A Topic-Map-based Framework to Enhance Components' Retrieval in a Process Control

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Abstract: Controlling a manufacturing process to meet customers' requirements is crucial for many industrial companies to remain at the forefront. The control of a manufacturing process requires for each actor involved in this process to be reactive and effective in monitoring the process in order to meet company objectives. Enhancing the sharing and the retrieval of the components that support the control of such a process is necessary to effectively meet actors' requirements for the accomplishment of their business tasks. Semantic description with knowledge representation techniques is one of the widely used techniques to address components' retrieval. Existing methods focus on describing components according to their functionalities, thus they don't really tackle user requirements that the components meet. We propose in this paper a layered conceptual framework to add semantic description to the components that support the manufacturing process control starting from the users' requirements. A Topic-Map-based solution is proposed to support the implementation of this framework.

1 INTRODUCTION

Controlling large scale manufacturing processes in industrial companies is a complex task that requires a continuous monitoring and analysis of the process to ensure its achievement. The manufacturing process control consists of a set of tools and methods established to guarantee that products meet customers' requirements. To that aim, process control systems and tools enable to extract many indicators to follow the manufacturing process and to measure the adherence to company objectives. We note that an indicator is an aggregate of measures (Claudepierre, 2010) as known in the decision engineering field. The main problem in establishing such a control activity is giving access to process control tools to all the actors of the company that have same needs. The used tools are a set of heterogeneous components such as a software product, a software component, a database system or even an information resource. Thus, sharing and retrieving such components between users without an organized way and a consistent method is often difficult. There is a lack today of an efficient method to manage the sharing and retrieving of the components that support process-control methods in industries. The main difficulty in this context resides in the distance between what a component does (the *what*) and which need it addresses (the w*hy*). This distance can entail low-quality search and results (Lucredito et al., 2004). The goal of our work is to reduce this gap in order to improve components' retrieval during the control of a manufacturing process. We propose a Topic-Map-based framework to integrate users' requirements in the components' description. The conceptual design of the framework is based on three levels of abstraction: a requirement level, a functional level and a physical level. The characteristic of our proposal is that we use the Topic-Map standard (Pepper, 2009) which is an ISO semantic web standard to support the integration of these levels.

The second section in this paper presents an overview of the conceptual framework. The third section presents the Topic-Map-based solution which supports the implementation of the framework. The proposed framework with its Topic-Map implementation is illustrated by an example from STMicroelectronics.

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2 A CONCEPTUAL FRAMEWORK ALIGNING COMPONENTS WITH THE USERS' REQUIREMENTS

2.1 Overview

Our goal is to define a framework for components' description to enhance their findability and usability between users involved in the control of a manufacturing process. To that aim, we can distinguish three main types of knowledge underlying this context: User requirements, component functions and the components themselves. We propose then a three layered framework as follow: Requirements' level, Functional level and physical level. Each level is supported respectively with a meta-model (URM, FM, PM) to handle the components' description in an organized manner.

Figure 1 depicts the proposed layered framework. The goal of each level is to provide a semantic description above components driven by the users' requirements. In fact, the main difference between our components' description and the existing models proposed by the scientific community is that our framework is oriented toward non-expert end-users. Most existing components' description models are proposed for market components and are usually devoted to address retrieval issues in the context of software development. Our proposed framework is rather devoted to enhance the retrieval of diverse components related to a specific industrial process.

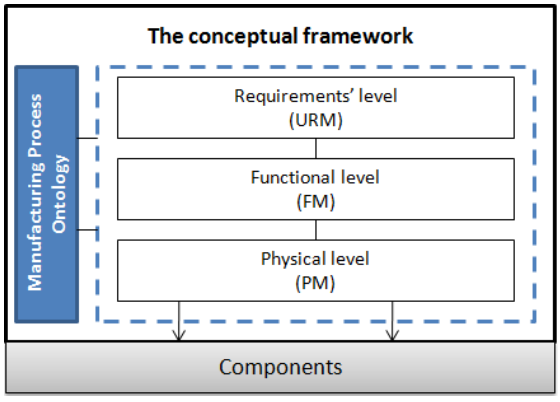

Figure 1: Overview of the conceptual framework.

The semantic description proposed in this framework starts from the users' requirements and focus on the relevant properties that can guide the user in the selection of a given component. In addition, each level is enriched by concepts from the manufacturing process ontology because these components are kinds of services supporting the control of manufacturing processes. Thus, the proposed framework enables in fact to align components with the users' requirements using semantic-description techniques.

2.2 The Requirement Level

The requirement level enables to capture the users' requirements in a manufacturing process control. A user in this context is an actor that can be a person or an organization from the process control function. This user has one or many requirements which can be simple or complex. Each requirement is then expressed as a goal that can be refined with an AND/OR graph (Lamsweerde, 2001). A goal at a low level is measured with one or many indicators. These indicators enable at the end to respond to the user requirement because the actor can know through an indicator if he reached company objectives. Figure 2 depicts an example of goal decomposition until the indicators definition from STMicroelectronics. STMicroelectronics is a French-Italian company specialized in the manufacturing of electronics chips. This example is related to the *Wafer-Fab-Yield* (WFY). A Wafer is a silicon plate used as support for the construction of chips.

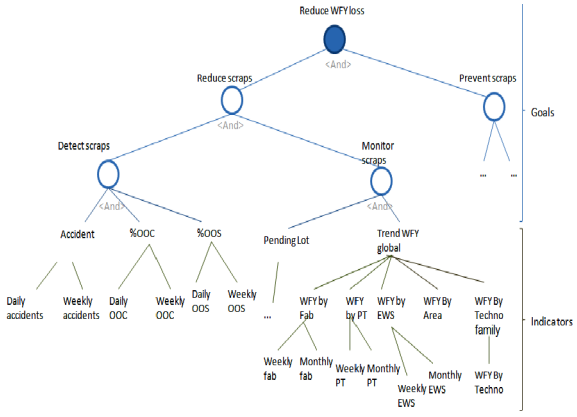

Figure 2: Example of a Requirement Model.

To reduce WFY loss, the company actors have to follow two main goals: to *reduce scraps* and to *prevent* them. A scrap is a wafer that is not compliant to the quality and the reliability requirements. To *reduce scraps*, process control actors need to *detect scraps* and to *monitor* them. To detect scraps, three main indicators are supervised:

the *number of accidents*, the *percentage of lots Out Of Control (OOC)* and the *percentage of lots Out Of Specifications (OOS)*. These indicators are mainly based on statistical methods.

2.3 The Functional Level

The functional level describes the *what* of the components to enable the user to know what a component does according to his requirement. In this level a component is described with its functionalities and its outputs. The outputs of the components here are in fact the indicators sought by the users for the process control. We can add also in this level some non functional properties. These properties give information about the quality of service of the component such as its usability, its performance or its reliability to help the user in the selection of a given component.

2.4 The Physical Level

The physical level provides information about the components themselves as physical entities. It gives the components with their meta-data to the user. As kinds of meta-data we can cite the execution environment of the component, its location and eventually the used data-sources to generate the indicators. We note that these components can be heterogeneous depending on company assets and its information systems. Some components can be kinds of decision-support systems - such as reporting tools and data analysis tools- or artifacts produced with these systems. Other components can be kinds of documents and web resources such as dashboards and web portals referencing process-control indicators.

We propose to support the implementation of the framework with the Topic Map standard which is a semantic web standard for resources' annotation and ontologies' construction.

3 TOPIC MAPS TO SUPPORT COMPONENTS' DESCRIPTION

Topic Maps are an ISO semantic web standard (Arroyo et al., 2004) usually used to build semantic networks of data and concepts linked to heterogeneous resources. The key concepts of a Topic Map consist of topics, associations, occurrences and resources (figure 3). A topic is a symbolic representation of a subject where a subject is a concept from a real world (Pepper, 2009). An association expresses a relationship between topics. An occurrence is what links an information resource to a topic and finally a resource is any technological support that handles information. It could be a document, a web page, a software product, a Database, etc.

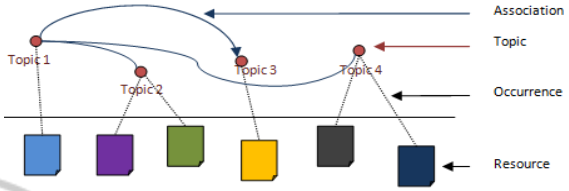

Figure 3: Core Concepts of the Topic Map Standard.

We chose to use the Topic Map standard mainly because it enables to describe heterogeneous resources with high semantic abstraction. A Topic Map can therefore represent any subject from the real world with any desired level of granularity by typing topics and associations. In addition, Topic Maps are highly oriented towards human users and are more optimized for findability (Pepper, 2008) comparing to OWL and RDF which are more devoted to machines and interoperability between applications (Arroyo et al. 2004).

According to our purpose, a Topic Map will enable to structure the way of navigation and search of components starting from users' requirements.

Thus we propose to extend the Topic-Map Meta-Model as depicted in figure 4 to include the proposed layered description of the framework. The added concepts are represented with dark color in figure 4. The standard concepts in Topic Maps consist of topics, associations, occurrences and other characteristics of a topic such as topic name that can have variant names and association role which indicates the role of each topic in a binary association. A resource is also a key concept in a Topic Map, which can be used to represent any kind of component. According to our proposed framework, we can distinguish two types of topics (figure 4): Requirement Topics and Usage Topics. A Requirement Topic refers to the user requirement. It can be a goal or an indicator. A Requirement Topic can be decomposed and refined into sub-topics according to the complexity of the user requirement. A Usage Topic is a kind of topic that describes the components (resources). A Usage Topic can represent the component name (CName), its functionality or its output. The physical level is represented as meta-properties linked to the occurrences in the Topic-Map Extended Meta-model.

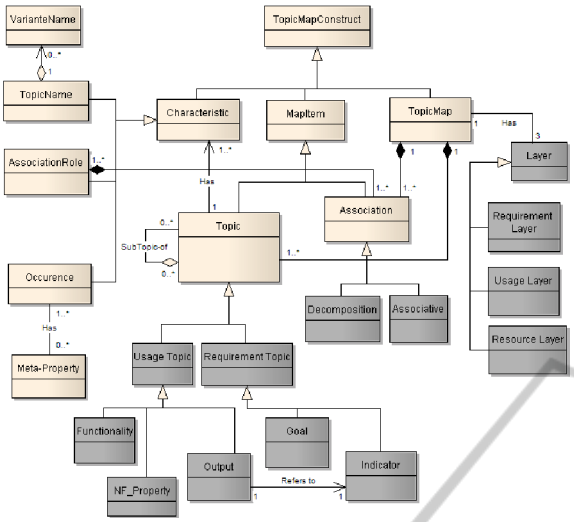

Figure 4: The Topic-Map Extended Meta-Model.

According to these types of topics we distinguish three layers in the Topic-Map Extended Meta-Model: the requirement layer (related to requirement topics), the usage layer (related to usage topics) and the resources layer. Figure 5 illustrates an example of a Topic Map exposing these levels. We take again the example of the WFY goals.

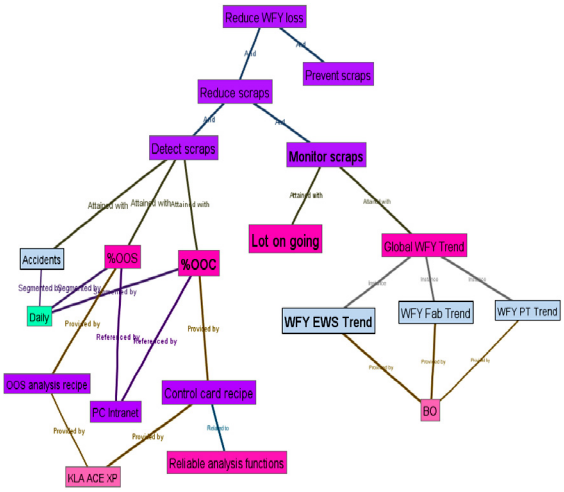

Figure 5: Graphic view of a Topic Map.

The Wandora tool, a free software environment for Topic Maps creation and visualization, was used to implement the Topic Map.

Starting from the goal *Reduce WFY loss*, the proposed Topic Map enables a structured navigation between topics so to discover the set of indicators required for this complex requirement and to obtain them with the available components of the company. For example to *detect scraps*, the Topic Map shows that the user needs to obtain the *%OOC* among other indicators. This indicator is an output provided by the *control card recipe* and is accessible via *PC intranet*.

7 CONCLUSIONS

This paper tackles how to enhance components' sharing and retrieval in a manufacturing process control by reducing the gap between the users' requirements and the components that support the process control. The study of the users' requirements within STMicroelectronics confirms us our findings and helps us to propose a suitable framework to address this need for the control of a standard manufacturing process. Our current works try to study in detail the concept of *indicator* in order to make a classification of the indicators according to types of requirements. The linking between the main levels of the framework can be better specified in this case. A search application based on Topic Maps is also planned.

REFERENCES

Arroyo, S., Lara, R., Ding, Y., Stollberg, M., Fensel, D., 2004. Semantic Web Languages: Strenghs and Weaknesses. *In IADIS04, International Conference in Applied computing*, Lisbon, Portugal.

Claudepierre, B., 2010. Conceptualisation de la gouvernance des systèmes d'information. *PhD report. Université Paris I-Pantheon Sorbonne*.

Lamsweerde, A., 2001. Goal-Oriented Requirements Engineering: a Guided Tour. *In the 5th IEEE International Symposium on Requirements Engineering*, Toronto.

Lucrédio, D., do Prado, A.F, de Almeida, E.S, 2004. A survey on Software Components Search and Retrieval. *On Proceedings of the 30th EUROMICRO Conference, IEEE*.

Pepper, S., 2008. Topic Maps and All That: http://topicmaps.wordpress.com/2008/05/11/topic-maps-and-the-semantic-web/

Pepper, S., 2009. Topic Maps. Encyclopedia of Library and Information Sciences. *Third Edition DOI*.