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WHAT HAPPENS TO INTEGRATED PRODUCT DEVELOPMENT MODELS WITH PRODUCT/SERVICE-SYSTEM APPROACHES?

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1 Introduction

Integrated Product Development (IPD) has traditionally focused on the development activities relating to physical technological artefacts. With the advent of business approaches for manufacturing firms based on providing customers the utility of integrated products and services – a term dubbed 'product/service-systems (PSS)' – companies need to extend their activities to include new dimensions of development.

Within the paradigm of mass production and consumption, traditional product-oriented business strategies regarded physical technological artefacts (products) as the mediators of customer value. Value was based on the exchange of products between a providing company and a receiving customer. The more products the company could sell, the more revenue it generated. At the point of sale the ownership and responsibility of the product was transferred from company to customer. A customer would buy a product because it represented potential valuable benefits. Several researchers [MOR-03] have pointed to the problems of this business strategy as: 1) *it links companies' economic growth with the consumption of natural resources*; 2) *it delegates the responsibility of a product's use, maintenance and disposal to customers that are often oblivious to proper behaviour*, as well as, 3) *it allows little opportunity for customers to influence the design to best suit their individual needs and preferences*. PSS approaches are business strategies where companies provide value to customers by supporting and enhancing the utility of products throughout their entire life cycle. This strategy represents a range of opportunities for companies that may ameliorate some of the problems listed above.

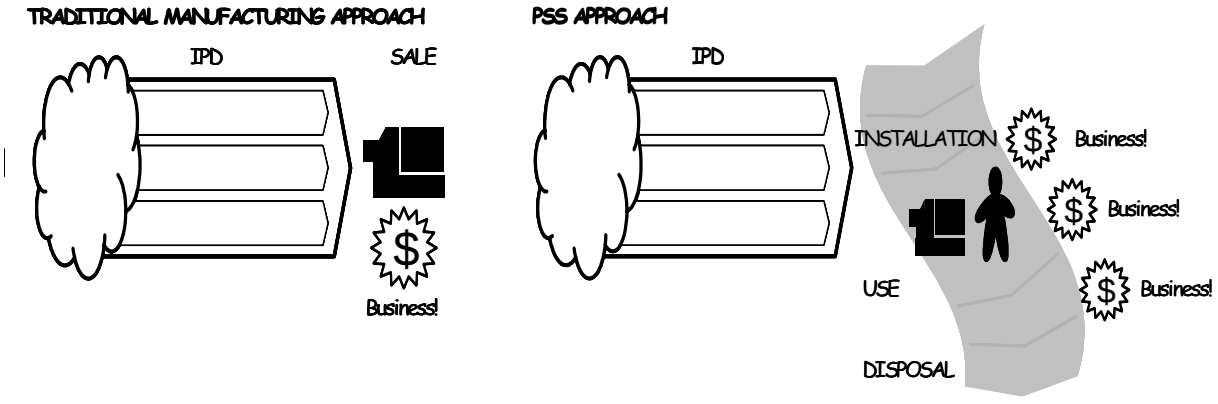

Figure 1. : A traditional manufacturing approach, where the value creation process ends with the sale of the product and a PSS approach, where the value creation process continues through out the product's life.

The underlying principle of PSS strategy is to shift from business based on the value of exchange of product ownership and responsibility, to business based on the value of utility of the product and services. The idea being that the customer pays only for the use of the product when needed and does not have to worry about operation, maintenance or disposal. In this way companies may dematerialise their business by decoupling their value creation with resource consumption. Value is instead created by supporting the customer's activities related to the use of products. This is done through intangible services and knowledge intensification that ensures optimal operation and performance of products in relation to the individual customer's activities. It is believed that PSS approaches will enable and motivate companies to reuse, rationalise and enhance their products and services more efficiently throughout their life phases. This strategy also allows companies to enhance their competitiveness by expanding features, value and benefits not apparent with traditional product-oriented offerings. The term 'PSS' is related and shared with other terms such as 'functional sales' [STA-97], 'functional (total care) products' [ALO-04], 'servicizing' [WHI-99] and 'service engineering' [TOM-01].

In traditional manufacturing companies the physical product is considered to be at the core of the offering with services being complementary and supplemented in aftermarket activities. With PSS approaches this view changes. Here the customer's interaction with the product and its related activity is at the centre of attention. Value is created during the activity and based on the performance and outcome of the activity. This shift in view challenges our current understanding of development and the models we use to represent the development task. At present little research has been done in the systematic design and development aspects of PSS [MON-04]. We therefore set out to explore the implications of a PSS approach with regard to the way in which companies set up their development activities. The aim of this paper is to examine what happens to the models of IPD when the result of the process is not focused on providing technological artefacts, but on providing integrated products and services that support customer's activities.

We will begin by giving a short overview of the attributes of development models in relation to product and services. Thereafter we will attempt to elaborate on the effect of PSS approaches to IPD models in relation to activities, knowledge and competencies, roles and responsibilities, and the relation to other parallel corporate processes. Finally we will discuss these issues and point to future research. The findings in this paper are largely based on literature studies, discussions with researchers within the area and with companies that actively develop integrated PSS solutions.

2 Product development models

Product development models seek to describe the complete chain of activities from need identification to successful business [AND-87]. A product development project is commonly dividing into a set of 'stages' or 'phases'. Each stage in the project is initiated and concluded with 'gates' in which the project group and corporate management can evaluate the feasibility of the project at various critical points in time. At the 'gates' it is possible to terminate bad projects at an early stage and thereby reduce risk and increase the chances of success. This division of the process has had a great impact of the practical management and organisation of the development task, increasing the chances for business success through the promotion of clarity, eased planning ability, reduction of risk and allowance of greater control over the development process. In IPD models the outline of future phases are drawn up and a terminology is created to facilitate communication across projects. This enables actors to

understand their roles and responsibility contributing to integration and concurrency in the development project.

Prescriptive development models, such as IPD [AND-87], suggest systematic approaches for companies to structure their development task by creating overlap and interaction between activities in order to improve the overall product development performance. IPD is characterised by a concurrent design approach in which multidisciplinary teams cooperate their activities both vertically and horizontally in the organisation. In order to achieve the benefits of integration, IPD approaches require that the objectives of the development project are complete and well defined. Consequently, understanding and the identification of customer needs and demands at an early stage of the project is vital for the success of the project. Although IPD models have been heavily adopted by industry, they have been criticised on various aspects, such as the risk of the development project being built on the wrong assumptions, limiting innovation in the company and hindering the involvement of customers [ENG-03]. A further limitation of IPD is that it no longer fits ideally to many industries' actual product development activities [McA-99]. We will take this issue up later in the paper, but first would like to characterise three groups of product development models, as follows.

2.1 Models for the development of products

Much of the product development literature as we know it has been based on physical technological artefacts as the object of study. Here value is thought to be embedded in the technological artefact [VAR-04] and the creation of value is traditionally based on the customer's reaction to the traditional virtues of "cost, quality and time". Since the product acts as the carrier of value, manufacturing may utilise the characteristic separation of production and consumption to achieve global cost efficiencies. Value is related as closely as possible to the properties of the product, which may be realised in the product first when ownership changes from company to customer. To exemplify, we pay to buy a bicycle, but our experience of value only occurs once we begin to use the bicycle. It is 'bicycling' that actually brings about value but the 'bicycle' here is the carrier of the product's quality.

With PSS approaches we need to be able to identify and support the customer's perception of value and not assume that this is only related to the product's quality at the time of purchase, but is also related to the utility of the product during the customer's activities. Typically in product development customer demands are translated in to a set of requirements relating to a product's properties. In PSS approaches requirements in development projects should be set in relation to the customer's activities regarding product use.

2.2 Models for the development of services

Compared to the research literature in product development, there is sparse literature regarding research in new service development (NSD) [ALA-02]. Models for NSD are often derived from existing models of product development, but researchers in service development emphasise that due to the difference that products are 'things' and services are 'processes' service development is different in nature to product development [SHO-82]. Typically these researchers are found in marketing research and base their studies on companies in the financial, insurance and health care industries [ALA-02]. Few studies have examined service development in manufacturing companies [MAT-01]. Many researchers in service development claim that in relation to physical products, services have the following characteristics: intangibility, heterogeneity, perishability and inseparability. Recently these characteristics have been challenged as to whether they actually are unique and inherent only

to services [EDV-05]. Every product involves services such as sales, delivery and support and every service involves physical products in order to provide the benefit. The conclusion is that it is difficult to identify a hard distinction between 'service' and 'product', but there is a general acknowledgement that there exists a service-oriented paradigm different from the traditional manufacturing product-oriented paradigm. With service-oriented perspectives the focus on customer relationships and on-going need satisfaction are cited as being pivotal [JOH-99].

In PSS approaches both products and services may be employed as potential means to fulfil customers' needs. This requires an expansion of competencies necessary to develop the total PSS offering. Services are executed within the customer's activities and their value has to be apparent to the customer.

2.3 Models for the development of product/service-systems

In essence both products and services are just two modes in which companies attempt to deliver value to their customers. The 'product' versus 'service' discussion is not so much an issue of a new 'object' that has to be developed, but a new perspective on what kind of value is being created.

With PSS approaches we create a dependency between a (providing) company's operations and a (receiving) customer's activities. We have a close integration of operations, both tactically and strategically. PSS development models must inform us of the integration across the different levels of the company's development activities:

- Strategic business/product planning in cooperation with networks and service partners, i.e. development of PSS concepts.
- Product management and product development projects leading to new PSS 'offers', i.e. development of the product/service offer.
- PSS delivery system or function, which in steady relation to the customer delivers services, i.e. offer customisation and development of the service channel.

With physical products the task is to determine the product's structural characteristics so that the desired properties may be attained, and the product in use then delivers the customer utility and value. In the area of services we do not have the equivalent insight into the relations between what structures a service and which properties contribute to the customer's perception of utility and value. Weber et al. [WEB-04] emphasise that "*the customer should be integrated into the development*" when considering PSS approaches as it is difficult to establish service characteristics without the customer's involvement.

We observe two life cycle systems that the company must consider in PSS development: 1) the life cycle of the physical artefact and 2) the activity life cycle relationship between the providing company and customer, representing a product-oriented and a service-oriented view respectively (Figure 2). Companies must gain insights to both views in order to achieve the potentials of PSS.

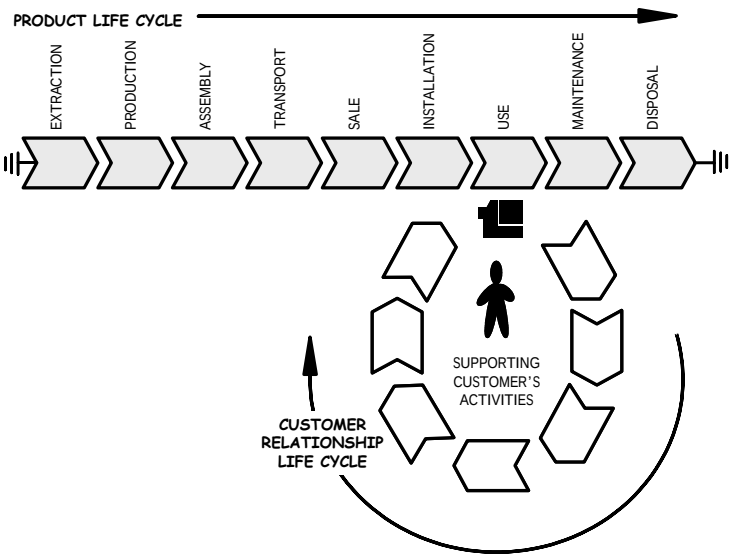

Figure 2. : Two life cycle systems must be considered in the development of PSS

Fundamentally the difference in PSS in relation to traditional product development is that:

- the physical product is supported and enhanced throughout the customer's activities by the providing company (the business relationship with the customer may spread over several product upgrades and generations).
- the value creation is in the resulting activity where both the physical product, supporting services and the customer all play a vital role (the perception of value is beyond the physical product itself).
- the customer's activities are part of the value creation process and the providing company must interact closely with the customer throughout the life phases.

3 Towards a model for integrated PSS development

The strength of IPD as a reference model for companies is that it allows practical management and organisation of the development task. IPD models propose a certain manner in which companies may establish: 1) the development activities; 2) the roles and responsibilities of team members; 3) the knowledge and competencies involved; and 4) the relationship of the development process with other parallel corporate processes. In the following we attempt to investigate how PSS affects these issues.

3.1 New activities

Traditionally manufacturing companies have not considered the customer's activities as a primary part of the value creation process, but merely as value extracting processes. In order to employ customers and stakeholders as resources the company must establish activities in

which customers and stakeholders are encouraged to participate in the development process. In product-oriented development models the process ends with a full product description or the realisation of production and sales. With PSS approaches we expand the development task in time so that it also encompasses the use phase to ensure continuous development that is aligned with the customer's activities.

3.2 New roles and responsibilities

A key difference with the PSS approach to business creation, when compared to the traditional product-oriented approach, is that the company plays a key part in the entire product life period. The company takes on the responsibility of the physical products during its use, maintenance and disposal phases. Exactly how and to what extent this involvement with the customer is, needs to be defined. It is central that the role and responsibilities of customers in such a process should be determined by the company. Likewise responsibilities in relation to partnering companies and their role in the process must be carefully considered. Here the field of study around 'Solution-oriented partnerships' gives some good insights into the way in which companies orchestrating PSS offerings manage the new roles and responsibilities [MAN-04].

3.3 New knowledge and competencies

The shift of perspective from a core product-oriented view to a service-oriented view represents a gap in knowledge for manufacturing companies [ERI-05]. The knowledge and competencies in manufacturing companies are directed at embedding knowledge into a physical product. With PSS approaches, knowledge and competencies can be aimed directly at the customer's activities or through the education and training of the customer. Value is not the only entity created in the interaction with the customer during a product's use phase; new insights about the product and an understanding of value are also attained. If captured and integrated into the providing company's organisation these insights can be a vital source of competitive advantage.

3.4 New relationships

Typically a company's development activities are derived (top-down) from the company's overall corporate strategies in relation to its position on the marketplace. This assumes that industry structures are relatively stable [POR-85] and is well suited to manufacturing industries, where products can easily be compared on specific parameters, (e.g. price, size, weight, etc.). PSS approaches attempt to uncover new relationships and different networks of stakeholders. The markets in which PSS companies operate on are not as stable in comparison, as they will rapidly follow emerging opportunities. Here innovation will depend upon the bottom-up approaches based on in depth knowledge of customers and their context.

4 Discussion and perspectives

The above considerations about the characteristics of product development, service development and PSS development raise many questions as to the actual development activities and therefore need methodical support in companies. Our literature research has shown, that the product development area is predominant with respect to the models and methods available, based on a long legacy of studies worldwide. It is worth noting that in the

shift from ‘product’ to product/service’ the single most important consideration to focus on is the need to (but also opportunity to) consider value creation as the main object of business development. An inevitable shift also occurs when focusing on PSS development, namely the need to even more closely consider the strategic, business-oriented and product life related issues of ‘business creation’, as opposed to mere ‘product development’. Thus the design task begins to move earlier up the value chain, involving new and different stakeholders – not least the customers of the PSS, in the case of solution-oriented partnerships.

Our earlier diagnosis of the limitations of IPD relate to a situation of increasing globalisation of product development and production activities. However the main essence of IPD – being the timing, value-added, risk-minimising, competence-integrating activities in a coordinated and repeatable fashion – still holds when we consider PSS development. The difference in this situation is that new parallel activities become apparent and the ‘front-loaded’ activities of PSS development dominate the later activities of detail design and manufacturing in a new way.

Our research thus far has drawn upon insight into a great deal of both theory and companies. As yet we have sparse experiences of actual implementation of our theories into companies. This activity will involve an intense relationship with companies, where approaches will be developed and tested with and in the companies. This research activity is currently being planned and will hopefully be implemented via a Danish ‘Innovation Consortium’.

One could of course ask the question as to whether products and services shouldn’t be kept independent of each other on their development. However it is our conviction that the opportunities that arise from a concurrent product/service development activity warrant an integrated approach. We see it as both an essential role for product developers, and a significant competition parameter to have physical products developed to be flexible to the service-systems in which the company also wishes to capitalise on.

5 Conclusion

When developing PSS offerings, the tasks and abilities of the providing companies are expanded in new directions. We see the following challenges for IPD in relation to PSS approaches:

- The *focus on activities* instead of products as the mediator of value – the development and providing activities within a company should be aligned with their customers’ activities.
- The characteristics of services *involve the customer in the co-creation of value* – the role of marketing, production and design in manufacturing firms should be prepared for increased user-orientation activities during the development process.
- The expansion of *competencies required to offer and deliver PSS solutions* – how should the partnerships with external companies be integrated.
- The *integration of products and services* – the development of the total range of products and services that are offered should be coordinated.

References

[ALA-02] Alam, I. & Perry, C., "A customer-oriented new service development process." Journal of Services Marketing 16(6): 515-534, 2002.

[ALO-04] Alonso-Rasgado, T., Thompson, G., et al., “The design of functional (total care) products”, Journal of Engineering Design, 15, 6, 2004.

[AND-87] Andreasen, M. M., Hein, L., "Integrated Product Development", IFS (Publications) Ltd./Springer-Verlag, 1987.

[EDV-05] Edvardsson, B., Gustafsson, A. & Roos, I., "Service portraits in service research: a critical review." International Journal of Service Industry Management 16(1): 107-121, 2005.

[ENG-03] Engwall, M., "Mysteriet med den orimliga modellen: Om utvecklingsmodeller, kunskap och kontroll [The mystery with the unreasonable model: On development models, knowledge and control]." Nordiske Organisasjonsstudier 5(4): pp 28-53, 2003.

[JOH-99] Johns, N., "What is this thing called service?" European Journal of Marketing 33(9): 958-974, 1999.

[McA-99] McAloone, T. C. & Robotham, A. J. (1999). A Framework For Product Development. Critical Enthusiam - Contributions to Design Science. N. H. Mortensen and J. Sigurjónsson. Copenhagen, Denmark: pp 83-98.

[MON-04] Mont, O. (2004). Product-service systems: Panacea or myth? The International Institute for Industrial Environmental Economics. Lund, Lund University. PhD: 140.

[MOR-03] Morelli, N., “Product-service systems, a perspective shift for designers: A case study: the design of a telecentre”, Design Studies Vol 24 No. 1, pp. 77-99, 2003

[SHO-82] Shostack, G. L., "How to Design a Service." European Journal of Marketing 16(1): 49-63, 1982.

[STA-97] Stahel, W., “The Functional Economy: Cultural and Organizational Change,” In Richards, D.J. (Ed.), The Industrial Green Game: Implications for Environmental Design and Management. Washington DC: National Academy Press, 1997.

[TOM-01] Tomiyama, T., “Service engineering to intensify service contents in product life cycles”, Proceedings of EcoDesign 2001: 2nd International Symposium On Environmental Conscious Design And Inverse Manufacturing, Tokyo International Exhibition Center, Tokyo, Japan, 2001.

[WEB-04] Weber, C., Steinbach, M., Botta, C. & Deubel, T., "Modelling of Product-Service Systems (PSS) based on the PDD Approach". International Design Conference, Dubrovnik, 2004.

[WHI-99] White, A.L., Sloughton, M., Feng, L., “Servicizing: The Quiet Transition to Extended Product Responsibility. Boston: Tellus Institute, 1999.

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