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A KNOWLEDGE-BASED ARCHITECTURE FRAMEWORK OF DESIGN FOR ASSEMBLE SYSTEM (DAEx)

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ABSTRACT

Malaysian manufacturing sector has played an important role to boost up the economy at the domestic market. Today, the Malaysian manufacturing sector has facing the challenges that the manufacturing industry need to stay competitive to compete at the global market. Manufacturing cost of the company will directly effect on the company profit as well as product cost. Manufacturing cost may include material cost, labor cost and overhead. Various type of techniques and methods have been used to lower the manufacturing cost. With the advancement of computer, computer software has been used to solve the manufacturing sector problem. In this research, expert system has been proposed to develop a diagnosis system to solve the problem of design of assemble. The effective assembly design of a product will able to reduce the total assembly time as well as reduce the manufacturing cost. An architecture framework of the developed Design for Assemble Expert system (DAEx) is described. The DFA expert system is developed using expert system shell to support the vehicle seat manufacturing process. The main aim is to reduce the assembly time and cost of vehicle seat manufacturing process.

Keywords: expert system, design for assemble, architecture framework.

INTRODUCTION

The advancement of computer technology has assisted the manufacturing sector to improve the engineering design process as well as manufacturing process. Design is one the important stage of manufacturing process. The right design at early stage is needed in order to reduce the rejection rate as well as to reduce the manufacturing cost. Computer has been shorten the design process by using the computer-aided design (CAD) technology. CAD has been used to improve the precision and accuracy of the design; to improve the design database management; to optimize the product design process and engineering; and to create a prototype rapidly. The computer system is able to assist the design engineer at early stage of product design process. The assembly process is one of the crucial stage in the manufacturing process. The design engineer need to design a product with simple assembly process in order to reduct the assembly time. Design for Assemble (DFA) is a technique that used to advice on the optimum product assembly design at early design stage. The right assembly design at the early stage of product design will able to reduce the manufacturing time and improve the design efficiency. DFA approach is able to reduce the number of components and parts of a product as well as the assembly time. At the same time, the assembly cost will be reduced as well. The developed DAEx is to assist the design engineer during early design stage to reduce the assembly cost. The architecture framework of a Design for Assemble Expert system (DAEx) is described.

EXPERT SYSTEM

The computer technology has promoted the advancement of software technology. One the creation by researcher is the artificial intelligence (AI). There are different type of artificial intelligence has been developed to assist the engineer, such as expert system and neural network. Expert system (ES) or knowledge based system (KBS) has been developed in the early 1970s and it has been used in engineering sector widely. The function of ES is to gather the expert knowledge and experience to solve the problem when the expert is not available (Giarratano and Riley, 2004). For engineering sector, ES can be used to advise the engineer to select the optimum design methods, design process, selection on right material, selection of engineering components and diagnose of the engineering problem. For engineering application, ES has been used to diagnose the problem of automatic wire bonding machine. The input parameters such as machine accuracy, materials and tooling information has been input to ES. ES also used to develop the fault diagnosis system of industry pipe manufacturing process. The developed system is to solve the problem in industry pipe manufacturing process and increase the manufacturing efficiency of industry pipe. Next, ES is able to select the right carbide cutting tools for computerized lathe machine. The selection criteria for carbide cutting tools is based on tool size, material type, tool type, insert, feed rate and turning speed.

KAPPA-PC is a software that developed to solve the problem with expert system approach. The KAPPA-PC enable the user to develop a user interface in graphical environment and generates program code. KAPPA-PC is able to build the expert system for different applications



with the expert system shell (Fichman and Kemerer, 1997; Negnevitsky, 2005). The application of KAPPA-PC including fault diagnosis, material selection, tool selection, feature recognition and stock market prediction.

AN ARCHITECTURE FRAMEWORK OF DAEx

The Design for Assemble Expert System is developed based on heuristic rules. The heuristic rules is developed based on the knowledge that was acquired from the experience of the assembly process personnel such as manager, design engineer, supervisor, technician and operator. The rule-based technique is used to classify the expert knowledge and to conduct the reasoning process of the developed system. The development process of DAEx includes knowledge acquisition from assembly design expert, selection of various assembly design and techniques, design of the user interface, knowledge hierarchy definition, programming of the developed system, documentation, implementation and maintenance. The development of DAEx involves the steps as follows:

- Knowledge acquisition: the knowledge of assembly design and process is acquired from the expert of assembly related design and process of the company. A few techniques such as interview, questionnaire and observation is used to acquire the knowledge from the assembly expert.
- Design: Next, the task is to select the right knowledge representation technique and assembly design strategy. A prototype of DAEx was developed to test and validate the proposed requirements. The prototype also demonstrating a working system of DAEx.
- Testing and validation: the developed DAEx is tested and validated to identify the error as well as to ensure the developed DAEx is able to fulfill the initial goals of the project.
- Documentation: the development process of DAEx will be documented for future improvement.

The architecture framework of the propose DAEx is shown in Figure-1.

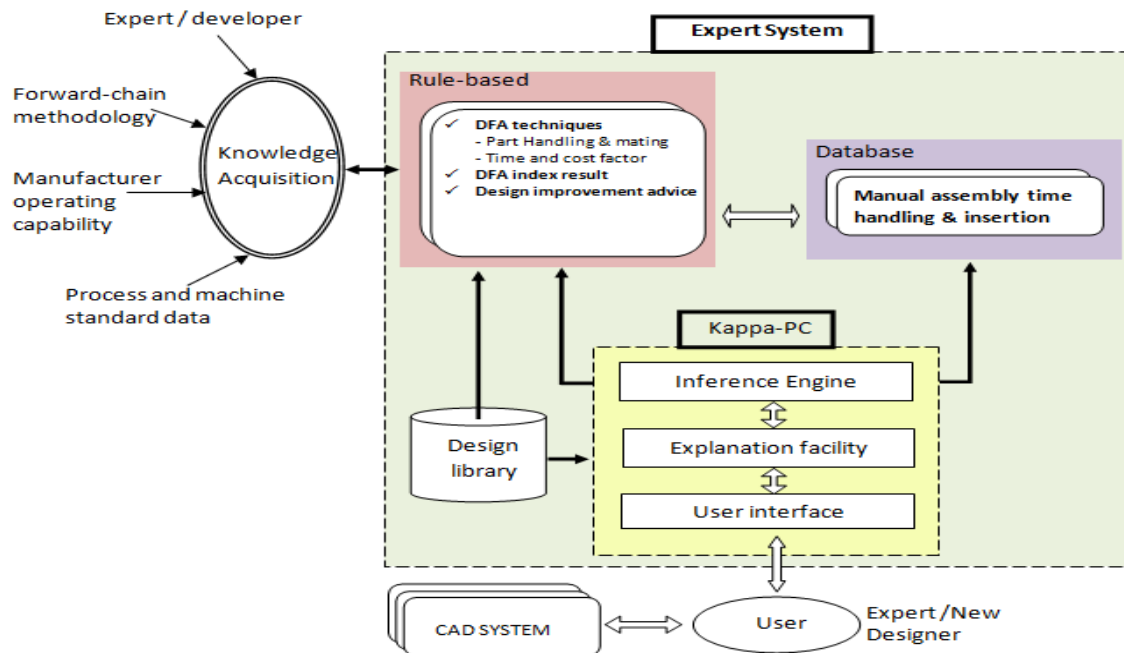


Figure-1. The proposed architecture framework for DAEx.

SYSTEM DESCRIPTION OF DAEx

The Expert System for Design for Assemble is based on the heuristic rules that are gathered from the experience of assembly design engineer, technician and operator. A rule-based approach is used to select the classification method and the reasoning approach of DFA. The development of DAEx involves 4 major phases.

Phase 1: Knowledge Acquisition

DAEx is developed to select the optimum assemble design technique of the vehicle seat in order to reduce number of parts and assembly time. The expert

knowledge is heuristic and the knowledge need to be acquired from the expert systematically. The experts that involves with the assembly process are managers, engineers, technician and operators. Their experience and knowledge is valuable as the input to DAEx. The knowledge can be acquired by interview with experts, refer to previous design approach, study on assembly design guidelines and study on innovative assembly techniques. Figure-2 shows the hierarchy tree of the DAEx.



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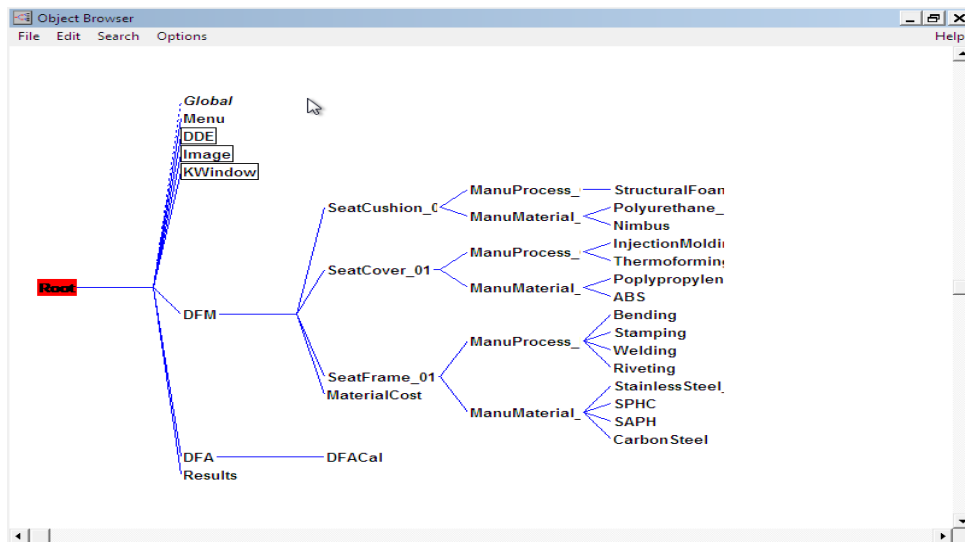


Figure-2. The hierarchy tree of DAEx.

Phase 2: Design

In the second phase, the knowledge representation and selection strategy will be defined. The developed DAEx will be tested and validated.

Phase 3: Testing and Validation

Next, DAEx will be tested and validated for its performance and functionality. The testing and evaluation process is to ensure the developed system is able to fulfill the assembly design process procedure and user requirements. User acceptance efforts are concerned with issues impacting how well the system addresses the needs of the user.

Phase 4: Documentation

Lastly, the documentation phase serves as the record of the developed project. It contains all the material collected during the project and used as reference in the future.

CONCLUSIONS

The developed Design for Assemble Expert system (DAEx) is to assist the design engineer during the early design stage. There are three main core of DAEx such as an assemble advisory module, a knowledge-based module and a user interface. With the developed system, the design engineer is able to select the optimum assemble design methods and process for the new product. DAEx is able to reduce the assembly time and cost. Overall, the developed system is able to reduce the manufacturing cost and increase the competitiveness of the new product in the market.

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