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An Architecture Framework of Design for Assemble Expert System

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***Abstract*—Nowadays, manufacturing cost is one of the important factors that will affect the product cost as well as company profit. There are many methods have been used to reduce the manufacturing cost in order a company to stay competitive. One of factor that affect on manufacturing cost is the time. Expert system can be used as one of the method to reduce the manufacturing time. The purpose of the expert system is to diagnose and solve the problem of design of assemble. The paper describes an architecture framework of design for assemble expert system that focus on commercial vehicle seat manufacturing industry.**

***Index Terms*—design for assemble, expert system, framework, vehicle seat**

I. Introduction

Computer-aided engineering (CAE) is used extensively in the industry to support and enhance the engineering design process. Computer has been used to represent the geometrical parts using computer-aided design (CAD); improved the visualization of the design with virtual reality capability; to produce a rapid prototype for product evaluation purpose; to improve the precision and accuracy with calculation and analysis capability; to propose alternative solutions for decision making purpose, etc. With the computer system, a good engineering design at early stage of manufacturing system is able to reduce the manufacturing cost. Computer software is a valuable and powerful tool to be associated with computer to assist human. Design for Manufacture and Assembly (DFMA) is a computer technique is used to focus on customer requirements to meet the quality and cost reduction goal. Design for Assemble (DFA) is one of method that used to ensure the right assembly design of a product at the early stage of the manufacturing process. The implementation of DFA in the early stage of product development is support a mechanical design to optimize the design efficiency by reducing the number parts and assembly steps and operation before mechanical product to be assembled. The assembly efficiency will be increased and assembly cost is able to reduce. In this paper, the design and development of the architecture framework of a design for assemble expert system (DAEx) was described.

II. Expert System

The artificial intelligence has been developed in a decade ago. Different types of artificial intelligence, such as expert system, neural network, genetic algorithm, etc. have been developed. For expert system (ES), it has been developed in the early 1970s. Expert system can be called as knowledge base system (KBS) is used to acquire the expert knowledge and solving problem when the expert is absent. Expert system has been used in many areas, such as engineering, medical, science, manufacturing, finance and others.

The expert system has been used to select engineering components, materials, processes as well as used for diagnose fault and problem. Arezoo et al. [1] has developed a KBS to select tools based on the turning operation conditions. Tan [2] developed KBS for fault diagnosis in automatic wire bonding machine. The diagnosis method is based on the maintenance requirements of the automatic wire bonding machine such as accuracy, machine and material. Tan and Kher [3] developed a fault diagnosis system for industry pipe manufacturing process based on KBS approach. The KBS is used to ease the problem solving method in Malaysian pipe manufacturing processes and reduce the manufacturing in particular domain. ES also used to select the carbide cutting tools for computer numerical control lathe machine [4]. The machining parameters such as tool holder specification, carbide tool types, insert, feed rate, turning speed and material type were input to the ES. Besides, ES also used in the CAD system to recognize a manufacturing features such as rotational features [5].

The expert system can be developed with expert system shell software. The expert system shells such as KAPPA-PC, Exsys Developer, KEE, VP-Expert, etc. are used by developer to develop the ES for different applications. In this project, KAPPA-PC was selected to develop a DAEx. The KAPPA-PC is developed by IntelliCorp Company.

The KAPPA-PC Application Development system allows the user to write applications in a high-level graphical environment and generates standard ANSI C code and GUI (Graphical User Interface) runtimes. KAPPA-PC is used to build mission-critical applications that form the core of business operations [3]. KAPPA-PC is a customization software that can be used to develop an ES for different application. Besides, different companies will have differences facilities, machineries, and strategy to reach the target which will lead developers to apply their knowledge and expertise for implementation into expert system. The KAPPA-PC expert system shell can be used in many applications such as fault diagnosis [2,3], feature recognition [5] and component selection system [4].

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III. Design for Manufacture and Assemble

Design for manufacture and assembly (DFMA) is combination of techniques of design for manufacture (DFM) and design for assembly (DFA) with objective to ease the manufacturability and assemble of the product. DFMA system development initially started early 1970s and become a most relevant computer aided tool to enhance optimization in the manufacturing and assembly process.

DFMA system would be a workstation-like environment as a platform for designer to create product design and would act as manufacturing expert [6]. These involve a design rule checking, productivity and assemble evaluation, cost reductions etc. There are three main activities for DFMA as follows [7]:

- As the fundamental guidelines for design team to simplify the product, therefore cost reduction of manufacturing and assembly can be achieved.
- As benchmarking tool to evaluate competitors' product and difficulties of manufacturing and assembly able to be quantified.
- As cost control of product design development and for a reason in negotiating contracts with suppliers.

DFMA as significant tool that provides the systematic procedure for analyzing a proposed design from the point of view of assembly and manufacture. Besides, with reduction of component parts which mean no more additional number of drawing and specifications, vendors may not require, and the inventory is able to be eliminated. All of these factors contributes to the total cost saving in a company. Furthermore, DFMA tools also encourage communication between designer and managerial department and other department that important during product development in early stage by means there are teamwork.

DFA is defined as a process for improving product for easy and low-cost assembly focusing on functionality and on ability to assemble concurrently. DFA is commonly used by the designer as a technique to improve a product design assembly especially in automotive industries, electronic industries, aerospace industries; telecommunications power utilities sectors, medical sciences, managements, military and others field.

DFA is a useful technique to help designer to analyze the design and manufacturability of product in early stage of designing process so that the better decision of final product design will being produced well. When the main purpose of DFA is successfully achieved that mean a great impact in reduction of manufacturing cost by optimization and minimize the product assemble varieties.

IV. An Architecture Framework of DAEx

The Design for Assemble Expert System will be developed based on heuristic rules and the experience as well as knowledge of the assembly personnel such as manager, design engineer, floor supervisor and operator. Classification and reasoning of DAEx are carried out using a rule-based approach. This includes knowledge acquisition, choosing the assembly condition, user interface design, define the knowledge hierarchy, program code design, program validating and testing, documentation, implementation and maintenance. The development of DAEx involves five major steps as follows:

- Knowledge acquisition: the knowledge of commercial vehicle seat assembly process will be gathered from a Malaysian commercial vehicle seat manufacturing company.
- Design: after the first phase, the next task is to select the knowledge representation technique and control strategy. A prototype ES will be developed.
- Testing and validation: the developed ES will be tested and evaluated to ensure the ES performance is converging towards established goals.
- Documentation: it is serves as the library of the project.
- Implementation: the developed DAEx will be commercialized and to be implemented at the commercial vehicle seat manufacturer in Malaysia.

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

V. Conclusion

An architecture framework of Design for Assemble Expert System has been proposed. The proposed system comprises of assemble advisory module, a knowledge-based module and a user interface. The proposed system will allows user to find the best solution for the assembly process during the commercial vehicle seat assembly process. Besides, the proposed system is able to support the design engineer in selecting the best and fastest assembly method. The main goal of the proposed system is to reduce the assembly time and reduce the manufacturing cost. The DAEx will be designed, tested and validated in a Malaysia commercial vehicle seat manufacturing company.

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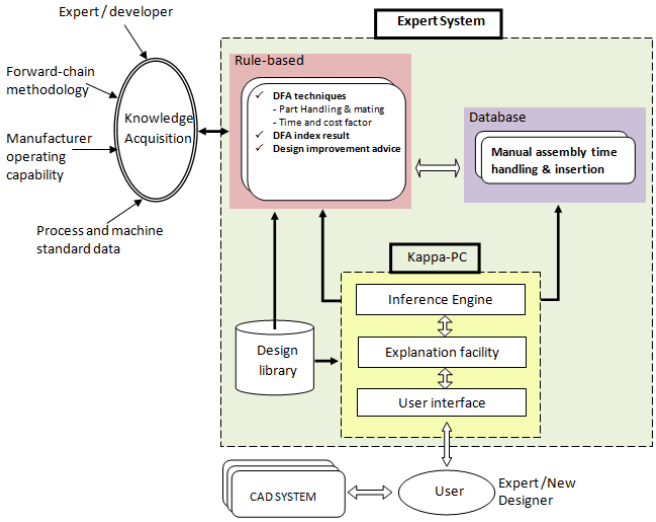

Figure 1. The proposed architecture framework for DAEx.

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