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Knowledge Sharing based on Semantic Nets and Mereology to Avoid Risks in Manufacturing

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***Abstract*—**The right information at the right time influences the enterprise and technical success. Sharing knowledge among members of a big organization may be a complex activity. And as long as the knowledge is not shared, can not be exploited by the organization. There are some mechanisms which can originate knowledge sharing. It is intended, in this paper, to trigger these mechanisms by using semantic nets. Moreover, the intersection and overlapping of terms and sub-terms, as well as their relationships will be described through the mereology science for the whole knowledge sharing system. It is proposed a knowledge system to supply to operators with the right information about a specific process and possible risks, e.g. at the assembly process, at the right time in an automated manufacturing environment, such as at the automotive industry.

***Keywords*—**Automated manufacturing, knowledge sharing, mereology, risk management, semantic net.

I. Introduction

MANY writers have stressed the importance of knowledge; for instance, in [1] it is argued that in today's society, the so called knowledge society, knowledge is not just another resource along the traditional production factors -such as: labour, capital and land- but the most critical resource (pp. 6-7). While in [2] it is considered that knowledge is a unique company resource because its value actually increases when it is shared and exchanged (pp. 41, 47).

Times of uncertainty often force companies to seek and accumulate knowledge held by those outside the organization: suppliers, customers, distributors, government, agencies, and competitors. Accumulated knowledge may be shared widely within the organization, stored as a part of the company's knowledge base, and utilized by those engaged in developing new technologies and products. That dual external and internal activity stimulates continuous innovation which leads to competitive advantage [1].

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It has been suggested that information can be exchanged formally within the boundaries of defined mechanisms, such as structured methods and formal processes; or informally; and both horizontally, e.g. cross-functional, and vertically within the organization [3-5].

On the other hand, management can determine knowledge sharing by implementing formal procedures for guiding information flows; moreover, there are mechanisms which can originate such process [6]:

1. Diffusion- members of an organization select and communicate existing information without being oriented towards a particular problem.
2. Information retrieval- someone who needs a particular piece of information obtains it by asking someone who has it.
3. Information pooling- members of an organization working together pool information; it is transferred not only factual information but also questions, suggestions and instructions.
4. Collaborative problem solving- new information is developed with regard to a shared problem.
5. Pushing- someone chooses to provide someone else with the existing information. It involves thinking that the other person needs to know something, or that certain information might be useful for his research activities.
6. Thinking along- someone developed new ideas with regard to someone else's problem. It may yield new ideas, hypotheses or questions.
7. Self-suggestion- in the same way as one can think about someone else's problem, one can also think about one's own problem during interaction. The need to explain one's own problem stimulates one to come up with new explanations, solutions, arguments and conclusions.

Nevertheless, sharing knowledge among members of a big organization may be a complex activity. And as long as the knowledge is not shared, can not be exploited by the organization [7].

Thus it is intended, in this paper, to trigger these mechanisms - *in particular: diffusion, pushing, information pooling, and information retrieval* - by using semantic nets.

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A semantic net, defined in the literature as "a graphic notation for representing knowledge in patterns of interconnected nodes and arcs" [8], will facilitate the dynamic navigation through the information, the information visualization and the sharing of information through formal procedures. The advantages of semantic nets to represent knowledge include [9]:

- Adaptable method of representing knowledge because many different types of object can be included in the network.
- Is graphical and therefore relatively easy to understand.
- Can be used as a common communication tool between the knowledge engineer and the human expert during the knowledge acquisition.

Moreover, it is proposed in this paper a knowledge sharing system based on mereology principles to present accuracy information to the operator of the assembling process and at the same time aware him of main risks during the process.

II. Concept and Requirements

The right information in the right time influences the enterprise and technical success. In this knowledge sharing system is achieved knowledge model for the user, where the user can use an intelligent search quickly and effectively. Semantic net gives a lot of possibilities. This knowledge sharing system is developed in a program called "Intelligent views" (i-views). The knowledge system is made by several different properties, making it exceedingly useful for the structuring of information and knowledge. The intelligent search with objects, relations has as an advantage finding attached documents, relationships between concepts, as regards the contents of the text.

The structure of a knowledge sharing system is based on objects, which are the basic modules of the knowledge sharing system, sub-objects and individuals. Between all this elements we can see different forms of interaction: concepts, instances, relations, attributes and extensions. Attributes define objects properties, while the concepts and instances in this system are connected to each other via different relations. In Fig. 1 are represented concepts and instances through cubes from different colours. Fig. 1 shows a semantic net, fragment of the knowledge sharing system:

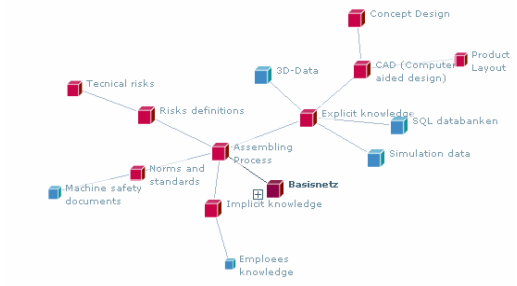


Fig. 1 Semantic net for a manufacturing environment (i-views)

This network can be requested through Internet. Under each concept, it can be found the description of the term with appropriate illustrations and files. Also 3D-constructions are accessible; this represents advantage for the designing process. When user searches e.g. definition of explicit knowledge, then he gets a window with precise object description similar to the one shown in Fig. 2.



Fig. 2 Object definition in a semantic net

All interactions of knowledge sharing system are described with the Mereology science. The mereology principle is shown in Fig. 3. A set of objects present a set-topology theoretical room. These technical terms are interlinked with support of components (such as information about assembling process). The intersection and overlapping of terms and sub-terms are as well described through the science of mereology. Mereology allows examining the relations between parts and whole system systematically. Classical mereological description is based on one rule of mereological composition which states that the quantity of individuals (subjects) always consists of the sum of sub individuals [11].

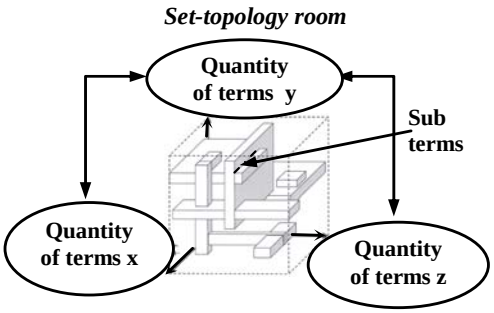


Fig. 3 Main principle of mereology

The advantages of this method are that it represents exact and obvious desired knowledge for the operator and avoid overlapping information. After sharing suitable components (definitions or technical parameters) in the knowledge sharing system, the quality assessment of terms is done by various criteria (e.g. source and actuality).

Furthermore, overlapping rule of mereological systems states that, two terms x and y are overlapped, if they have a common component (sub terms).

$$\forall x, y(x \circ y \leftrightarrow_{def.} \exists z(z \leq x \wedge z \leq y)) \quad (1)$$

Where,

$\forall$ – means "for all",

$\circ$ – means "overlapping",

$\leftrightarrow_{def.}$ – means "if and only if",

$\exists$ – means "there is",

$\geq$ – means "real or unreal component (element and no identical)"

It is especially important to define manufacturing risks in order to save time. For this purpose it is incorporated a database of technical risks and common rules to avoid them in this system.

Moreover, the modern production plants are marked by a high level of automation (application of program-technically supported machines, robots, CNC, transportation facilities) and these often show a potential danger. Safety measures and facilities must be used to protect themselves from potential dangers. With the help of knowledge sharing system it can be solve the most relevant tasks of the risk management. These are: risk identification, risk analysis, risk assessment, prevention of risk, risk supervision and risk control [10]. The algorithm to extract information about technical risk is presented on the Fig. 4 [12].

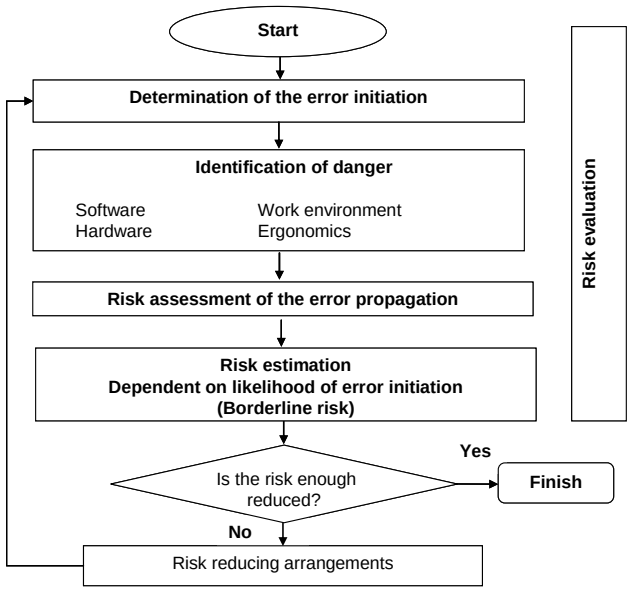


Fig. 4 Algorithm of risk detection in knowledge sharing system

Within this algorithm for knowledge sharing it is possible to avoid risks and thus make faster and saver the milling, designing and process optimizing in production.

III. Conclusion

In the literature, many authors have addressed the importance of knowledge and the sharing of knowledge. It is well known that the right information at the right time influences the enterprise and technical success. Therefore, it is proposed in this paper a knowledge sharing system based on mereology principles and semantic nets to present accuracy information to the operator of the assembling process and at the same time aware him of main risks during the process. Avoiding risks may result in faster and saver process, and consequently a great benefit for the company.

On the one hand, there are mechanisms which can originate the knowledge process sharing. Thus it is intended, in this paper, to trigger these mechanisms [6] - in particular: diffusion, pushing, information pooling, and information retrieval - by using semantic nets. Semantic nets are graphic notations for representing knowledge in patterns of interconnected nodes and arcs [8] that will facilitate the dynamic navigation through the information, the information visualization and the sharing of information through formal procedures.

On the other hand, the structure of the knowledge in the knowledge sharing system proposed in this paper is based on objects, mainly those in the higher hierarchical levels, sub-objects and individuals. Between all this elements it can be identified different forms of interaction: concepts, instances, relations, attributes and extensions. These interactions are described within the mereology science in order to avoid overlapping information and extract only desired knowledge for the operator.

Finally, it is suggested an important system solution that will be able the sharing of information concerning risks during a determined process; thus, making possible faster and saver designing, manufacturing, assembling and process optimization.

The proposed sharing system was developed in the Automation department's laboratory and is being used to train students, so they may get relevant knowledge of specific processes which they may use during a practice period at the industry. The main idea was to develop a knowledge sharing system for manufacturing but it may be extended to other functional areas in the companies.

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