime industry, particularly from the viewpoint of suppliers to the industry.

## THE INNOVATION CONSORTIOUM'S FOCUS

The PROTEUS Innovation Consortium is working to jointly develop new knowledge about how after-sales service can be effectively integrated into business and product development in industrial organisations, so as to become a source of revenue and value, rather than a cost to the company. The company participants in PROTEUS are all from the maritime industry and are interested in understanding, through examples, how to effectively and systematically integrate service development into their product development and business creation processes.

## UNIQUE WITH RESPECT TO PSS

Current literature, tools and methods on Product/Service-Systems (PSS) include examples of procedures for the integration of product and service features in product development. However these approaches do not consider a number of key areas for business, such as the commercial considerations, the strategic organisational issues, or the possibilities of collaboration across the value chain. With its industry-wide consortium of companies, PROTEUS is in a unique position to begin to address some of these issues from a whole branch perspective.

## PROTEUS PROJECT IN DETAIL

The PROTEUS* project is a 3 ½ year Innovation Consortium financed by the Danish Agency for Science, Technology and Innovation (DASTI). The consortium is formed by ten companies (see page 10), a branch organisation, two research institutions and an engineering consultancy. The participating companies are mainly suppliers of equipment used in ship building, operation and maintenance. Danish Maritime is the branch organisation, where most of the participating companies are represented. The research institutions are DTU Department of Mechanical Engineering and CBS Department of Operations Management. Finally, IPU Product Development supports the project with its services in engineering consulting and methodology implementation.

* The name of the consortium, **PROTEUS**, is an acronym for the research project title: "**PRO**duct/service-system **T**ools for **E**nsuring **U**ser-oriented **S**ervice". It is also an apt title, as it is the name of a mythological Greek sea-god, symbol of adaptability in the face of the changing nature of the sea.

# But what is PSS?

**PRODUCT/SERVICE-SYSTEMS (PSS)** is an innovation strategy, where a greater integration of products and services has the potential to decouple business success and economic growth from mere product sales.

Instead of viewing a product as an isolated entity, the PSS design activity focuses on creating the right combination of products and services, needed to aid the customer in reaching their goal. Incorporating service thinking into the product development process gives rise to new business opportunities; the product has the opportunity of being made more robust throughout its life cycle (i.e. it is 'Designed for Service') and the customers' entire needs and activities are considered and catered for, from the very beginning of the development process. A PSS solution does not necessarily imply that the service provider is the producer of the physical product(s) included in the PSS, but the service provider must take responsibility for the delivery of the service to the customer, including its timing, physical elements, agreements and related risks. Examples of PSS are emerging in a broad range of markets, from Business-to-Consumer (B2C), through Business-to-Government (B2G) to Business-to-Business (B2B).

# PSS CONCEPTUALI-SATION AND DEVELOPMENT

# FOUR DEVELOPMENT PHASES

The process of developing PSS is greatly strengthened if built on a solid product development mindset. But in addition to this, the PSS conceptualisation process must address the added complexity of combing products with services. Many companies struggle to transition from being product manufacturer over to becoming provider of PSS solutions. The two most cited reasons for this struggle relate to the necessary reorganisation of the company and the methodology and tools required to develop PSS solutions. This book focuses on the methodology and tools.

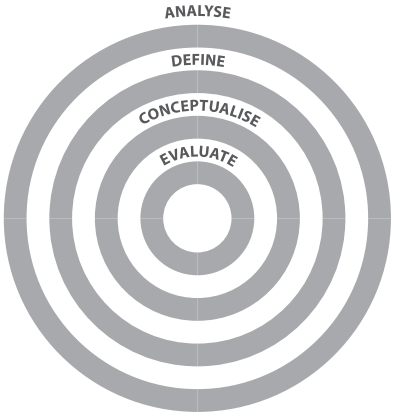
We begin by describing a structured PSS conceptualisation framework, within which the tools that have been selected for this workbook are organised. The PROTEUS project has built and tested the PSS conceptualisation framework on a number of cases in the maritime industry, with the aim of providing an efficient and value-creating approach to PSS development. The PSS conceptualisation framework consists of four phases, each of which share the same four dimensions to consider.

**The iterative nature of design and development**

As with traditional product development, the process of developing PSS concepts charts a journey, which is by no means linear. PSS opens up channels for gathering more data about the product, its use and also the user's ideas and opinions about the whole needs satisfaction experience. By nature a PSS can emerge from an existing product, an existing service, or from an entirely new acknowledgement of an unmet customer need. The process of PSS design will be iterative, depending on the start-point for the design and also the amount of data and insight the developer has on the customer, the product portfolio and the stakeholders surrounding the product and the market.

Based on empirical observations and own experimentation with PSS conceptualisation in industry companies, we describe the process towards the development of a PSS concept in four phases. These phases should help structure the process and facilitate the development of PSS concepts, with sound business potential:

- Analyse market and capabilities
- Define focus and set goals
- Conceptualise
- Implement and Evaluate




## ANALYSE MARKET AND CAPABILITIES

A PSS should not be designed blindly. There is a need to understand the impacts of products and services in relation to the value that they provide, before attempting to change and improve existing systems.

Some of this understanding may already exist in the company. However, data about the market and the company's own capabilities to provide solutions to the market are typically not gathered by the company, such as data pertaining to the sequence of events after a product has been delivered to the customer and during which time it is subject to interaction with users. Developers of both products and services exercise a dominant influence on a number of aspects, ranging from performance, through customer satisfaction, to profitability. By coupling this influence to an understanding of offerings throughout their lifetime, the needs of the user and the full ecosystem or network of stakeholders round them, there is a great potential to identify the potential to supply solutions, which better meet the needs of the user.

*This phase should result in a clear overview of the market, the need, the current ecosystem and the PSS providing company's own capabilities, relevant to solving the need.* →

## → DEFINE FOCUS AND SET GOALS

Resources are almost always limited and companies cannot initiate new development projects for every good idea they get. It is necessary to prioritise at an early stage amongst the many directions that the PSS conceptualisation team may pursue. Through Analyse phase, analysis of the market and company capabilities, the PSS design team has been equipped to assess the overall potential and likely consequences of the different directions that the PSS ideas point towards. With this in mind the focus and goals can be defined to guide both the selection of ideas as well as the subsequent conceptualisation of the concept during the next phase. The objective is to focus on the key elements in the value proposition, the areas of user need to address and the key stakeholders to involve in the emerging PSS concept. Feasible goals should be set, determining elements such as customer segment, amount of customers to target, dimensions of the value proposition, and a clear definition of which measureable elements will lead to customer need satisfaction.

*This phase should result in a focused PSS description, sufficiently delimited to fulfil the needs of the customer, and a basic specification for the emerging PSS, including tangible goals for the final PSS design.*

## CONCEPTUALISE

A concept can be defined as an idea within a context. PSS concepts are proposals for a carefully integrated chain of product and service offerings, which describe a holistic solution to the user's needs, where the combination of product and service elements is chosen on the basis of the best possible way to solve the problem. The PSS concept will describe the most important features and requirements of the final offering.

In this phase all relevant dimensions should be sufficiently described, and unknown risks investigated. By developing multiple concepts the possibility of identifying the best solution is increased, whether it appears from one concept alone, or whether it emerges as a combination of numerous ideas and concepts. The conceptualisation phase is the design phase where prototypes are made, in order to test out the many ways in which the identified customer need can be satisfied. Should we, for example, design redundancy in to a ship's main operating machinery? Or should we

provide a spare parts package instead? Or maybe an automatic shutdown and remote monitoring system is the best concept for the particular problem in hand?

*This phase should result in a number of PSS concepts, ideally described to the same level of detail, prototyped to an extent where they can be tested, and prioritised by means of a systematic selection process.*

## IMPLEMENT AND EVALUATE

There is rarely an absolute best solution. It is only when comparing two promising solutions that one can determine, which may be the best solution to proceed with, relative to the alternative. An existing baseline, consisting of the most relevant current product and/or service offered by your company, should be used to evaluate new ideas and concepts. If a concept does not seem to provide substantially improved value and performance, it should be reconsidered and other concepts explored further.

A particular challenge with PSS solutions is that they are difficult to prototype within the confines of the company workshop alone. Unlike typical products, PSS solutions do not simply reach a final design, ready for launch on the market. By very nature, one needs to "connect the power" to the PSS concept and involve a select few lead users in a closely monitored pilot implementation of the concept. →

→ All PSS solutions depend on collecting and processing customer- and usage-intelligence. But such data collection and processing also adds to the complexity of implementing the solution. Depending on the scale of the PSS solution under development, it may be possible to "wireframe" the solution and implement the customer-experienced front-end, whilst manually providing the back-end support. This activity is typically exercised with PSS concepts, which are lighter on physical artefacts. Otherwise, co-development partnerships are often ventured – either together with the customer of the emerging PSS (this is common in B2B cases) or by creating a consortium of investors and service providers.

The implementation and evaluation process is in itself a very complex and intricate activity. To supplement the few evaluation tools we present in this book, which has its main focus on tools towards the PSS concept development process and less on the implementation and rollout of PSS solutions per se, we refer to workbooks 6 and 7.

*This phase should result in the chosen PSS solution being implemented for the customer. A close follow-up and evaluation is necessary in order to test and adjust the PSS solution when experienced in use, where the evaluation cycles should be short and flexible in the early implementation. The advantage of the producer being present whilst the PSS is in operation (as opposed to a traditional product scenario) is that close improvement cycles can be achieved.*

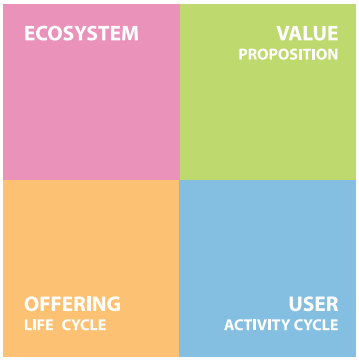
# FOUR FUNDAMENTAL PSS DIMENSIONS

From our observations of industrial PSS practice, a successful product/service-system concept needs to address and incorporate four fundamental dimensions:

- A satisfactorily composed Value proposition, considering and serving the central stakeholders and especially the activities and needs of the users. It is crucial to readdress, what your company's value proposition to the customer is. Are you delivering a motor, or a guarantee of thrust? Ship paint, or warranteed surface protection?
- An extensive understanding of the customer and the actual users' activities, so as to identify and understand their needs with the PSS. The inclusion of service and complex value delivery systems into the design object (which traditionally comprises merely of technology) requires a very close proximity to the end-user. A detailed understanding of the customer/user's activities and needs will inspire new ideas that would not occur by simply studying the product for technology upgrades.
- An in-depth understanding of the entire life cycle of the offerings (be they product- and/or service-based), which provide the basic support for the user throughout their activities. A greater and more systematic understanding of the product will also lead to new insights into how to serve the customer better, given the abilities of the providing company to create improvements.
- Careful consideration and integration of the various stakeholders, which in combination constitute the ecosystem in which the PSS concept must perform. Understanding not just the user but the whole ecosystem of different stakeholders is key to successful PSS design. The motivations, capabilities, needs and influences of the various stakeholders in the ecosystem are also important to chart.

## VALUE PROPOSITION

The starting point for the conceptualisation of PSS solutions is the Value proposition. The value for different stakeholders must be encapsulated within the value proposition, in order to support the development of robust PSS concepts. The value proposition can range from very product dominant to very service dominant, with many blends and flavours in between. The basic




questions when considering the Value proposition should be:

- What is the customer's actual need?
- How can this need best be fulfilled?
- Which stakeholder has the best-suited competencies to provide the solution to the customer's needs?
- Why should the customer change from their current mode of needs satisfaction to the new value proposition we are considering here?

## USER ACTIVITY CYCLE

One of the main characteristics, and indeed advantages, of PSS development is that it is, by definition, an example of user-oriented innovation. The very essence of PSS is to provide the user with the solution to their need, as directly, efficiently and conveniently as possible. From a PSS perspective it is not enough to simply convince the customer to purchase a product and find out how this will satisfy their needs themselves, as customer contact and relations extend well into, and often beyond, the use phase of the product. By thoroughly mapping and visualising the actual activities of the users of the company's offerings, new insights can be gained, regarding the actual needs of the user, plus where the producing company actually plays a role in the needs satisfaction process today. In many cases the customer and the user are not actually the same; the distinction should be made clear. →

→ The reason for differentiating customer and user is to ensure that value is provided to both parties. For example the customer of a pump monitoring system on a ship will be the shipowner (covering the main need of reliable and efficient monitoring, for the reason of cost-saving), whereas the user of the monitoring system may be the ship technician (with the main need of being guided towards better pump operation behaviour). Both of these stakeholders ought to experience from a PSS solution, that their needs are being catered for and that value is created for them, through the PSS solution.

Throughout the course of the PROTEUS project, we have mapped a typical user activity cycle for a shipowner, charting a number of needs, in a typical activity cycle of commissioning, operating and later disposing of a ship. This user activity cycle can be seen in Figure 5 of Workbook 1. If you are a component supplier to the maritime industry, which parts of this user activity cycle do you appear on? Could you be present in other parts of this cycle? If so, which PSS offerings could help you to provide a solution to the shipowners' various needs?

## OFFERING LIFE CYCLE

The fundamental difference between product-based business and PSS-based business is that the producing company assumes a greater responsibility for the product, away from a traditional "cradle-to-gate" responsibility over to a "cradle-to-grave" (or -cradle) responsibility. This notion may seem daunting to the company, which is used to transferring (the majority of) the liability and operational responsibility, together with the sold goods. However, if planned correctly, this greater responsibility should be accompanied with greater customer contact and insight, greater market share, new business opportunities, and ultimately reduced production costs.

To achieve all of the above, and in order to be able to provide the best possible combined solution that constitutes a complete PSS, an in-depth knowledge of the whole life cycle of the product is necessary, spanning from the production throughout all further interactions with the customer, users and other stakeholders, during and after its useful life. The decisions made early in the design process affect both costs and value in subsequent phases of the physical products. Better understanding of the subsequent

consequences allows the PSS developer to positively affect them throughout the development process. Similarly, the added understanding of the technical products may inspire solutions, based on new or improved services.

The word "product" does not refer exclusively to physical products; less tangible offerings (software, maintenance agreements) are products as well, that need to be understood thoroughly, from a life cycle perspective. This is the reason for this fundamental dimension to be named the "Offering life cycle ".

## ECOSYSTEM

In order to function and to create value, product/service-systems closely intertwine with customers, actual users, partners and many other stakeholders. The collection – or community – of related stakeholders that have internal and external influences on each other is known as an ecosystem. The realisation of the importance of the ecosystem to PSS prompts the need for extensive insight into both the current ecosystem and also the ability to model and evaluate likely changes to it, brought about by new PSS concepts, with the aim of improving the concepts and reducing the risk of market failure.

In the case of the maritime industry, the ecosystem is large and complex. A number of key stakeholders from the ecosystem define the game-rules on a global plane, and others are already active, providing service offerings to the industry. A depiction and full explanation of the maritime ecosystem can be studied in Figure 2 of Workbook 1 .

# FRAMEWORK FOR PSS CONCEPTUALISATION

Incorporating the four PSS development phases, the four fundamental dimensions and the generic iterative nature of design, we provide a framework to guide the PSS conceptualisation activity.

The four development phases: *analyse, define, conceptualise, evaluate* form the concentric rings, focusing on the result, whereas the four fundamental PSS dimensions: *Value proposition, User activity cycle, Offering life cycle, Ecosystem,* are represented as segments of each concentric ring. Our implicit recommendation throughout this workbook and its examples is to follow the process, from outside-in, and in a clockwise direction. However, your company may be positioned such, that another approach is more suitable.

The outside-in movement through the framework's four development phases is almost a given, but the four fundamental dimensions can be completed in a number of sequences. The main idea is that the PSS concept is completed when all sixteen elements of the framework have been considered and, where appropriate, executed.

The remainder of this workbook aims to prepare your company to reach a basic level of PSS conceptualisation proficiency, firstly by introducing a selection of eleven PSS tools and subsequently by navigating you through the PSS conceptualisation framework, connecting each tool, in turn.

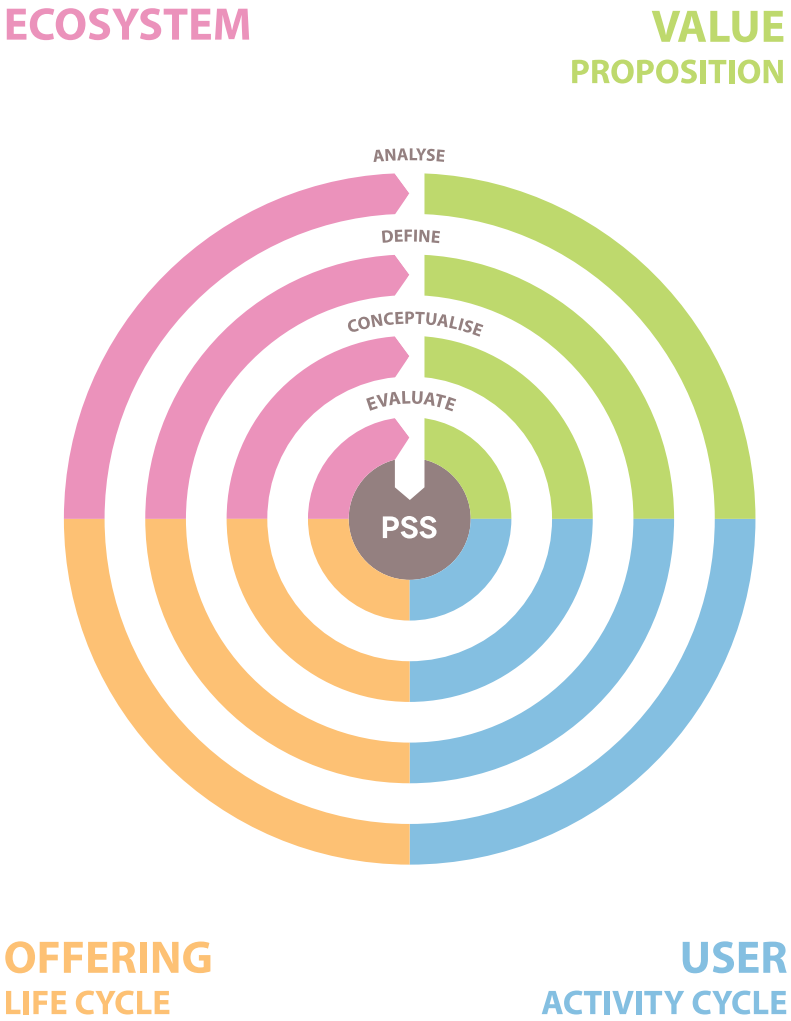



**Figure 1:** Framework for PSS Conceptualisation

# PSS TOOLS

| | MODULAR SYSTEM | | COMPLEX SYSTEM |
|---|---|---|---|
| SYSTEM DECOMPOSITION | Easy | ↔ | Difficult |
| STANDARD COMPONENTS | High | ↔ | Low |
| COMPONENT SHARING | High | ↔ | Low |
| SYSTEM VARIATIONS | Many | ↔ | None |
| OUTSOURCING | Easy | ↔ | Difficult |

## PSS AUDIT MATRIX

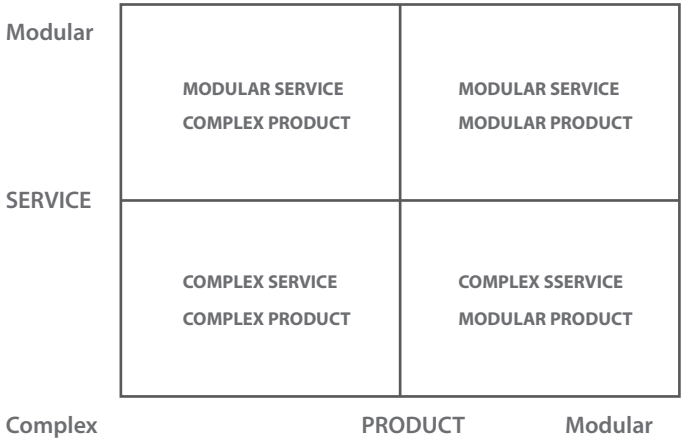
This tool facilitates the communication between product/service developers and strategists in the organisation, by translating modular design rules to PSS development strategies. The tool will furthermore help to assess the company's current and future product/service portfolio, with critical lenses. The matrix tool maps a PSS offering in terms of its design and provides four discrete combinations (quadrants), based on the degree of a system's modularity and complexity. The mapping process, once completed, will help companies to identify critical areas for improvement and to evaluate their PSS strategy, with respect to other elements at the company's discretion (e.g. competitors, shipowners, suppliers and customers), and based on these considerations devise how competitive strategies affect the system modularity and complexity.

The matrix is also a means to enhance consensus in top management, as it brings together knowledge from technology/product managers, and service managers in order to make solid decisions.

PROTEUS companies need to consider all the current offerings available in the market, consider their own portfolio and finally consider a reconfiguration of resources in order to adapt in the new market conditions. Reflection at product and service level currently available to customers, the installed base, and the production capabilities all need to be considered.

### MODULAR AND COMPLEX SYSTEM DESIGNS

Systems with modular design ease the breaking up (decomposition) of the whole system into sub-systems that can be managed separately. Modularity describes the level that parts of a system can be separated and combined in different ways, in order to create different structures and system variations. The less modular a system is the more complex it becomes to separate into different parts that can operate independently. It is common that complex systems exhibit higher performance and quality but modular systems allow ease of scale-up and lower costs. In order to categorise a system as modular or complex and understand the implications for each, five key characteristics (shown in the figure and described in the table) should be addressed.




**PSS Audit Matrix, PROTEUS**

| System Characteristics | Explanation | Questions |
|---|---|---|
| System decomposition | The degree a system can be broken up into smaller portions, so that each can be managed independently | Can the system be disaggregated into autonomous sub-systems? |
| Standard components | The extent a system is comprised of standardised parts | Can we change parts of the system without affecting the functionality of the whole system? |
| Component sharing | The extent the system can support product variations | Are there systems sharing the same sub-systems? |
| System variations | The extent components are provided by third parties | Can system variations be developed and customised easily? |
| Outsourcing | The extent components can be shared across other systems | Are there multiple suppliers from where we can source parts of the offering? |

## IDENTIFY YOUR CURRENT POSITION AS WELL AS YOUR TARGET

Many companies lack the overview of their PSS offerings, due to lack of cross-departmental knowledge or consensus about strategic alignment between market demand, customer needs and company's capabilities to stay competitive. As the PSS strategy is being considered, it is necessary to acquire a good understanding about the specificities of current PSS system(s) (which can vary between complex and modular), before one can devise a competitive strategy. In order to help categorise the offerings, four types of PSS are detailed as well (and depicted in the PSS Categorisation Matrix).

## RESULTS

- Support in strategic decision making.
- Evaluation of product/service portfolio.
- Implications for new product and service development.
- Shared model for reaching consensus across different departments and levels of an organisation.

## REQUIREMENTS

### Data

- Knowledge about product design (e.g. engineering) and service design (e.g. customer insights and interactions).
- Knowledge about current development strategies.
- Knowledge about supply chain management (e.g. sourcing decisions).

### People

- Product managers and service managers.
- Strategic managers.

### Time

- 1 hour to carry out the self-assessment exercise (if discussed).
- 1 hour for discussion based on internal strategy.

## APPROACH

1. Complete the self-assessment exercise *(see Tools section on the PROTEUS website)*.

2. Find where the product/service is placed on the matrix.

3. Understand the implications for each of the four quadrants, as each quadrant has different implication depending on

the context of your company, the market, the customer, technology which the product is based, etc. See right side box.

4. Decide your target quadrant, based on your internal PSS development strategy. This should reveal gaps that need to be addressed – a new point for the target is to be added to the matrix. The distance between your PSS and the compared PSS is the gap.

5. Find out which characteristics require attention: go back to the self-assessment exercise, and identify those characteristics which differ most (i.e. characteristics that have large difference in scores).

6. The strategic implications of each of these characteristics should then be addressed, with respect to market dynamics 1, organisational dynamics 5, partnerships 6, and business models 7, if applicable. The questions in the online tool (see PROTEUS website) may further inspire for how to move toward a target.

7. Deploy your new PSS development strategy.

## ADVANCED

- Once you have assessed your current and target PSS type, you may gain new insights by plotting competitors into the quadrant, perform scenario analysis (long- and short-term), benchmark against industry requirements or on specific customer insights and demands.

**Complex Service + Complex Product**

The complex product is difficult to decompose into distinct, simpler portions due to, complexities embedded in it or proprietary technology. An example of this kind of PSS is consulting in R&D strategies, where specialised suppliers work closely with shipowners to develop sophisticated technologies to reduce emissions.

**Modular Service + Complex Product**

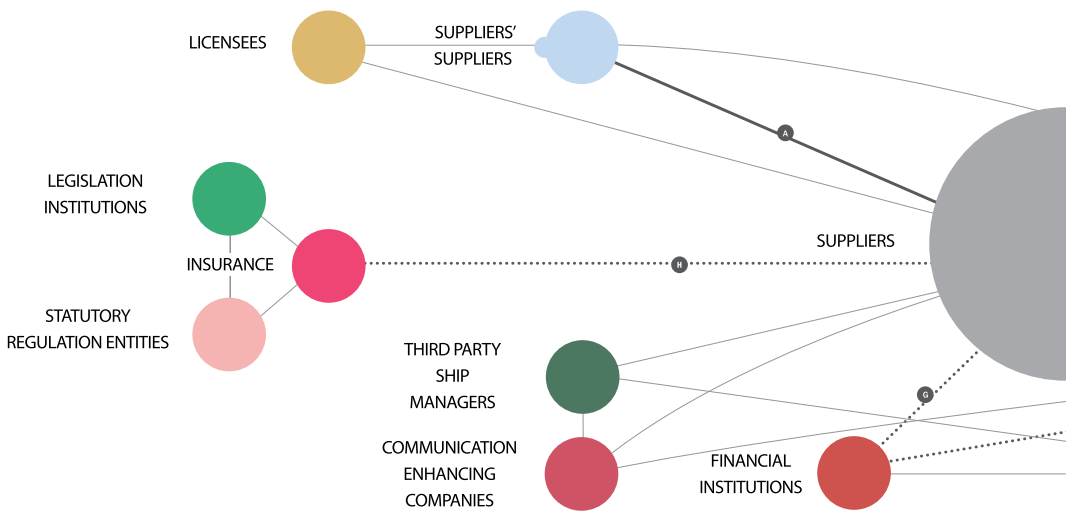
Many traditional manufacturers offer this type of PSS with specialised products such as life rafts that once installed may be supported by standardised services and eventually replaced, where upgrading or repair is not economical.

**Modular Service + Modular Product**

With standardised modular components, as an example, the maintenance and repair of galleys in bulk carriers (i.e. modular products comprised of stoves, pipes, sinks, etc.) does not require specialised skills and can be delivered by many third-party service providers, or even by the crew.

**Complex Service + Modular Product**

This kind of PSS has many standard components, often with short product life cycles, where there are continuous upgrades that are coupled with incremental innovations. The services provided to the product have to be tailored to that particular system. An example of this type of PSS can be software upgrades for navigation systems.




# ECOSYSTEM MAP

This tool maps the interactions between stakeholders relevant to your company, a PSS concept or more specifically a single product or offering. Insights gained by this tool ensure that important aspects are identified and can be taken into account when developing new offerings and solutions.

## RESULTS

- Understanding from a general viewpoint of relevant stakeholders and important interactions to be used as basis for other tools and to form a shared understanding across the organisation.
- Insights regarding interconnections between stakeholders, which often reveals potential for improvement, i.e. it may become obvious how profits can be increased, by rethinking the sales model.
- Visual representation of PSS concept ideas and their impact on stakeholders, value chain, etc.

## REQUIREMENTS

### Data

- Good insight into the company's ecosystem is sufficient.

### People

- A diverse group of company participants (some should have knowledge about the supply chain and the customers/users).
- A team including the right members is sufficient.

### Time

- 1 hour for workshop design.
- 2 hours for the workshop participants to form a basic network map.
- Additional time for graphical presentation of the results.

## APPROACH

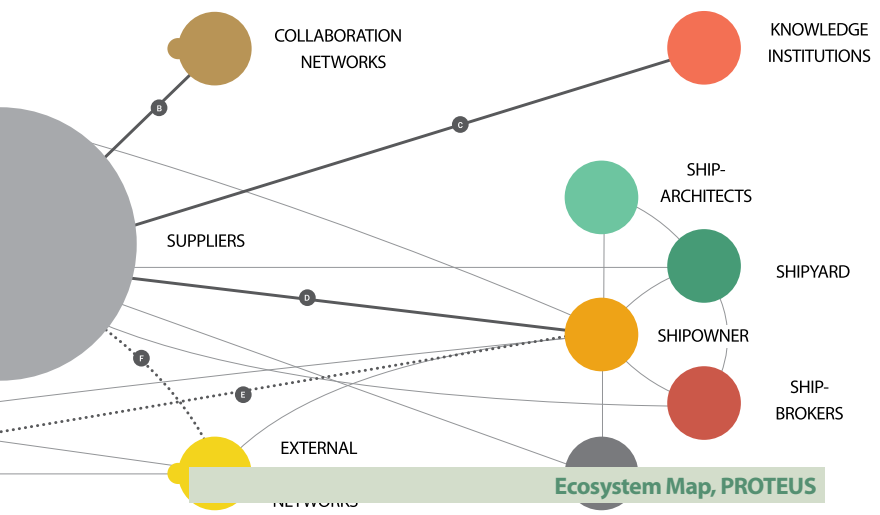
1. Define what you want to map; a specific product/offering or your company, more generally.

2. Clarify why this is to be mapped; to understand the value creation process, to deliver a service more effectively, etc.

3. Next determine the level of detail and the boundaries, e.g. you may choose not to map the suppliers of your suppliers, as they will take too much time to identify, whilst also cluttering the map and making it difficult to interpret.

4. Identify central stakeholders (customers, decision-makers etc.). Initially use a whiteboard or a large sheet of paper, to foster iteration.

5. Relate stakeholders to each other, preferably indicating the direction of flows and transactions. Flows and




Ecosystem Map, PROTEUS

transactions to map:

- Money
- Information
- Products/parts
- Service
- Optionally a custom stream relevant for your company

6. Finally the map can be digitalised to make it more suitable for cross communication. Applications like Powerpoint, Visio or Omnigraffle, are useful tools to enable periodical updating of the map.

## ADVANCED

- Include direct stakeholders in the group mapping exercise.
- Apply pictograms/logos.
- Represent central physical objects, regulation and technologies side by side with the stakeholders.
- Conduct ethnographic research among stakeholders.
- Scale transactions to visualise importance, based on subjective terms or directly related to volume (materials, money etc.).
- To understand more detailed issues, use roles (set of activities) instead of stakeholders as nodes.

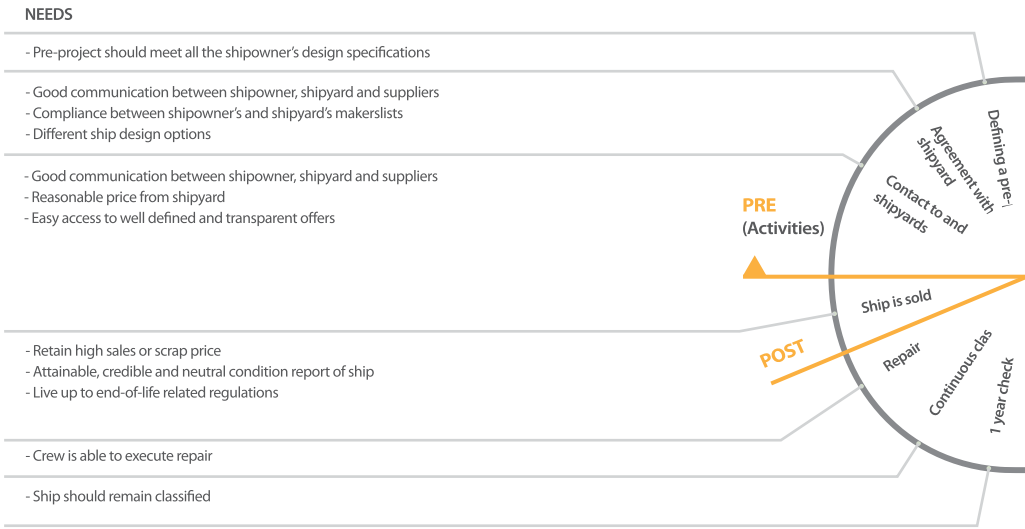
### Ecosystem Map to visualise a PSS

This **Ecosystem Map** can explain and visualise a PSS in a simple way.

Only central transactions are mapped to communicate the concept visually and reflect on the proposed changes to the ecosystem by the PSS concept.

Many of the PROTEUS partner companies have used the Ecosystem Map to chart the current and possible future ecosystem, after having applied a PSS.

One such company explored concrete PSS solutions as part of the PROTEUS consortium. One concept proposed a PSS pivoting around offering a subscription for the company's products, freeing the shipowner of any problems connected to the ordering, operation and maintenance of the product. Typically the comapny's products are not maintained until they break. The concept proposed to include service check, pre-defined maintenance schedules and handling of emergency situations for the customer.




# USER ACTIVITY CYCLE

The **User Activity Cycle** (UAC) is used to identify activities and associated needs of the user and to identify new business opportunities. This tool consists of three phases. The first, PRE, describes all user activities and associated needs, prior to using the product. The second phase, DURING, details the activities that are carried out by the user during use. Finally, the activities that the user incurs after the product has fulfilled its purpose are described in the POST phase. A comprehensive needs cycle for a typical shipowner is presented and discussed in figure 5 of Workbook [1]. A further mapping of the stakeholders involved in each user activity allows for visual identification of how your company is positioned, enabling insights into how much of the potential revenue is captured from the customer.

## RESULTS

- A visual overview of the activities of the user enabling better communication within and outside the development project.
- A basis for identifying activities and needs to be covered by new PSS offerings.
- A basis for identifying means to reach the user needs, through specific activities.
- A basis for defining strategic goals for the PSS development activity.

## REQUIREMENTS

### Data

- Good insight into the user and their various activities, when in the process of satisfying a need.

### People

- A diverse group of company participants to cover the full User activity cycle (representatives who possess insights in the domains of supply chain and the customers/ users).

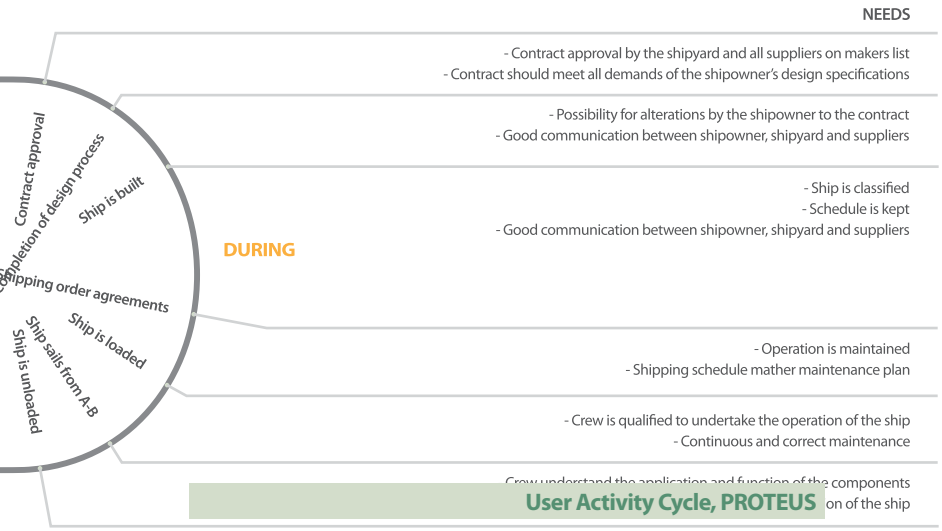
### Time

- 1 hour for preparations (organisation of the workshop).
- 2-4 hours for the workshop group.
- Additional time for graphical presentation of the results.

## APPROACH

1. Start by defining the focus, typically your main customer contact, or maybe the actual user of your product.

2. Next, chart known activities within the three phases. Activities can be described as a sequence of actions or




specific actions, such as a decision. A large piece of paper or a whiteboard may be the format, to ensure easy collaboration.

3. Identify areas, where it is sensed that there is a gap in knowledge regarding user activities, for further iterations.

4. For each activity, detail which need or needs are associated to the activity.

5. Make sure all relevant activities are included and be prepared to update the tool, if additional activities are identified subsequently. Be open to ideas of how your company can cover new activities, through new offerings or by redesigning existing ones.

6. Proceed by modelling the results into digital format to improve their communicative value.

## ADVANCED

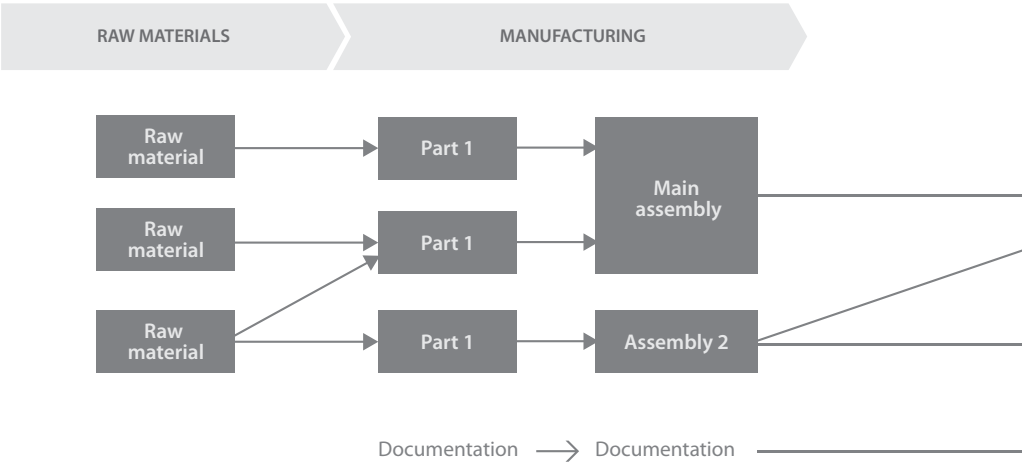
- Activities are the objective manifestation of user needs. Accordingly, several activities can be motivated by the same need. A need is the perception of a problem, and in order to uncover needs it is required to use ethnographic methods. See Needfinding Methodology for example.
- For each activity the delivery network can be detailed to show your own company's relation to that activity, to reveal ways to improve this.
- Conduct direct customer research to acquire first-hand data to inform the model.
- Co-create the cycle with the customer.

## TORM

The tool has been applied in PROTEUS in collaboration with TORM, putting emphasis on the DURING phase in order to gain an understanding and overview of the system, activities and product as a whole. Each activity can be detailed into a sub **User Activity Cycle** to go into details.

Activities may be performed out of sequence, independently of other activities. This way of applying the tool introduced three bands to reflect this situation.

The most important finding from the tool and the following analysis was the importance of vetting (in-depth assessment of a ship's quality and suitability for a task) the condition of the vessel, how this influences the whole system, and to some degree dictates, whether or not there is a need for maintenance or if the vessel can enter actual operation.




# PRODUCT LIFE GALLERY

Each physical product experiences a number of life phases, starting when the raw materials are extracted and processed, proceeding through manufacturing into an actual product. After sales, the product enters its use phase and at some time in the future it will be disposed of. Using new raw materials or better still, recycling/ reusing the old product, a new product may be produced, hence the notion of a life cycle.

Different life cycle phases are central for different products and by mapping the life cycle for each of your offerings, you gain valuable insights that are easily shared in the project team and tend to give rise to new ideas and exploration of new business opportunities. This tool maps the life cycle of physical products from the perspective of the manufacturer, whereas the tools **User Activity Cycle** and **Service Blueprint** (next tool) apply the perspective of the user, mainly.

## RESULTS

- Overview of all of the phases that a product goes through, from production to disposal.
- Estimations of material flow sizes in each phase (volume, value, costs, etc.).
- Indications of business potential (large energy use during usage phase, high material consumption during service etc.).
    - An overview of the product and its life cycle, to form a basis for generating new ideas for a PSS concept.
- A shared understanding of the physical product and its life cycle across company departments.

## REQUIREMENTS

### Data

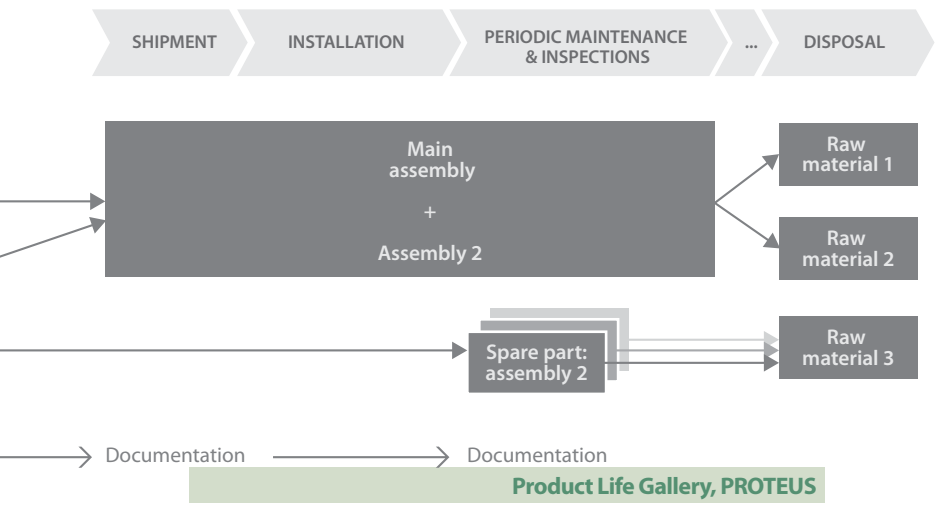
- Bill-of-Materials for product (list of parts and their respective weight and material).
- Data on associated services.
- Sales statistics (for mapping distribution).

### People

- Members from product development and sales and if possible product related service functions.
- A team including the right members is sufficient.

### Time

- 2 hours for preparations (gathering data, organisations).
- 2-3 hours in a workshop setting.




- Additional time for graphical presentation of the results, plus further data gathering/verification.

## APPROACH

1. Identify the main life phases of the product under investigation.

2. Identify the sub-components of the product and the raw materials they are made from.

3. Map how the main raw materials are passing through the life cycles and what happens to them during disposal.

4. Identify single activities executed throughout the life phases, such as typical maintenance events, cause-and-effect chains, regular problems, etc.

## ADVANCED

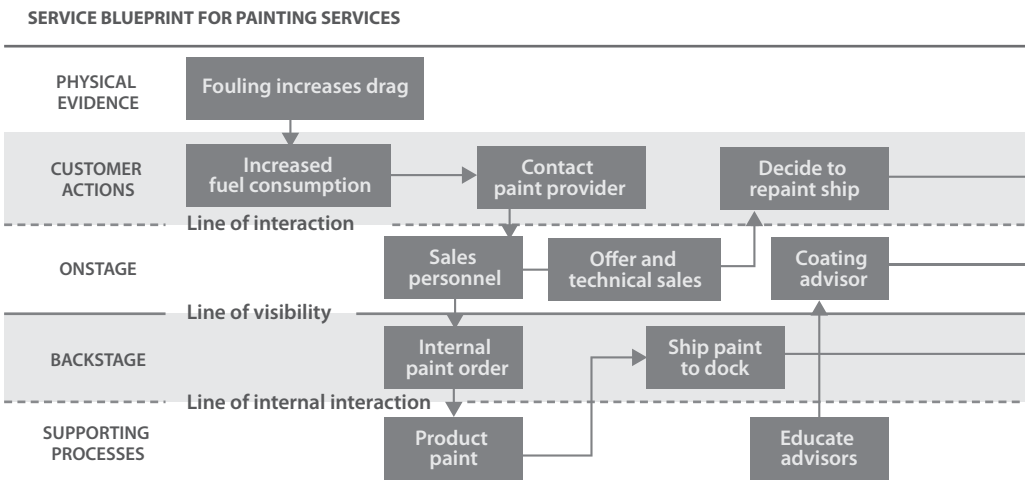
- Identification of crossing life cycles and their impact on performance as well as environmental impacts.
- Identification of manufacturers' offers, in regard to specific life phases and activities.
- Requirements set from stakeholders regarding performance, processes etc., with respect to specific life cycle phases and activities.

## NOVENCO FIRE FIGHTING

The fire fighting technology of Novenco Fire Fighting has been modelled using the **Product Life Gallery**. The results showed how Novenco FF covers the important life phases of system design, sourcing and manufacturing in order to deliver complete high quality systems and assuring the correct installation in new-build or retrofitted vessels, through their supervision and commissioning services.

While all these elements of the company's strong value proposition were clearly visible from the **Product Life Gallery**, the results also indicated important life phases, which were not proactively covered by the company product/service offers.

Inspections of fire fighting systems (and their correct documentation) were evaluated to be increasingly important for the smooth and successful passing of authority inspections, and the area represented an obvious possibility for the offering of scheduled services of the Novenco FF after-sales organisation.




# SERVICE BLUEPRINT

The **Service Blueprint** is a fundamental tool for service development and conceptualisation, which is equally as applicable for PSS conceptualisation. Essentially, the **Service Blueprint** aims to map the journey of the service recipient and relate this to the service operations. On this journey the user will come in contact with the service providing company at a number of so-called 'touchpoints'. Typically the **Service Blueprint** is divided into the Frontstage: what the user sees and interacts with directly; and the Backstage: containing everything the user does not see, but enables the service to perform. Expanding on the activities of the user as identified during the **User Activity Cycle** the **Service Blueprint**, in combination with the **Product Life Gallery**, provides a sound basis for developing a robust PSS.

## RESULTS

- A systematic representation of services offered by PSS.
- Identification of aspects of services that have potential for improvement.
- Better user-oriented services.

## REQUIREMENTS

### Data

- List of activities from the **User Activity Cycle**.
- An overview of the current offerings that your company offers and the ones interacting with your customer, known as touchpoints.

### People

- Employees from the front line, such as sales organisation, technical service, service-related departments and product designers.
- A team including the right members is sufficient.

### Time

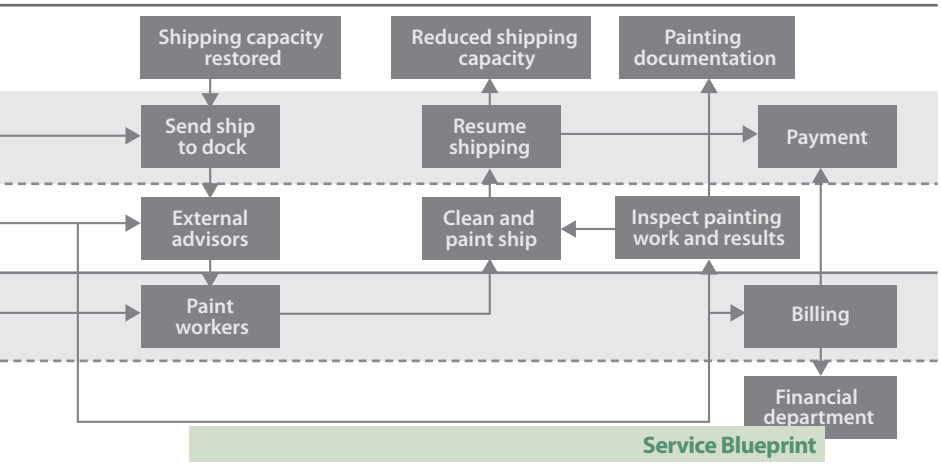
- 2 hours for preparations (gathering data, organisation the workshop).
- 4 hours for an initial version.

## APPROACH

1. Start by determining what service you are going to map, either an existing or a new service/PSS to be analysed or developed and define who the user is.

2. Next, define the overall phases that the user goes through, from initially learning about the service until finishing using the service. For maritime services these phases may include: Aware, Join, Use, Develop, and Leave.

3. Define each step the user has to go through in each phase. The level




of detail should initially be quite broad, in order to obtain an overview of the service.

4. For each step, proceed by mapping the touchpoints between the user and your company. Through which channel (phone call, website, technician etc.) and which background processes facilitate the interaction (IT systems, internal activities, etc.)?

5. In each touchpoint, map the tangible deliverables, such as products, spare parts and manuals.

## ADVANCED

- Critical individual steps may be expanded to detail every little detail in separate **Service Blueprints**, in order to maintain overview in the overall blueprint.
- Flow models can be used to further develop the operations of the services provided.

### Yellow Transportation

Yellow Transportation, now part of YRC Worldwide, is a truck transporting company that in a short time managed to turn its business from the worst to the best in its sector, as rated by Fortune Magazine. In a few years the company managed to establish a company-wide focus on the customer. Several new customer centric services were developed and existing services were reassessed and improved. According to Maynard Skarka, President of Yellow Transportation, service blueprinting played an important role:

*"Our senior leadership as well as individuals from across sales, operations and our service center management are involved in our ongoing efforts to drive change through customer focus. Service blueprinting is a technique that we have found extremely useful in this process. From the mailroom to the boardroom, everyone is more focused on the customer."*

Maynard Skarka, President of Yellow Transportation.

| DISCOUNT FACTOR (based on WACC DK2013) | | Present Value | 1,0000 Year 0 | 0,9325 Year 1 | 0,000N Year N |
|---|---|---|---|---|---|
| CUSTOMER COST | Physical Product | 10.869,56 | 10.000 | | |
| | Distribution | 1.869,56 | 1.000 | | |
| | Installation | 3.865,00 | 2.000 | 2.000 | |
| | Training | 11.168,84 | | | 1.000 |
| | ... | ... | ... | | |
| | Total Cost | 64.451,10 | 13.500 | 3.000 | 4.000 |
| CUSTOMER VALUE | Energy savings | 7.017,00 | 500 | 500 | |
| | ... | ... | ... | ... | |
| | Total Benefit | 11.400,73 | 700 | 710 | 690 |
| **TOTAL COST OF OWNERSHIP** | | **53.050,37** | **12.800** | **2.290** | **3.310** |

# TCO CHART

An important aspect of PSS design is to broaden the view of the value creation process, to a wider spread in the value chain. An economical view of cost, incomes and the balance between these is a helpful approach to take. Increasingly customers realise the importance of taking into consideration all direct and indirect costs of products and services. In many cases initial investment constitutes only a fraction of the Total Cost of Ownership (TCO), as revealed by this tool.

This tool can be used to highlight areas of the product's life cycle, where it would be beneficial to affect a change, to improve the whole life cost.

## RESULTS

- Improved understanding of economic value from the owner's standpoint.
- Overview of all the costs related to products and services for a given customer.
- Identification of costs not covered by your company that may become new business areas through PSS offerings.
- Basis for marketing economic value to the customer, beyond the initial investment.

## REQUIREMENTS

### Data

- As much information as possible, regarding the costs associated to the customer activities (sales pricing spare parts pricing, energy use, product reliability, service pricings, etc.).

### People

- A diverse team from the company, to identify and map all the various cost types).
- Members from the sales organisation, support/service department and accounting.

### Time

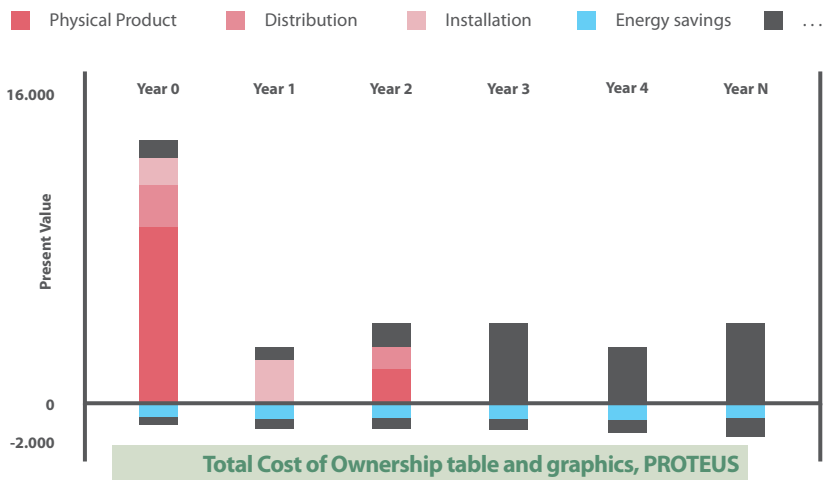
- 2 hours for preparations (gathering data and organisation of the workshop).
- 1 hour for the workshop to identify all posts with readily available data.
- Follow up: Several hours, to gather missing data and quantify all posts and create a visual presentation.

## APPROACH

1. Go through the spreadsheet template and fill in the proposed cost categories, if relevant for your context.

2. Check that all costs have been included and at least estimated initially.

3. Next, move on to customer value and




**Total Cost of Ownership table and graphics, PROTEUS**

asses each of the relevant categories, proposed by PROTEUS *(see Tools section on PROTEUS website)*.

4. Additional costs and values may be revealed by systematically going through the needs identified in the **User Activity Cycle** and the stages of the Product Life Cycle, both of which aspects are covered by tools presented in this workbook.

5. Make it clear, which costs are currently covered by offerings of your company.

## ADVANCED

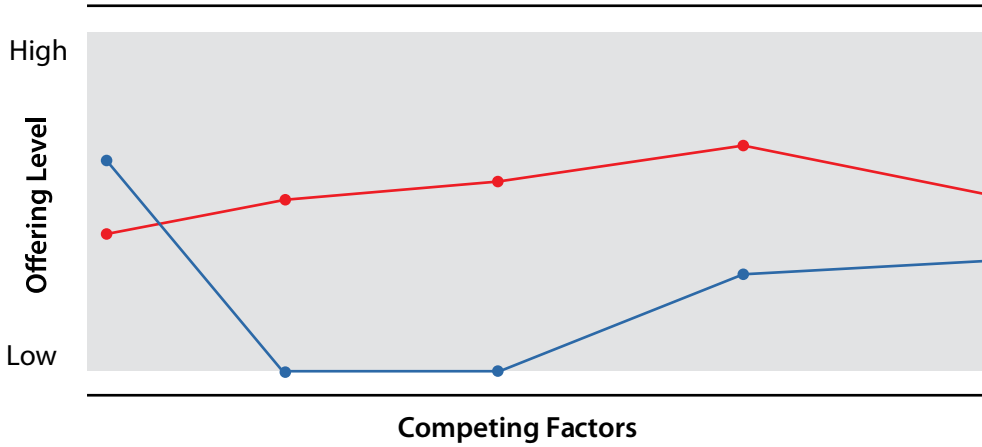
- Expand the study to quantify indirect costs and savings as a result of the PSS.
- Expand or focus the study on cost volatility, see right side box.
- Costs controlled by your company, such as sales price or service level agreements, may be further detailed by splitting them into profit and internal costs for production, assembly, distribution etc.

## TORM

As a customer, the volatility of variable costs was the motivation for TORM to investigate which components have the largest potential for being handled by supplier, as part of a PSS. Ignoring initial investment and focusing on maintenance, costs were identified on a 10 year period.

As an example it was found that the cost of maintenance for the Auxiliary Engine on one of TORM's ships mainly composed of the cost of spares. This relates to the complexity of the engine and expensive spares. The cost when docking is relatively high for the Auxiliary engine, due to components that need extensive service and repairs and requiring the ship to be docked. Consumables in regards to the Auxiliary Engine are items that are changed regularly, such as O-rings, filters and ball bearings. Engineers further order extra consumables to ensure that they always have an inventory. The service of the Auxiliary Engine was not found to be very costly in this assessment, as engineers onboard the vessel can carry out most of the maintenance and their wages are considered fixed.

Expanding the scope beyond maintenance, there is a further large potential to reduce the fuel consumption of the engine by including this centrally in a PSS.




# VALUE STRATEGY CANVAS

The **Value Strategy Canvas** visualises the value proposition with respect to user needs, as well as costs. Traditionally this tool forms the basis for formulating so-called Blue Ocean strategies, but additionally it serves to facilitate a prioritisation, upon which the value proposition is to be focused for your PSS concept.

The **Value Strategy Canvas** helps to visualise the strategic differences between several value propositions. Each value proposition is divided into several dimensions, corresponding to general ones such as time, quality or price. These dimensions will allow for a comparison between the proposed value proposition and e.g. your current value proposition to the customer, and one from a selected competitor.

## RESULTS

- A map of the factors of competition for products and services.
- Benchmark concepts or products against a reference.
- Identify value areas to focus on improving.
- Identify the value of the existing product or new concept.

## REQUIREMENTS

### Data

- As much information as possible regarding costs, sales prices and performance of products/concepts such as energy use, service intervals etc.

### People

- A diverse team from the company, to enable identification and rating of relevant value parameters.

### Time

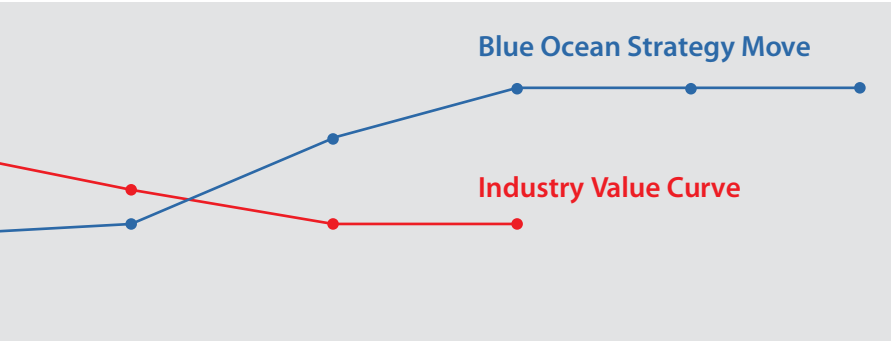
- 1 hour for preparations (organisation of the workshop)
- 2 hours for the workshop.

## APPROACH

1. In order for the **Value Strategy Canvas** to apply for PSS concepts, the costs for the customer should consist of both the initial costs and Total Cost of Ownership (see **TCO Chart** tool).

2. Next, the values to be compared must be defined. This step can be facilitated by going through all identified needs, as revealed by the tool: **User Activity Cycle**.

3. Define whether a given element should be "high" or "low" in order, as an informed choice of where to focus the value proposition in your offering.




**Competing Factors**

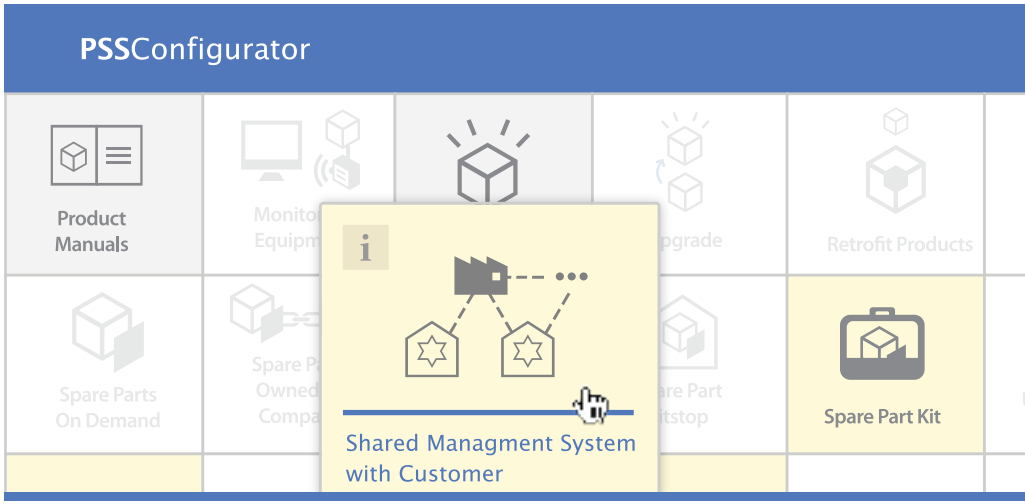
**Strategy Canvas, Blue Ocean Strategy**

4. Plot one or more PSS concepts into the tool and compare them either to one of your existing offerings, or possibly the offerings of a competitor.

5. Consider if the PSS concept is focusing on the right needs and whether this should be shifted.

ADVANCED

- To develop the value proposition further in relation to business models, the Business Model Canvas can be used. This particular tool is exemplified in Workbook 7.




# PSS CONFIGURATOR

The combined experiences from the PROTEUS consortium and its partners have resulted in a comprehensive catalogue of already applied offerings that constitute the building blocks of a PSS. Some offerings naturally complement each other, while others may even be counterproductive, if combined. This tool uses the knowledge that has emerged from the relations found between the offerings, to present combinations of offerings that are likely to suit your company situation and priorities.

## RESULTS

- A selection of offerings, tailored to your company context and strategic priorities.
- An exemplification of the suitable PSS offerings for a certain strategic focus and prioritisation of certain PSS offerings.

## REQUIREMENTS

### Data

- An overview of the current offerings that your company offers.

### People

- A high-level team with decision power on company strategy and product development strategies.

### Time

- 1 hour for applying the configurator.

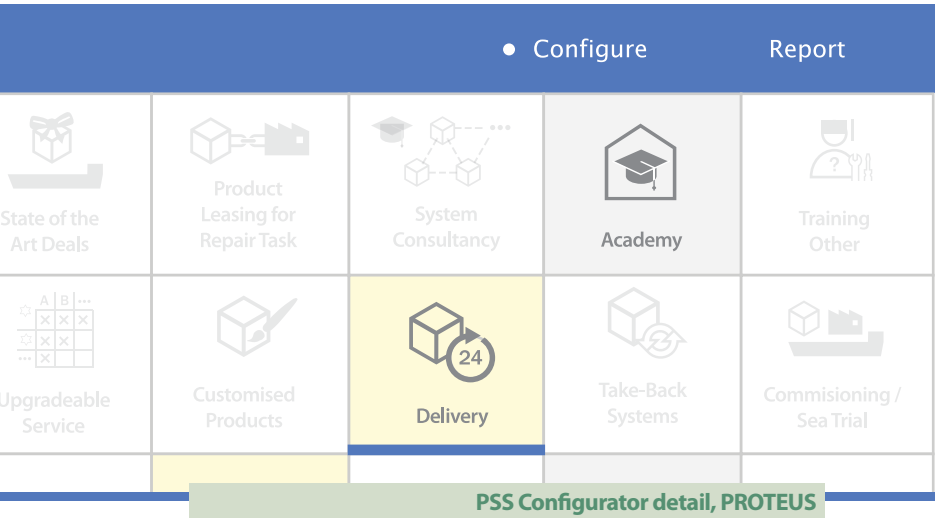
## APPROACH

1. Browse the pool of offerings found in the maritime industry, and become inspired by these.

2. While over a single offering, click on the information button to see a short description and highlighted relationships with other offerings.

3. Select all the offerings you have in your portfolio. If you don't have a list of your company's offerings portfolio, you can use the configurator's existing catalogue to help you select the ones present in your company.

4. Before moving forward to the next step, it is important to understand that the configurator has a built-in logic. This logic means that for any offering selected by the user, relationships will be identified and relevant/ related offerings will be proposed, whilst also hiding the ones with a negative or neutral relationship to the current offering you are considering. Furthermore, some offerings will depend on certain other offerings being in place for the service-system to function, in which case the configurator will select them automatically.




**PSS Configurator detail, PROTEUS**

5. Starting from the offering you consider most strategic and interesting, select it to find relationships to surrounding offerings and choose between the offerings recommended. Then, select one of them to find relationships and a second group of offerings will be proposed. Repeat this process and iterate back and forth at your leisure, until you have a string of related and complementary offerings that constitutes a PSS concept.

6. Whenever you are satisfied, go to Report to see a summary of the selected offerings, and how do they cover the User activity cycle. Add a name to the configuration and an email address to share it.

*Please visit the PROTEUS website for the online version.*

| Strategic Characteristics | Variation A | Variation B |
|---|---|---|
| Benefit is oriented towards: | Ownership of the physical product | Use of the product |
| Transfer of ownership | After delivery | After installation |
| Responsibility during use | Customer has full responsibility | Company is responsible for installing |
| Management of life cycle activities | Company manages all before and included installation | Company manages the operation and maintenance |
| Availability of offering | Always present at the customer | Present at the customer when needed (serial use) |
| Expansion of benefits | Core benefit alone | Multiple benefits aggregated together |
| Economical value based on | Transfer of ownership | Value based on per use |

# PSS MORPHOLOGY

A PSS can be understood in several ways, one of which is by strategic characteristics. These strategic characteristics (seven in total) have been combined into a morphology of alternatives, which may be combined in numerous ways, to describe a PSS concept at a high level, which should best fit the situation of your company and customer. Unlike the practical **PSS Configurator**, the **PSS Morphology** is a strategic tool, challenging the user to evaluate and decide on strategic aspects of a PSS.

## RESULTS

- Characterisation of PSS concepts in terms of business strategy.
- New PSS ideas through combining different strategic characteristic variations.
- Indication of business strategies that PSS ideas point towards.
- Basis for deciding on business strategy, in regards to PSS development.

## REQUIREMENTS

### Data

- PSS concept idea(s) to structure and evaluate through the tool.

### People

- The PSS development team and decision-maker for the company's business strategy.

### Time

- 1 hour for preparations (gathering data, organisation).
- 2 hours for running the workshop.

## STEP BY STEP

1. Start by mapping the current main strategic characteristics of your company. In each strategic characteristic, mark the one variation that best fits your company today. See the Tools section on the PROTEUS website for the newest version including comments for both characteristics and each variation.

2. Next, map an existing or proposed PSS concept in the same way, to highlight the strategy behind it.

3. Discuss if the PSS strategy is compatible with the overall company strategy and if it is desired.

4. Explore new combinations of strategic characteristics, to reveal potential strategies that may be more desirable to pursue.

| Variation C | Variation D | Variation E | ... |
|---|---|---|---|
| Results of the use of the product | Consumption of the product | ... | ... |
| Returns to company at end of life | Is never transferred - owned by the company throughout its life | ... | ... |
| Company installs, maintains and takes back | Company has full responsibility for the use of the product | ... | ... |
| Company manages upgrading | Company manages continuous improvements | ... | ... |
| Present at the company when needed | ... | ... | ... |
| Multiple benefits integrated with each other | ... | ... | ... |
| Value of the manag | Value of taking | Value of the | ... |

**PSS Morphology with a path chosen, PROTEUS**

## ADVANCED

- To ensure more mature, complete and robust PSS concepts, the tool PSS board may be useful as described in Journal of Cleaner Production 37 (2012). Through a predefined matrix this tool challenges the design team visualise the PSS and to systematically mature the PSS concept, by considering various details of importance to the realisation of the PSS concept.

## LLOYDS ODS

As a service providing company Lloyds ODS has applied the **PSS Morphology** to conceptualise new PSS ideas into concepts and to challenge the idea by exploring variations in each characteristic. The tool facilitates discussion within the design team, regarding PSS ideas and their characteristics. It is further demonstrated how the tool gives rise to a broad palette of new ideas and facilitate that ideas are adjusted and combined, to improve in the different categories. Compared to other tools applied by the company, the morphology brings the qualified design team closer to core issues, which need to be addressed, rather than abstract considerations.

Successful application of the **PSS Morphology** at Lloyds ODS was ensured through an experienced workshop facilitator.

# PSS CONCEPT EVALUATIOR

With predefined metrics this tool allows for fast evaluation of one concept, compared to another. It is a tool meant to be performed by each team member, individually. The tool ensures that the full team is engaged in the process, to identify discrepancies and facilitate the discussion with the aim of at improving the concept. The tool supports both the changing  and adding of new criteria to suit the application.

## RESULTS

- A quick and democratic rating of alternatives.
- Integration of relevant PSS metrics as identified by PROTEUS.
- Identification of concept uncertainties.

## REQUIREMENTS

### Data

- One or more PSS concepts/offers to compare.

### People

- The PSS development team.

### Time

- 1 hour for preparations (gathering data, organisation).
- 1 hour, including discussion.

## STEP BY STEP

1. Go through the metrics of the tool and if needed add/remove relevant metrics.

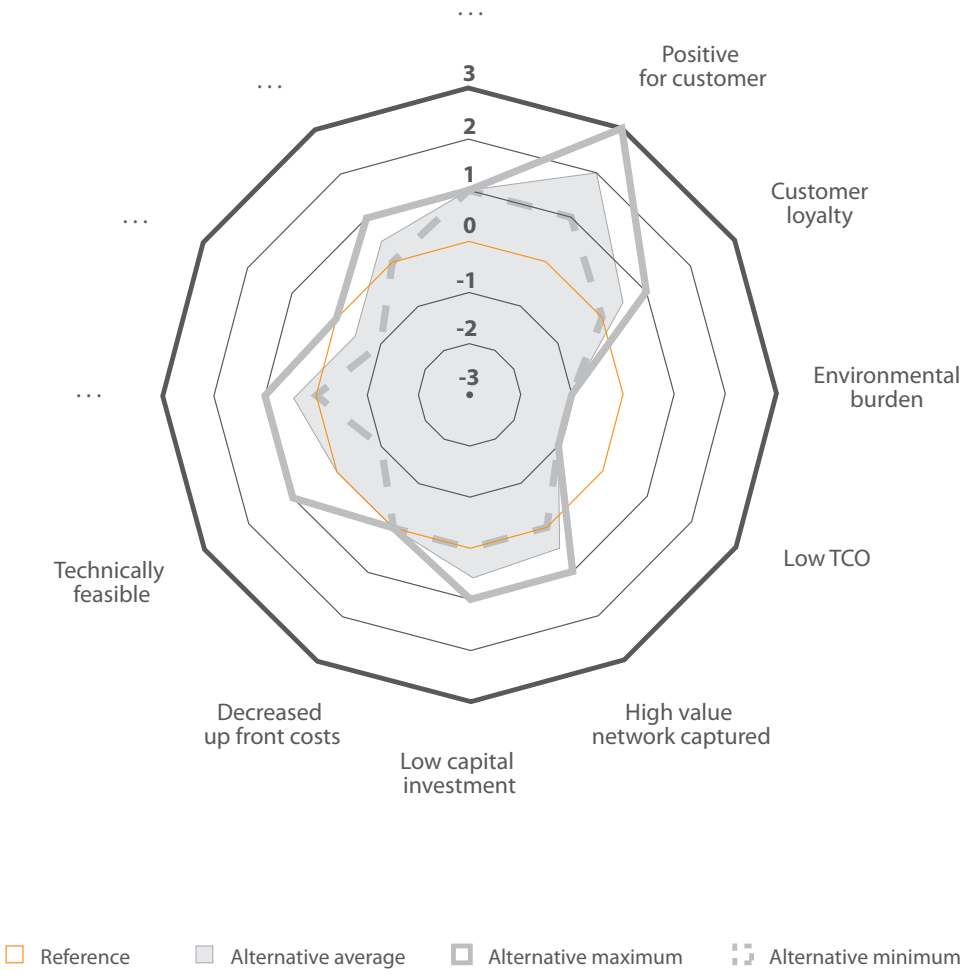
2. Have every team member fill out the template individually, so as not to affect the scores and surface as many considerations as possible.

3. Aggregate the ratings and discuss discrepancies in individual metrics, with the aim of agreeing on the most correct rating, by evaluating all the individual reasons for the various ratings awarded initially. In this process it is important to realise that individuals may be more or less qualified to rate different metrics.

## ADVANCED

- A number of alternative methods exist to quantify PSS concepts and identify the strategies to maximise profit, including:
  - A value-based PSS evaluation method
  - Recovery Profit Evaluation
  - Screening the System's Profit Dynamics
- Such methods are comprehensive and typically suited to certain types of PSS concepts.

## PSS Concept relative to reference




**PSS Concept Evaluation, PROTEUS**

| Design for X methods | Cost savings |
|---|---|
| Design for Remanufacture | · Reduced raw material cost<br>· Reduced production cost<br>· Reduced expenses for maintaining spare part support for obsolete products |
| Design for Reliability | · Reduced costs related to product failures (service, spare parts and replacements) |
| Design for Disassembly | · Reduced time for service and maintenance |
| Design for Maintenance | · Reduced cost for service and maintenance |

## DESIGN FOR PSS

Within the field of product development, specific aspects of the product may be adapted to several contexts or dimensions. This is known as Design for X, where the "X" element stands as a proxy for a number of design considerations (such as Manufacturing, Quality or Service).

Particularly four Design for X methods contain tools that directly support PSS concept profitability and increase offering value, as depicted in the figure above. Each of the four Design for X methods has a different focus area and there is some overlap, such as how both maintenance and remanufacturing will benefit from a product design that through a structured design process incorporates disassembly considerations effectively.

In this workbook only Design for Remanufacture is further presented as it is the most mature and involves several opportunities for product development that complement PSS offerings and overall profitability. The remaining design for X's should be explored, depending on the situation of your company.

Remanufacturing involves subjecting a used product or part to the full treatment and testing process– similar to manufacturing new products – in order to guarantee performance and reliability. As such it necessarily involves more effort, time and cost than other reuse/recycle strategies, restoring products to high quality and often at a fraction of the cost of producing a new product. Remanufacturing is not a new concept, but found in many industries. In many cases it is very profitable. In recent years, the interest in Design for Remanufacture has seen renewed interest, due to a combination of rising raw material costs, a general move by companies down the value chain, towards PSS and environmental awareness. Academic research has improved the fundamental understanding of the field and has placed focus on setting up frameworks with supporting tools, to increase effectiveness and efficiency.

Remanufacturing may be applied without PSS offerings; however there are a number of synergies to be gained from combining the two. Remanufacturing can significantly reduce the costs of (remanufactured) spare parts and full products, whilst also ensuring quality. Through PSS offerings such as service agreements, similar savings can be captured by

| Improved customer value | Other benefits |
|---|---|
| · Reduced costs for refurbished products<br>· Reduced maintenance costs | · Valuable feedback on product failures<br>· Access to developing markets (due to lower pricing alternatives)<br>· Reduced impact of rising raw material costs |
| · Reduced losses due to increased up-time<br>· Reduced risk of failures | |
| · Reduced maintenance duration<br>· Reduced maintenance duration in case of self-service becomes possible | · Improved potential for remanufac-turing<br>· Improved material recyclability |
| · Reduced maintenance and service duration | · Fool-proofing reduces risk of malfunction |

**Methods of Design for PSS, PROTEUS**

your company, thus directly improving competiveness. The initial design of the product determines the potential profitability of remanufacturing, as this governs many of the associated costs. If, for example, the materials are degraded during use, much of the potential savings will be lost through remanufacturing. Similarly, parts that experience wear and tear may be isolated so as not to degrade the quality of other parts of the product, while other parameters are critical to the efficiency of the remanufacturing process, such as the use of non-destructive disassembly techniques.

The methodologies, techniques and tools for optimising the many related product design parameters cannot be thoroughly presented in this book. Instead we present a tool to assess the business potential of remanufacturing for your company.

## REMANUFACTURING OPPORTUNITY TOOL (REOPT)

**ReOpT- the Remanufacturing Opportunity Tool** – is a software tool, developed by The Centre for Remanufacturing and Reuse (CRR), based on a set of core issues affecting the decision-making process, such as the nature of the product, customers, markets, customer support, environment and resources. Not only does ReOpT boast an interactive feedback mechanism, dealing with each core issue, the software provides your company with a final report for each product.

## RESULTS

- Assessment of business opportunity in applying remanufacturing for your product.
  - In the six categories:
    - Product, Customers, Market, Customer Support, Environment and Resources.
- Recommendations for the improvement of the business potential.

## REQUIREMENTS

**Data**

- A newly developed/deployed PSS concept.

**People**

- Product development team and its management.

**Time**

- 1 hour for preparations (gathering data, organisation of the workshop).
- Implementing Design for Remanufacturing will be a large task.

## APPROACH

1. Go to Tools section at PROTEUS website and find the link to the online tool.

2. Fill out all the fields as prompted.

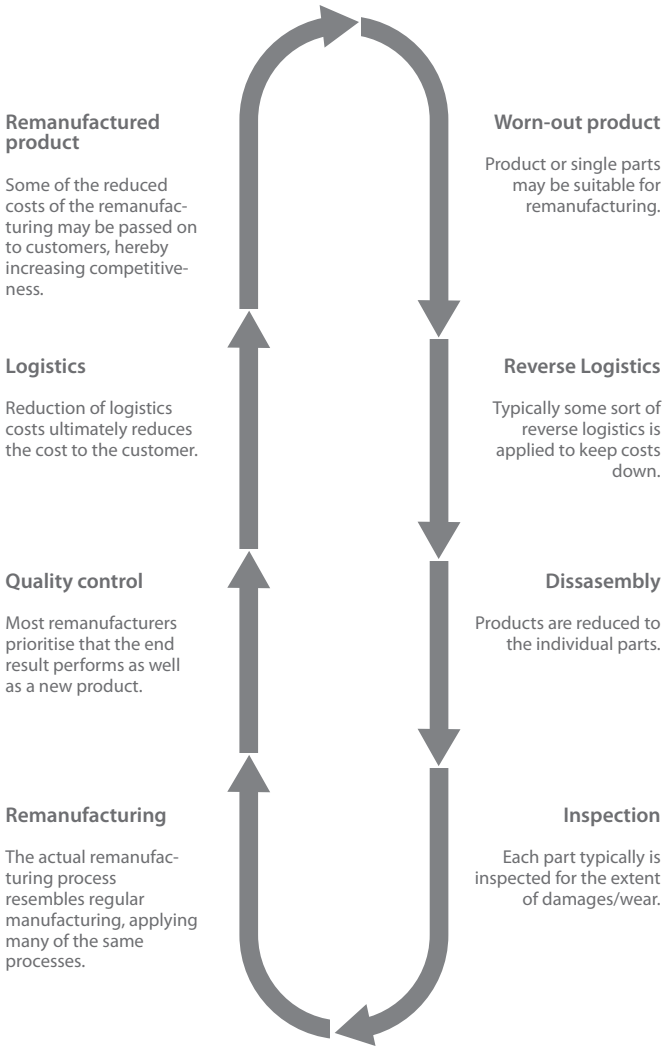
3. Submit the form.

4. Review the report containing recommendation and an assessment of the overall potential.

5. Depending on the report, consider taking action to utilise the potential for remanufacturing and design your PSS accordingly, to optimise the advantages for you and your customers.

## ADVANCED

- Regardless of the specific potential in applying Design for Remanufacturing the remaining **Design for PSS** methods may be pursued to assess their potential to support profitability and increase the value of your PSS.




**Typical remanufacturing process, PROTEUS**

## CATERPILLAR

In one year, the producer of construction machinery Caterpillar takes back over 2.2 million end-of-life units and remanufactures over 73 million tonnes of material. With a sustainable business model and a high-quality, lower cost product support option, Caterpillar considers remanufacturing to be good for its customers, its business and for the environment.

Products are returned at the end of their lives to same-as-new condition and helps reduce owning and operating costs, by providing customers same-as-new quality at a fraction of the cost of a new part.

At "Reman" facilities, products are disassembled down to the smallest part, losing their original identity. Each element goes through a cleaning process and is inspected according to specifications, to determine if it can be effectively salvaged. Accepted worn-out components are then converted into production ready material through advanced salvage techniques such as physical vapour metal deposition that increases the durability of remanufactured injectors. This specific process allows applying a precise coating to components, enhancing surface hardness and wear resistance. Another advanced metal deposition salvage technique uses a high density laser beam to deposit new material, restoring the wear surface to original specifications.

# A PSS DEVELOP-MENT PROCESS

# TOOL MAP

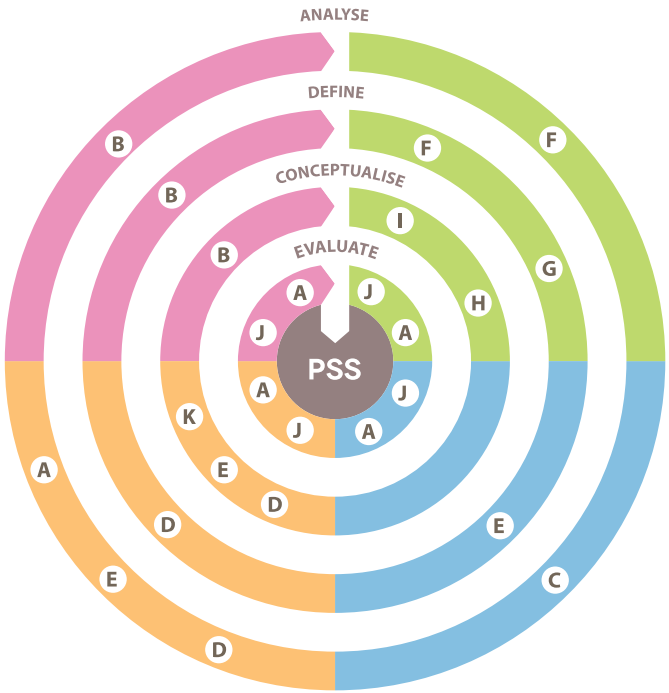
This chapter presents a simplified approach, which will guide your company, step-by-step, towards developing a sound PSS concept. It provides a context for the tools presented here in the book and exemplifies a way of thinking about PSS development, which is currently considered as best practice. As mentioned earlier, we chart a route through the framework, which follows an outside-in and clockwise path. However, your company may be positioned such, that another approach is deemed more suitable. Following the approach will provide your company with experience in the tools and allow for all of the tools to be considered for integration into your own (PSS) development process.

## ONE IMPLEMENTATION PATH

The route marked on the tool map shows how the process, presented in this chapter, systematically covers all fundamental PSS dimensions in each of the four PSS development phases. After having gone through the process once, however, it is fully recommended to revisit only those tools, which seem to be most suitable for the particular job in hand, and expanding on relevant areas specific to the context of your company.

## ECOSYSTEM

## VALUE PROPOSITION




| | |
|---|---|
| PSS AUDIT MATRIX | A |
| ECOSYSTEM MAP | B |
| USER ACTIVITY CYCLE | C |
| PRODUCT LIFE GALLERY | D |
| SERVICE BLUEPRINT | E |
| TCO CHART | F |
| VALUE STRATEGY CANVAS | G |
| PSS CONFIGURATOR | H |
| PSS MORPHOLOGY | I |
| PSS CONCEPT EVALUATOR | J |
| DESIGN FOR PSS | K |

## OFFERING LIFE CYCLE

## USER ACTIVITY CYCLE

# MARKET ANALYSIS AND CAPABILITIES

The first phase of the PSS concept development process comprises of defining current state, with respect to market situation and own company's capabilities. This phase is often omitted, due to the eagerness to begin to conceptualise PSS solutions, but at great cost later in the process. It is very important to spend good time to ensure a sound knowledge of the market situation and own current possibilities to address this.

**What brings you here**

- Your company has decided to explore the potential of PSS and/or to actually develop one or more PSS.
- The need for improving the understanding of the effects and workings of an existing PSS concept.
- The need to identify improvement potential for an existing PSS concept.

**Ouputs**

The initial analysis phase provides the foundation for both setting the right focus and for identifying as well as combining the best possible solutions in any development process. PSS further adds complexity, by combining products and services, thus increasing the need for a thorough understanding of the company offerings and the full context, as obtained in the form of:

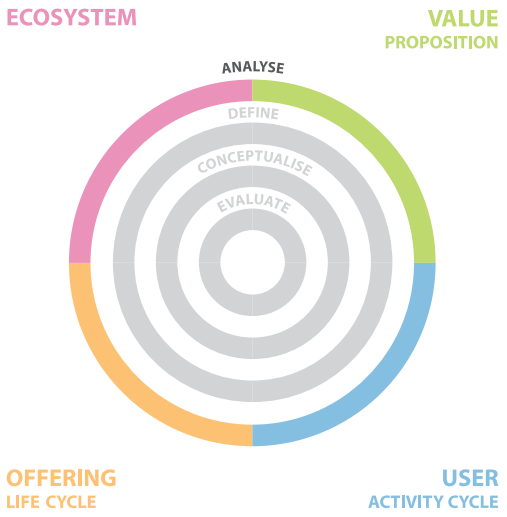
- Increased knowledge of existing offerings (products and/or services).
- Identification of areas for improvements to address through a PSS.
- Better integration and understanding between departments, regarding both company offered products and/or services.

## ECOSYSTEM

Initial step to cover in the first dimension:

- Select a current offering by your company to function as a baseline for the PSS concept to be developed. The offering may be a product, a service or an existing PSS concept.
- Apply tool: **Ecosystem Map**, centred on your baseline offerings.

PSS concepts will interact closely with the ecosystem surrounding your company, products and services. At this early stage in the process it is important to gain an understanding of the current Ecosystem, i.e. which are the relevant stakeholders and how do they interact with your company, your offerings and one another? Basic interactions, such as the flow of money and products, should already be common knowledge within your company and through the tool




proposed, this knowledge is visualised and made easily accessible to the design team, and provide new insights.

## VALUE PROPOSITION

Any PSS solution to be developed must have the potential to provide an improved value proposition, if not in a status quo market, then in the expected near- to midterm market.

- Apply the tool: **TCO Chart**, to assess the baseline cost inferred by the offer, through initial investment to the final ending/disposal of the offer. Clearly state which costs are inferred to the customer, directly or indirectly, and which of this are covered by your company.
- Notice the proportion of TCO that is revenue for your company as the rest holds potential for business opportunities.
- If the **TCO Chart** reveals that your company is already involved in the vast majority of TCO, consider analysing another offering or alternatively make sure that all customer-related costs have indeed been included.

Market surveys and sales data by the sales organisation of your company may already have quantitative data on what provides value to the customer. Throughout the next phases, insights related to the value propositions may be revealed. Make sure to update the **TCO Chart** in the next phases when additional aspects are revealed, that may infer direct or indirect costs to the customer. →

## → USER ACTIVITY CYCLE

Detailing the actual activities performed by the user of current offerings by your company and deriving the needs associated to each activity, is closely related to the value proposition. Mapping all the activities that are relevant to the customer forms a basis for identifying the underlying needs and how current offerings cater to these, thus inspiring improvements and fostering new ideas.

- Apply the **User Activity Cycle** on the central user of the product. In the case that the user and the customer are not the same, it is additionally recommended to map the User activity cycle for the customer.

## OFFERING LIFE CYCLE

Understanding the workings of the baseline offering serves to identify strengths and weaknesses that may become part of the PSS concept, as well as new opportunities. This step maps all the phases that each offering passes through, from production to when it is eventually being disposed of, in the case of a product offering. In the case of a service offering, the life cycle to be considered stretches from when the customer is made aware of the service and it is prepared to the point, where it expires or is terminated by the user. This step complements the **TCO Chart** results, as well as existing knowledge in your company, regarding your offerings.

Depending on your baseline as defined in the beginning of the Analyse phase:

- In case the baseline contains a physical product, apply the tool **Product Life Gallery** on this product.
- In case the baseline contains a service, apply the tool **Service Blueprint** on this service.
- Analysing both a product and a service related to your company offerings, provides valuable insights for the further conceptualisation of PSS concepts and may reveal different understandings of the offering life cycle across departments (or between customer and supplier).
- Apply the tool the **PSS Audit Matrix** on your baseline offerings, to assess your current design in terms of PSS and obtain a sense of where your company should go from here, in terms of the overall development strategy.

## SUMMARY

This initial coverage of all four dimensions in relation to your current business has probably given rise to a number of PSS ideas. Before moving to the next phase of defining focus and setting goals one should consider, whether one or more of the dimensions deserves a second round of investigation. This can be carried out by using the tools already presented in this workbook, by further detailing certain aspects e.g. on one life cycle phase, or by analysing the User activity cycle for an additional type of user.

# DEFINE FOCUS AND SET GOALS

The second phase of the PSS concept development process sets the focus for directing further resources at PSS development containing ideas with the most potential and a strategic fit with your company's market situation and capabilities.

**What brings you here**

- Your company is ready to define new potential ideas, to form the basis of one or more PSS concepts or improve existing ones that may already be implemented.
- Your company has a number of loose ideas that should be focused into one or a few PSS concepts, with as much business potential as possible.
- The importance of focusing resources on the best PSS ideas.
- The need to set overall and guiding goals for the selection of PSS ideas and subsequent conceptualisation phases, towards realising the full business potential.

**Ouputs**

During this phase initial high-level goals are set for potential PSS concepts. To support the subsequent conceptualisation process, the central outcome of this phase is a definition of the direction for your PSS, which is to be routed in a robust value proposition.

**Ideation**

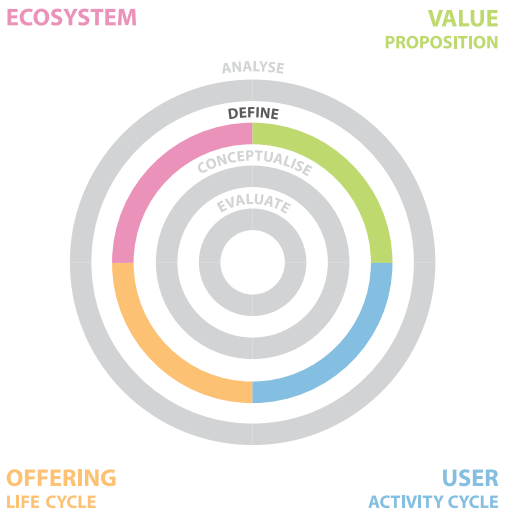
As preparation for the creation of new ideas, it is recommended to gather and briefly review the results from Analyse phase.

New PSS ideas may be generated as part of a workshop, applying ideation tools that the team members are familiar with. Standard brainstorm sessions etc. will serve the purpose and the aim of the activity must be to generate a number of PSS ideas that may be matured into actual PSS concepts, during the next phase.

The format of the PSS ideas may be anything from sketches to written descriptions of the idea. What is important is that all initial ideas need to be detailed to more or less the same level more the less, to prevent ideas from being discarded for the wrong reasons, i.e. differences in presentation and maturity, rather than business potential.

**ECOSYSTEM**

Pursuing certain PSS ideas is going to alter how your company engages the




user, the customer and other stakeholders. At this stage the tool **Ecosystem Map** can be used as a visualisation of each idea, using icons to describe the stakeholders and transactions central to each idea. This will additionally allow for immediate evaluation of the idea, as well as give rise to improvements and new ideas.

- Apply the tool **Ecosystem Map**, centred on a few of the promising PSS ideas. The map does not need to be complete or very detailed, but should instead focus on the transactions altered/created by the idea and whether new stakeholders are introduced or needed to realise the idea.
- Make sure to record and pursue possible new ideas generated in the process.
- Consider if the tool adds value to the ideas, in terms of evaluation, maturing and communication.
  - If this is the case, continue to map the remaining PSS ideas.

## USER ACTIVITY CYCLE

Some PSS ideas may alter the **User Activity Cycle** and it may be briefly considered for each idea, whether this is the case and if so, to what extent. Remodelling of the **User Activity Cycle** is, however, not critical at this stage. →

### → OFFERING LIFE CYCLE

Ideas consisting of new services may benefit from initial application of the tool **Service Blueprint** for structuring and maturing. Consider how the various ideas differ from existing services, possibly mapped by **Service Blueprints**. See the dimension Offering life cycle in Analyse phase for more details.

Ideas consisting of new or altered products will similarly benefit from briefly revisiting the baseline, using the tool **Product Life Gallery** to consider how the life cycle of the ideas will be likely to differ from the baseline.

### VALUE PROPOSITION

With the other three dimensions already covered, the development team should have gained an overall understanding of the potential and consequences of the various ideas. Next, potential value propositions are to be explored in this dimension and support the ideas in relation to your company strategy.

- Optionally revisit the tool **TCO Chart**, screening the PSS ideas to include newly covered aspects to the tool and to understand how different ideas translate into Total Cost of Ownership.
- Use the tool **Value Strategy Canvas** by mapping your baseline, a competitor's offerings and some of the promising PSS ideas you have identified. Mapping the different ideas may reveal patterns or prompt for decision on a certain direction for the value proposition.
- Define one or more value propositions.

Workbook 7 thoroughly details the considerations for developing the business models. For the scope of arriving at the first PSS concept proposal the development team should formulate one or two overall value propositions, to guide the conceptualisation of one or more PSS concepts in the next phase. This activity may benefit from involving representatives that can ensure a fit with your company strategy.

### SUMMARY

This second phase should have resulted in a number of ideas that have been investigated in all four fundamental PSS dimensions, in terms of their potential as PSS solutions. The ideas have probably already undergone some first adjustments, as well as given rise to new ideas.

- Define what direction(s) of PSS your company is to pursue further.

- Define a set of goals to guide the selection, development and further evaluation of the PSS concepts.
- Narrow down the ideas to a few, so as to form the basis for one or more concepts in the next phase.

Your company will need to consider all the current offerings available in the market, as well as your own portfolio, before considering a reconfiguration of resources, in order to adapt to new market conditions.

The number of ideas to further develop into PSS concepts depends on the resources available. Through the fundamental PSS dimension of Value proposition the design team is equipped to define one or more directions of ideas to be carried on to the next phase. The goals should reflect the findings in all four fundamental PSS dimensions, but focus on the value proposition. Depending on the ecosystem of your current offerings the goals might relate directly to actual users of the product or to other stakeholders as well, in order to provide overall value to the customer.

Quantitative ratings may be performed to select the prime candidates amongst the ideas generated, but at this stage the ideas will not be very mature, so the convergent idea selection process ought to be performed as part of an open discussion in the development team. Such evaluation will be based on the collective insights and understanding obtained to this point, to result in the most promising ideas to turn into PSS concepts.

# CONCEPTUALISE

This the third phase of the PSS concept development process ensures that the PSS ideas are matured into actual concepts, adding more usage context, detailing more aspects of the value proposition and uncovering uncertainties regarding the offerings and the user activities. All four fundamental PSS dimensions are treated to ensure that all relevant aspects are integrated to complement each other and improve the resulting PSS.

**What brings you here**

- Your company has decided to start developing one or more PSS concepts.
- The focus has been defined for the PSS concept and the goals are to be effectively addressed.
- The prime candidate PSS ideas have been selected to be developed into robust PSS concepts.

This phase proposes a process that will guide your company towards defining solid PSS concepts, applying specific tools as appropriate along the way. We fully recognise that this generic conceptualisation process can be further optimised to better fit your company and specific situation.

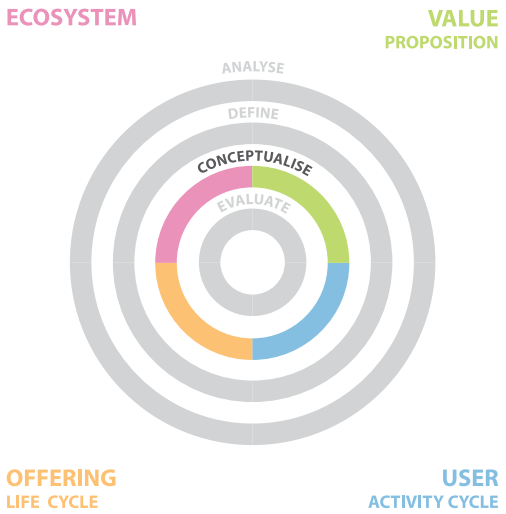
**Ouputs**

The conceptualisation phase develops ideas into concepts that consider a number of areas and risks, in order to establish business potential and feasibility in terms of technical solutions, how they will interact with stakeholders, as well as existing offerings by your company. Key outputs include:

- One or a few PSS concepts that describe the main offerings and how they are going to work together.
- An understanding of each PSS concept in terms of:
  - Value proposition.
  - Offerings throughout their life cycles.
  - Relation to the key stakeholders such as customers and users.

## ECOSYSTEM

The development team is to formulate a few initial concepts, based on the PSS ideas. The initial concepts are to be matured by covering each of the four fundamental PSS dimensions to form robust PSS concepts. The concept may combine more than one idea and should be described as a complete solution. The development




team may arrive at the concepts in their own fashion, but the following tool is recommended for visualising the ideas:

- Apply the tool the **Ecosystem Map**, to sketch initial concepts. At this stage each map should be detailed with the revenue streams, along with the main product and service transaction in the network and possibly other transaction characteristics specific to the concept.

As the initial concept will be subject to change, the visualisation should only be detailed to a certain level and it is recommended to use a format that is easily manipulated.

## VALUE PROPOSITION

During conceptualisation process, the value proposition for the initial PSS direction is to be explored in terms of business strategy and further opportunities:

- Apply the tool **PSS Morphology** to explore the potential business strategies of each of your PSS concepts. The tool further provides an understanding of what constitutes a PSS concept. Furthermore it proposes elements that may be combined in different configurations to be considered for your PSS, resulting in different business strategies.
- Apply the tool **PSS Configurator** by entering the offerings considered in →

→ the PSS ideas, to form the basis for the PSS concepts. The tool will propose related offerings that may be considered as possible supplements or alternatives. The tool may additionally highlight problematic combinations of offerings.

Based on the findings of applying the two tools, it may be sensible to adjust and update the value proposition, in terms of the focus and goals until the proposition is aligned with the current PSS concepts.

## USER ACTIVITY CYCLE

Considering the **User Activity Cycle**, is central for concepts entailing proposals for new services and radical changes in products. This is the case, especially for services that include new types of users, such as service personnel in key roles, in terms of either customer value or costs to your company.

- For concepts that are dominated by service offerings apply the tool **Service Blueprint,** to sketch the overall PSS in the eyes of the central user.

By applying the **Service Blueprint** tool during the conceptualisation, the needs derived from the **User Activity Cycle** are systematically included in the resulting PSS concepts.

## OFFERING LIFE CYCLE

Depending of the nature of your PSS concepts the new offerings must be designed to fit into the overall PSS concept:

- If physical products are to be radically changed, apply the tool **Product Life Gallery**, to better understand and design how the products are to perform across their life cycle, taking the full PSS into account.
- If your PSS concepts involve new services, apply the tool **Service Blueprint** to start structuring and maturing the specific services.

In many cases there is a large business potential for designing physical products for the new context of your PSS:

- Apply the tool **Design for PSS**, to assess the improvement potential in your physical products and support the profitability of your PSS concepts.

## SUMMARY

The **Ecosystem Map** was initially presented as a means to visualise the

initial PSS concepts. Depending on the anatomy of the resulting PSS, the tools in this phase in combine to communicate and visualise the PSS concept.

Systematically covering each of the four dimensions ensures that important basic considerations are made. The challenge with PSS development is to combine the dimensions in a way that makes sense and provides new value to the user. To challenge the traditional thinking of both product designers and service designers, the development team should try the following exercise:

- Place the **User Activity Cycle** in the middle of a large sheet of paper or a whiteboard.
- Next, connect if possible every activity to one or more phases of both the **Product Life Gallery** and the **Service Blueprint(s)**.
- Notice the overlaps and possible activities that are not connected to any offerings.

To ensure that the PSS concepts are robust and that the right choices have been made, prototyping of the critical parts of the offerings, as well as the overall concept, is paramount. The format for prototypes depends on the types of offerings and the ecosystem of your business. In software, prototypes such as virtual slices quickly emulate the final offerings for test users, whereas prototypes of physical products usually involve more time-consuming and costly processes.

# IMPLEMENT AND EVALUATE

In this workbook the fourth phase is limited to an internal assessment of whether one or more PSS concepts are ready for further development of prototypes, pilot implementations, etc. Implementation of a PSS concept may require and result in various organisational changes etc., some of which are covered by Workbook 5.

**What brings you here**

- One or more PSS concepts developed and described in all four dimensions as presented in this book.
- The need to determine if the potential of the PSS concept is good enough for further and more costly development, or if other ideas and concepts should be pursued.

**Ouputs**

This phase aims to provide your company with tools for assessing the overall potential of your PSS concept(s) and provide the basis for deciding whether the changes fit your company, in terms of overall business strategy.

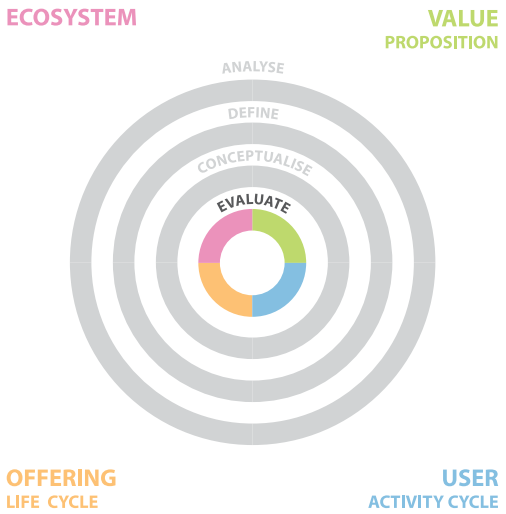
## THE FOUR DIMENSIONS

For the evaluation, all fundamental PSS dimensions of the concept are necessary to consider. Unlike during the other phases, here the four PSS dimensions are treated simultaneously:

- Apply the tool **PSS Concept Evaluator**, to gain an overall assessment of each of the PSS concepts.

The result of the tool may prompt you to revisit earlier phases, to improve one or more concepts or to start over, by searching for new ideas and forming better starting points for new concepts. In the case that one or more PSS concepts show real promise according to this quick assessment, it is time to assess the implication on your business strategy and consider if this is indeed in line with decisions-makers in your company:

- Apply the tool PSS Design Audit, to assess the one or few most promising PSS concepts, to provide a platform for deciding whether this is in line with appropriate decision-makers or how to align the strategy with the PSS concepts. Note that the tools primarily deal with two strategic dimensions (product and service type) and other dimensions may be equally or more important for your company, in relation to your overall business strategy.




If their business strategy and the concepts are able to align at this level, it is time to check the completeness of the concept. This provides an opportunity to realise potentially missing aspects of the concept that may contain large obstacles in terms of time, resources and business potential for the final PSS solution.

# SUMMARY

There is no one correct way to develop a PSS for your company. Applying the tools as proposed in the simplified PSS conceptualisation process, as presented in this book should result in sensible PSS concepts that hold potential for your company. This process is, however, a simplified guide to the different tools, in order to exemplify one way in which they can be combined and deployed, in order to each other.

Creative design processes are always threatened by the rigid format of following a linear process. For your company there is potential in adopting the parts and tools from this workbook that work for your situation and placing them into a setting that is tailored to your company. But this must evolve over time, to adapt to your changing situation, based on increased experience on your part.

If you followed the workbook the task of implementing the most promising PSS lies ahead of you. The PROTEUS innovation consortium has experience with all of the tools in this area and is continuously searching for ways in which to test the methods and tools developed and adopted for this workbook.

A PSS is never finished and it is recommended to set up processes that ensure systematic re-development, prompted by changing market conditions and changes in the broader ecosystem around the PSS.

Keep in mind the remaining workbooks that cover areas, which may be critical for your situation. The readiness manual, Workbook 3 proposes the appropriate workbooks, depending on your company situation, market and intentions.

PROTEUS has charted and detailed eleven tools in this book, from a much larger catalogue of possible tools. Some of the additional tools are mentioned in the advanced sections of this workbook's tools descriptions. Furthermore, partners of the PROTEUS team may be contacted to address your specific situation.


## References

Page 40-41: Blue Ocean Strategy by W. Chan Kim and Renée Mauborgne.

Page 50-51: The Caterpillar example refers to information by Caterpillar.

Page 36-37: The example refers to: Service Blueprinting: A Practical Technique for Service Innovation, 2007, by Center for Services Leadership, Arizona State University .

Originals of material attributed to PROTEUS can be found online at www.dtu.dk/proteus.

PROTEUS workbook series

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**The intention with this workbook is to equip the reader for the process of developing concepts of successful Product/ Service-Systems (PSS). It contains eleven tools that can be applied both individually and in combination with each other. Alongside them a structured PSS concept development process is proposed for the formation of solid and innovative PSS concepts.**

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