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Impact of Adequate Knowledge Model on Bottom-Line

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ABSTRACT--- ***As the competition is getting fiercer, smarter knowledge representation is needed to keep our bottom line un-compromised. With the so much outsourcing of jobs, more of our youth are going away from studying and/or training in manufacturing. Unless more is done immediately, this will hit the whole manufacturing community with lack of expertise and less people with the "know how" skills to keep our manufacturings prospering. In this paper advantages of an adequate knowledge modeling are highlighted. Ontology will be used as a platform for modeling the accumulated knowledge in manufacturing. A meta model will be built to capture the manufacturing knowledge in an easy to use and maintain model. A turning process is selected to model the knowledge needed for it in an ontology model.***

Keywords--- knowledge modeling, ontology, process modeling, CAD/CAM, CIM

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1. INTRODUCTION

Competition is increasing year after year, and the economic crises that US and the world is going through had manufacturing falling so sharply [1]. Unfortunately, manufacturing is not as easy as other areas of the economy to rebound back. Example of the many factors which distinguished manufacturing from other areas of economy is: the manufacturing network and decencies are more complicated than other areas of the economy [2].

Are we done with economical crises? Many areas of the economy are on the rise, and manufacturing is not an exception. John Ryding, chief economist at RDQ Economics in New York, states "It has a long way to go before we get anywhere near back to normal levels -- or what was normal before the recession -- but the forces that produced this massive drop in output and collapse in trade volume appear to be reversing." [3]. People have hard time communicating business knowledge in their working environment. With the advancement of search engines, people expect to be able to “google” the knowledge regarding their manufacturing environment within some one’s company internal electronic system. Inmon stated that knowledge management today is primitive, and he refers that to the fact that we have poor meta business data [4]. Cameron pointed out the need of comprehensive knowledge regarding manufacturing process [5].

Advances in manufacturing have been steadily coming true. However more focus has been on the actual processes improvement and modeling. In traditional ways of modeling by capturing the parameters relations of the manufacturing process and govern them via an algorithm or program, where behavior of the process could be predicted via the algorithm or program. Many papers were sited where the focus is the process model. Fung has turning parts roundness and develop an error forecasting and compensation system for it [6]. Switek studied the dynamic modeling of the turning machining [7]. Qian studied the effect of forces on the Cubic Boron Nitride inserts [8]. Al-Aomar used genetic algorithms for parameter design to find near optimal setting for a lathe machine [9]. Chou studied the thermal modeling of white layer in turning process [10]. More modeling was cited using nontraditional modeling techniques like fuzzy logic and neural networks. Jiao modeled the surface roughness using fuzzy logic to capture the process behavior [11]. Kwon used fuzzy neuron adaptive technique to predict the surface thickness for CNC turning process [12]. Very little work has been done to encompass more than the direct process aspects; which created a lag in the system view and understanding of the whole manufacturing arena. Where we find a lot of literature and computer systems related directly or indirectly to different manufacturing processes, we also find very little related to the integration of many processes and to the business side of the processes.

This paper will highlight a new approach to model all aspects of the manufacturing process. It will cover the business and technical aspects of the process as well as any relevant process aspect. It models what we know today about the process and it allows updating the model with new aspects without having to build a new model. In this paper, the turning process is selected to capture the different aspects of the process and model it as an example. It will also show the possibility to expand on process aspects as well as expanding to other new processes. This paper demonstrates the ability to model different aspects of the process on one platform and cite the benefits of the impact of this on the knowledge transfer as well as the knowledge accumulation and build up.

2. ONTOLOGY FOR KNOWLEDGE MODELING

Ontology is the new approach, followed in this paper, to modeling all aspects of the process. It can accommodate parameters of the process, their relations and the other aspects of the process.

What is ontology? Ontology is the full description of all entities in a knowledge domain, including properties and relations.

Ontology modeling via protégé is used to model aspects of turning process. Protégé is a tool developed by Stanford University, medical school. However, it can be used as a knowledge acquisition tool as well as a knowledge solution. It can be used very much to model any knowledge domain. The author acknowledges his appreciation to Stanford Center for Biomedical Informatics Research especially for putting out this valuable tool and supporting it.

3. TURNING PROCESS

It is the process of shaping objects by using cutting tools while the workpiece rotates rapidly on a lathe. It has many types such as tapped turning, facing, grooving, etc. examples of those processes will be modeled using ontology, and the impact of having all in the same framework will be highlighted.

Turning process parameters:

Turning process parameters are identified and modeled in such a way that they are defined at the highest level that they are shared among the different processes and/or sub-processes. Examples of those are: depth of cut, cutting speed, feed, tool geometry, etc.

Ontology model for turning process entities:

In this section the entities that are related to the turning process are identified and modeled per a meta class (which determines very much the type of the entity) and in the next section the parameters of the processes are modeled and linked to the different processes. After that the relations are captured and modeled. All those steps are done in the same platform, which adds a great value to the usage and application of the model.

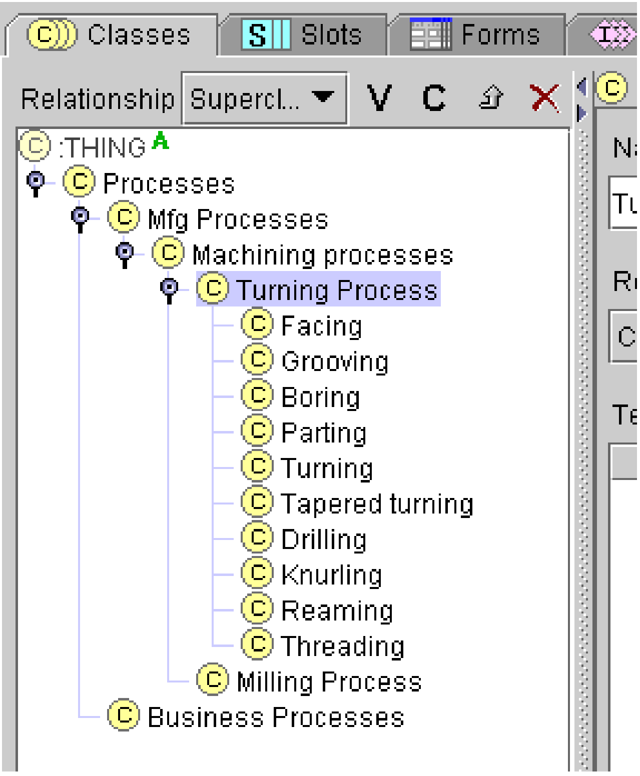

Figure 1, Turning processes "is a" relationship

Ten types of turning are shown in the model below. The model refers "everything" to be a "Thing" in the model. As we go down the tree, the relationship modeled in figure 1 is what we refer to as the "is a" relationship. A Facing "is a" Turning Process. A Turning Process "is a" Mfg Process, and so on. The value of having this relationship is that it helps model properties and/or relations at the highest possible rank in the model and then inherits it to all the subsequent children of a certain class. It means we define once and use as many times as we need to. Another value of this type of modeling is that it allows to cross types of classes and have the link among them predefined through the "is a" and other user defined relations. Example is the milling process, it "is a" machining process, which means it shares the same parent type with turning process. However, each one still can have its own parameters which are not shared.

Relations among different entities:

One of the valuable features of the protégé framework is that it allows to model relations among different entities within a domain or even across different domains. An example is shown in figure 2 below for a customized relationship between a machining process and a manufacturing process. Other relations are modeled between business process and manufacturing process are modeled in the example the same way. However, if business processes are modeled in a different ontology, then we need to include the business ontology in the turning ontology. The idea of inclusion is clarified for the materials ontology.

One of the most important factors for the machining processes is the materials, namely material of the workpiece and tool material. Also, obviously we need to consider the workpiece or product description. So naming few "things" we

need to describe our knowledge domain, it is so difficult to link them while maintaining their knowledge. Using the protégé framework, we can simply include the material ontology into our turning process ontology, and all the materials will be available to link to our workpiece and to our tools.

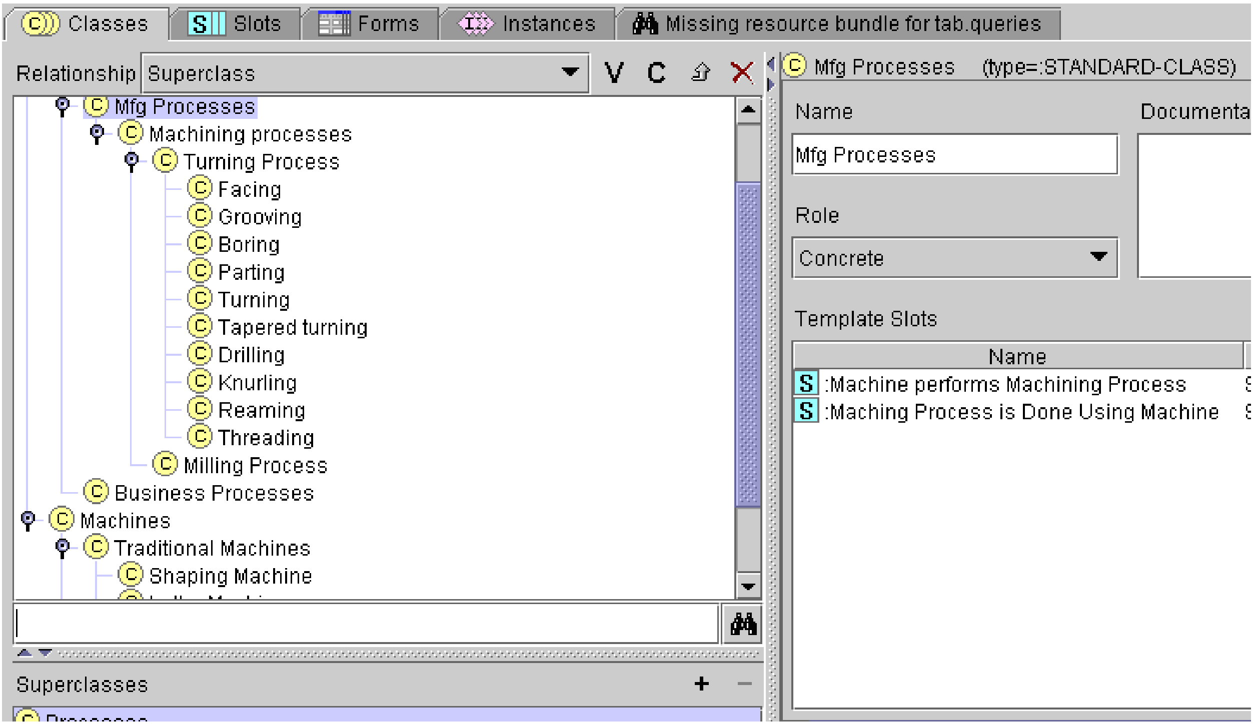

Figure 2, relationships between machines and machining processes

In figure 3, the material ontology is shown as included in the turning ontology. Materials ontology was modeled separately by the materials expert. Meaning we don't need to worry about the maintenance of the materials if we are the machining experts. Same applies for the business process, tolerancing, product structure as well as all other aspects related to the turning process. Figure 4 shows how the different aspects could have different ontologies maintained separately and utilized by different domain knowledge per need. It is paramount to notice that sinking the knowledge is one of the shortcoming, which is dealt with to some extent using a database to store the knowledge model. Which should take care of any new development and could track changes and verify highlight changes in included ontologies. However, finished products or unlinked ontologies used afterwards will be out of sink. It is advisable not to include knowledge which is still not established and/or unauthorized knowledge to be shared by other domains.

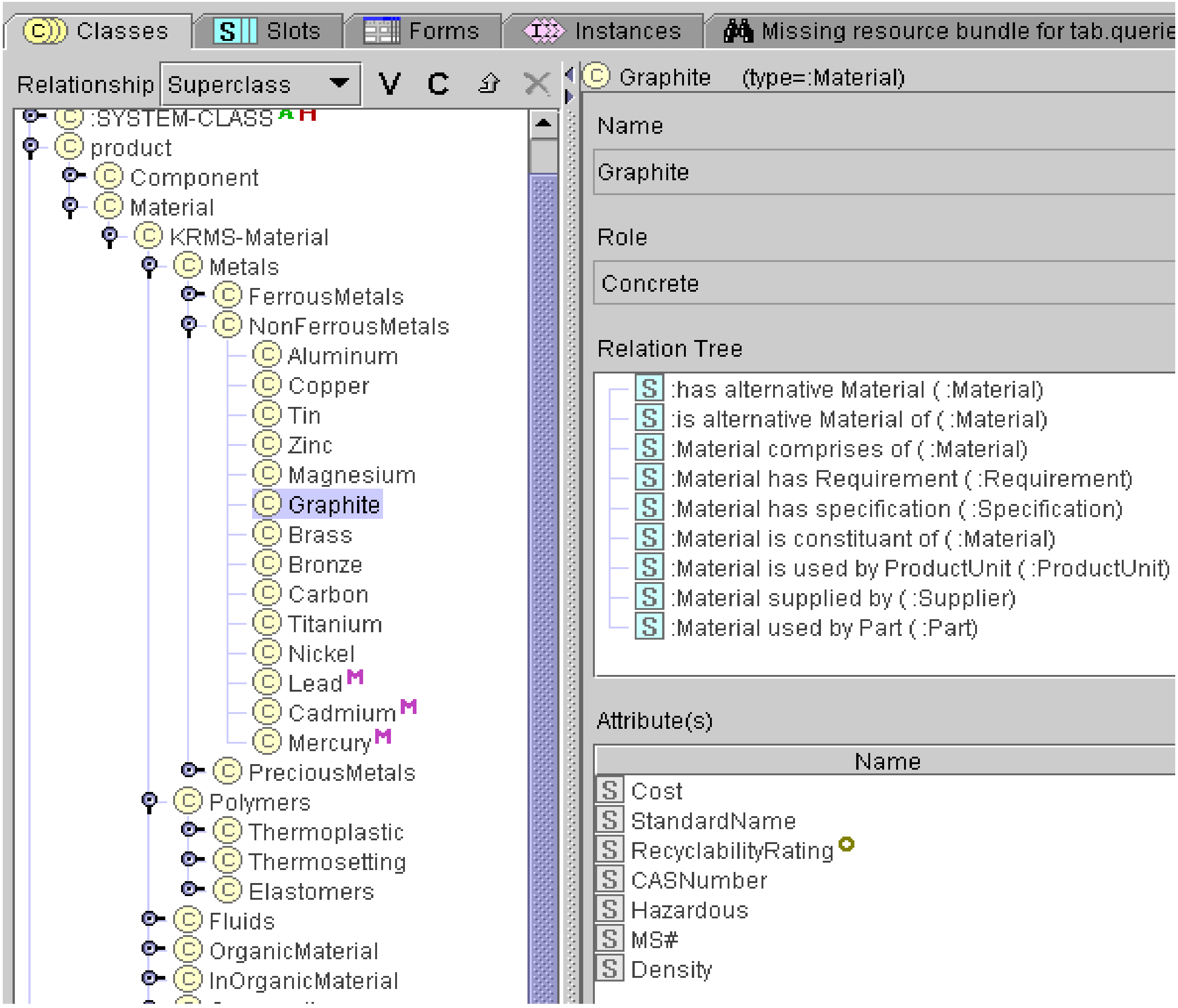

Figure 3, Material ontology is included in the turning ontology

4. IMPACT OF KNOWLEDGE MODEL

Manufacturing is one of the pillars of US economy as well as other industrialized countries economies. It is paramount that the manufacturing sector is well taken care of, it supports so many other sectors including R & D for different industries related to manufacturing which almost touches every aspect of our life. It impacts whether an economy can revive or not. It impacts whether we have commodities to sell and buy and have people manufacture it or not. In general it impacts the bottom line for every related industry and all the people in those different industries.

5. ADVANTAGES OF USING ONTOLOGY FOR KNOWLEDGE MODELING

1. Integration of different aspects of a knowledge domain will make validation of applications that are built based on those ontologies easy and fast.
2. Preserving the knowledge: this is very important specially those days, where we have less people wanting to go into manufacturing engineering. And with the slow down of economy so many experts are lost out of the manufacturing arena.
3. Any knowledge domain has to interface with other domains of knowledge. In fact many rules are based on multiple knowledge domains. With the ontology framework we are able to link different knowledge domains easily without compromising the level of details within each ontology.
4. Knowledge based systems can be built on top ontologies to check for different areas of the turning process or any other modeled process.
5. Manufacturing and design aspects of the product realization integration will be given.

6. More robust process performance can be achieved by including many rules and/or algorithms that will work based on the low level relations among the domain entities.
7. Deployment of ontologies can be done over the intranet. Communication among the different parties involved in the turning process or the related domains will online without delays. This will impact the time to deliver.
8. Furthermore, ontology will be the platform to manage the knowledge regarding turning process or any other modeled domain.

6. CONCLUSION

In this paper it was demonstrated that ontology could be used to model the turning process and related aspects from other knowledge domains. Using ontology for CAD/CAM integration and for managing the process from all aspects related to it, is a huge enabler not only for the process but for the whole manufacturing environment. It further will make it possible to automate the process and link it to other processes, materials and other manufacturing engineering aspects. Having a formal model for the process simplify the maintenance of knowledge related to the process as well as the reusability of this knowledge. Configurations of the process is a huge benefit that will enable utilizing the process in a reconfigurable manufacturing environment which is shaping up to be the future of manufacturing for the coming decades.

7. ACKNOWLEDGMENTS

The author acknowledges his appreciation to Stanford Center for Biomedical Informatics Research especially for putting out their knowledge management valuable modeling tool (protégé) and supporting it.

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