



TECHNICAL  
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REPORT

Integration of Computer Aided Design  
and Computer Aided Process Planning

by

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# Integration of Computer Aided Design and Computer Aided Process Planning

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## Abstract:

In recent years, CAD/CAM systems have gained wide acceptance in industry. As experience in the use of these systems builds up, it is becoming increasingly evident that for most effective operation, they must be integrated. Process Planning, being responsible for the conversion of design specification to manufacturing instructions, is essential to this integration process. Research is being conducted to enable geometric data from a CAD database to be accessed by process planning programs for use in generating appropriate process plans for a given part. The resulting process planning data is then translated into an NC program which can be used to machine the part.

# Automatic geometry data transfer between

## CAD and Process Planning

### 1. Introduction

Today's industrial climate is one of intense competition with great emphasis being placed on reducing costs and improving productivity, product quality as well as reliability. To achieve these goals, manufacturers have had to adopt radical new production techniques. The use of computers in various fields such as design, control and manufacture has been of particular importance.

Experience in the use of various computer-based systems in industry has shown that while each can individually benefit the production process, these gains would be enhanced if the various systems were integrated. There are many functions in which at least some of the required information is common. In such cases, it makes sense to provide a means by which these functions can share the common information. This would be an important step in moving towards the goal of achieving a fully integrated manufacturing system.

### 2. Proposed Research

In developing an integrated computer aided design and manufacturing system (CAD/CAM) it is important to appreciate that even the best design can become useless unless it is properly manufactured. The design data must therefore be converted into proper manufacturing instructions which can then be executed to produce the desired component. The function responsible for converting design data into manufacturing instructions is process planning. This is therefore an essential element of an integrated CAD/CAM system.

The present proposer has developed a computer-aided process planning system (ICAPP), capable of determining all necessary machining operations and associated cutting conditions for a range of features commonly associated with prismatic type parts. Work on integration between design and manufacturing has already started, using the said process planning package. Using interactive procedures, the system establishes exactly what features are required to be produced taking into account machine tool capabilities, available cutting tools and workpiece material. The detailed operations required are determined. In addition making use of the available geometrical information, a detailed part program is generated which can be used to machine the component in question on an NC machine tool.

The research proposed here will be undertaken within the Computer Aided Production Control Systems Laboratory of the mechanical engineering department. The proposed work is part of a major long term research effort and achievements in this research will contribute towards this goal of a computer integrated manufacturing system. It is anticipated that results from this research will be publicised in the form of conference and journal papers.

#### 2.1. Integration with CAD

As outlined above, the ICAPP system in its present state of development is capable of generating both process plans and NC part programs which can be used to machine the part under consideration. In carrying out these functions, the system requires a considerable amount of geometrical information for two main reasons:

1. Establishing the size of individual features to be produced and hence

determine the necessary detailed machining operations. For example a simple feature such as a hole may require machining operations such as center-drill, pilot-drill and final drill. Which combination of these is required will depend ultimately on the size of the hole feature and hence the need for geometry information.

2. Having determined the required machining processes, a tool path has to be established for the purpose of NC-part programming. This requires that geometry information describing the relative positioning of features and how the tool is to move around and between the features has to be obtained. For an integrated system, there has to be a means of communicating this information to the system.

In its current form of operation, the ICAPP system requests this information from the user on an interactive basis. In the simple case of a hole, diameter and depth is the basic geometrical information required to determine the necessary machining operations. For part programming additional information would be required so as to be able to establish hole location. All that geometry information is currently requested interactively.

It is recognized however that this is an interim solution. Although user-friendly, the extensive interactive process is quite laborious and time consuming. To achieve full CAD/CAM integration, it will be necessary to establish a more efficient method for accessing the required geometry information from a CAD database. The main thrust of this research will be to establish the required communication between CAD and Computer-Aided Process Planning (CAPP) so that the CAPP function can extract the information it requires from the CAD database, with minimal human intervention. This would

considerably speed up the CAPP function while at the same time achieving a more truly integrated CAD/CAM operation.

This research will investigate various avenues of communication which can be used to transfer geometry information between a CAD system and a process planning system. Since the process planning system (ICAPP) to be used in this research is feature oriented, the approach to be taken will involve methods of feature recognition and extraction from the CAD database. This will require the formulation of means of geometry data interpretation which do not simply refer to points, lines or arcs in the CAD database but can also recognise connectedness of the various geometrical elements. The interconnected geometry elements would constitute features. Once the various geometry elements can be manipulated as features, the appropriate geometrical data can then be transferred to and used within the process planning system.

The IGES system has become an industry standard for the storage and communication of geometry data. The proposed research will start by exploring the suitability of this standard for feature representation. In this case it will be necessary to establish specific feature attributes which can be used to recognise each type of feature and to determine if such attributes can be represented in the standard IGES format. If IGES proves inadequate for this purpose, then the research will consider enhancing IGES capabilities or formulating another data representation format capable of representing the feature attributes. It is expected that this research will lead to a system capable of representing geometry data in a form which can be interpreted by a process planning system and thus effectively achieve integration between the design and process planning functions.

This will be an important step in the development of the capabilities of computer-aided process planning systems which as has been emphasized before are essential to an integrated manufacturing system. It is anticipated that this will form the beginning of an intensive research effort in the area of computer integrated manufacturing, with future research utilizing the results obtained here to develop an integrated CAD/CAM system via process planning. There will be active collaboration with other interested faculty members and preliminary discussions have also been held with the National Bureau of Standards who have expressed interest in the research. It is anticipated that at a later stage, industrial sponsors will become involved as well.

### 3. Conclusion

The development of integrated computer aided design and manufacturing systems is a long term goal of critical importance to today's industry and vital to the nation's competitiveness in the international arena. The proposed research will contribute to this goal by developing procedures for automatic recognition of features from a CAD database and subsequent data manipulation within process planning; thus integrating design and process planning. Such a system would provide communication between design and production and hence improved productivity and competitiveness could be achieved.