

A framework for development of an intelligent system for design and manufacturing of stamping dies.

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Abstract. An integration of computer aided design (CAD), computer aided process planning (CAPP) and computer aided manufacturing (CAM) is required for development of an intelligent system to design and manufacture stamping dies in sheet metal industries. In this paper, a framework for development of an intelligent system for design and manufacturing of stamping dies is proposed. In the proposed framework, the intelligent system is structured in form of various expert system modules for different activities of design and manufacturing of dies. All system modules are integrated with each other. The proposed system takes its input in form of a CAD file of sheet metal part, and then system modules automate all tasks related to design and manufacturing of stamping dies. Modules are coded using Visual Basic (VB) and developed on the platform of AutoCAD software.

1. Introduction

In sheet metal industries, design of stamping dies is generally considered an art rather than science. Since the early seventies, there has been a remarkable advancement in computer aided design (CAD) of stamping dies. But till today, not a single CAD system is available in the market which is capable to fully automate the task of design of stamping dies. From early seventies, many researchers applied efforts to develop CAD systems for design of specific type of stamping die such as blanking die, progressive die, and deep drawing die. The developed systems were not integrated in nature and required lot of human intervention. Within the mid of nineteen's, the research work in this area inclined towards development of expert systems to simulate the experts' logical thinking in die design. With the start of 21st century, there has been a remarkable research interests towards the integration of CAD, computer aided process planning (CAPP) and computer aided manufacturing (CAM) in the area of design and manufacturing of stamping dies. In the absence of an automated system for design and manufacturing of stamping dies, experienced die designers and process planners are compelled to use many general purpose and costly CAD and CAM software's/packages. Besides this, the quality of stamping die designed using these systems is much dependent on the experience and skill of die designers.

Development of an intelligent system for automated design and manufacturing of stamping dies is an urgent requirement of sheet metal industries. This type of system can be developed using

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applications of expert systems in CAD, CAPP and CAM of stamping dies. In this paper, a framework for development of an intelligent system for design and manufacturing of stamping dies is proposed. According to the proposed framework, the system initially receives the CAD file of sheet metal part. Then it automatically extracts design features from the CAD file of part and identifies the required operations and their sequence for manufacturing the part. Next, the system selects the required type of stamping dies, and its arrangement for carrying out identified sheet metal operations. For each type of stamping die, expert system is to be developed for optimal die design. Once the task of die design is completed, the system displays its final output in form of three-dimensional (3-D) drawings of die components and assembled die. From 3-D drawing of die components, required data is extracted automatically for execution of processes planning module. The proposed system is to be coded using Visual Basic on the platform of AutoCAD software. Microsoft products such as excel and accesses are required to be used as a package database.

2. Literature review

Some researchers have applied efforts to develop computer aided system for design of stamping dies. For example, Cheok and Nee [1] from National University of Singapore developed a computer aided intelligent system for design of progressive dies. The system covers sheet metal unfolding, strip-layout, punch recognition, and die design. Lee et al. [2] proposed a CAPP system for progressive die. Wang [3] from Gintic Institute of Manufacturing Technology developed a CAD system for progressive die using feature based design approach. This system has five modules which covers all applications of progressive dies. In his further work [4], he constructed a CAD system which covers three types of dies namely progressive, compound and deep drawing dies. Hwang et al. [5] from Busan National University developed an automated progressive design system with multiple processes (piercing, bending, and deep drawing).

Park [6, 7] from Busan National University discussed how the cost estimation of the die has important role in decision making in the tool and die factories. He developed an integrated CAD/CAPP/CAM for both sheet metal dies and plastic moulds. He used Taylor made software's such as "In-MouldTM for initial estimating calculations, Pro-MessTM for detailed estimate, and Pro-PESSTM-for press Die. The integrated system covers all activities of design and manufacturing of dies and moulds. It generates die cost estimation and reports to help the workshop administration to take the right decision.

The new trends in Europe are focused more on advanced technical machines instead of dies. Cser et al. [8] suggested a work cell consisting of cutting machine (laser or punching nipling machine) and bending machine. The sheet metal part automatically transferred from one machine to other using a belt conveyor. The system controls the part position during moving through computer vision technique. Recently, researchers have applied efforts to develop integration in many industrial applications. For example, integration in prismatic machined parts [9], integration in cylindrical machined parts [10], Integration in manufacturing using CNC machines based on STEP [11] and Integration in sheet metal machining applications [12]. In fact, all these kind of integrations has their impact on the intelligent integrated system in sheet metal die design and manufacturing.

From the critical review of available literature, it is concluded that no intelligent system is available which is capable to fully automate the design and manufacturing tasks of all types of stamping dies. Authors have applied efforts to develop a framework for development of such type of system.

3. The proposed framework of Intelligent system

The proposed framework of intelligent system is depicted in Figure 1. This framework consists of four main sections. The first section is concerned with the feature extraction and process planning. The system takes its input in the form of 3-D CAD model of sheet metal part. Then it analyzes part data base -STEP file to extract and classify the part data. Next, it recognizes part features and prepares process plan for the part. The system also identifies the required operations and their sequence for

manufacturing the part. Next, the system selects the required type of stamping dies, and its arrangement for carrying out identified sheet metal operations. It must be noted that once the sheet metal part is inserted in the database with all its related data, many sheet metal applications could be achieved such as cost and time estimation, manufacturability assessment, nesting and strip layout, die type selection, part comparison, die block design, preparation of wire cutting program, writing of CNC laser cutting G-code, features recognition, flame cutting, folding and unfolding, punch arrangements, punch recognition, process planning, indexing and retrieving, CNC drawing preparing, computer vision, CNC nipping machine program preparation, die design etc.

The second section of proposed framework focuses on development of CAD systems for automatic design of stamping dies. The system deals with eight types of stamping dies namely, piercing, blanking, progressive, compound, bending, deep drawing, fine-blanking, and forming. Each system for a specific type of die is structured in form of various modules for design and modeling of die components. Production rule based expert system approach is used to develop system modules. The system finally gives its outputs in form of 3-D drawings of major die components and die assembly.

The third section of proposed framework receives 3-D models of die components automatically generated by the previous modules. The system automatically reads the 3-D model component data base in STEP format. It extracts the component data, recognizes the machined features, and then prepares the process plan for manufacturing die components.

The fourth section of proposed framework is concerned with CAM. It takes inputs in form of 3-D models of die components and process plan generated by the previous modules. It also invites the user to enter the required data of machine which will be used for manufacturing of die components. A database file of that machine can be prepared and recalled by the proposed system. The system automatically prepares G-code for manufacturing die components, and simulates the machining operation.

The proposed system is to be developed as a package on AutoCAD platform using visual Basic. The databases are constructed using MS-Excel and MS-Access.

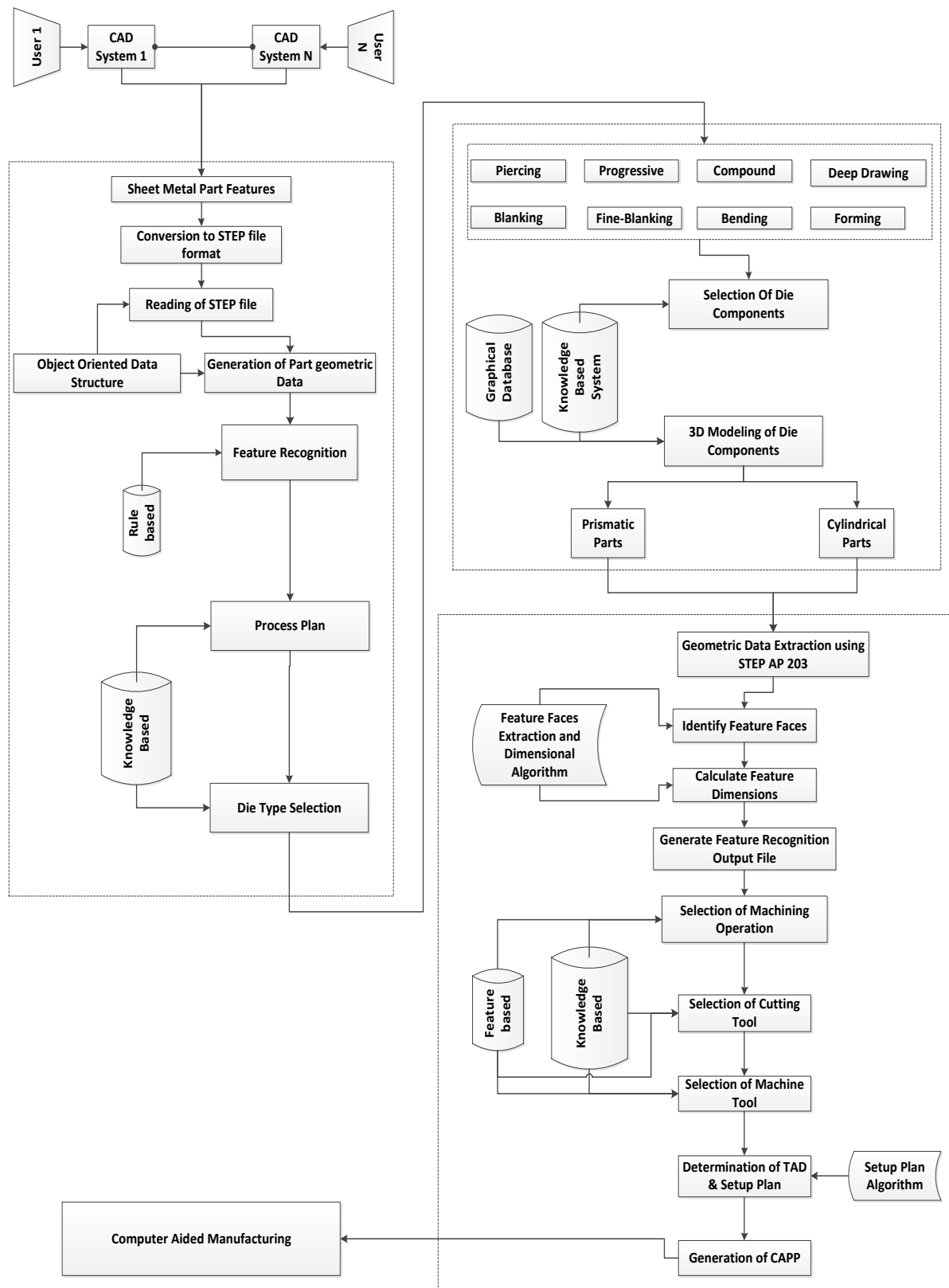


Fig. 1 Proposed framework of intelligent system

Conclusions

The present paper discussed the necessity of an intelligent system for automated design and manufacturing of stamping dies. A framework for development of such system has been proposed. This framework recommends developing the whole system in four sections. The developed system should be capable to automate the design and manufacturing tasks of almost all types of stamping dies without the involvement of experienced and skilled die designers. Authors are engaged in the development of system modules in line with the proposed framework.

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