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Dimensions of Expert System in Manufacturing Industry

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ABSTRACT

This paper show description of how one company is using expert system approach is given. Expert systems are described and reasons for using them are given. Study of large systems and small systems is also given.

Keywords : AI (Artificial Intelligence), CAD (Computer Aided Design), CAM (Computer Aided Manufacturing), Computer aided Production control Computer (CAPC), CIM (Computer Integrated manufacturing)

I. INTRODUCTION

Expert Systems are a branch of Artificial Intelligence (AI) and these systems capture knowledge of Experts via set of rules and solve problems heuristically, efficiently and effectively by using knowledge with reasoning procedures. Expert system is a system that acts like as a human expert for a particular subject area Waterman [1] defines the ES in the following fashion.

The process of building expert systems is often called knowledge engineering and knowledge engineer is involved components of an expert system. An expert system contains a knowledge base, a dialog structure and an inference engine, which consists of an interpreter and a scheduler. A knowledge database is quite different from the normal database because it stores concepts and dedicated procedures that need to be done in order to solve a problem unlike numbers, text, logical values in a normal database. So knowledge base is the collection of the domain knowledge. For collecting knowledge in database different methods are used like Predicate calculus, semantic network, script .The dialog structure provides communications and interaction with the use during the operation and processing of the expert system. Knowledge acquisition is another process of expert system for gathering and transferring problem solving expertise from all sources of knowledge in a computer programme. Knowledge acquisition process is usually comprised of three principal stages which are Knowledge elicitation, intermediate representation and executable form. The inference engine considered the brain of expert system which contains the general problem solving knowledge that pairs the facts stored in the working memory with knowledge domain that is stored in the knowledge database, to get the method from the problem. The interpreter makes decisions on how to apply the rules for inferring new knowledge and the scheduler prioritizes the rules in the appropriate order.

Artificial intelligence is an attempt to teach machines the characteristics of human intelligence. Intelligence is associated with the ability to recognize patterns, apply experience and expertise to patterns to solve problems, learn from new experiences and apply judgment when data are incomplete or unavailable. ESs captures the strengths of, and integrates well with, other branches of AI such as natural language processing, pattern recognition and programming. It is different from conventional program in the way of representing knowledge and processing it. Expert systems can be distinguished from conventional computer systems in that way it simulate human reasoning about the problem domain, perform reasoning over representations of human knowledge,

to provide explanations and justifications of their solutions, manipulate a big and effective database, referencing and use of knowledge ,execution done logically and heuristically.

It attempts to simulate the human reasoning by using the human knowledge representation. It uses the heuristic methods to find the solution. Basically it is made of three parts:

- User interface
- Knowledge base
- Inference engine

User interface: It allows the user to ask question and provides advice correspond to it.
Knowledge base: It consists of facts and rules which are created from information which are provided to it.
Inference engine: It helps to matches the user's query with knowledge base and provides the result.
Expert system for manufacturing:
Artificial intelligence helps to teach machines so that machine could learn the characteristics of human intelligence. It involves the criteria to learn from new and past experiences, various patterns to solve problems and also the judgment if data is inadequate or incomplete. Expert system has been applied to manufacturing domain for process control, quality control, scheduling, production management, trouble shooting and diagnosis.

II. APPLICATIONS

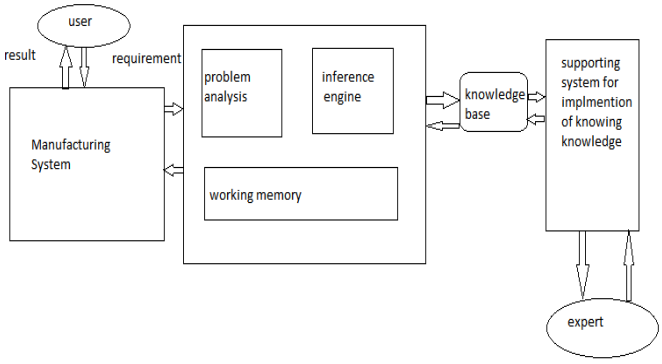
Expert system in manufacturing has various applications like system configuration, interpretation of data, and design of some pattern. There is various application of expert system in manufacturing environment. Expert system benefits in manufacturing among 500 largest industrial companies in USA. There are some questions that are arising in developing the expert system. In manufacturing environment of computer system, global competition leading enhance the development of expert system in manufacturing of system with quality of their service customer satisfaction.

Expert system in manufacturing from view point of computer consist of Computer Aided System(CAD), Computer Aided Manufacturing (CAM), Computer aided Production control(CAPC), Computer Integrated Manufacturing (CIM). Application fields and basic structure of expert system in manufacturing include various fields as given below:

FIELDS OF APPLICATION	SUBJECT OF APPLICATION
DESIGN	1.Specification understanding and recognition
	2.Functional Requirement
	3.Formation of the model
	4.Analysis and simulation of structure
	5.Inspection of drawing
	6.Documentation of the design
MANUFACTURING PLANNING	1.Process of planning
	2.Planning of operation
	3.Functional requirement
	4.Manufacturing formation
CONTROL AND OPERATION	1.Robot planning
	2.Software system for

	assembly
	3.Software system for material handling
MANAGEMENT	1.Production planning
	2.Load planning
	3.Scheduling material requirement
	4.Facility planning
	5.Modeling management
	6.Estimation management

Table 1. Basic structure of expert system in manufacturing result as below:



III. ROLE OF EXPERT SYSTEM IN MANUFACTURING

In the manufacture and sale of wafers and related intermediate products to the semiconductor andsolar industries has been using Expert system knowledge automation expert systems technology in its worldwide manufacturing operations for a number of years. The company has realized significant, measurable ROI and benefits by implementing and fielding over 40 systems in many areas including operator training, manufacturing operations consistency, and complex process control troubleshooting.

1. Simplified Training: Due to the nature of the company's complexity of manufacturing processes and procedures, the company needed more effective and efficient problem solving training of operators. Expert systems have streamlined and cut training costs by over 10%. Instead of time consuming and confusing "classical" instruction that concentrates on figuring out and understanding many, varied complex processes; operators simply "consult" with the expert systems to take appropriate situation- specific actions in troubleshooting. The systems also accelerate new training. The expert systems guide operators through problem - solving steps, allowing them to concentrate more readily on solving immediate real - time problems. Without having to suddenly locate a process - specific expert, or learn all of the background complexities of many processes, operators can quickly learn to solve real- time problems at hand. In turn, instead of answering repetitive questions, this frees up company experts to solve unique problems and concentrate on creative product development.
2. Consistent Answers & Ongoing Improvements: Another major benefit that expert system technology brings to the company is assurance that the same decisions are made under the same circumstances and conditions every time. Operators rely on and are guided by a consistent step - by- step process of evaluation and decision making that reduces variations throughout the system. The expert systems are consistent and certain in problem solving abilities in "knowing" what works and what does not work. Using this knowledge, the systems allow engineers to access collect and analyze data to help them make further corrections and improvements in manufacturing operations and procedures.
3. Solving the Problem the Right Way Averts Many Other Problems: The company's manufacturing and operations processes can be incredibly complicated, and every process may impact dozens of others. Many problems the operators encounter are more involved than they can

handle themselves. The experts conduct a Design of Experiment (DOE), account for the relationships among the various process steps and parameters, and use expert systems to provide operators with simple and logical instructions for complex decision- making processes. The expert systems take them though a series of appropriate questions drilling down to solve specific problems, and makes recommendations including the correct sequence in solving problems.

4. Improved Process Control: Expert systems bring other advantages to the company's manufacturing operations. It strengthens and builds upon their focus of continuous improvement. The systems are linked to their Statistical Process Control (SPC) to enhance control chart reaction effectiveness, and are integrated with the plants' database.

Because of the advantages of Expert system knowledge automation expert systems, the company has further expanded their utilization on a worldwide basis including locations in North America, Europe and Asia.

IV. EXPERT SYSTEM IN MANUFACTURING OF DIFFERENT SYSTEMS

A. EXPERT SYSTEM IN MANUFACTURING MACHINE SELECTION:

Automated expert systems are trustworthy way to improve safety of patients in hospital environment. Statistical process used to monitor an expert system.

B. EXPERT SYSTEM IN MANUFACTURING OF CONSTRUCTION MATERIAL:

In Japan a chemical factory known as Sekisui chemical company, develop plastic molds in Japan. In 1971, Sekisui chemical created the Heim division to build modular houses. HAppS provides you with all the major server components you need to build high quality. You can use them individually or compose them together into a single deployable package that handles all aspects of your internet app including the database. HAPPS systems (High Performance Dynamic Web serving Framework) that manages control-flow within server. It can easily access the data they need anywhere on the internet. In prefabricated houses, modular houses are semi-custom houses designed and construct out of modules. In 1984 Sekisui start building an expert system and made decision to invest in this technology known as expert system, ISAC Company of Sekisui named as International Sekisui AI Corporation. ISAC start building applications for both housing division and parts of Sekisui building. Three kinds of capabilities into tool kit to complete process in production of modular houses:

1. An intelligent CAD tool to help with the development of new designs
2. A room layout consultant and other consultation systems to help in sales
3. Production control and other expert systems to help with the actual manufacture of units

The first expert system to be put in routine use, HAPPS, identifies and selects the necessary parts for a given house design and schedules the delivery of the parts to the right place on the factory floor at the right time. Sekisui Heim has also developed an expert system for sales personnel to help customers with room layouts, but it is experiencing limited acceptance by the sales force.

C. EXPERT SYSTEM IN FOOD PROCESSING

Nestle has installed knowledge automation systems in real - time applications at their processing facilities. Real- time readings from a plant programmable control collected and provided to a knowledge automation system, which performs an analysis on the process status. Messages that guide the operator

in optimizing the operations are then generated. The system operates with special interface software developed for Nestle. A special operator's screen, and extensive use of interrupts provided by Expert system, were keys to success of the project. A model of the process was also built to support the system in the real - time analysis.

D.EXPERT SYSTEM CONNECTION WITH SIMULATION OF COMPLEX SYSTEMS

Expert systems are also merges with simulation into one package. The knowledge automation system increase productivity and performance of flexible manufacturing systems. Expert systems are keeping the equipment working at optimal level by maximize machine utilization. Simulation is concern with process arrival and monitoring. This monitoring occurs anytime, this monitoring cause progress and provides facility. This monitoring occurs anytime wait in queue for particular facility. This simulation system consists of entities that have attributes of job such as number, time of job, start time. The total collection of entities and their attributes at any point in time is called the status of thesystem, and rules called events govern changes in the status. Typically an order will be generated consisting of 20- 100 jobs at a time, by using some function of time. The processes enter the queue for a machine, process the job and then release controls, the rules of the knowledge automation system are based on:

1. Preventing delay of Orders.
2. Delay of Orders minimize
3. Optimize Use of Machines

These rules use the attributes of the jobs that are in a corresponding queue of a free machine to make decisions.

E.EXPERT SYSTEM IN COMPUTER INTEGRAED MANUFACTURED CELLS (CIM):

Allen- Bradley is one of the major manufacturers of Computer Integrated Manufactured Cells known as CIM Cells is Allen Bradley. This company has fielded this system worldwide and their sales force uses it extensively. CIM cells are a highly advanced form of automated machining equipment. The CIM cell is capable of re - configuring itself under computer control to produce a wide range of different parts in lots of 1 to 10,000 or more. The flexibility and speed with which differing parts can be produced make CIM cells one of the most advanced production technologies available.A CIM cell is extremely complex, utilizing many different types of sensors, controls, cutters and peripheral equipment. There are hundreds of components that can be included in a CIM cell, and many possible configurations will not function properly. Configuring a CIM cell involves determining that all components are compatible and that the system is complete. This used to require a human expert with extensive experience, and take a full day.A large knowledge automation system was built that now configures a CIM cell in minutes. The system backward chains extensively and uses external programs for data input, and obtaining current prices of equipment. A sales person can input information to the configuration using a large customized "fill - in - the blank" type screen. The system then checks the configuration and asks the user for additional information as needed. Once the CIM cell is configured, the system looks up prices of the selected components and prints a detailed quotation, using the Report Generator. The report can then be incorporated into a sales proposal and given to the customer.

F.EXPERT SYSTEM IN WELDING COMPANY

Many engineering companies have built many knowledge automation systems for a wide variety of construction applications. Several systems have been developed to assist in various aspects of welding.A PC based Welding Procedure Selection knowledge

automation system was developed by an engineering company's construction specialists to help project supervisors identify appropriate welding procedures at field sites. The complexities of reconciling weld material types and sizes with construction policy make selecting these procedures difficult. This knowledge automation system gives welders printouts of the correct welding procedures, after simply inputting material specifications and related information. With some additional information, the system also provides time estimates and material requirements. The Weld Defect Diagnosis knowledge automation system was developed to identify the causes of weld defects. To do this, it analyzes material types, welding procedures, environmental conditions, and personal observations of the welding area.

This knowledge automation system chooses tests for welders, taking all relevant factors into consideration. Welder qualification tests, which are based on welding requirements and a complicated set of construction policies and procedures, can be very expensive. This system has significantly reduced costs at a major oil company by helping in the efficient selection of these tests.

V. CONCLUSION

Computers have changed the industrial Engineer's way of thinking and become a part of our systems approach to problem-solving. It is the IE who integrates skills of engineering with the tools of mathematics and computer science to formulate and build models for design, analysis, evaluation and prediction purposes. Future computers are predicted to introduce staggering changes in our abilities to use computers; and AI is part of this future making it important for some of the IE's to get involved in AI.

VI. FUTURE

1. Expert system may be integrated with some optimization software for improving industry performance.
2. Some methodology and computerized diagnostic prototype may be utilized as an internal management or self-assessment toolby companies in their continuous improvement strategies for expert system.

ES's are good problem-solving tools for very specific domains. Most problemsencountered in organizations are not of this type, and thus for ESs to be more effective problem solvers, the system architecture should be modified orredesigned to overcome this domain-specific limitation. Most of the ESs thathave thus far been discussed and developed are essentially stand-alonesystems. However, in the very near future it is likely that a large portion (if notthe majority) of the ESs developed will be embedded systems, that is, systemsthat form a part of the overall software package. Hybrid ESs is one example ofsuch an approach.Co-operative distributed problem solving is an area of AI which studies waysof solving problems by first decomposing the problem into sub-problems. The sub-problems are sent to specialized problem solvers (possibly an extension of a specialized ES where there is an attempt to decompose them intocomprehensible subunits. This phase corresponds to disaggregating theproblem. Once the sub-problems are solved, they are aggregated to result in aglobal solution to the problem. The implementation mechanisms of how this network of problem solvers can be realized have been studied to a lesser degree by computer science researchers.

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