Designing Knowledge of The PPC with Semantic Network

Ari Fajar Santoso¹, Iping Supriana², and Kridanto Surendro²,

¹ School of Industrial Engineering and Information System, Telkom University, Indonesia
arifajar@student.itb.ac.id, arifajar@telkomuniversity.ac.id, arifajar2012@gmail.com
² School of Electrical Engineering and Information Technology, Bandung Institute of Technology, Indonesia
iping@informatika.org, endro@informatika.org

Abstract. A manufacturing process is a very complex activity, which involves a variety of knowledge, such as the product design and description, manufacturing operations, tools, machines, and the relationships between these entities. Production planning control (PPC) as dominant part of manufacturing process has a very important role in determining the measures taken by the management of company. The PPC construction is an interactive process that requires the collaboration of both ICT and manufacture experts. Building PPC process can be used as a basis for making knowledge in manufacturing domain that will be used in manufacturing intelligent system. This paper describes about designing knowledge with semantic network in the production scheduling.

Keywords: PPC; semantic network; knowledge; intelligence.

1. Introduction

In manufacturing companies, parts production into one of the core processes of large companies. The production department in which there are process planning, control, execution and evaluation of the production of a product accurately and systematically. Production data recording is done in principle production process. One part of the manufacturing is a control system and material requirements commonly, production, planning, control and inventory in called Production Planning Control (PPC) became the dominant, crucial and complex in the production process. In the domain of informatics, knowledge production mainly PPC becomes the center of attention for a major role in the company. Production scheduling problems become urgent because it involves many units are inter-related and operational very rigid in its implementation, so that the records and information to be important in supporting the implementation of the PPC.

PPC systems have a number of fundamental flaws. Manufacturing planning and control systems a recurrently dominated by systems based upon material, control and planning. A potential alternative to PPC systems is suggested after research into the economic batch scheduling problem. An alternative approach to manufacturing planning and control is developed, Based on the ideas of economic batch scheduling, and enhanced through artificial intelligence techniques [1].

Applications of Artificial Intelligence is made up of two main parts, the knowledge base and the inference mechanism. Knowledge base contains facts about objects in a particular domain and mutual relationship with each other. The knowledge base can also contain thought, theory, practical procedures and mutual relations. Knowledge is a concept that has gained importance in recent years as interest in knowledge management [2]. Inference mechanism is a series of procedures used to test basic knowledge systematically while answering questions, solving problems or making decisions in the domain that have been determined. Schematic representation generally categorized as declarative knowledge or procedural declarative scheme is used to explain the facts and statements (statement). This method including logic, ontology, scripts, and frames, semantic networks.
Semantic (associative) network can be seen (Sowa, 2000) as a directed graph consisting of nodes and edges. Nodes represent individual objects of described world and edges connecting these nodes represent relationships between these objects. Very often we can meet with following types of the relations [3]:

- Is-Instance-Of (ISA) relationship is used to express the fact that a particular object (an instance of a particular class) belongs to the specified class.
- A-Kind-Of (AKO) relationship can express that a class is a subclass of another class.
- A-Part-Of (APO) relationship serves to express that a certain class of objects is composed of certain parts.

Semantic networks are knowledge representation schemes involving nodes and links (arcs or arrows) between nodes. The nodes represent objects or concepts and the links represent relations between nodes. The links are directed and labeled; thus, a semantic network is a directed graph. In print, the nodes are usually represented by circles or boxes and the links are drawn as arrows between the circles. This represents the simplest form of a semantic network, a collection of undifferentiated objects and arrows. The structure of the network defines its meaning. The meanings are merely which node has a pointer to which other node. The network defines a set of binary relations on a set of nodes. Most semantic networks are cognitively based. They also consist of arcs and nodes which can be organized into a taxonomic hierarchy. Semantic networks contributed ideas of spreading activation, inheritance, and nodes as proto-objects [4].

Semantic network have been used successfully to representation knowledge domain well-establish taxonomies to simplify problem solve. Some of advantages of semantic network are: 1. Flexibility in adding, modifying, or deleting new nodes and arcs, 2. Ability to inherit relationships from other nodes, 3. Ease of drawing inferences about inheritance hierarchy [5].

Semantic model allows users to ask questions about what is happening in the system being modeled with a more natural way. Therefore, semantic models can be used to connect the physical world, to complicate matters reference information and aggregation, data points of interest can be managed through a database, file, application, or service components each have an interface method itself and naming conventions for access the data [2]. When talking about integration-oriented architecture-based operating system information, in this context, we are really referring to utilize the semantic model as the core functional applications to provide a model to navigate the data and associated relationships that represent knowledge in the target domain.

The basic advantage of the semantic network is that it contains information similarly as information is stored in human memory, and it is machine-understandable. This means that it can be machine-processed - is it possible to analysis facts and information included in the semantic network and to acquire new knowledge about represented Facts [6].

The purpose of this paper is to map domain entities as a frame or basic knowledge of scheduling of material requirements planning in the production process. This knowledge base can be as the basis for designing the next production intelligence system.

The recommended approach is based on a semantic network that can capture the basic elements of the frame information and reciprocal relationship. Semantic network is defined as a representation of knowledge that includes linkages between topics. The second approach to Lisp. Lisp is a convenient language for representing any graph structure, including semantic nets. Lists provide the ability to create objects of arbitrary complexity and these objects may be bound to names, allowing for easy reference and the definition of relationships between them.

2. Production Planning Control Cycle

The production planning control process is a quite complex domain which requires precision in building knowledge about it. And it’s a part of the management production that have functionality to record, process
and make some reports of production transactions. Manufacturing is an art and science that involves recording transactions in a particular manner. Today there are many production users apart from the business organizations themselves like plants, shareholders, suppliers, academicians, students, researchers etc. and it becomes utmost important for them to know the exact meaning and relation of the production terms [7]. In some organization, there are several users of production process who do not know well about the concept of management production.

The production cycle starts on the order of marketing. Marketing needs analyzed recorded then made plans for production. Preliminary calculations based on a rough estimate. The production cycle begins on the evidence of process order. Analyze each order and event from source documents, then based on the evidence of production process, such as order marketing, bill of material (BOM), purchasing receipts, inventory order, were recorded in the form of document production as master production schedule. A typical manufacturing planning and control system consists of three process: front end process, engine process, and back end process[8].

![Figure 1. Production Planning Control System Architecture](image)

Model Production Planning System architecture is an extension of the Ronald S. Dattero, the PPC system architecture, as in Figure 1. The development of production processes by considering the machine elements, human and inventory. As the figure shows, the system takes a schedule of marketing requirements as a major input and produces two major outputs: a schedule of planned manufacturing orders, and a set of order release prompts to the shop floor and to Purchasing, include requirement labor and machine. Those elements are a factor in making production scheduling constraints. The main problem in production scheduling, the constraints of each element. Further optimizing the feasible area.

The PPC system divides the manufacturing task into subtasks such as master scheduling, shop floor control, and inventory planning. Subtasks that are fairly standard, in the installations we have seen, are denoted with solid boxes in Figure 1. Other subtasks (modules) such as maintenance planning, purchasing, and tool planning are often present as well. A rough-cut capacity planning module, used to aid the development of master schedules, is also available in many implementations.
3. Related Work

From his research Yingzhong proposed about Knowledge of unit processes, knowledge can be considered as the theoretical or practical understanding of a subject, which generally includes facts, information, descriptions, or skills acquired through experiences or education. With the practice and development of manufacturing industries and technologies, a lot of unit process’s domain knowledge has been created, which mainly includes the following three aspects: concepts of unit processes and their taxonomies, manufacturing capabilities of a unit process and process parameters of a unit process [9].

Abhinav also proposed a semantic network based approach is being presented for natural language processing of qualitative information available from industrial systems in the form of textual descriptions. Focus of this research in compared to other current automated methods to manipulate text messages which are computationally expensive, this technique takes advantage of the semi structured nature of the text and domain limited vocabulary in industrial environments in order to create an architecture that processes textual information efficiently and effectively [10].

Garcia-Crespo proposed about the Industrial manufacturing processes representation is a key challenge for leveraging interoperability among business partners. The Semantic representation of information enables the creation of intelligent systems, which can interpret and understand potentially automated tasks, harnessing added-value decision-making processes. A. Garcia-Crespo and B. Ruiz-Mezcua said that The model is based on different situations a problem might yield and the correspondent behavioural responses which should be generated. Using the concept of “Situation” as the conceptual corner-stone and building block of descriptions, we discuss how semantics provides a natural knowledge representation strategy, which eases the resource-intensive process of acquiring knowledge [7].

Antonio also proposed about the modeling of manufacturing processes independently of the structure and composition of the industrial plant. The rationale for the proposal is in the incorporation of knowledge, supported by ontologies regarding manufacturing processes, industrial machinery and the industrial plants involved. With this knowledge, process engineers can focus their efforts exclusively to define the activities to be performed on the raw material (abstract model). To refine the proposal, a case study is put forward in which the management system was able to infer the way for the raw material to be processed according to the abstract model and automatically composed the activities necessary for achieving it. Finally, an implementation of this management system for processes is presented together with the design of two models of industrial plant that demonstrate the validity of our proposal [11].

Sormmaz DN and Khoshnevis B, 1997, propose about the Knowledge representation for manufacture processes In general, the manufacturing activities are guided by process planning, which is a pivotal link between design and manufacturing. Process planning involves the selection of necessary manufacturing processes and the decision of their sequences to transform a designers idea (namely the designed part) into a physical component economically and competitively. The selection and decision depend on the manufacturing knowledge heavily [12].

4. Designing the Semantic Network in The PPC Process

A manufacturing process is a very complex activity, which involves a variety of knowledge, such as manufacturing operations, the product design and description, machines, tools, and the relationships between these entities. Yingzhong Zhang, and Xiaofang said that Knowledge representation for manufacture process is the design approach to manufacturing processes unit. Manufacturing consists of several major processes. A unit process is a fundamental part of the product manufacturing process. In the face of a very large number of units existing and emerging processes, how to form a unit of knowledge representation process is very difficult. So do the two approaches: Taxonomy of unit processes and unit process capabilities. Taxonomy of unit processes is a primary knowledge representation work for organizing unit according to reviews their processes some common characteristics. While the process unit capabilities are
Referred to as the limitations or performance constraints and the range of applicability of a given unit manufacturing process [9].

Figure 2. Production Planning’s Semantic Network of Manufacturing

Proposed approach is illustrated in the example of Production Planning Control environment. This case study shows how semantic networks and flow PPC process help to frame the Capacity Planning’s, Shop Floor Control’s, Purchasing’s and Marketing Requirements’ preferences. Thus it helps to decide what information should be shown on the master scheduling. Semantic networks may serve as a supporting tool in the management production strategy.

Four object semantic networks of major process scheduling were identified:
- Semantic network of the Process capacity planning’s frame - refers to the basic features and links of what affects the capacity planning process in selecting the information about his PPC.
- Semantic network of the process shop flow control’s frame - refers to the basic features and links of what influences the shop flow control in create information process.
- Semantic network of the process purchasing’s frame - refers to the basic features and links of what influences purchasing in the selection of published information about the PPC.
- Semantic network of the process marketing requirement’s frame - refers to the basic features and links of what influences marketing requirement’s in the selection of published information about the PPC.

With the practice and development of manufacturing industries and technologies, a lot of unit process’s domain knowledge has been created, which mainly includes the following three aspects: concepts of unit processes and their taxonomies, manufacturing capabilities of a unit process and process parameters of a unit process [9].

Semantic network of the capacity planning’s frame shows what affects the decision about information published on bill of material (BOM), capacity planning process, resources. Figure 2 shows that production planning’s semantic network of manufacturing. The shop flow control is the semantic network representation control of production, taking into account the resources of companies which consists of labor,
machine, tools. Control also noticed how much inventory material, such as work in process product, and the final product that is so. The process of purchasing's frame to explain how much raw material required in the production process and raw material supplies, rested on raw-p, q and a raw-raw-z. The process of marketing requirement's semantic network shows the need to assess the market of rough-cut capacity planning and forecasting required demand of the market potential. The PPIC's semantic network shows sub-class consisting of capacity planning, control, marketing requirements, purchasing of material needs.

5 Conclusion

Designing production process with semantic network can be used as a basis for making knowledge in production planning control domain that will be used in production intelligent system. The Production Planning Control (PPC) process is a quite complex domain which requires precision in building knowledge about it. And it’s a part of the introduction domain that have functionality to record, process and make some reports of production transactions. The PPC in manufacturing firms has a very important role in determining the measures taken by the management of company.

Production Planning Control cycle must be understood by the users of production data. It can improve the understanding of knowledge in process production. Knowing about classifications of production planning control transaction is used for designing production and planning control transaction semantic network.

References

1. Ronald S. Dattero. : Enhancing Manufacturing Planning and Control Systems Through Artificial Intelligence Techniques University of Dayton eCommons MIS/OM/DS Faculty Publications Department of Management Information Systems, Operations Management, and Decision Sciences. Missouri State University - Springfield John J. Kanet University of Dayton, jkanet1@udayton.edu Edna M. White (1989)
2. Tim Hanis., Dave Noller .: The role of semantic models in smarter industrial operations, hanistt@us.ibm.com, Chief Architect, IBM Integrated Information Core, IBM, nollderd@us.ibm.com, Senior Architect, Industrial Sector Solutions IBM (2012)
3. Sowa, J. F.: Knowledge Representation: Logical, Philosophical, and Computational Foundations, Brooks/Cole Publishing Co., Pacific Grove, CA, ISBN 0534949657 (2000)
4. Soroumnaz DN., Khoshnevis B. : Process planning knowledge representation using an object-oriented data model. Int J ComputIntegr Manuf 10(1–4):92–104 (1997)
5. Acedeki B. Badiru., John Y. Cheung.: Fuzzy Engineering Expert Systems with Neural Network Applications, ISBN: 978-0-471-29331-6., John Wiley & Sons, New York (2002)
6. Steyvers, M., Tenenbaum, J. B. : The Large-Scale Structure of Semantic Networks: Statistical Analyses and a Model of Semantic Growth, Cognitive Science, Vol. 29, Iss. 1, p. 41–78. ISSN:0364-0213 (2005)
7. A. Garcia-Crespo., B. Ruiz-Mezcua., J.L. Lopez-Cuadrado., J.M. Gomez-Berbis.: Conceptual model for semantic representation of industrial manufacturing processes Computer Science Department, Universidad Carlos III de Madrid, Av. de la Universidad 30, 28911 Leganés, Madrid, Spain. Computers in Industry 61, 595–612 (2010)
8. Vollmann , T. E., Berry, W. L. ,Whybark, D.C.: Manufacturing Planning and Control Systems (Homewood, IL: Irwin) (1984)
9. Yingzhong Zhang., Xiaofang Luo., Hong Zhang., John W. Sutherland.: A knowledge representation for unit manufacturing processes, Published online: 11 May 2014# Springer-Verlag London (2014)
10. Abhinav Saxena., George Yachtsevanos.: Processing Textual Information from Industrial, Systems Using Semantic Networks, Georgia Institute of Technology, Atlanta GA 30332, {asaxena,gjv}@ece.gatech.edu. IICAI (2005)
11. Antonio Ferrández-Colmeiro., Virgilio Gilart-Iglesias., Francisco Maciá-Pérez.: Semantic Processes Modelling Independent of Manufacturing Infrastructures, , Computer Science Department, University of Alicante, {aferrandiz, vgilart, pmacia}@dici.ua.es. 978-1-4244-6850-8/10. IEEE (2010)
12. Soroumnaz DN., Khoshnevis B. : Process planning knowledge representation using an object-oriented data model. Int J ComputIntegr Manuf 10(1–4):92–104 (1997)