INTEGRATION OF CAD/CAM/CAE IN MOLD DESIGN AND MANUFACTURING

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Introduction

During the past decade, the technology of the computer aided design and manufacturing has been rapidly improved. Many of the mold manufactures have adopted this technology in their production process. Mold design has gradually changed from the draft board to the 2-D computer aided design. Mold manufacturing has changed from duplicating machine to CNC machine [1]. In the recent years, the software and hardware of CAD, CAM, and CAE have brought the moldmaking a new change. Since most of the product designs have used 3-D model, the mold designs have been gradually pushed from 2-D to 3-D design. With the advantage of the 3-D modeling, the CAM and CAE can be implemented more efficiently. The development of computer technology has improved some degrees of productivity in the toolmaking industries. The maximum benefit of the CAD/CAM/CAE is heavily depended on the integration of software and hardware system [2,3]. In the present moldmaking industry, many of the computer systems have been introduced variously. In most of the cases, the CAD is one system, CAM is another system, and CAE is the other system. Although the data files can be transferred with different translation package, the results are confusing and incompleteness in many cases. The incompleteness of the file translation will cost profit and delay the production time. If the CAD, CAM, and CAE systems are incompatible, the recreating geometry model in each system stage is necessary. The objective of this study is to investigate the integration of the CAD, CAM, and CAE system in the mold design and manufacturing. The investigation includes the concept of the integration and the comparison of 2-D and 3-D system. In order to understand the performance of the CAD and CAM integration, a back cover of a computer monitor was used as a case study.

Current Engineering in Moldmaking

Conventional tool design and manufacturing is a sequential process. This type of manufacturing process is very difficult to survive in today's global competition. Most of the conventional tool designers use two dimensional drawings as the main tool to communicate with part designer and tool shop. Tool designers have to design the 3-D parts into 2-D design drawings. Then, the engineers in tool shop need to figure 2-D mold design drawings into 3-D tool making. This iterative process costs the manpower and production time. Although the drawing is implemented by the CAD system, the operation of each process is individual. Frequent reworks and modifications become inevitable for most conventional processes.

Current CAD/CAM/CAE system can be implemented by 2-D and 3-D model. A simplified schematic diagram is shown in the Figure 1. In part design and mold design, designer may use the same or different CAD system. If each process uses different CAD system, the geometric model needs to be transferred by the translation software. To implement CAE and CAM, the geometric model also needs to be translated. Geometric model translation is an obstacle to improve the productivity of moldmaking. There is no standard for the exchange of geometric data at the present time. Most of the CAD, CAM, and CAE systems have been developed individually for their own system. It is recommended that developing a standard geometric format will help the integration of the CAD/CAM/CAE in most of the engineering industries [4].

Proposed Engineering in Moldmaking

A single geometric data system is important for moldmaking. To reduce the waste of rework and modifications, a single geometric data base is needed. The proposed system is shown in the Figure 2. Since every product development is start from concept drawing, it is important to develop other application systems based on the original CAD system. With a single geometric data, all the design information can be communicated with digital format. Since each application software is developed based on the same geometry file, the translation of geometric data is no need. With the single geometric data, the product geometry is very easy to access by the CAM and CAE system. Any modifications of the product can be rapidly transferred to every process.

Except the concept of the single data base, team approach and early involvement are also the main factors for the cost reduction and the lead time shortening. To organize a task force team involved by the toolmaker and molder is very important [5]. Moldmaking process in the product development takes majority of time. The early involvement of the moldmaker can reduce many of the mold reworks and the product developing times.

Case Study

A CAD system with the feature of single geometric data base was used. The system also includes mold base and CNC programming package. The plastic product used for this study was a monitor back cover (Figure 3). The figure shows the solid model of the product. Figure 4 shows the flow chart of the mold design process. Since all the processes share the same geometric model, the CAE and CAM can be implemented easily. Once the part geometry was created, the EDM model and mold design job were started at the same time. Since the CAD system has mold base data bank, the selection and modification of the mold base become easier. After the parting line and slides had been created, the mold assembly was completed by combining part model into mold base. The solid models of the core, cavity, inserts, and slides are shown in the Figure 5. At this stage the CNC programming for cavity, core, and slides was completed within two days. After the editing and the dimensioning of drawing, the mold design was completed.

The activities of this mold design are tabulated in Table 1. The total mold design is twenty working days which include all the 3-D CNC data. The 3-D CNC data included core, cavity, slides, mold plates, and EDM electrodes. Since the part drawing was created from different CAD system, the 3-D part model was recreatrd by mold designer. If the part design has same CAD system, the working days can be eliminated to sixteen days. It should be noted that the model of all design is 3 dimensional.

Compare this case with a similar conventional 2-D mold design. The total work day for the design is forty (Table 2). The table shows the cavity, slides, core, and EDM electrodes involved majority of the production times. Because the drawing is created in two dimensional, the rework on different views is inevitable. The sectional views of slides, core, and cavity usually take tedious work when 2-D model is used. Comparing the 3-D modeling to the 2-D modeling, the slides' blocks can be created in a short time with 3-D modeling. The results of the integration of the CAD and CAM show that the working time is drastically reduced.

Conclusions and Recommendations

In this study, different CAD system between the part design and the mold design resulted the rework of the part geometry model. The results showed that at least 4 to 5 working days could be reduced if the integration of CAD system between the part design and the mold design was available. The integration of CAD and CAM with 3-D modeling showed the design and manufacturing times was reduced significantly. The integration cf CAD and CAE with no file translation may perform more user friendly. To improve the integration of the CAD/CAM/CAE system, the CAD system developer should implement and release easier geometric format for third-party software development. Integration of the CAD and the prototyping is another interesting subject for further study.

References

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5. Plastics Design Forum, March/April 1993, p. 23.

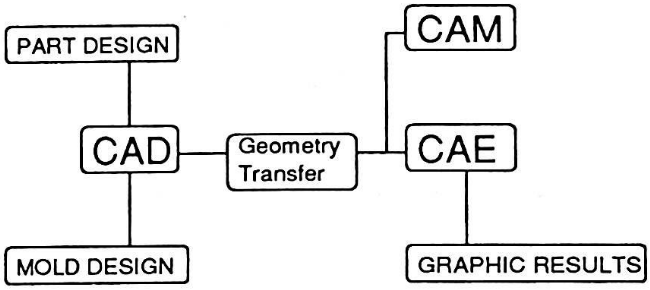

Figure 1. Schematic Diagram of Current Engineering

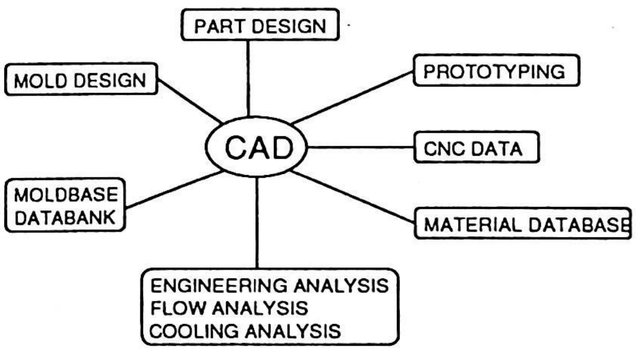

Figure 2. Schematic Diagram of Proposed Engineering

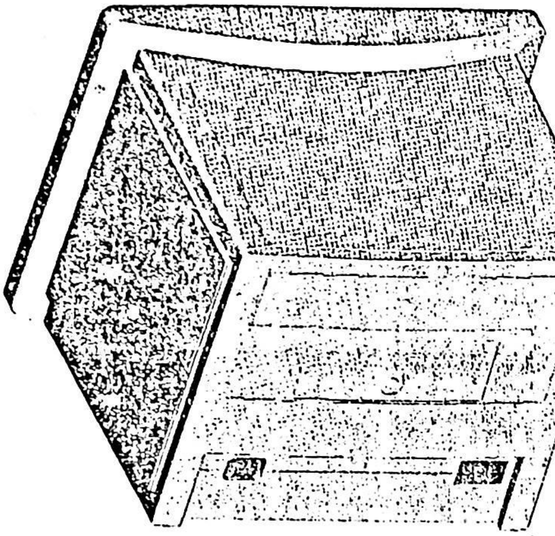

Figure 3. The solid model of the monitor back cover

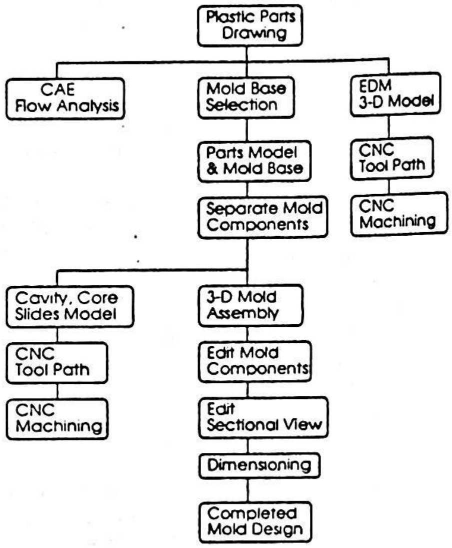

Figure 4. 3-D Mold Design Process with Single Database Model

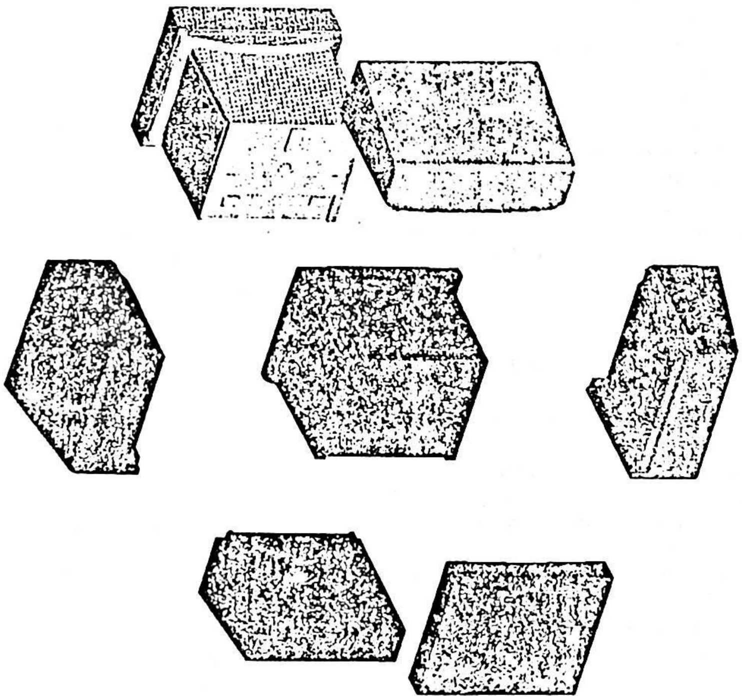

Figure 5. The solid model of the mold components

TABLE 1. Mold Design Activities with 3-D Modeling

Stages	Work Days	
Part Drawing (3-D Model)		4
Mold Design		5
Mold Assembly		
Cavity		
Slides		
Core		
CNC Model		1
Tool Path	2	
CNC Machining	26	
Edit Drawing		10
Sectional View		
Dimension		
Modify		
Total CNC Work Days	28	
Total Work Days		20

TABLE 2. Mold Design Activities with 2-D Modeling

Stages	Work Days	
Part Drawing (2-D Model)		5
Mold Assembly Drawing		4
Cavity Retainer Plate		2
Cavity		4
CNC Model	2	
Tool Path	1	
CNC Machining	3	
Slides		8
CNC Model	6	
Tool Path	2	
CNC Machining	14	
Core		3
CNC Model	2	
Tool Path	1	
CNC Machining	5	
Core Retainer Plate		2
Other Mold Components		7
Bill of Materials		1
EDM		4
CNC Model	4	
Tool Path	2	
CNC Machining	4	
Total CNC Work Days	46	
Total Work Days		40