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A Product Avatar for Leisure Boats Owners: Concept, Development and Findings

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Abstract. The European boat industry is suffering from a slowdown in customer demand. The manufacturers and other stakeholders are forced to think of new ways to regain competitive advantage and to attract and maintain their customers. A promising approach is to develop new services based on the collection of information throughout the product lifecycle. Different stakeholders can use the services over different channels, such as Social Network Services, by means of a Product Avatar. In this paper, a general introduction to the Product Avatar concept of providing targeted information through selected channels is given first. Next, the technical aspects regarding the implementation and integration of the required data sources are outlined briefly. A presentation of a Product Avatar prototype for a leisure boat and results of two customer acceptance surveys towards end-user acceptance is concluded by a brief discussion and interpretation of the findings and an outlook towards further research.

Keywords: PLM, Product Avatar, Closed-loop PLM, Intelligent Products, Leisure Boats, Social Network Services, Servitization

1 Introduction

Customers increasingly expect physical products and related information of the highest quality. This brings the entire product lifecycle into focus for the manufacturer based on customer demands towards increased individualisation, customisation, sustainability, and maintainability. Accordingly, emphasis is shifting in industry towards actively managing, sharing and developing value-added services based on product lifecycle information. Intelligent Products are key to generating product data throughout the entire lifecycle. The Product Avatar is a promising approach to managing the communication, presentation and interaction with that data for all stakeholders in the lifecycle. These individualized digital counterparts of Intelligent Products can enable stakeholders to benefit from value-added services built on the lifecycle data generated by Intelligent Products.

A broad variety of usage data can be generated, stored and communicated by Intelligent Products. The availability of this item-level information creates potential benefits for processes throughout the product lifecycle. In order to make use of the information, its selection and presentation has to be individualized, customized and

presented according to the stakeholders' requirements. Product owners have particular requirements towards Product Avatars. They need to interact with product data and services in ways that are intuitive and comfortable. Social Network Services such as Facebook are important not only for interaction with other people, but also as personal data management platforms and constitute increasingly dominant interaction and design paradigms. Thus, Social Network Services consequently need to be taken into consideration in the design of Product Avatars for consumers.

In this paper, first the Product Avatar concept is introduced as a concept for digital counterparts to represents the closed-loop lifecycle data and services of Intelligent Products towards different stakeholders involved in their lifecycle. Then, the prototypical development of a Product Avatar in a Social Network Service for leisure boat owners is described. The results of a survey for the evaluation of the prototype are presented next. The paper concludes with a summary of the findings and an outlook to future work.

2 Relevance of Product Avatars to Closed-loop Product Lifecycle Management

This section describes the relevance of the Product Avatar concept to Closed-loop PLM. It begins by describing the perspective towards the product lifecycle adopted by the authors here. It then briefly describes Closed-loop PLM and Intelligent Products. The section concludes with a more in-depth description of the Product Avatar concept, its relevance, and finally, how Product Avatars for consumers – in the case boat owners – can benefit from being presented in Social Network Services such as Facebook.

Closed-loop PLM and Intelligent Products

Literature broadly differentiates marketing and production engineering perspectives towards the product lifecycle [1]. The marketing perspective tends to adopt a sales-oriented view, in which the lifecycle is divided into the introduction, growth, maturity, saturation and degeneration of a product. The product seen not as a physical thing but only in terms of the degree of its economic success [2]. The scope a product refers to in this view may be a model, type or category. The production engineering perspective used here follows [3]. Here, the processes related to the development, production and distribution of the product are arranged into the beginning-of-life (BOL) phase. A product's utilisation, service and repair are labelled middle-of-life (MOL). Reverse logistics take place in the end-of-life (EOL) phase.

Closed-loop PLM describes an approach to PLM which facilitates the closing of information loops between the individual phases of the product lifecycle [4]. It aims to achieve a pervasive availability of relevant product information at any point in the product lifecycle. Furthermore, the concept deals with closing information loops between different IT layers, from the data acquisition, through middleware and knowledge transformation layers to the business application layer. In order to do so,

the concept proposes different methods of applying information technology [5], [6], [7], [8], [9]. With Closed-loop PLM, a paradigm shift from „cradle to grave” to “cradle to cradle” is put forward [10].

Closed-loop PLM relies on the pervasive availability of information throughout the product lifecycle in order to fulfil its aims. This is especially difficult in the MOL and EOL phases of the product lifecycle where, unlike in BOL processes such as design, production and sales, little data is collected in an organised manner. The “Intelligent Product” concept can support Closed-loop PLM by providing a means to collect and communicate product data throughout the entire lifecycle. “Intelligent Products” are physical products which may be transported, processed or used and which comprise the ability to act in an intelligent manner. McFarlane et al. define the Intelligent Product as *“a physical and information based representation of an item [...] which possesses a unique identification, is capable of communicating effectively with its environment, can retain or store data about itself, deploys a language to display its features, production requirements, etc., and is capable of participating in or making decisions relevant to its own destiny.”* [11] The degree of intelligence an intelligent product may exhibit varies from simple data processing to complex pro-active behaviour [12]. Intelligent Products can make use e.g. of RFID, sensors and embedded computing throughout their lifecycles in order to collect data for example about their usage, service, maintenance, upgrading, decommissioning and disposal. They thus can contribute significantly to closing the information loops throughout the product lifecycle and are fundamental to a holistic implementation of Closed-loop PLM in many types of product.

The Product Avatar Concept

Closed-loop PLM and Intelligent Products together provide the conceptual and technological basis for a holistic management of item-level product information throughout the product lifecycle. The stakeholders in the product lifecycle are heterogeneous and have very different requirements towards the selection, presentation and use of product lifecycle data. They include product designers, manufacturers, sellers, maintenance staff, service providers, recycling operators and, of course, the actual owner of the product in question. Consequently, a single interface to closed-loop PLM data is not viable and a more flexible approach is required. A *Product Avatar* is a distributed approach to the interaction with and management of item-level product lifecycle information [13]. It can be understood as a *digital counterpart* or set of digital counterparts which represents the attributes and services of a physical product towards the different stakeholders involved in its lifecycle. This means a Product Avatar presents different interfaces and delivery channels depending on who uses it and how. Stakeholders such as owners, producers, designers may interact with the Product Avatar e.g. via dedicated desktop applications, web pages, or mobile “apps” tailored to their specific information, service and interaction needs. Product Avatars can also interact with other Product Avatars. This can be facilitated, for example, by means of web services, software agents, common messaging interfaces such as QMI, or a combination of these. This

paper focuses on the former type of interaction between human stakeholders and Product Avatars [14].

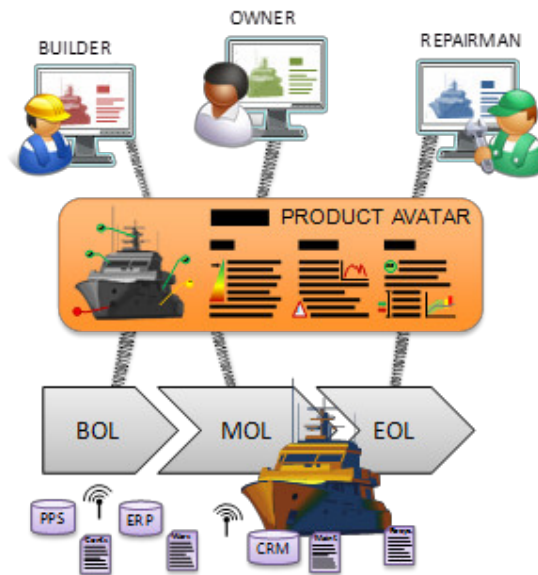


Fig. 1: Digital Representation of a Product through a Product Avatar [14]

Before the design and development of the Product Avatar for a specific intelligent product, requirements need to be elicited and analysed regarding how, over which channel, and for whom the digital counterparts need to be made available. This necessitates considering each stakeholder individually, as they each have their own individual requirements and preferences. In order to achieve a high level of acceptance for a Product Avatar with leisure boat owners, it needs to be designed taking into account interaction channels and paradigms they are already comfortable with and have come to expect. At the same time, European boat builders are seeking to expand their target market to attract the younger generations who have grown up with the Internet – the so-called “digital natives”. Amongst other considerations, these two factors make Social Network Services such as Facebook an interesting channel for interacting between boat owners and Product Avatars.

Social Network Services such as Facebook boast user bases which are already familiar with their design, functionality and interaction paradigms. Furthermore, the service is an accepted communication tool, which is used anytime, anywhere via a plethora of different devices both stationary and mobile. The Product Avatar concept is, in essence, inherent to these tools – users of Social Network Services interact with “avatars” of other users as a matter of course. Thus, it seems a small step for boat owners who already actively participate in Social Network Services to also interact with their boats and the services which augment it through the same channel.

In summary, designing a Product Avatar which uses a popular Social Network Service as its interaction channel and conforms to that network’s interaction paradigm promises to help users interact intuitively with it and thus enhance user acceptance, immediately leverage the user base for potential new value-added services

augmenting the product, and leverage the in-built multimodality and mobility for anytime, anywhere interaction with the Product Avatar.

3 Development of a Prototypical Product Avatar in a Social Network Service for Leisure Boat Owners

This section describes the development of a prototypical Product Avatar implemented in a Social Network Service targeted at the lifecycle stakeholder group of leisure boat owners.

Use Case – Leisure Boat Industry

Up until today, leisure boat builders have focussed solely on the improvement of their products' quality to remain competitive in the marketplace. However, with the recent, drastic downturn in the boat market they are increasingly being forced to realise the need to additionally emphasize both the after-sales market and their customers' demands for products that are easy in upkeep, environmentally friendly and which offer them added-value services to enhance their boating experience. In order to fulfil these requirements, boat builders need to take concepts such as item-level and closed-loop Product Lifecycle Management (PLM) as well as Intelligent Products and Intelligent Maintenance into consideration.

In this research, boat manufacturers aim to employ Product Avatars for leisure boat owners for a number of reasons. One reason is to achieve enhanced customer relationship management and new revenue sources by enabling, for example, the boat manufacturer to provide service offers directly via the Social Network Service. Upgrades, winter storage service, maintenance and other services can be offered in this way. A further motivation is to gain access to a new market segment – spark the interest of the younger generation of “digital natives” who previously had little interest in leisure boats. Leveraging the social network – the “friends and fans” of Facebook users, for example – will also provide exposure of the products to a large number of new potential customers. Finally, boat manufacturers aim to enhance brand recognition by associating with innovative social media services.

Boat owners could integrate their product into their digital lifestyle. They could interact with their product and monitor boat functions using interfaces and technologies they already know. Checking the fuel and battery level on their boat via an app on their smartphone is a simple example. They could share their boating experiences and pictures of the places they visit or check whether their friends are at a location close by. They could also benefit from value-added services offered via the Product Avatar, for example intelligent maintenance, upgrade offers and winter storage monitoring.

Product Avatar Design

As put forward in Section 2, for the Product Avatar to be accepted by the users, in, the Product Avatar has to be tailored towards their individual requirements. For that reason, interviews with more than 100 visitors were carried out (see **Table 1**). Boat owners as potential buyers one were targeted in the survey. Highlights of the results show that 40% use a one or more Social Network Services. Of those 40% an overwhelming majority of 90% use Facebook. This indicates a strong preference of Facebook as the target Social Network Service for the implementation of the Product Avatar. However, a further significant result of the survey was that almost 50% of the interviewed persons expressed their concern over data security issues especially with regards to the use of Facebook as the interaction channel for the Product Avatar.

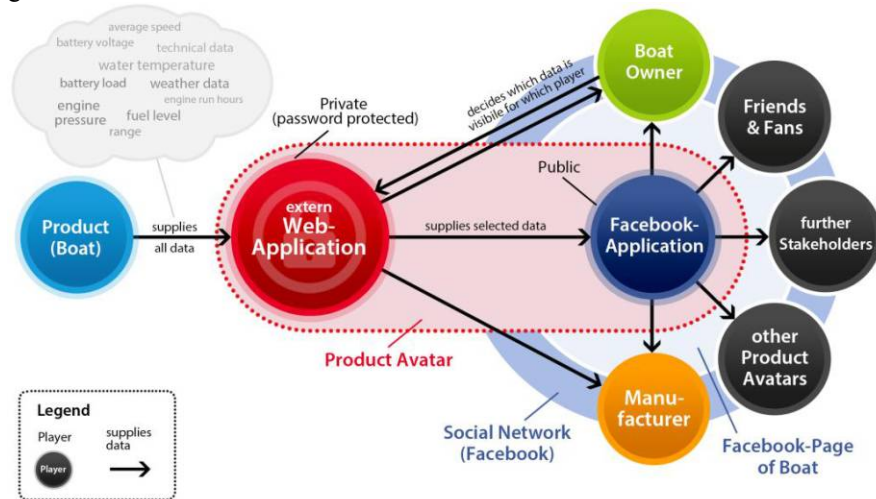


Fig. 2: Design of the Product Avatar for a Leisure Boat

This was taken into account developing the prototype Product Avatar by developing a secure and standalone web service which has most of the functionalities requested already available for the users without any connection to the Social Network Service. Fig. 2 shows the resulting Product Avatar design. It focusses on how the requirements towards data collection, data security and Facebook integration should be handled. On the left hand side, the boat generating lifecycle data can be seen. The data is fed into a standalone Product Avatar web application. The web application is password protected by the boat owner. It can be integrated into Facebook profile of the boat owner, where it can be made available to public if the owner chooses to do so. The owner can also select exactly which data should be shared via the Social Network Service. Stakeholders who can use the Product Avatar are foremost the boat owner, but also the manufacturer who can thus interact with his customer. Friends of the boat owner can also view and interact with the Product Avatar via the Social Network Service.

Closed-loop PLM Architecture

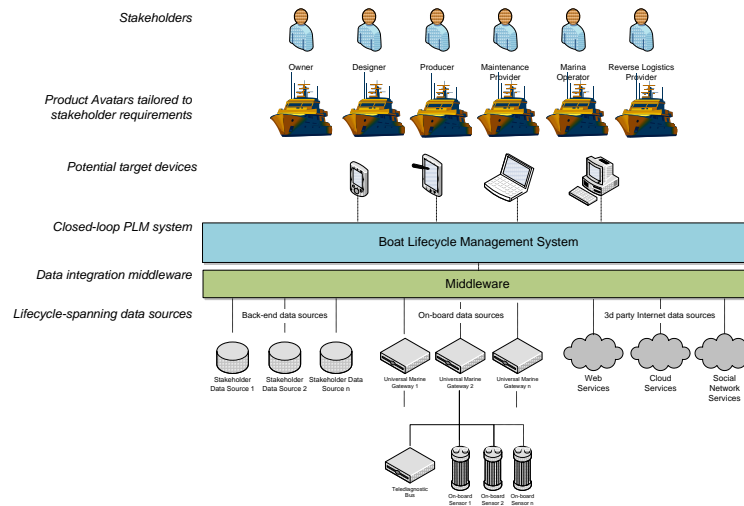


Fig. 3: PLM System Architecture

In order to provide a technical basis for providing data to the Product Avatar, a suitable backend system is needed. Fig. 3 shows the PLM system architecture designed for the Product Avatar. The bottom layer consists of the different data sources which need to be integrated. These include on-board data sources, which can be sensors installed on the boat itself, such as slam, temperature, speed over water sensors, etc. Furthermore, existing data sources such as those connected by a NMEA 2000 bus on the boat (e.g. engine and navigation system data sources) are taken into consideration. These are connected via a gateway device which can be accessed via wireless channels such as WiFi, mobile data and satellite networks. Further data sources are the enterprise systems used by the various stakeholders. 3rd party data sources in the Web and Cloud are also taken into consideration, as well as Social Network Services. The integration of these data sources are handled by the next higher level, the middleware. For the prototype, a semantic middleware (semantic mediator) is used. The data is collected and stored in the next higher layer, the Boat Lifecycle Management System. In the prototype implementation, the Holonix iLike Intelligent Lifecycle data and Knowledge Platform is used to realise this layer.

The next layer represents the potential target devices for the representation of the lifecycle data in Product Avatars. Both mobile (smartphones and tablet PCs) and stationary (laptop and desktop PCs) devices are targeted. On the layer above, different Product Avatars tailored to the needs of the stakeholders shown in the topmost layer are indicated. Depending on the needs of the stakeholders, these can take the shape of traditional, dedicated desktop applications, mobile apps, or in the case described here, a Product Avatar in a Social Network Service for the leisure boat owners.

Prototypical Product Avatar for Leisure Boat Owners

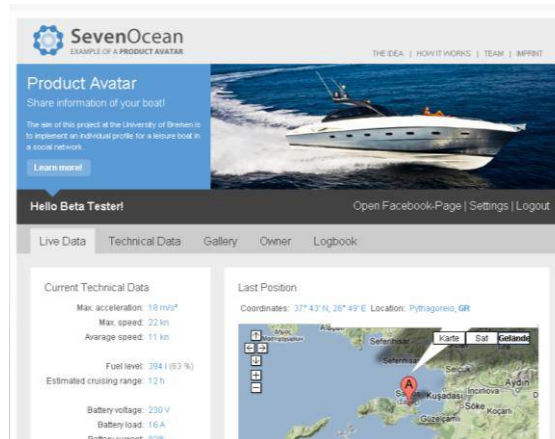


Fig. 4: Product Avatar Supplying Lifecycle Information on for Registered Users

This section presents the prototypical Product Avatar for leisure boat owners which realises the design shown in Fig. 2. Fig. 4 shows a screenshot of the live Product Avatar web service¹. After registration the user can decide what information he or she wants to have and who else can access that information. It is furthermore possible for the users to create new content, like photos or blogs, and add it to the Product Avatar connecting it to the boat.



Fig. 5: Product Avatar representation via Facebook

Some social features requested by owners are only available on a Social Network Service, in this case Facebook. Thus, the Product Avatar has to be implemented there as well. The approach taken here combines both worlds by representing the stand alone web application on the Facebook wall of the Product Avatar representation. This way, the user can decide specifically what information to share internally via the web service or openly via the Social Network Service (Fig. 5).

¹ <https://prodavat.ikap-web.biba.uni-bremen.de/fb/>

4 Evaluation

The prototypical development was evaluated in a survey carried out at the major leisure boat fair boot Düsseldorf 2013. 38 boat owners and potential buyers were interviewed. The avatar was demonstrated live on tablet PCs to the interviewed persons, who had the opportunity to use the avatar prototype. The response was overwhelmingly positive. The survey questions “Is the Product Avatar an important selling point for you?” received a 78% positive approach. In the first survey, without a practical demonstration, the same question received 83% negative responses. This result highlights the viability of the idea to integrate Product Avatars with Social Network Services, and also that providing the service to compliment a leisure boat can be a significant competitive advantage to boat manufacturers.

Table 1. Survey Overview

Survey No.	Event	Location	No. of responses	Nature
1	54 th Hamburg International Boat Show	Hamburg, Germany	100	Questionnaire for requirement elicitation
2	boot Düsseldorf 2013	Düsseldorf, Germany	38	Prototype presentation for evaluation purposes.

5 Conclusion and outlook

To conclude, the approach presented to apply the developments of Facebook and its user-driven, constantly evolving information infrastructure to the Product Avatar of an Intelligent Product for consumers currently seems viable and promising. As shown in the use case, the technical realisation as part of a holistic closed-loop PLM system is feasible. The positive results of the evaluation survey indicate that integrating a Product Avatar with Social Network Services is well accepted by the target group and could constitute a significant market advantage for boat manufacturers. Future work will focus on extending the functionality of the Product Avatar to integrate service offers from the manufacturer and other stakeholders. Furthermore, push notifications from other boat lifecycle stakeholders will be integrated. The prototype will be improved to provide a fully functional pilot for select boats built by European SME boat manufacturers in the BOMA “Boat Management” project. Beyond the leisure boat sector, research needs to be conducted to investigate whether the positive reaction to the concept is isolated to the use case or transferable to other Intelligent Products.

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