The Semantic Enterprise - bringing Meaning to Business Processes

Jasmin Franz[1], Andreas Gaag[2], Mohammad Abuosba[1]

[1]*empolis GmbH, Europaallee 10, 67657 Kaiserslautern, Germany, {jasmin.franz, mohammad.abuosba}@empolis.com*

[2]*TU München, Lehrstuhl für Produktentwicklung, Boltzmannstr. 15, 85748 Garching, Germany, andreas.gaag@pe.mw.tum.de*

Abstract

This paper presents an answer on the demand for more interoperability of data, systems and thus organisations. PROCESSUS as a particular project of the German national funded high-tech-initiative THESEUS has the objective to create an IT-based corporate system that will allow companies to compare products, solutions and details of business associates, as well as locating the complex and sometimes obscure specialist information needed by employees whose work involves high-density knowledge bases. The research teams are also aiming to develop a basic semantic platform that will integrate a company's internal planning of resources with management of the digital content of agile business processes. One specific scenario taken from the domain of mechanical engineering will demonstrate the requirements of intra- and intererenterprise communication and the envisaged solution.

Keywords

Business processes, semantic platform, SOA, Internet of Services, agile workflows, ontologies, design methodology

1 Introduction

These days one often comes across the vision of the World Wide Net: The Internet of the next generation, also called Web 3.0, will provide easy access to the structured global knowledge and to novel services, and crucially improve the quality of information of the relevant contents that are needed at a given moment.

In this new semantic infrastructure, companies will also be able to communicate more efficiently with other companies and, more to the point, with their customers as well as consumers in the future. In the process, innovative digital goods and services will be developed whose safe utilization are guaranteed through novel rights-management tools. For example, in the future it will be possible to organize new business and production processes on the basis of interenterprise systems such as Internet-based and interoperable software modules in small and medium-size companies.

For helping to fulfill this vision, the governmental program THESEUS[1] has been implemented for contributing to the creation of a knowledge- and IT-based service economy (Internet of services). THESEUS is an umbrella organisation uniting researchers from the public sector and industry, who are now working together on the development and design of innovative basic technologies and technical standards for the creation of a new Internet-based knowledge infrastructure that will allow faster and more effective processing and use of online knowledge in future.

PROCESSUS is one of THESEUS' application scenarios with the objective to create an IT-based corporate system; this system will allow companies to compare products, solutions and

[1] THESEUS is part of the "Information Society Germany 2010 (id2010)" program of the federal government. See http://theseus-programm.de/front

details of business associates, as well as locating the complex and sometimes obscure specialist information needed by employees whose work involves high-density knowledge bases. The research teams are also aiming to develop a basic semantic platform that will integrate a company's internal planning of resources with management of the digital content of business processes [Schmelzer, Sesselmann, 2006]. PROCESSUS is mounted on the technical platform used in the TEXO application (another THESEUS scenario), and provides a number of additional services that define the semantic Business Integration Platform. This will involve integrating the various TEXO and PROCESSUS modules and components in a single platform, with the addition of some new functions. The ideas and solutions will be tested on examples taken from mechanical engineering applications in the drive and automation technology areas, and from the field of IT, where the focus will be on service-oriented architectures.

2 The Vision and the Research Approach

The idea of the semantic business process integration platform is to give users selective access to the unstructured data[2] found in emails, minutes of meetings, offers, etc. Nowadays organisations have a big amount of structured and unstructured data that are stored in different CMS, ERP, DB etc., systems. In our daily business we do need dedicated information for our different and special business processes. This information is held "somewhere" in our content assets in the organisation. But because of missing interpretation of the meaning of that information we are not able to find the right information we really need. That means we have a "semantic gap" in the interpretation of information. According to the current state of the art, "Ontology" seems to be the right medium to solve this semantic gap.

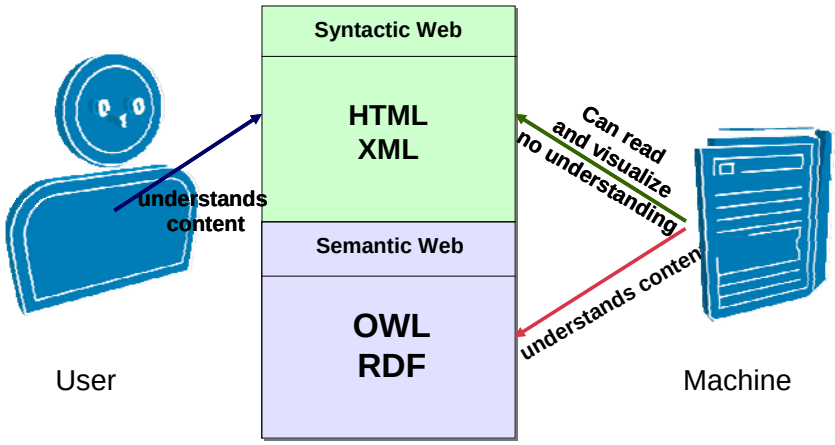

Figure 1: Syntactic versus Semantic Web

In future, universally applicable ontologies will make it possible to harness the interrelated information located in unstructured data and use it to create automated business processes. This will require the development of functions that are capable of creating structured content, which will then be enriched by the addition of semantic information. Content processed in this way can subsequently be linked with other information. By the allocation of the products and their information objects to the ontology, products become intelligent objects. They possess not only attributes but also abilities and relations to other products or services. The "abilities" are the connecting points to the services.

A prototype Business Integration Platform will be designed for this purpose, incorporating tools for the semantic accessing of content and contextual relationships in collections of unstructured

[2] Merrill Lynch estimates that more than 85 percent of all business information exists as unstructured data - commonly appearing in e-mails, memos, notes from call centres and support operations, news, user groups, chats, reports, letters, surveys, white papers, marketing material, research, presentations and Web pages.

data. The emphasis will be on new components and services, or the expansion of existing ones. Here are just a few examples:

- Content Management (creation and editing of content that requires semantic enrichment)
- Ontology administration (creation, import, export, maintenance, etc.)
- Specialist ontologies for selected application domains
- Improved access to semantic content (reasoning, semantic search, semantic classification)
- Service accounting and invoicing (logging, billing, licensing, DRM)

PROCESSUS' high level features can be grouped into five categories: content creation, content usage, infrastructure, to be integrated applications, ASP. Even though the list is not comprehensive it provides a good overview about the proposed solution.

Those solution features will be made available as web-services, orchestrated on a SOA-platform environment. While a SOA platform creates the environment to run the web-services [Bieberstein, Bose, Fiammante, Jones, Shah, 2005], the collection of the basic services (such as content management, ontology management, content classification, workflow management, access management etc.) will build the PROCESSUS platform technology.

The Vision of PROCESSUS is a "Butler" who gives us the right and needed information - independent of its storage place and format - in the process context and process step that a user works on in the moment of his search request (see fig. 2). On the other hand PROCESSUS shall support the users by the design and deployment of their own business processes.

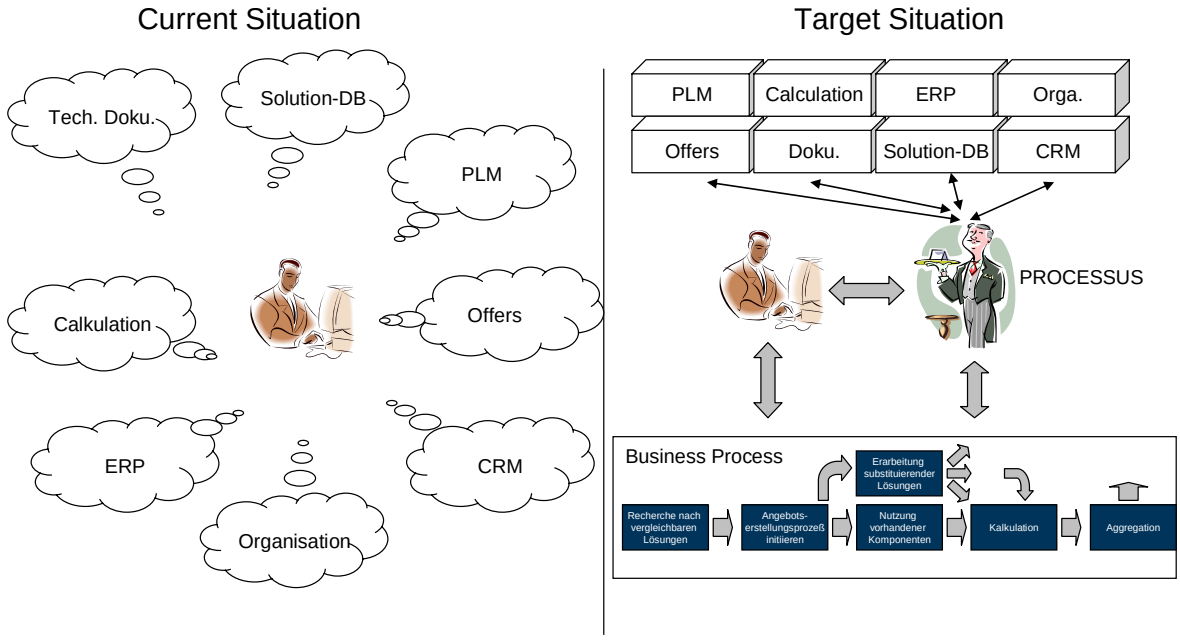

Figure 2: Processus vision

The horizontal PROCESSUS platform enables vertical applications for different usage scenarios on top of it. A central operated model of this platform is postulated, which makes it possible to easily manage and operate the service, avoids long implementation phases and allows sharing of content, semantics and ontologies between parts of the organisation and especially across different organizations (e.g., in supply chains).

PROCESSSUS also involves research into two industry-specific ontologies. While the first of these focuses mainly on solutions and applications in the domain "drive technology / automation technology", the second pilot project application in the software industry concentrates on service-oriented architectures (SOA). There will first be an analysis of existing standards and

classifications in the respective specialist domain of each of the ontologies. Following this, existing data compilations will be structured and finally incorporated into the ontology. The aim is to create the ontologies automatically and then check them manually.

This paper introduces the research approach of Processus by exemplifying the first pilot project in the domain of drive technology / automation technology (mechanical engineering) in its current status. Typical user groups are sales and production staff that require continuous, unrestricted access to the company's store of knowledge about the functions and possible applications of products and solutions. At present, software systems provide only inadequate support for this kind of search for knowledge about products or solutions. These days, the heterogeneous nature of the information in question, and the almost infinite range of different viewpoints of those providing or consuming information, represent a very real challenge; no set of standards yet exists that would allow these heterogeneous viewpoints and their respective specialised terminology to be linked systematically and consistently. Using ontologies guarantees standardised knowledge transfer. The second pilot project will see PROCESSUS create a semantic infrastructure for context-driven content management. Those pilot projects will provide the potential of quickly implementing a first solution, consisting of existing components and new developments, on top of which market-individual implementations with a defined value-proposition are to be build.

3 The Problem: Barriers in finding Solutions and Applications

The scenario for mechanical engineering is developed to support the value-added chain for design, manufactoring and deployment of a Drinks bottling plant (see fig. 3).

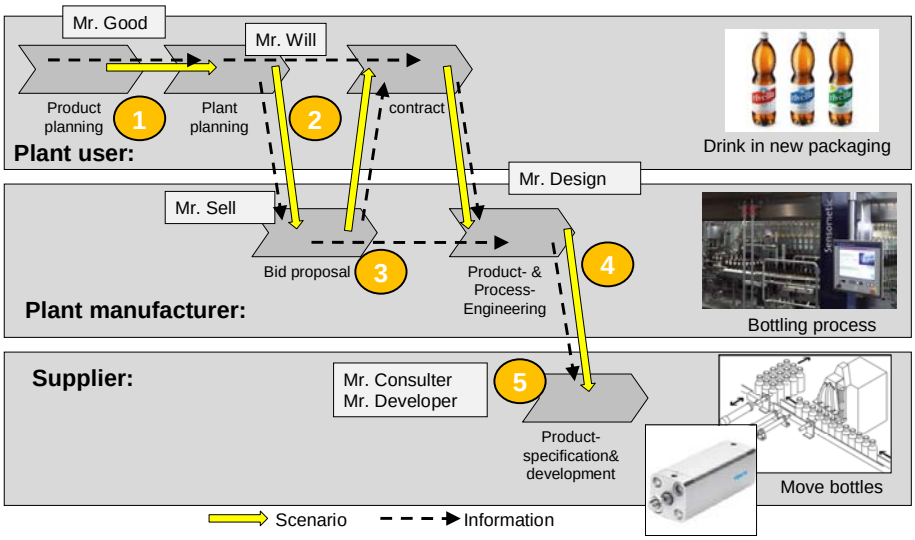

Figure 3: Scenario for the manufacturing process of a drink bottling plant

The general objective of this scenario is the support of users in the efficient and effective administration of knowledge within heterogeneous digital data repositories and the target-oriented access to relevant contents. Target companies are providers of components and system solutions (mainly represented by small and medium sized enterprises) as well as OEM manufacturers (primarily large companies), e.g. within the area of drive and automation technology.

The knowledge in focus of the considerations within the scenario concerns technical functions and applications as well as corresponding (product) solutions. Two types of knowledge transfer are addressed: first, the knowledge transfer within a single company (e.g. via intranet), second, the exchange of information and knowledge on applications and technical solutions via publicly

available platforms addressing a high number of companies as content providers and clients (e.g. e-market applications).

In the scenario discussed here (see fig. 4) one employee of an OEM manufacturer has to find a solution for transferring bottles within an automated packaging system. Nowadays he can use different information systems within his company (e. g. Product Builder/Set-Up Systems, PDM-Systems/Databases, Product Catalogues) to access solutions already used and developed before in his company. If he doesn´t find a fitting solution he has to look for further companies offering possible products and solutions which can fulfill the requested task. For that goal he can use e. g. the Internet or existing e-Market platforms.

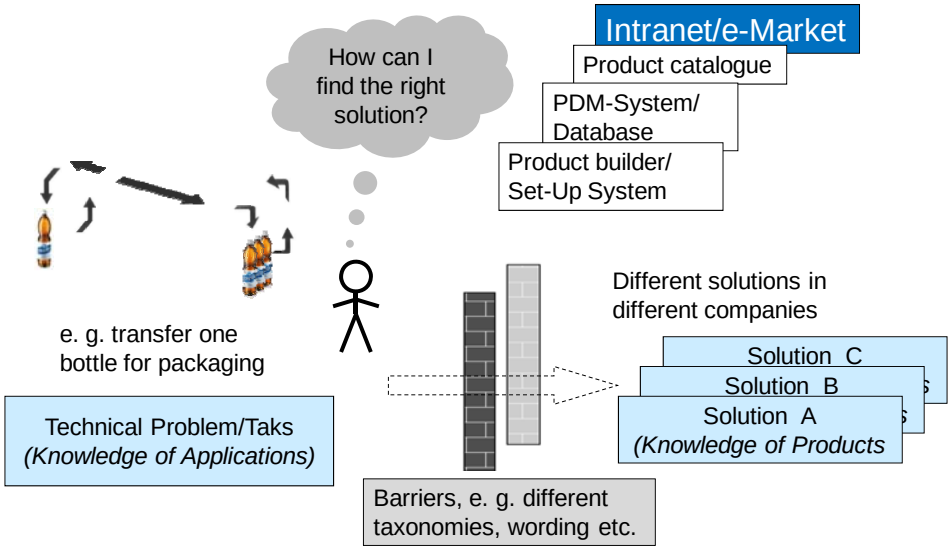

Figure 4: Barriers in finding the right solution – focus of first pilot project in domain of drive technology/automation industry

The access to digitally available knowledge on field-tested solutions and applications represents a problem, especially in small and medium sized enterprises (SMEs). Problems arise due to the organizational structure of the companies (many remote sales and distribution departments) and corresponding distributed competencies. Available information channels are often insufficient. Personal communication still represents the most favoured way of knowledge transfer, but works only in a limited number of cases, since knowledge bearers are often not available or simply unknown to the persons looking for information. In addition, relational databases currently do not provide efficient access to relevant knowledge.

The common search mechanisms (keyword or category search) in databases show noticeable deficits concerning the quantity and quality of hits as well as the duration of the search process. Static structures, basing e.g. on the product classification of a manufacturing company do not offer support in the search for information for new solutions that are not known to the searching person yet, when only requirements, functions and details on the field of application are known. Up to now, the provision of knowledge in the form of competencies, products or solutions as well as the efficient management of the required effort for providing that knowledge are rarely supported by existing generic approaches or software systems [Ponn, Lindemann, 2006].

The focus in the first pilot project is to find solutions to overcome the existing barriers and to support the interoperability between the user and the provider of technical products. Therefore real inter-enterprise systems and methods have to be developed to reach this goal.

4 The solution: Apply Meaning to Business Processes

A special challenge for a successful knowledge transfer is represented by the heterogeneity of the regarded information and by multiple viewpoints of providers as well as clients of information.

Ontologies, which are essential features of the *PROCESSUS* platform, enable the integrated consideration of various viewpoints (e.g. business sectors, requirements, functions, products etc.). The specific ontology to be developed within this scenario represents an internal as well an external standard. By providing several classifications of the individual concepts within the ontology and linking these concepts, existing problems can be overcome and new ways of exchanging knowledge are created, e.g. the possibility to switch between different views or to combine several categories and therefore allow for a more focussed search. It is the goal to combine distributed and heterogeneous data repositories to one knowledge base with the ontology as central key of their semantic interconnection. Furthermore, a methodology [Vrandecic, Pinto, Sure, Tempich, 2005] is created that enables the classification and standardization of the regarded contents, which minimizes the effort for editing the ontology.

In the design and engineering field four root concepts for ontologies have been developed and evaluated in former research projects [Ahmed, Kim, Wallace, 2007]. These root concepts are:

- Design-Process: description of the design process and the different stages in engineering design, e.g. requirements engineering, concept design.
- Function: description of the functions of the product which have to be fulfilled.
- Issue: description of the considerations of designers during design process.
- Product: description of the product itself, e. g. the product component structure.

Because of the focus of overcoming the barriers between the application and possible solutions in the first pilot project abstraction and function modelling have been identified as the core aspects of the ontology to be developed. According to design methodology the function of the product and the application are described with object and operation. This kind of description is regarded as the key for finding solutions and bridging the gap between the application and the product side (see fig. 5).

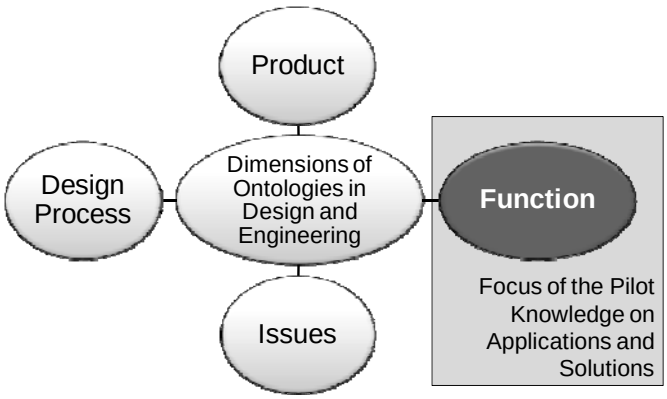

Figure 5: Ontologies in Design and Engineering and the focus of the methodology in Searching for Applications and Solutions

The methodology to access solutions by describing the applications and the products in a function-based ontology as well as the possibilities offered by the *PROCESSUS* platform shall be illustrated by giving a representative example that also will be demonstrated in more detail via a first prototype during the talk at the conference:

A product development engineer from a company offering system solutions for the layout of plants is looking for solutions to a sub-system of a new packaging station. One important subsystem of the packaging station is the transfer of bottles. Since the solution has to be cost efficient, but of high quality, the engineer wants to investigate alternative principle solutions first before looking into specific components from particular manufacturers. The consideration of competing technologies for a given application is currently rarely supported in existing systems. At present, providers as well as clients of knowledge are faced with a huge complexity due to

extremely heterogenous contents and inadequate access mechanisms. Here, the *PROCESSUS* platform provides a semantic connection between requirements, functions, solution principles and corresponding products.

By searching with the keywords “transferring a bottle” (representing function and application), the designer is supported to describe his problem in an abstract and more general view, e. g. “moving a cylindrical workpart”. The relationships between the concrete problem descriptions and the general concepts are implemented in the domain specific ontology for packaging industry. After describing his problem the engineer is led to a number of promising solution principles (e.g. mechanical, hydraulic, and pneumatic). The solutions itself is linked into the ontology the same way the designer described his problem. Whereas the product is described with “packaging of beverages” the ontology supports abstracting the function of the product and describing it in a more general way with “moving a cylindrical workpart” (see fig. 6).

By typing further requirements (“batch quantity, merchandise, packaging material, etc.”), the solution space can be narrowed down and different solutions and products as well as a number of companies offering these products are given out as result.

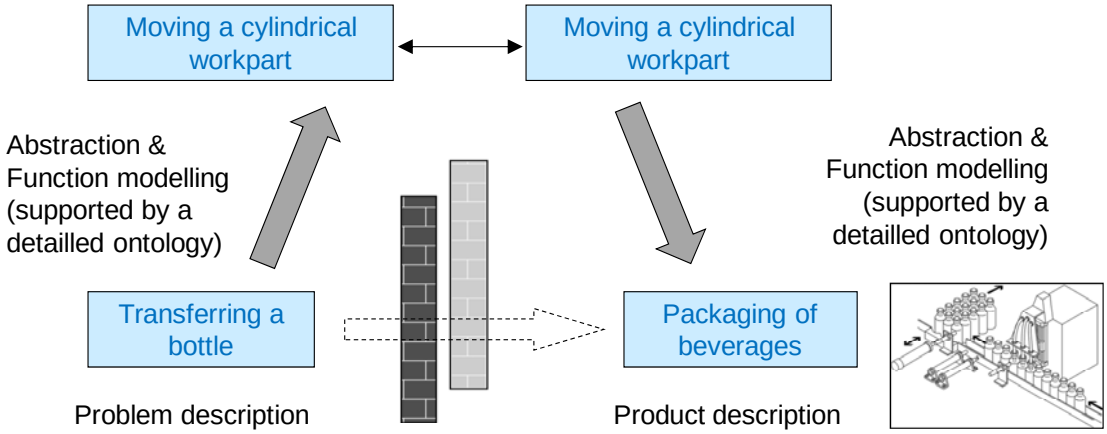

Figure 6: Linking Problem and Product description

After the engineer has expressed his needs and requirements, the sales employee consults an online product catalogue in order to gain a quick overview over potential solutions that are available, field-tested and up-to-date. Hereby, the customer view (product requirements, functions) and the concepts in the mind of the sales person (product portfolio, sensor specifications) are ideally linked by the ontology-based search support to enable a target-oriented search and restrict the results to relevant documents. Also, reference cases are identified, where similar orders have been processed within the company in the past. In the end, an adequate product is found that fulfils the specified requirements and additionally contributes to a cost-efficient system design.

After the negotiations, the sales employee is willing to enter the gained knowledge, which itself represents a new reference case, into the company knowledge pool. The features offered by the *PROCESSUS* platform minimize the effort of adding the semantic content that is necessary for a targeted access of this knowledge by other employees in similar business situations. Therefore, ideal preconditions are created for such an internal knowledge management that gains acceptance from providers as well as clients of knowledge.

5 Discussion and Conclusion

Concluding, the Processus team forecasts that by the deployment of semantic technology for content usage and search, enormous competitive advantages are to be expected. The planning

and design phase can be arranged more efficient up to 50% in time and budget, due to better search and finding of existing similar solutions.

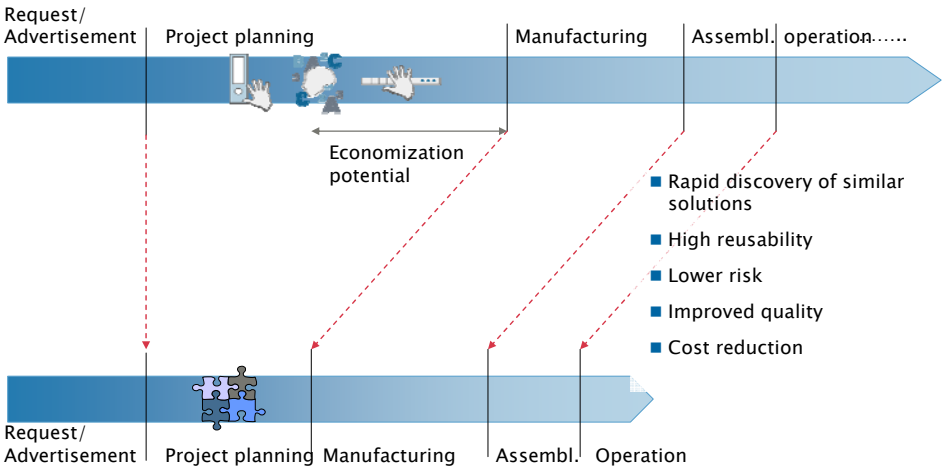

Figure 7: Competitive Advantage

This scenario has been illustrated with examples from the drive and automation industry but is also generally applicable for knowledge transfer in other business sectors. For knowledge providers, especially SMEs participating in the e-marketing-platform, the *PROCESSUS* approach provides adequate mechanisms to display their competencies and available solutions on the market and attract possible clients in a more efficient way than before.

This scenario is being inquired by the Verband Deutscher Maschinen- und Anlagenbauer (VDMA) together with partners from the industry, among them Festo AG & Co. KG. They are willing to set up a pilot in order to realize a business platform which allows engineers, sales people or procurers to quickly identify products, solutions or possible business partners. The intended platform targets about 3,000 member companies of the VDMA.

Acknowledgement

This work has been partly funded by the BMWi through *THESEUS*. The author wishes to acknowledge gratitude and appreciation to all the PROCESSUS project partners for their contribution during the development of various ideas and concepts presented in this paper.

Literature

Ahmed, S., Kim, S., Wallace, K. M.: A Methodology for Creating Ontologies for Engineering Design. In: Transactions of the American Society Engineering Design Computing in Information Engineering (ISSN: 1530-9827) , vol: 7, issue: 2, pages: 132-140, 2007.

Norbert Bieberstein, Sanjay Bose, Marc Fiammante, Keith Jones, and Rawn Shah, Service-Oriented Architecture Compass, IBM Press 2005.

Lloyd, S.; Lloyd, T.:Bits and bucks: Modeling complex systems by information flow, Massachusetts Institute of Technology, Engineering Systems Division, Cambridge, 2003.

Paetzold, K.: Workflow-Systeme im Produktentwicklungsprozess, 15. Symposium “Design for X”, Neukirchen, 2004.

Ponn, J., Lindemann, U.: Intelligent Search for Product Development Information - an Ontology-based Approach. In: Marjanovic, D.: 9th International Design; Conference Dubrovnik, 15 - 18 May 2006. Glasgow: The Design Society 2006, S. 1203-1210.

Schmelzer, H.; Sesselmann, W.: Geschäftsprozessmanagement in der Praxis. 5. Aufl. München: Hanser Wirtschaft, 2006.

D. Vrandecic, H. S. Pinto, Y. Sure, and C. Tempich. The DILIGENT knowledge processes. Journal of Knowledge Management, 9(5):85{96, OCT 2005.