Integration of Flexible Manufacturing and Change Management Processes in a Service-Oriented Architecture

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ABSTRACT — The success of a company invariably depends more and more on the ability of a company to recognize changes in its environment at an early stage and consider these changes timely in its competitive behavior. Flexibility, as one of the major factors, marks the ability of a company to master complex environmental situations in order to boost its chances to survive and safeguard its long-term success. This article reflects on the perspectives offered by the utilization of the service oriented paradigm for realizing the integration of a flexibility evaluation platform used for 'near real-time' flexibility measurement and monitoring of a manufacturing system, within the scope of a change management platform.

***Index Terms* — Flexibility, SOA, Web Services, Production System, Business Processes**

I. INTRODUCTION

Since the last decade, producing companies are confronted with an ever more complex and fast-changing environment, which is the result of an increasing individualization of the customers. They are forced to integrate a rising number of products and product varieties whereas the predictability for manufacturing determinations like break evens, turnovers or sales is decreasing [1]. Accordingly, the success of a company depends more and more on the ability to recognize internal and external influences as early as possible and to react to resulting changes with an adaptation of their organizational structures, and eventually their production systems.

To ensure a fast response to these influences the most critical challenge for manufacturing companies today is the management of product and production changes in general, not only within a production system of one factory but also across organizational borders. That implies a permanent alertness of manufacturing companies regarding for instance the flexibility of their production systems. At present, most major manufacturing companies and OEMs[1] consider flexibility as an important performance factor representing a significant feature in order to master the complex situations on the market and at the same time to ensure a long-run success of companies [2].

However, since as stated in [19], flexibility cannot be properly considered in the decision making process if it is not properly defined in a quantitative fashion, quantified data has to be gathered from a variety of sources and in a near real-time frequency. Another viewpoint is that flexibility is a relative attribute that depends not only on the manufacturing system itself, but also on the external demands placed upon it [18].

To enable a long-run success a serious need to adapt existing business processes according to the demands from customers, suppliers or laws has to be realized. Whereas the approaches from the past focused on static applications and legacy systems, applications operating in modern dynamic changing environments need a suitable IT-Architecture. Traditional IT-Systems are inadequately architected to meet the rapidly evolving needs of scalable, platform independent enterprise applications [8] [9].

The Service-Oriented Architecture (SOA) is a new software development paradigm developed to support dynamic changing enterprise applications and open, flexible, agile software systems.

An added advantage of SOA is that applications can be composed at runtime using already existing services.

II. PERSPECTIVES

Funded by the European Union[2] the X-Change project aims to develop and integrate flexibility measurement methods to support and improve change management processes within production systems. The project will provide a software framework that will extend and enhance the effectiveness of production systems in general by optimizing change processes within a production network.

[1] Original Equipment Manufacturers

[2] FP6-2004-IST-NMP-2

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To achieve this objective three general topics have to be addressed [15]:

1) The development of a platform for measuring the flexibility of a production enterprise by the means of suitable flexibility evaluation methods.
2) The integration of the flexibility evaluation platform in a flexible and agile service oriented framework which facilitates change management in production systems and extended enterprises which operate in dynamically changing environments.
3) The provision of decision-support through the software framework regarding the management and planning of short and mid-term changes of a manufacturing system as well as a continuous redesign and improvement of change management processes in the product lifecycle.

The X-Change vision is illustrated in Figure 1.

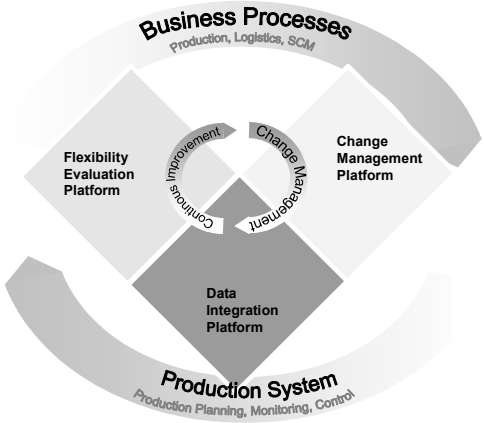

Figure 1 Continuous improvement of change processes within the product lifecycle

It elucidates the interwoven processes of continues improvement and change management within the business processes of production systems. The concept presented in Figure 1 connects formerly separated domains like manufacturing systems (products) and change management (processes) with each other. Thus it enables a continuous improvement both of processes and of next generation products by integrating them in a service-oriented architecture.

In order to assemble the project objectives the following five subtasks have to be accomplished:

1) Development of a Data Integration Platform
2) Integration of existing business process of the involved companies in DIP
3) Integration of a change management platform
4) Integration of the flexibility evaluation platform on IT level
5) Provision of an easy-to-use human-machine interface

The focus of this paper is the integration of the flexibility measurement platform together with a change management platform into a service-oriented architecture to achieve the maximum flexibility of the applicable software systems.

III. Service-oriented Architecture in a Nutshell

The following section provides an outline to the essential advantages and characteristics of SOAs.

Literature offers several definitions of service-oriented architecture [4] [16] [17]. Regarding the context of flexible and agile production systems the authors consider SOAs as an evolution of past middleware platforms. They are preserving successful characteristics of traditional architectures, and bringing with it, distinct principles that foster service-orientation in support of a service-oriented enterprise (SOE). Contemporary SOAs represent an open, agile, extensible, federated, composable architecture compromised of autonomous, quality of service capable, vendor diverse, interoperable discoverable and potentially reusable services [4]. In essence SOAs can be characterized by a number of discrete, organized services for an end-to-end solution. Typically these services come on two flavours:

1) Business Services containing implemented business logic (processes and rules) and
2) Technical Services supporting technical functionality required to ensure the smooth operation of the overall solution. This might include data services (for persisting business objects), services for authentication or identification, or even services that provide online access to catalogues of other services.

This approach is very similar to the component based architectures of the late 90s but the main difference is that SOA takes a more coarse-grained view of functionality.

In general SOAs persist of three basic attributes: *autonomous, interoperable* and *composable*.

Autonomous services means that the data inside the SOA is private to the service and always encapsulated by the service so the only way of accessing it is through the business logic of the service. This data is only loosely correlated to the data on the outside traveling in form of messages. Furthermore *autonomous* services can be distinguished into three principle properties [7].