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# Accessing enterprise knowledge: A context-based approach

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ABSTRACT

This paper deals with the challenge of knowledge reuse and its adaptability to each activity context in the working environment. The scientific work focuses on the context idea as defined by the ubiquitous computing paradigm. The purpose of this approach consists of conceptual models design allowing knowledge structuration according to multiple completeness scales. The proposed approach allows the management of contextual information in a knowledge-based system. A prototype has been implemented to demonstrate the industrial feasibility and the contextual task assistance tool is called "Digital Factory Assistant". The Assistant is dedicated to production line workers and can also be applied in design context.



## 1. Introduction

Complementary visions contribute to the Factory of the Future (FoF) initiative [1]. According to recent researches, the Factory of the Future requires holistic production systems with learning capabilities integrated within the entire product lifecycle: from design and initial configurations up to after-sales services [2]. Moreover, with the new FoF strategies, companies intend to use new organization for production networks so as to maintain their competitive position in the markets [3].

In particular, the smart factory will enhance the control and the optimization of factory processes based on advanced ICT (Information and Communication Technologies) tools.

Indeed there is a correlation between how the concept "factory of the future" is introduced in an enterprise and the place given for humans. Positioning human as a key driver for better factory performance has been pointed out by many visions and roadmaps about the Factory of the Future [4]. Specifically, Westkämper outlined that the next production systems will be more human-centred [5]:

> *"Factories are the place of humans work. Humans generate and drive factories. Humans are the most flexible resource in the manufacturing system. [...] Humans can use computational intelligence to learn and overcome "oblivion" and taking advantages of computational knowledge. [...] Their motivation and their creativity as well as their experience are the driving forces for innovation, adaptation and optimization in manufacturing".*

The continuously and constantly changing landscape of today's factories leads their management to focus on new and more efficiency production systems. So as to succeed, new industrial practices are combined with the technological revolution from the new ICT trends.

In their book, Westkämper and Walter [5] demonstrate that, next generation of knowledge based systems to be used to support humans activity should contribute to this vision. The objective of maximizing the benefits of knowledge management in production environments is shared between both industrial and research communities. In order to help users during the business process, systems must integrate cognitive aspects and allow enhancing workers awareness within their virtual and physical working environment. Awareness of the collective situation can also improve the collaboration between actors [6] and reduce industrial accident and failures risk [7].

Nowadays, manufacturing knowledge is reaching a key factor for the success of the factory by contributing to the improvement of product quality and the development process.

How to combine new technologies and human being?

This paper deals with the challenge of knowledge reuse and its adaptability to each activity context in the working environment. The objective is to propose a new way for structuring knowledge and managing contextual information. We will demonstrate that worker knowledge depends on the context of use.

After introducing the main objective of the paper and the research questions, the second section details the proposed meta-model and the developed approach for context-knowledge adaptation. The third part of the paper explains how the knowledge can be formalized according to different completeness scales using conceptual graphs (CGs). In the fourth part of the paper, a guideline for implementing and using the knowledge structuring approach is presented. A synthesis and discussions conclude the paper.

## 2. Ubiquitous computing for Knowledge Management

21st century is quickly moving towards intelligent factory thanks to the development of many IT trends. One important concept is the Ubiquitous Computing (UC). UC is based on the principle that computers will be deeply incorporated in our daily life until they "disappear" [8,9].

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Even Weiser has set up the basis of ubiquitous computing [10] starting early 90s, UC applications is still up to date. Main reason is that contemporary technologies are more mature and consequently, the concept of UC can be applied.

Context-awareness is considered as a core feature of UC. Context-awareness is defined as: the capability of ubiquitous systems to adapt the provided services according to the instant user situation. Schilit was the first one to use the term "context-aware" in 1994 [11]. Since this discovery, a significant amount of prototypes and solutions has been developed. However, we can consider that ubiquitous computing is still not very well analyzed by the manufacturing research community.

A critical aspect to reach proper efficiency of such systems is the definition of robust models based on generic concepts covering a large variety of situations [12].

### 2.1. Proposed meta-model

For supporting the context-knowledge structuring approach, we have developed a conceptual model (Fig. 1). The model is built around a master object: the enterprise object.

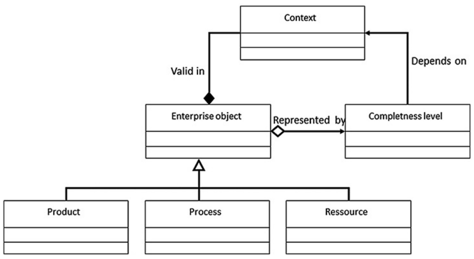


**Fig. 1.** Proposed context-knowledge meta-model.

An *enterprise object* is defined as "an entity of the enterprise manipulated by itself and associated to its own performance" [13].

The *completeness level* concept is based on the hypothesis that knowledge associated to each enterprise object can be decomposed with three levels as explained in part 2.2 of this communication.

Each level can translate a full *completeness level* of an activity domain in the factory. Therefore, Knowledge can be represented as a "book collection" encapsulating three knowledge parts: the product, the process and the resources used.

However, the *enterprise object* is realized in a particular specific *context* [14]. Consequently, the *knowledge completeness level* depends on the *context* where the *object* is requested/used.

### 2.2. Context-Knowledge adaptation process

In this section we detail the conceptual framework proposed to manage the ubiquitous knowledge reuse process. We called this framework "the context-knowledge adaptation engine" (Fig. 2). The main objective is to extract the knowledge and to give it to the right person, at the proper time and the suitable place; in other words: knowledge that fit with a given user situation context.

Context-awareness is achieved by different components. They support the management of context information. The *context data extractor* component is going to extract the context data from *context sensors* and different *existing IT systems*. Once the context data are gathered, the *context inference* process applies rules (previously established) in order to generate other additional context information of the current situation.

At the beginning of the process, the *context identifier* is empty (equals to zero in the context recognition). Then the process will compare different context elements: those that have been extracted and/or inferred with other situations previously stored in the *context repository*.

At the next step of the adaptation process, the *knowledge configuration extractor* will extract the relevant knowledge asset for the given context. Therefore, this component takes a situation as input and induces knowledge set configuration according to it as output.

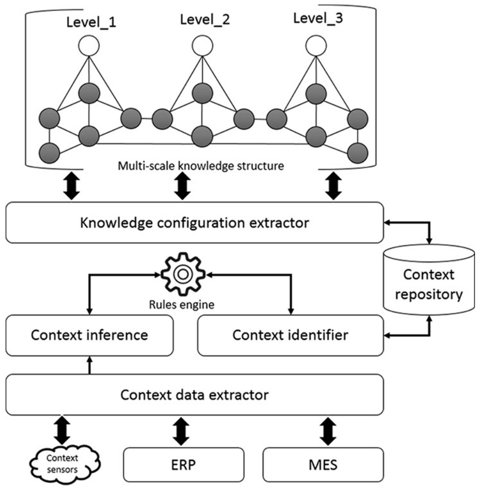


**Fig. 2.** Architecture of the context-knowledge adaptation process.

According to ubiquitous computing paradigm, a computer technology can be considered as ubiquitous if it anticipates user's needs. It must operate proactively to provide the appropriate information or assistance regardless it is a standard or specific situation/action. Moreover, with respect to Weiser's definition [10] about ubiquitous computing, this adaptation process has to be invisible for the user.

Those principles add challenges for implementing the *Context-knowledge adaptation process*: forwarded knowledge has to be proactive as much as possible.

## 3. Knowledge formalization: a graph based approach

The scientific framework is implemented inside a multi-scaled knowledge database. This database stores and formalizes various forms of knowledge. It can include tacit knowledge (expert knowledge formalization) and explicit knowledge (such as enterprise technical documents). The scientific backbone of our proposal is that this multi-scaling can:

- enhance the learning process during working phases;
- help the workers to acquire more knowledge on the activity that he is performing usually as an implicit way.

This approach can also reduce the information overload by giving the workers the appropriate knowledge asset (worker being either beginner, intermediate or expert). The multi-scaled knowledge base is formalized using conceptual graphs [15]. In the following part, we will present a graph-based formalization of each *enterprise object* concept explained in Fig. 1.

### 3.1. Product Knowledge

The decomposition of the product knowledge into multiple scales consists of decomposing the set of its views into three abstraction levels.

For each step of its lifecycle, the way of representing the product changes. Quantity of information and level of the product *knowledge completeness* also change at each step and are nearly never the same.

If we focalize at a determined state, the principle of multi-scale knowledge structuring is defined as the *multi-view model* [16].

For designing the multi-scale knowledge database we use a nested graph as presented in Fig. 3. The different views that a product may own can be represented by the graphs $VP_i$. $VP_i$ includes sub-graphs that represent the different elements related to the views structuring the product.