Design for Service (DFS) in the Product Development Process (PDP)

Design for Service (DFS) no Processo de Desenvolvimento de Produto (PDP)

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Julio Cesar Berndsen
Doutor
Instituição: Universidade Federal de Santa Catarina
Endereço: EMC – Departamento de Engenharia Mecânica, Universidade Federal de Santa Catarina, Caixa Postal 476 – Campus Universitário, Trinidade, 88040-900, Florianópolis, SC - Brasil
E-mail: julio@ayzer.com.br

Fernando Forcellini
Doutor
Instituição: Universidade Federal de Santa Catarina
Endereço: EMC – Departamento de Engenharia Mecânica, Universidade Federal de Santa Catarina, Caixa Postal 476 – Campus Universitário, Trinidade, 88040-900, Florianópolis, SC - Brasil
E- mail: forcellini@gmail.com

Samuel Borges Barbosa
Doutor
Instituição: Universidade Federal de Uberlândia
Endereço: Universidade Federal de Uberlândia, Faculdade de Arquitetura e Urbanismo e Design - FAUeD. Av. João Naves de Ávila, 212, Santa Mônica, 38400902. Uberlândia, MG - Brasil
E-mail: osamuelbarbosa@gmail.com

Lauber de Souza Martins
Doutor
Instituição: Universidade Federal do Paraná
Endereço: Departamento de Engenharia Mecânica, Núcleo de Pesquisa e Desenvolvimento de Energia Autossustentável, Universidade Federal do Paraná Centro Politécnico, Francisco H do Santos n. 100 Jardim das Américas, 81531-980, Curitiba, PR- Brazil
E- mail: lauber@ufpr.br

Rejane Costa
Mestre
Instituição: Universidade Federal de Santa Catarina
Endereço: Programa de Pós-Graduação em Engenharia e Gestão do Conhecimento Centro Tecnológico (CTC) – Universidade Federal de Santa Catarina (UFSC) Campus Universitário Reitor João David Ferreira Lima
Trinidade, 88040-900 Florianópolis, SC – Brasil
E-mail: rejanecostafloripa@gmail.com

ABSTRACT
Due to the importance and growth of the demand of new products and services, there is a constant necessity to improve business processes. However, there are different approaches from different authors regarding this subject. In the context of Design for Service (DFS), the first and the most traditional approach among the companies is to develop the products through a Product Development Process (PDP), which fundamentally considers the product design while the services are only intuitively presented throughout the life cycle. The DFS can also be developed in a parallel manner, putting service and product together. However, there are only few methods that integrate DFS into the PDP. Review the existing literature about the best practices of the Design for Service (DFS) that incorporate "design for service" into the Product Development Process (PDP) in order to bring a better understanding of how to implement the DFS to PDP. The focus of this work is the DFS and its best practices, constituted by a Systematic Literature Review. A Systematic Literature Review elaborated in indexed databases (Scopus, Web of Knowledge, Compendex) was used and it was complemented by exploratory searches in the literature in order to compose the bibliographic portfolio. By examining the portfolio and the selected documents, it was possible to elaborate an analysis and organize it in chronological order, creating a timeline. The results indicate a growing interest in the service area in the past years, and clarify that the period between 2006 and 2014 were the years that had the greater research activity. The results are also important because they identify what the best practices of DFS are and what the important contributions to future research that may lead to the development of a model goal to incorporate DFS into PDP.

Keywords: Design For Service, Product Development Process, Process Systematization, Service Orientations.

RESUMO
Devido a importância e o crescimento da demanda de novos produtos e serviços, há uma constante necessidade de se melhorar os processos de negócios. Há contudo, diferentes estratégias adotadas por diferentes autores a respeito desse tema. No contexto do *Design for Service (DFS),* a primeira e mais tradicional estratégia adotads pelas companhias é o desenvolvimento de produto através do *Product Development Process* (PDP), o que fundamentalmente considera o design do produto enquanto serviço é simplesmente apresentado intuitivamente durante o ciclo de vida do produto. O DFS pode também ser desenvolvido de modo paralelo, colocando serviço e produto juntos. Contudo há poucos métodos que integram DFS e PDP. Revemos a existência na literatura de práticas de DFS em que incorporam "design for service" no Product Development Process (PDP), para que se tenha um melhor entendimento de como se implementar o DFS no PDP. O foco deste trabalho é o DFS e suas melhores práticas, apresentando uma revisão bibliográfica sistemática. Esta revisão bibliográfica foi elaborada usando base de dados indexados (Scopus, Web of Knowledge, Compendex) complementado por uma pesquisa exploratória a fim de compor um portifólio bibliográfico. Ao examinar o portifólio e documentos selecionado, foi possível elaborar e organizar-lo em ordem cronológica, criando uma linha do tempo. Os resultados mostram um crescente interesse em serviços nos últimos anos, enfatizando que o periodo entre 2006 e 2014 foi o período de maior atividade de pesquisa. Os resultados são também importantes pois identificam as melhores práticas de DFS e quais importantes contribuições para pesquisas futuras podem levar ao desenvolvimento de um modelo global que incorpore DFS em PDP.

Palavras chave: Design For Service, Processo de Desenvolvimento de Produtos, Sistematização de Processo, Orientações de Serviços.

1 INTRODUCTION

To create and deliver value to the client, the business processes must be consistent with the wishes of the interested parties. On the other hand, companies need to survive and generate positive financial results, and for that reason, they have to strengthen their business and control their progressions, which create a constant necessity to improve the organizational processes. Therefore, organizations should not only adopt conventional models focused on the creation of value of production and price, but also be engaged in a deeper view related to three important items: processes, people, and technology. Thus, the main goal of this process is the aggregation of value (Jacobs and Chase 2013).

Complementing the views of product development processes (PDP) require a more comprehensive interpretation disseminated by a paradigm shift, in which the combination of services (intangible) and products (tangible) create and harmonize a new view of interaction (Vargo and Lusch, 2008, Ferreira et al., 2019 and Christovam et al., 2020). This view is in opposition to the proposal established by the OECD (2006) that states that goods are tangible and services are intangible.

Services can also be considered an economic activity in which one party provides to the other party. It is usually based on time and performance, and offers to the interested party access to goods, labor, or professional skills in monetary exchange (Lovelock and Wright, 2012). Services are purchased by consumers because of the benefits packages or value that their clients receive. Most of the time, this value comes from experiences created in the back office and then moved to the front office (Barbosa et al., 2017).

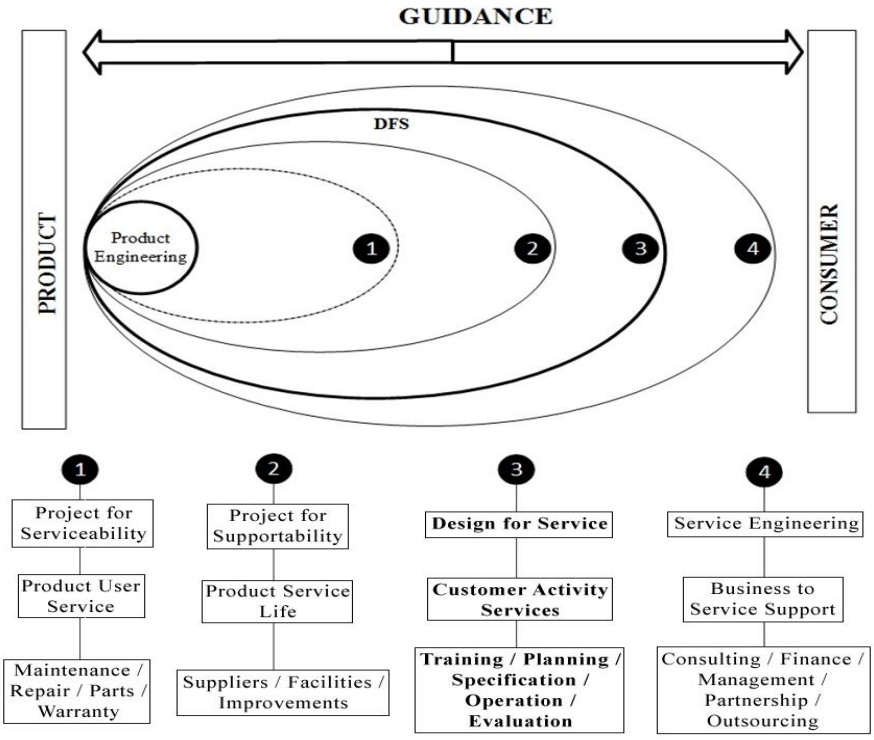
A different manner to present the mutual influence of products and services is described by Tan et al. (2010). Tan et al. (2010) positions himself between two opposites, different orbits between the product and the consumer. This indicates a greater approximation with the consumers as the service supply increases and the relationship is valid for the reduction of services in regard of product engineer. The Design for Service acts as a third orbit between the two opposites as it is illustrated in Fig. 1 below:

Lovelock and Wright (1999) and Kotler and Keller (2006) present services as a combination of tangible and intangible assets, in which they need to be objects of idealization and be controlled by the intervention of a formal and established process, involving all stakeholders[1].

These stakeholders define the condition of quality and satisfaction of the process, because in the end, all they want is to be appreciated for providing a great quality of service. Thus, the company´s image regarding service quality is directly related to the stakeholders and to the market´s competition factors. The most common methodologies used are Design for Manufacturing (DFM), Design for Assembly (DFA), Design for Quality (DFQ) and Design for Cost (DFC), which are applied during the design process in order to find the right solutions that contain the desired properties.

The "X" in DFX represent different life-phase systems that should be optimized (e.g., manufacture, assembly, disassembly configuration, etc.) or properties that the product must group together during any of the life-phase systems (e.g., cost, quality, reliability, flexibility, environment, etc.). For those, the generic concepts X are collections that are motivated by experiences that can be found at the design stage.

Figure. 1. Product Service Orientation.



Source: Prepared by the authors base on: Tan et al. (2010).

[1] *Stakeholder is a person of a group of people that participate, invest, or have interest in a determined company or business. The word "stake" means interest, participation, or risk.*

The service design requires a simultaneous application of multiple DFX approaches, although they can be used partially (Meerkamm, 1994).

In order to improve the product design, DFX methodologies have been improved, so they can be applied along with concepts that are syntheses activities, in which distinguish the structural characteristics of a product and its systems. That is done to achieve the desired proprieties of the product according to the desired quality (Andreasen and Hein, 2000).

Therefore, the service aspects aligned with the products can contemplate the following approaches: Design for Environment (or Ecodesign), Design for Maintainability / Serviceability, Design for Supportability / Supportability, and the main focus of this research, the DFS (Design for Service).

The service literature found is very broad due to its comprehensiveness and its different classifications. It can be noticed that in the last decade, many projects have focused on the methods, methodologies, and tools for the development of the PSS concept (Komoto et al., 2005). Each of these tactics represent different degrees of service orientation and they show how the design and the production processes are related. According to the literature, a series of observations are made regarding manufacturers in the development of integrated product/ service solutions.

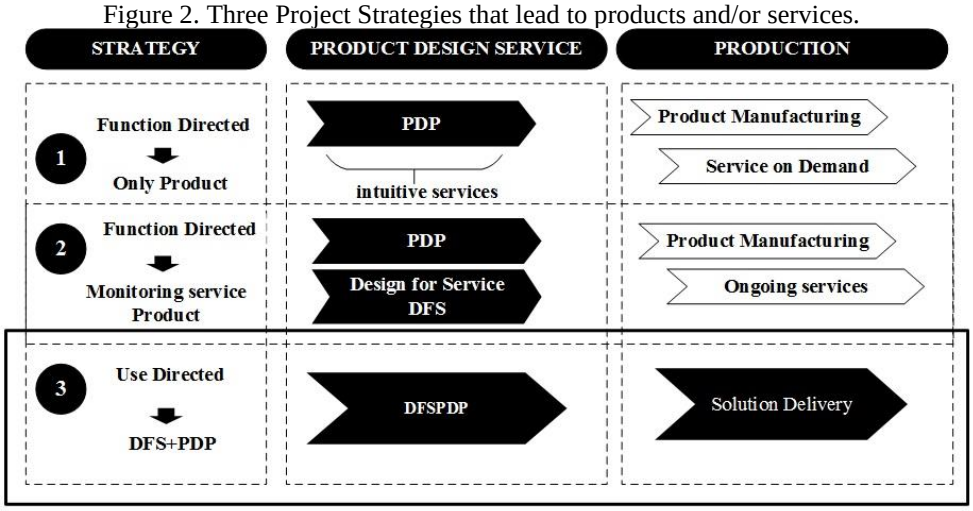
Aurich et al. (2004) propose three strategies about product integration and service development, as represented on Fig. 2. The focus of this article is highlighted on the last row, where an integration between the product and service development can be noticed.

The Design for Service, just as the rest of the other DFX approaches, contains some elements that are very important. Souza (1998) describes them as three important factors that contribute for a better understanding: (i) the first one is related to the process; (ii) the second one is related to tools; (iii) the third and last one regards philosophy.

It is important to notice that in a DFX approach, the DFS coexists integrally with each of the three conjectures: Philosophies, Processes, and Tools. Fig. 3 exposes this relationship using scientific knowledge and creates a better understanding:

According to the literature, the service design needs to approximate the requirements to the designers. Case studies show developers working at different levels (from a more strategic level operation) through different methods, and adapting tools to the all stages of product development for different purposes (Meroni and Sangiorgi, 2011).

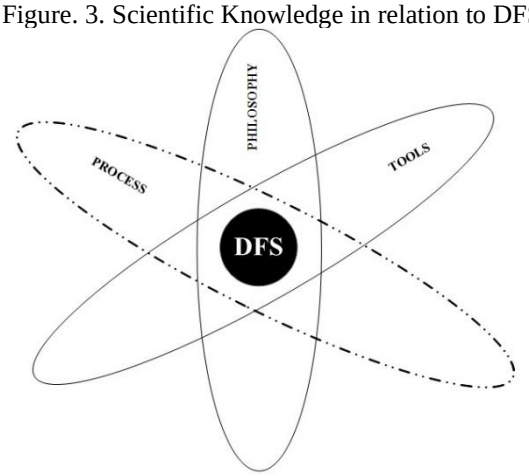
Figure 2. Three Project Strategies that lead to products and/or services.



Source: Prepared by the authors based on: Aurich et al. (2004).

The next point talks about the methodology and it gives a detailed explanation about the developed method used in this research study, as follows.

Figure. 3. Scientific Knowledge in relation to DFS

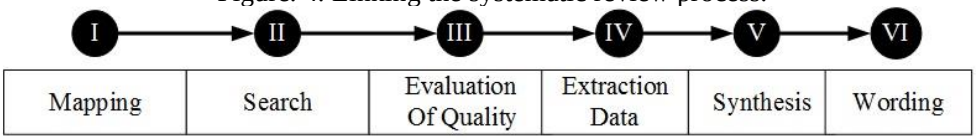


Source: Souza (1998).

2 A SYSTEMATIC REVIEW OF METHODOLOGY APPLIED

In this research review process, some principles of systematic review were adopted, as recommended by Levy and Ellis (2006), giving a general and analytic view of this study. The systematic review allows the quantitative and qualitative gain of knowledge, which is necessary to determine the current body of knowledge intended by this work. As shown below, Fig. 4 presents the orderly procedures of the six phases that comprehend the following principles:

Figure. 4. Linking the systematic review process.



Source: Prepared by the authors based on: Levy and Ellis (2006).

In Table 1 the description of the activities of each methodological phase of the Systematic Review is presented:

Table 1. Description of the Systematic Review´s methodological phases.

Phase	Description of the actions
I	A research plan was developed in order to find the answers to all the questions. It also involved key words and an inclusion and exclusion criteria. Since the main focus of this work was to establish the current body of knowledge and identify promising paths, it was decided to use key words to identify relevant studies, such as the models of Product Development Process (PDP), *New Product Development* (NPD) e *New Service Development* (NSD), and especially the *Design for Service* (DFS). Two different research methods were used: the systematic analysis of literature denominated as #01 and #02 using the same indexed databases. In addition to the researched articles, an exploratory analysis of the literature known as #03 was conducted. This analysis relates the use of other product development models (PDP/ NPD) / NSD characterized for being reference models for other researchers and for being used in congresses.
II	To establish the state of art about the research topics, RBS was used with the inclusion criteria: (i) the research is considered empirical, (ii) *peer-reviewed*, (iii) in english, and (iv) indexed material with the following database: *Compedex, Scopus and Web of Knowledge*. The "gray literature" was excluded from the research, such as reports and non-academic researches. The systematic review used three databases with keywords combinations were previously defined in the literature review. Publications from 1982 to 2016 were considered in this research
III	The summaries of the relevant documents were elaborated and, where necessary, further parts of the articles were also read in order to certify that they actually met the scope of interest of the research, and to reduce the number of articles, excluding duplications.
IV	The documents were coded in an electronic spreadsheet according to the specific criteria
V	The individual data was summarized, and then elaborated in a spreadsheet.
VI	The obtained results were written in this article.

Source: Prepared by the authors.

The research of database was composed by two parts - A and B, as presented on table 2 below:

Table 2. Description of the searches.

Search	Database	Strings
# 01	A	((*"design for service" OR dfs OR (design AND service)) AND ("product development process" OR pdp OR npd OR "New product development" OR "New service development"))*
# 02	B	*((service) AND (oriented) AND (strategies) AND (product))*

Source: Prepared by the authors.

With the intention of showing the results from the research conducted in RBS, the results of each stage are presented. Fig. 5 bellow provides a better illustration of the procedures, which outlines the results of each stage respectively:

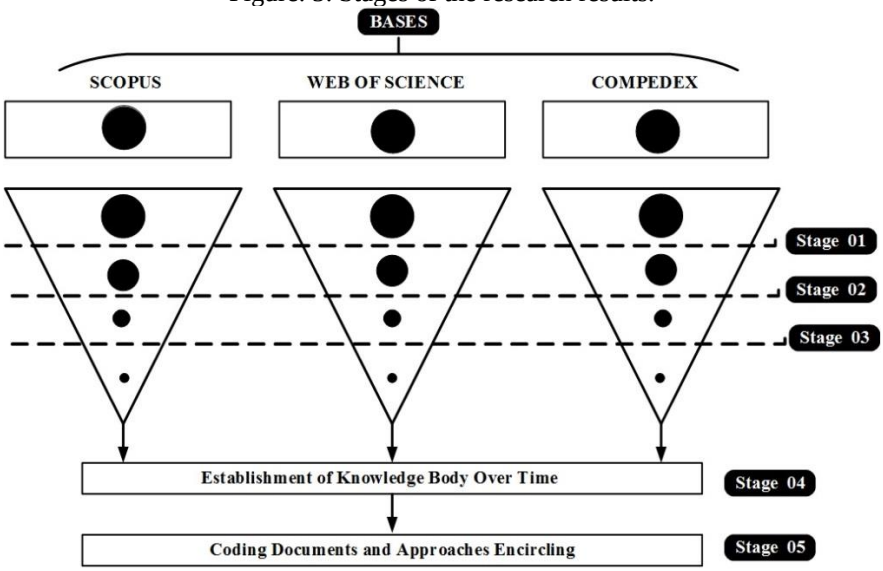
2.1 PRESENTATION OF THE RESULTS

On **Stage 1**, articles were researched in three different scientific bases, where 3.355 documents were found. In addition, by using the database sheet elaborated during the methodological stage for document examination, the following items were described: title, authors, periodic, year of publication, and analysis of the content with investigation intention and theoretical perspective.

On **Stage 2,** once all the questions had already been defined, the databases were accessed and the articles were analyzed according to the procedures that were established on the methodological stage. The initial search used the combination of words and combinations (Table 2), in which resulted in more than 3.355 articles, where 1.114 of those were found in Scopus base, 678 in Web of Knowledge, and 1.563 in Compendex. By removing duplicated articles, a total os 1.524 documents remained.

On **Stage 3,** by analyzing the summary and understanding its context, new sections of the articles were revised in order to certify that they covered the pre-defined scope, in which, through an exploratory search and other researchers' indication, five more models. Out of 92 primary studies selected in this stage, 67 documents were available for download.

Figure. 5. Stages of the research results.



Source: Prepared by the authors.

From the final portfolio composition (92 documents) and from the analyses conducted in this research, it was possible to elaborate a spreadsheet that demonstrated each of the items related to the documents individually, such as: article code, author, article name, year, the DFS relationship with PDP and NSD, and other service guidelines. It was also analyzed if there was an existing model, what were the strengths, weaknesses, gaps, and which model analysis were of greater interest for the research.

The identified journals were attributed to fields of information, operations, services and development of products, businesses, and management, computer science, robotic and computers, quality management, and sustainability. In the remaining journals the following areas were discussed: innovation, industrial organization, decision science, sector and businesses studies that demonstrated a comprehensive framework of public interest investigation.

On **Stage 4**, 37 codified models were analyzed and selected. They present greater adhesion and contribution to the systemizing approaches of the thesis subject. The documents were investigated according to the guidelines of Products (manufacture), Services, Product and Services, Service Orientation Strategy, non-linear flexibility to services, DFX and DFS presentation, and insertion of DFS into the Product Development Process (PDP).

As described on table 3 below:

Table 3. Definitions identified in the relevant documents gathered from RBS.

nº	Author(s)	Syntheses
1	Chew, 2016	The document states that in order to profit with innovation, the organizations need an interdisciplinary, holistic method integrated to design and commercialize service innovation. From different but inter-related theories of service science, strategic management, science organization and literatures of information systems, this article develops a new method of integrated project, known as ISIM (Integrated Service Innovation Method), for the innovation of simultaneous services and service model design for the creation of value to clients.
2	Ko et al., 2016	The authors state that the conceptual Project is a fundamental activity during the initial phases of the new product development (NPD), because most of the creative ideas are generated during this process. Without creativity, there is no potential innovation. A complete project process for the innovation of products should include analysis of problems and ideas generation at the same time.
3	Santanna Filho, 2015	Collaborative development of partnerships. In the model, the author presents three spaces; one space is created for idea development, another one for solution development, and the last one for the delivery of solution applying the SOA concept. .

4	Rondini et al., 2015	It presents a case study done in collaboration with the ABB spa, a leading power and automation technology group. Routine and corrective maintenance, *retrofit*, spare parts.
5	Schmidt et al., 2015	It presents a three stages composition that is easy to understand but exposes vague steps, leaving gaps in the processes that are related to other models that seek consumer satisfaction in order to solve their needs. The text is composed by three simple steps that are of easy comprehension.
6	Pourabdollahaian and Copani, 2015	Customizing medical products that are designed based on each patient´s individual requirements may create a considerable impact on treatment or quality of life.
7	Lo et al., 2014	This study reveals a new service-oriented development model in which Taiwan service providers participate by analyzing, testing and verifying the largest operating company KTV, AA, as an empirical target. The study examines how the service industry evaluates a model for developing innovative services. The model was built based on customers´ service experiences. This new service model is produced through a thorough exam of consumer behavior, preferences, and knowledge. Overall, the integrated service design process is applied to explore what type of methods and processes the KTV operator can adopt to digitalize its services.
8	Sobolewski, 2014	The authors describe a SOA service-oriented architecture that describes guidelines for innovative service-oriented process (front-end services called efforts) and its (back-end service providers) dynamic and on-demand actualization. Domain-specific Language (DSLs) for modeling or programming, or both, are introduced and their unifying role for front / back-end services is presented.
9	Voigt et al., 2014	This study focuses on the role of creativity support systems (CSS) in developing creative service concepts. We analyze how service organizations assess the IT they use in service concept development with regard to three distinct tool properties (playful, supportive of comprehension, or task-specific) and the impact of these properties on service concept creativity and user satisfaction. To answer corresponding research questions we conducted a survey of 425 German service companies.
10	Chou et al., 2012	A “feedback map” and a “workflow model” are proposed in this work in order to help the decision makers to create appropriate service models. These tools are integrated with existing methods and knowledge, creating a systematic structure to deal with information flow in service design. A workshop is conducted to demonstrate the feasibility of the proposed approach. The research has a strong relationship with sustainability.
11	Zhang and Wang, 2012	A model composed by two stages that incorporates both strategy formulation and implementation. They conduct an empirical study of a sample of 221 manufacturers in China. This study provides evidence for the proposed conceptualization of a service orientation strategy. The authors also consider that the investigated background explain some variation of the service orientation strategy, which positively influences its market effectiveness and profitability. They explore the organizational configuration factor that will affect the implementation performance of the manufacturer’s strategy.
12	Guijun, L., 2010	It researches the development of new services based on the relationship of service management with the development of new products (NPD). This study projects a new service development model (NSD) for China's financial industry, including nine steps and five gates. The model can help financial institutions in China develop better services in a shorter period of time.
13	Ribeiro et al., 2010	The authors present two strategies: one presents a software for product line (SPL) and the other one for service orientation.
14	Tan et al., 2010	This article presents an overview of service-oriented development strategies found in the literature and the types of service that they relate to. It talks about DFS in a superficial manner, presenting the positioning between product engineer and the user.
15	Tsai and Wang, 2010	It is a proposal to improve the quality of service of real estate companies.

16	Yan et al., 2010	In this paper, it is first discussed the relationship between service-oriented architecture and the service-dominant logic, based on strategic alignment model.
17	Reinoso et al., 2009	The authors propose four stages: *design,* analysis, development but do not state any important activity regarding new service strategic plan, or either suggest how the selection of ideas and services tests are elaborated.
18	Goudarzlou and Chuan, 2008	A set of indicators is proposed to measure the effectiveness of the process. It also used tools and techniques, such as Balanced Scorecard, which can lead the organizations to a successful development process. The DFSS is shown here as a Design for Six Sigma.
19	Hochstein et al., 2008	The suggested model gives to the service providers the opportunity to create consumer segmentation, not only according to traditional classification schemes, but based on a systematic and complete analysis of consumer dimensions, as well as the comprehension of their interrelationships.
20	Jiang, 2008	The research focuses on service interaction between customers and service providers. It presents a service design framework that includes nine elements and a process model of service design that integrates customer experience and service innovation strategy.
21	Zeng et al	This work proposes a collaborative platform solution for the development of services. This platform allows the collaboration of several engineers from different areas in the development of a complex system, such as an automobile.
22	Ulrich and Steven, 2007	It presents specific engineering features in the areas of machinery engineer and installations. It does not allow conventional approaches of product data management or product lifecycle management as future-oriented or market-oriented processing strategies.
23	Froehle and Roth, 2007	The authors make it clear that the activities that will develop the product are announced in the development phase. On the other hand, the authors do not make an analogy about the organizational context, tools, and staff that will generate the service. In addition, they add the post-launch activity on the launch phase.
24	Crawford and Di Benedetto, 2006	In this study, the authors emphasize the predevelopment and the development stages. They both end the model in the product launch stage; therefore, they do not worry about post-launch factors, such as reuse, etc.
25	Mello et al., 2006	In this document, service development is presented in four phases: service design project, service process design, service facility design, and evaluation and improvement of services. An important detail is highlighted, in which the authors define a phase intended for service facilities.
26	Rozenfeld et al., 2006	In the model proposed by the authors, there is a combination of nine phases and three macro phases. In the end of each phase there is a gate, which works as an approval point to give continuation the project. In case it does not get the approval, the process should be reanalyzed, minimizing possible mistakes. An economic viability monitoring is maintained throughout the whole project. DFX is only mentioned in the conceptual design phase and it is not clear how it should be inserted in the development of the project.
27	Arias-Aranda and Alvarez-Gil, 2004	This study has two objectives. First, it tries to promote an understanding of the relationship between the design of the service operation strategy and its implementation. Second, it explains how they are driven by the customization efforts.
28	Aurich et al., 2004	The research work aims at developing a service design process. Based on three main strategies for combining products with related services, a design process is proposed. It considers, simultaneously, the product, the process, and the dimensions of information of the services.
29	Alam and Perry, 2002	The study proposes the implementation of services in the financial area and recommends a sequential usability of the phases. However, it also emphasizes that this process can be elaborated in a parallel way to generate greater speed.
30	Menor, et al., 2002	It brings several challenges and opportunities in the use of DFX. However, none of them deals with DFS issues.
31	Cooper, 2001	In this document, the development process is divided into several stages and decision-making is done through gate.

		Five different stages are described: Preliminary Investigation (I), Detailed investigation (II), Development (III), Validation and Tests (IV), and Commercial Launch (V).
32	Goffin, 1998	They explore the ways which the companies evaluate the product support requirements during the design phase. They also study the necessity that the companies have on using quantitative goals and making the design team focus in one product.
33	Johnson and Menor, 1998	The model is proposed through a case discussion regarding new service development. It presents the factors related to the success of service development.
34	Bitran and Pedrosa, 1998	The authors propose six phases for the service development: strategic assessment, concept development, system design, design components, testing and deployment, and feedback and leaning. In the strategic assessment phase, just as in the other models, the strategic planning of service occurs. The concept development phase is recognized as a point where the design of the solution concept occurs. In this stage, there is a strong marketing-client interaction resulting in services attributes. In the system design phase is necessary to state that there is a strong interaction.
35	Edvardsson, 1997	It is a quality study that obtains its results in an empirical way.
36	Pahl, and Beitz, 1996	It is one of the traditional works of the "engineer project". This model initially presents the problem by going through phases such as: confrontation (I), information (II), definition (III), creation (IV), evaluation (V) until it gets to a final solution (VI). The focus of the model connects to specific techniques.
37	Booz et al., 1982	It can be noticed that, in the proposed document, the authors consider some of the stages are considered activities. However, seven processes are used in the model, such as: strategy, idea generation, sorting and evaluation, business analysis, development, tests, and commercialization.

Source: Prepared by the authors.

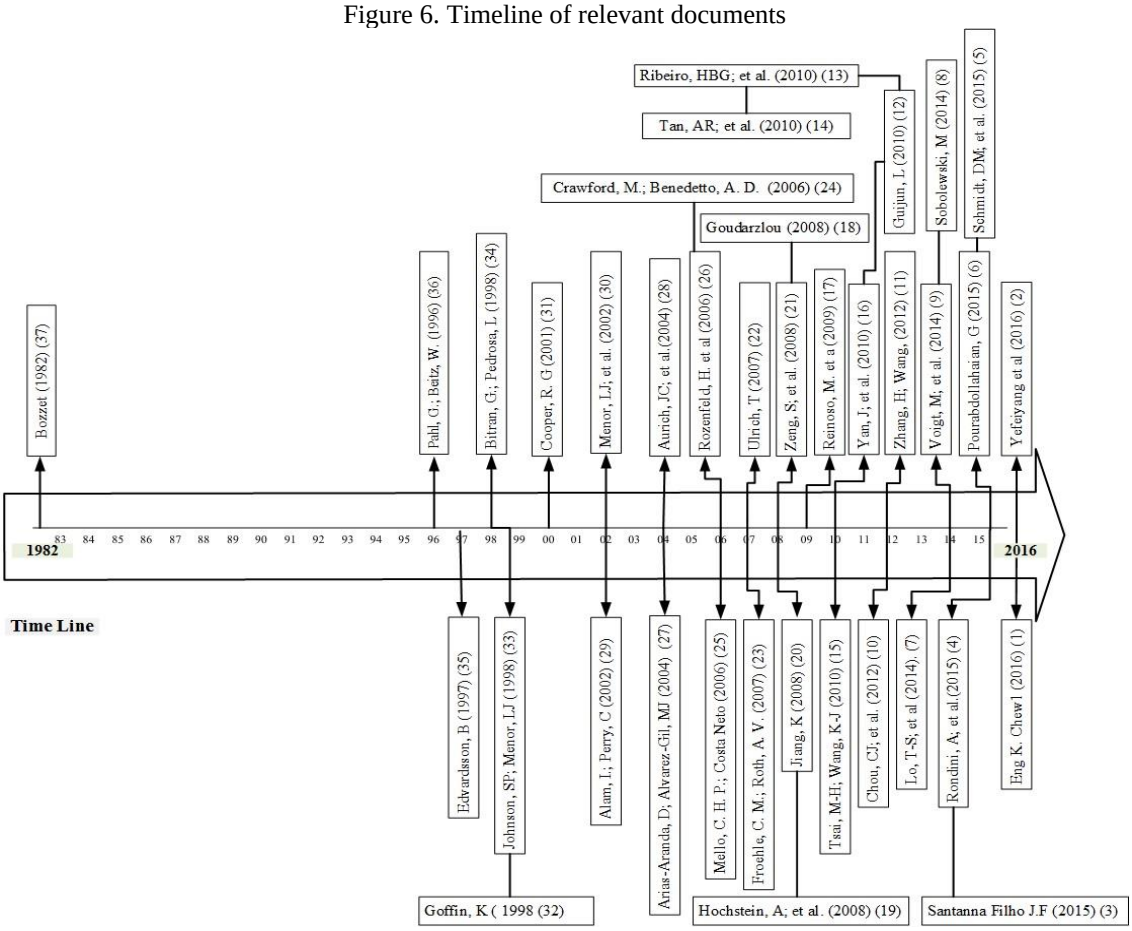
On **Stage 5**, a timeline of the established documents portfolio was elaborated. By having a timeline, it is possible to visualize the events in a chronological order, described as the element of the project. Fig. 6 shows the timeline of the identified publications in the research. Throughout the timeline is possible to verify the authors and years of the 37 publications found. It is important to highlight that the period between 2006 and 2014 represent the years of greater research activity levels, and it indicates that in the last decade the growth of interest in the subject is 50% higher than the previous decade.

The issues are attributed to the domains of information, operations, services and product development, business and management, computer science, robotics and computers, quality and sustainability. In the remaining journals, the following areas are addressed: innovation, industrial organization, decision sciences, sector studies and business studies that demonstrate a broad research framework of public interest.

The timeline indicates that some authors demonstrated a continuous interest in studying the issues regarding product development, services, or both, which indicates the continuing relevance of the topic, but none clearly indicates how to systematize DFS to the Product Development Process (PDP). Consequently, with the results of the relevant

documents and its encodings, another analysis was elaborated indicating issues related to the objectives of Products (A), Services (B), and Product and Services (C) respectively.

Figure 6. Timeline of relevant documents



Source: Authors, 2016.

3 CONCLUSION

Since the service field has been growing significantly, this study proposes and expands the dimensions of the state of the art and it helps to illustrate a perspective of systemizing DFS into the product development process. The study indicates that in the current approaches there are gaps and possibilities to incorporate the DFS into the PDP, which may reveal important meanings to the other main axes related to technology, procedures, and people. Because this study presents the researches done until this moment, it is recommended that future researches take into consideration articles that are highly focused on the development of the DFS attributions into the PDP.

Thus, the emphasis should not only be on making the contribution of visible service dimensions, but also on the dimensions of services that are not visible. Tangible

resources also have to be taken into consideration in order to create service value. There is also a need for future researches that address the operation of services in specific areas (eg finances, public services, hospital services). Even if different measures have been proposed throughout the years, there is the impression that the common characteristic of these measures need a more suitable systematization that justifies the increase in efforts. This study partially covers the contributions of the chosen research process, but it has a reasonable contribution in relation to the literature review process that covers a significant part of the available articles and materials about the application of DFS methods into the PDP.

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