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COMPARISON OF DESIGN RESEARCH ON MANUFACTURING FIRMS MOVING TOWARDS SERVICES

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ABSTRACT

Corresponding to a steadily advancing integration of products and service operations in the manufacturing industry, a number of research groups within the design community are working with issues of integrated product and service development. Although closely related, the evolving groups focus on different research dimensions, and thus the terminologies and concepts used in research contributions are not fully compatible.
This research attempts to promote and support an evolving collaboration between the different research groups within the design community, by analysing and comparing the key contribution areas of three of the existing groups, namely the groups of Integrated Product and Service Engineering, Service/Product Engineering and Product/Service-System development.
A review of the groups' research contributions is carried out and the main characteristics' of their research is compared. Furthermore a comparative table of concepts and terms used in the contributions of the three groups in compiled. Based on this comparison, 3 focal research dimensions are identified: the product lifecycle dimension, the customer lifecycle dimension and the provider lifecycle dimension. Finally the research domains' linkages to other related research domains outside the design community are identified.

Keywords:Integrated Product and Service Engineering, Service/Product Engineering, Product/Service-Systems

1 INTRODUCTION

Throughout the industrialised world more and more enterprises focus their internal competences and operations, outsourcing all other operations and tasks to external suppliers or network partners. This outsourcing of activities implies that the partnering supplier companies perform an alignment and development of customised solutions to fit the needs of their contractors [1]. But also private consumers are readily subscribing to a rising number of service offerings, requiring companies to change their operations and products accordingly.
As a response to these trends in the industrial world, researchers in many domains have begun to inquire on the mechanisms, the benefits and the opportunities fundamental to the industrial shift from manufacturing to servicing.
In the design research community, it seems like two dominant influences from other research domains have contributed to the emerging research into PSS development and engineering.
One is marketing research, where several sub disciplines have covered the marketing of services and intangibles for a number of years, and where a consolidation movement in recent years aims for the reunification of service, relational and traditional marketing disciplines under a new marketing paradigm [2]. This new paradigm promotes a view, where there is made no distinction between physical, discrete products and other offering elements such as physical, management and information services.
However, this is not completely new. More than two decades ago, Shostack [3] proposed methods to design and manage services properly mainly for marketers in the service industry. It should be noted

that the main designed object in this case is the activities of the employees at the sites. The modelling method is called *Service Blueprinting*, which is widely known.
Servitization, meaning that firms deliver added value to customers by offering services, is seen as a powerful feature of a total market strategy leading to a new kind of relationship with customers [4]. The authors claim it was at the time already happening in almost all industries on a global scale. Quinn, Dooly and Pauquetee [5] argued that managers in manufacturing companies needed to break the mindset that manufacturing is separate form the service activities and that most companies, product manufacturers and service providers alike, are largely service operations. Other researchers claimed that manufacturers viewed downstream services, which the researchers called the new profit imperative in manufacturing, a necessary area of operation in order to sustain revenues [6]. Also in the service research community and the organisation research community it has been discussed how the transition from products to services should be managed [7, 8].
The other influence comes via the environmental discipline. Stahel for example in 1997 promoted a functional economy taking a more holistic approach involving how society needs to change [9]. A number of theoretical concepts and company descriptions were made showing how moving into a more service oriented society could lead to dematerialization and environmental benefits. A dutch report by Goedkoop et al. [10] is interesting because it is one of the first publications where the authors describe and define the term Product Service System and the elements comprising a PSS solution, while still acknowledging the differences between the two modes of value creation and their exchangeability. Besides that, the report is concerned with both the macro- and microeconomic benefits of PSS solutions and presents a number of business cases, which are compared with other "less service intensive" solution models, regarding their environmental and business economic performance. Seen from a design research point of view however, Goedkoop et al. make no efforts to identify best practice or propose good methods for the creation of PSS solutions.
Along the same general lines, Mont [11] investigates what the drivers are for a change to sustainable PSS solutions and what the actual environmental benefits of existing PSS solutions are.
Established in different contexts and with different focal areas, a number of research groups work with research related to PSS. Based on environmental foundations or business economic foundations, different terminologies and means have been used, aiming for different goals. Among design researchers different perspectives have been researched on, for example how to realise the environmental benefits promoted by environmental researchers focusing on remanufacturing [12], how products should be designed [12, 13] and how the development process within companies can be adjusted [14, 15].
Within the design research community, Tomiyama in the late 90s proposed a change in paradigm for the manufacturing industry [16] i.e. the post mass production paradigm. Later he initiated the development of the theories (called Service Engineering) for developing products in such a paradigm, defining the fundamental service model [17]. Tomiyama does not categorise in products (tangible commodities) and services (activities) but rather in delivered elements and elements utilised in delivery. Tomiyama starts from a detail level, the level of describing the actual service situation, while Mont and Goedkoop et al. start from a macro level i.e. the macro- and microeconomic impacts of business operations. Tomiyama's aim is the support of synthesis based on a development methodology [18], while Mont and Goedkoop et al. have an analytical aim of describing the change of impact, due to a changed way of conducting business. Tomiyama's initiative was followed by research within a discipline called Service/Product Engineering (SPE) currently lead by other researchers [19]. The main outcome of this research, which is more elaborately described in section 3.2 is a service CAD prototype.
As described above the phenomena is studied from different perspectives and by different research disciplines. The terminology confusion is significant, which makes it difficult for researchers to benefit from others research. This is the case even among researchers in the design research community.
In this paper the authors attempt to compare and bring together some of the strands of design research related to PSS – namely the work of groups working under the headlines of Functional Sales & Integrated Product and Service Engineering (FS/IPSE), Product/Service-System development (PSS) and Service/Product Engineering (SPE). The reason for choosing these 3 groups as the main objects of this research is an evolving collaboration between them and other groups within the research domain, namely Functional Product Development (FP) [20] and evolving groups using headings such as

Hybride Leistungsbündel and Product Service Systems, which is to be supported by this study. Means of the comparison is a literature review. By doing this we hope to clarify how the different design research groups are related despite the use of different terms in their research.

2 METHOD

A literature review is carried out. In the review, important concepts which are presented in literature are identified. By comparing the underlying definitions of the identified concepts a table is compiled, showing how the varying concepts of different research groups and fields fit together. The table thus gives an impression of the areas of investigation of the different research groups and the concepts used within those areas of investigation.
In a further analysis of the literature resources, the delimitation and focus of the research areas are identified, in order to unfold the general landscape of PSS research.
Based on these definitions and a further analysis of the literature, it is then attempted to categorise the research contributions into a number of research dimensions, dealing with different aspects of PSS research.

3 FINDINGS IN THE REVIEWED LITERATURE

In this section the 3 strands of research, which are covered in this paper are presented. The presentation builds on the largely common fundamental background already described in the introduction, and elaborates on the focal areas and research approaches of the 3 groups.

3.1 The Product/Service-System development discipline

This section is based on the research work done by the group at DTU, researching under the headline of Product/Service-System development.

Background and goal of research

The work of the DTU group builds on the theoretical foundations of Andreasen [21], namely the Domain Theory, the Theory of dispositions as formulated by Olesen in 1992 [22], and the groups efforts in the exploration and promotion of integrated product development approaches [23]. Based on the above, the group has for some years been working in the field of EcoDesign research, and is currently moving on from a focus of reducing environmental impacts of artefacts primarily in their production and end-of-life life phases, to a more focused inclusion of use-phase-potentials, i.e. the creation of Product/Service-Systems.
The research within PSS is aiming for an inclusion of servicing operations into the theories and tools of product development, in order to enable developers facilitate the conceptualisation and development of industrial solutions featuring the integrated design of both product and life phase systems.

Research approach and methods

The research approach combines student experiments with case studies in industry and supervised student projects with industrial partners. Case studies are utilised to explore industrial practise and build a foundation for the creation and validation of the explanatory models.
The developed models and methods are taught and applied by bachelor students of the DTU curriculum *Design & Innovation*, where the students benefit from the evolving methods and models are evaluated. Finally the development methods are applied in industrial projects, where the students after attending the before mentioned course test the methods in industrial settings, and the outcomes are evaluated and commented by industrial contacts.

Characteristics and critical concepts of the model

The research of the group is working along two strands; one is the creation of models for the explanation of PSS. The other is the development of models and procedures aiding the developer in concretely conceptualising PSS solutions and communicating his ideas to other stakeholders.
The characteristics of PSS are followed in 3 different dimensions. The first is the time of the customer-provider relationship and the life-phase system dimension of the product life [24]. The second is the development levels of offers transcending the organisational boundaries of customer and provider [1]. The third is unfolding the opportunity parameters of implementing PSS solutions [25].

Concerning tools for the concrete development of solution concepts, the group is adapting some of the group's existing modelling techniques. Furthermore the group is experimenting with models from other research areas, such as the strategy canvas of Blue Ocean Strategy [26] and the AMC modelling technique [27], which is based on the Customer Activity Cycle model first published by Vandermerwe [28].

Characteristics of the design method

The design method mainly helps the designer in understanding the product life implications and dispositional effects of his design work. The concrete development tools aid designers in understanding and conceptualising specific product life phase systems and communicating these concepts to team members and other stakeholders. Thus the methods and models generally are supporting the designer in making informed and well considered decisions in his synthesis work, concerning both the design of products and life phase systems.

Current status and future research works

Currently the theoretical explanatory models are under development by application and refinement in industrial cases. The concrete development methods are developed by the iterative application in student course environments, supported by a series of application with industrial partners.

3.2 The Service/Product Engineering research discipline

Background and goal of research

As described in Section 1, research of a discipline called Service/Product Engineering (SPE) originates from Tomiyama's proposal [17], where a different term Service Engineering was used. The research themes of his group included General Design Theory [29] and CAD in conceptual design (e.g. [30]). The authors regard one of the motivations of the new research the question; what is the ultimate goal of providing *functions* that are described at the top level in product CAD? - It is service in a sense of providing something that is needed and wished for in a matured economy. In addition, with knowing that dematerialization through servicification is among the measures to solve environmental problems, they regard this research is expected to modernize life cycle engineering or EcoDesign methodologies [31]. They have attempted to develop an engineering discipline to increase the value of artefacts and to decrease the load on the environment by focusing on service delivery. SPE aims at intensifying, improving, and automating the whole framework of service creation, service delivery, and service consumption.

Research approach and methods

Research of SPE has adopted a relatively practical approach. This characteristic can be found in their efforts of developing a practical computer tool [19], named Service Explorer, for designing services. The approach is supported by cooperation with companies. The research group operates a membership-based community in Japan since 2005, where some 10 companies participate. This community is utilized for verification and transfer of the developed methods/tools as well as for extracting the needs and wishes of the participating companies. For the companies, the community works as a forum to exchange knowledge and experiences with other industries. A theoretical aspect is maintained through building upon conventional theories for conceptual design of engineering systems and information system for such purposes (e.g. [32]).

Characteristics and critical concepts of the model

This research group captures services in a way where the receivers' transition of status called "receiver state parameter" (RSP), not the providers' activities, is the core of the service. Thus, a service is defined as an activity that a provider causes, usually with consideration, a receiver to change from an existing state to a new state that the receiver desires, where both contents and a channel are means to realize the state change (after [17]). Service contents are provided by a service provider and delivered through a service channel. Physical products and service activities are either the service contents or the service channel. Thus, selling physical products is also regarded a service. This is a remarkable characteristic that provides designers with a flexible modelling scheme.

The service model in SPE consists of several sub-models [33]; "flow model" describing the agents participating in the concerned service, "scope model" used for specifying an effective range of the

service development scope from an initial provider to a final receiver, “scenario model” represents receivers themselves using the concept of Persona [34] and their behaviours in receiving the service, and “view model” representing the provider’s functions and entities to influence an RSP. The major goals of the model are supporting designers to develop solutions and evaluating (intermediate) solutions semi-quantitatively.

Characteristics of the design method

Characteristics of the design method of SPE include representation as procedures [33]. It utilizes the model of service and is supported by the computer tool, Service Explorer. Importantly, it is value, not service activity that is designed. Service activity or product is a measure to realize value. That is intended by the name SPE as well. Note that SPE has both synthetic and analytical aspects. For the evaluation process a modified QFD (Quality Function Deployment) technique is utilized [35]. Since the method has been developed in a general form, this has a benefit of wide applicability but a relatively lower conformity for a specific type of service design.

Current status and future research works

So far, the model, the design method and the computer tool[1] have been verified through several industrial cases in European countries and Japan within e.g. a logistic-equipment company [36] and the accommodation industry [33]. Development of methods and tool has been continued. For instance, a reasoning engine for abduction [37], which would enable users to discover analogy between different models, is being implemented and verified.

3.3 The Integrated Product and Service Engineering discipline

Background and goal of research

This research within the Linköping/KTH research group has evolved since the beginning of year 2000 when work was performed in the area of Functional Sales [38] and how to design products and remanufacturing systems [12, 39]. The decision to use the term Functional Sales was based on historical reasons, as Swedish industry, for example Electrolux, used this term and it had also been used by other researchers, as for example [40]. It was also chosen in order to reflect that the phenomena were evolving in industry for business reasons rather than environmental reasons, even though the research also had an environmental focus. Since the area has evolved fast in both industry and academia the researchers now use the term *integrated product and service engineering (IPSE)* [41], as it better illustrates what is being studied. The Japanese researchers using the term Service Engineering have also influenced the research groups’ use of terminology. The research group is currently working on a methodology for developing Integrated Product and Service Offerings. The IPSE methodology objective is *to create better prerequisites for firms to develop integrated product and service offerings that are gainful for the supplier firm, the customer, and for the society in large.*

Research approach and methods

The research is based on the research group’s earlier work with remanufacturing, Functional Sales and the collaboration with Japanese partners on Service Engineering. The research group includes researchers from the design discipline and the business discipline. The IPSE concept has its origin in a lifecycle-based interactive design model (see Figure 1). The model, which has been developed based on earlier studies and tested with partner companies, illustrates areas that are critical in order to be able to create good integrated product and service offers. It has been concluded that these areas therefore should be considered in an IPSE methodology. The research group now have two research projects working together with about 15 companies and the methodology will be based on the cases together with suitable theoretical models, rather than have the starting point in a specific theoretical model.

[1] Service Explorer can be distributed from the developers for academic research purposes.

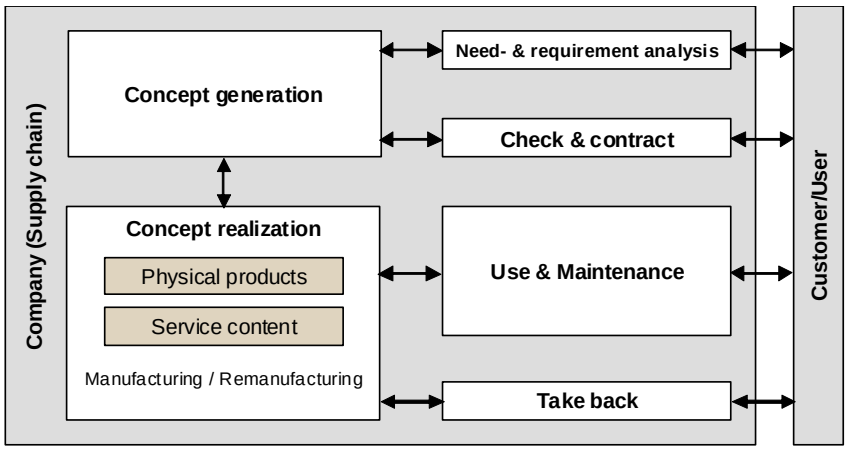

Figure 1: The IPSE model [42]

Characteristics and critical concepts of the model

The IPSE-model is quite general in character pointing out important areas within a supplier's organisation that are affected when developing integrated product and service offers. The areas and the interaction and collaboration between actors in the different areas are also in focus.

The research is general in character developing the theory in the area concerning how to organise and handling the concept generation, concept realization and the operating phase and handling the products at end-of-life. The research also focuses on developing managerial implications and also a method guiding companies in how to develop *integrated product and service offers (IPSO)*. By collaborating with researchers developing the Service Explorer, and testing it in the project, a more practical approach is also taken.

Current status and future research works

The research group is in the state of developing and refining the IPSE-method before the recommendations and guidelines will be tested in the companies. In collaboration with the Japanese partners also the Service Explorer software is tested.

3.4 Compiling a terminology table for PSS design research

The review of the contributions and work of the three research groups reveals interesting overlaps and differences. In this section the authors have attempted to draw up and compare the general characteristics of the research work and the terminology used for certain compatible concepts in two tables. Table 1 shows key characteristics of the research groups in comparison.

Table 1: Overview of the different research groups

	Product/Service Systems	**Service/Product Engineering**	**Integrated Product and Service Engineering**
Research group	DTU	U. Tokyo Tokyo Metropolitan U. TU Darmstadt	Linköping U. KTH
Aim of research	Inclusion of service operations into the theories and tools of product development.	Intensifying, improving and automating the framework of service creation, delivery and service consumption.	Improving the development of offerings in companies, both service and product development processes.
Expected results	Models for explaining and conceptualising PSS	Design method and computer tool for services	Methods for supporting companies in developing integrated product and service offerings.
Theoretical foundation	Design such as Andreasen ét al, Olesen and EcoDesign	General Design Theory, Knowledge Intensive Engineering Framework, EcoDesign	Integrated Product Development. EcoDesign (remanufacturing)
Main research method	Qualitative case studies, project experiments in university and industrial environments.	Learning networks of companies, testing of methods, semi-quantitative studies	Qualitative case studies, qualitative studies learning networks of companies, testing of methods in companies

Table 2 is a comparison of the terminology used by the three research groups. It is attempted to identify compatible concepts used by all or some of the groups. These are described briefly in the left column, together with the terms used by the different groups for those specific concepts. The table gives an impression on the focal areas of the research groups, as well as an indication of the groups' research foundations.

Table 2: Overview of the terms used in different research environments

Research group / **Concept**	**Service/ Product Engineering**	**Product/Service-Systems**	**Integrated Product and Service Engineering**
Design object			
Customer	Service receiver (a kind of *agent*)	Customer	Stakeholders
What are required by a customer in an abstract level	Change of RSP (receiver state parameter), namely value	Needs	Needs
in a concrete level	Content	Activities	Functions
What delivers the service	Channel	provider network	Providers
What is paid for by a customer	Change of *RSP*, namely *cost*	Depending on the offer composition	Availability Functionality
Environments (conditions) of a customer	Scenario	Scenario Life phase system	Scenario or actual conditions
Customer's behaviour and habits concerning the service offer	A chain of *actions*	Activities, modelled by AMC-model	A chain of activities
Measures to satisfy the customer's requirements	Function	Activities, operations, products	Availability Functionality
Provided physical product	Entity	Product	Product
Provided service activity (maintenance activity, remanufacture, spares provision, logistics service, etc.)	Service activity	Service activity	Service activity
Actor of service activity	Service provider (a kind of *agent*)	Service provider	Providers
Provider	Service provider (a kind of *agent*)	Provider or supplier	Providers
Other contributing organizations	Service provider (a kind of *agent*)	Network partners	Providers
Design process			
The stage of identifying customer needs-and requirements	Analyzing customers	Part of concept phase	Need- & requirement analysis
The stage of conceptual design of the service	Conceptual design	Conceptualisation	Concept generation
The stage of simulating the service	Simulation	Development	Concept generation
The stage of prototyping the service	N.A.	Development/implementation	Concept realization
The stage of implementing the service	N.A.	Implementation	Use
Operating the service	N.A.	Operation	Use & Maintenance

4 ANALYSIS OF RESEARCH AIMS

In this section the authors will attempt to analyse and discuss the differences and overlaps apparent in the review sections. The analysis will be divided into 3 subsections dealing with the general characteristics described in sections 3.1 - 3.3, aspects underlined or revealed by the comparative terminology table in section 3.4 and finally an attempt of laying out the research dimensions within the research domain.

4.1 The different groups' focal areas

In this analysis it is chosen to divide the characteristics of the three analysed research groups into 4 main issues, the research methods, the attempted application area, the goals and finally the approach for reaching those goals. The four issues will be dealt with separately in the following sections.

Research methods

All the three research groups have grown, at least partially, from research in the EcoDesign discipline. Thus one of their commonalities is the aim for optimised resource consumption in the fulfilment of modern societies needs. All the groups try to reach this ultimate goal by supplying designers, developers and managers of industrial enterprises with tools and models that enable them to move towards more service oriented offerings. However, the nature and application of these tools and models differ considerably, as well as the current mode of dissemination.

While both the SPE and IPSE groups have established relatively concentrated research exchange networks in industry for the development and validation of their work, the PSS group has chosen to integrate their research closely with the *Design & Innovation* engineering curriculum at DTU. That way the SPE and IPSE groups can count on a more dedicated and intensive collaboration with their industrial partners, while the PSS group can possibly draw on a broader range of industries by evaluating and analysing the work of roughly 50 students' projects pr. year.

Application

As mentioned the intended application of the research results differs considerably among the groups. The SPE group is intensively working on an implementation of their theories in a CAD-tool for service design. Thus the insights obtained by the researchers are intended converted into a software package, automating many of the analytical tasks involved in the conceptualising of service offerings.

The PSS group on the other hand is attempting the creation of a theoretical framework that will enable the designer to understand the product life implications of his development work and the embedding of P/S development in the enterprise strategy. The methods and practical models of the PSS group are also intended to inspire the designers rather than automating tasks – and are kept on a more visual, illustrative and communicative level.

Finally the IPSE group is currently in the process of defining a framework of tasks and process sequences necessary to organise the successful development of IPSO. Their contribution lies mainly in the structuring and sequencing of development tasks, the identification of necessary competence within the development organisation and the definition of a development framework.

Approach

In extension of the above, the research approaches and intended research results are differing somewhat among the groups. Where the SPE group is aiming for data-models which enable the automation of analysis tasks, their research is oriented towards the definition of quantitative relationships between analysis properties, e.g. the adaptation of QFD methods into the service design area.

The PSS group is exclusively working on a qualitative level, where quantitative measures are expected to be brought into the development work by the respective professionalisms coming together in the frame of PSS-development.

The IPSE group is also working on a qualitative level, but focusing more on the process-oriented aspects of IPSE.

Goals

The most important difference among the three groups is their differing focal point, the object of inquiry.

Based on the Service Engineering theories of Tomiyama, the SPE group is attempting to bridge the traditional gap between (industrial) product development and the customer focus of the service industry. The fact that the customer – or receiver – of services is an individual human represents the important difference between standardised specification and production of manufacturing industry and the individualised delivery mode of services. Therefore the main challenge of SPE research is the capturing of the receivers needs and his evaluation of service delivery elements. In a short sentence, the important questions asked by the SPE researchers are "What will make the receiver happy?" and "How can his values be translated into computational models?".

The PSS group focuses on the deliverables of the PSS being the elements in the form of products, services and operations. The focus is how the interaction and interplay between these elements can be optimised and how the integrated offer can create strategic alignments between provider and customers. The main questions could be “What elements of delivery can be envisioned?” and “How can these elements’ utility and value be optimised by the interplay between them?”.
For the IPSE group, the providing enterprise is the pivotal point of research. The prerequisites for the successful delivery of an integrated offer and the process of negotiation upon the customisation of the standardised offering elements are key. Thus the main questions here are “What should we deliver in order to increase customer value?” and “How should we be organised when developing and delivering IPSO?”.

4.2 Analysis of the groups’ use of terminology

Table 2 shows that the concepts the three research groups utilize to conduct their research overlaps to a large extent as only a few concepts are neglected by a group (e.g. “Operating the service” is not explicitly addressed at present by SPE). This is not surprising since the three groups more or less belong to the design community. In addition, an identical term for a concept is adopted in common by two or three groups (e.g. “provider” and “needs”). Several characteristic terms of a group to be remarked include “RSP” (receiver state parameter) of SPE, “Network partners” of PSS, and “Availability” of IPSE. These can be linked with the research approaches explained in Table 1. For instance, the term RSP has been introduced due to the expected result of SPE, a computer tool for service design. The term of PSS, “network partners”, originates from their focus on strategic business planning. In addition, “functionality” of IPSE shows their relatively high interest in how to deliver, and the before mentioned “availability” stresses the IPSE groups origins in the Functional Sales business models.

4.3 Defining main dimensions of research

Summarising the analysis of the 3 addressed research groups, 3 dimensions of research related to product and service development become apparent as being the main contribution areas.

The Provider Lifecycle dimension

This dimension addresses the evolvement of product/service providers’ organisation and operations. Much of the work of the IPSE group is within this dimension, covering issues such the setup of development projects, organisational streamlining of the company towards service delivery and the identification of necessary partnerships for the successful operation of services – both internally and externally of the focal organisation.

The Customer Lifecycle dimension

This dimension addresses the evolving needs of service receivers. The wishes of individual customers evolve constantly, and it is crucial for the provider of services and products to both being able to anticipate receivers’ reaction to new offerings while in development phases and being flexible in the modes of delivery as to react to changes in the way receivers conceive the value of actual offerings.

The Product Lifecycle dimension

This dimension is addressing the sequence of interactions and meetings of both products and servicing systems in their evolving life cycles. The successful development of PSS is depending on a thorough understanding of the interactions occurring in the solutions lifecycles and an active designing of beneficial linkages between the heterogeneous systems involved.

5 CONCLUSIONS

One important outcome of this research is the great benefit of collaborative initiatives within the design community as to identify and take advantage of different research groups diverging viewpoints and focal contribution dimensions.
As the integration of products and service operations is advancing steadily in industry, partially due to the ever accelerating development of information technologies, it is important for the design community to be at the edge of that movement, adapting the methods and tools of developers to reflect present challenges. The research groups analysed in this review are generally working on a migration

of the structured methods used in product development into the area of service development, where the tradition is more based on adhoc or experimental approaches. In that respect the community has much to offer, but must also admit that the boundaries to other research communities are getting blurry and many aspects of other professionalisms must be taken into account. Thus there is a need for consolidation within the community, but also a need to open towards other research areas.
Figure 2 depicts the issues within the research boundary that the surveyed research groups address in common and the needed inputs from other fields. For instance, one of the central issues lies in the design process, which is expected to be influenced from management insights. In addition, our community needs inputs from other fields such as marketing, psychology, and socio technology, which address the differing and changing value perceptions of customers. On the other hand, fields like management and production investigate how products, services, and design processes are structured.

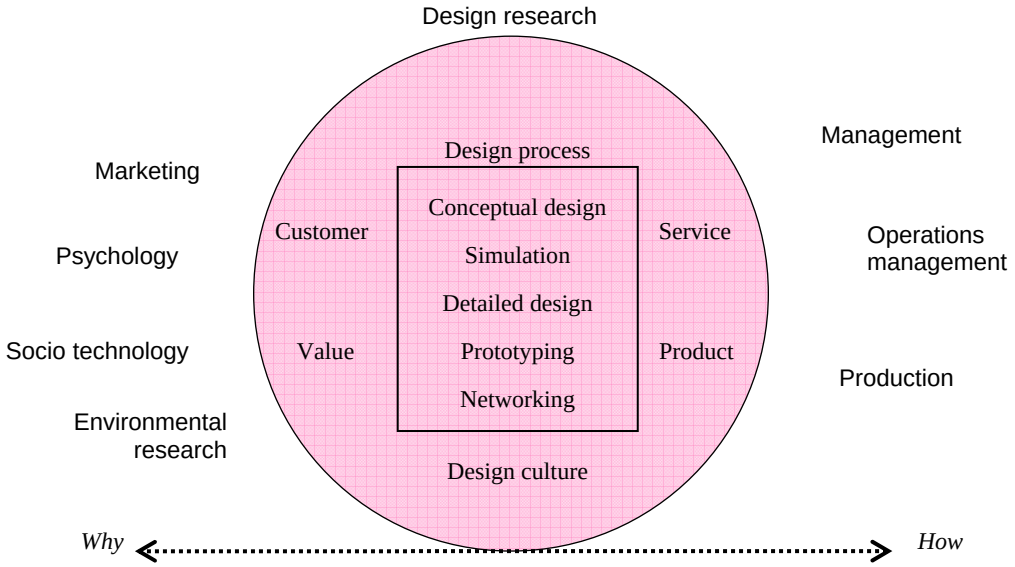

Figure 2: Boundary of design research in this theme and inputs from other fields.

Future research in the design community can result in contributions to those other fields, but certainly it will be more feasible to bridge the research communities' gaps if the contribution dimensions of the groups within the design community are clearly defined.

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