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I. Introduction

The major characteristics of present day manufacturing systems are low quantity, high variety, small batch production, automation of various activities, and application of information technology for integrating different activities. Major business challenges for today's manufacturing enterprises are: Time-to-market, global competition and continuous improvement to satisfy higher expectations of customers. The major goals of manufacturing industries are: high quality, low cost and short delivery time. For achieving these conflicting but essential goals and to be in competition, the manufacturing enterprise must constantly evaluate its business strategy and fine-tune its processes as and when needed. They must be able to implement new production strategies rapidly. The strategy which is currently getting much attention of manufacturing industries is the consideration and determination manufacturability of a product during the preliminary stages of its design.

Manufacturability of a product can be defined as an indication of the effort required for manufacturing that product. Evaluating the manufacturability of a product design involves determining whether or not it is manufacturable with a given set of machining operations and recourses and if it is, determining the corresponding manufacturing efficiency. Since there can be alternative ways of manufacturing a proposed product design, the production plans related to all the possible ways to manufacture it should be considered, in order to determines which one meets the design and manufacturing objectives and is optimal. Given a set of manufacturing resources and product information, the problem of manufacturability evaluation simple becomes to determine whether or not the design is manufacturable and if manufacturable, determine the manufacturability of the given product in terms of manufacturing time, costs, quality and necessary resources.

II. Literature Survey

The basic concepts of Manufacturing features and feature-based representation of given part have been considered as a key area of research on manufacturing systems and engineering, owing to their ability to provide necessary link between design information and manufacturing operations. However, there are several critical research issues which should be must be taken into consideration while fitting the concepts of feature technologies into a systematic framework for manufacturing organizations. A good number of research works are being carried out in this direction. A sample of reported works is presented below.Belay [04] has presented a paper whose aim is to consider the different product development methods in particular on Design for Manufacturability and Concurrent Engineering. Companies can realize and be benefit by minimizing product life cycle, cost and meeting delivery schedule. In this paper work shows the simplified models that can be used by different companies based on the companies' objective and requirements. The Methodologies that are used in this research work are taken in case studies. For the product development process two companies were taken for analysis. From this research, it has been found that the two companies fail to achieve delivery time to the customer. It is found that 50% to 80% of their products

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not delivered in time to the customers, have analyzed the most frequent coming products. The companies which are following the conventional way of product development that is sequentially design and production method, which highly influence time to market. In the case study it is observed that by using these new methods and by forming multi disciplinary team in designing and quality inspection; the work flow steps have reduced from 40 to 30.

Hoque and Szecsi [2 ,3] have explored the application of feature-based representation and design in the area of Design-for-manufacture. The idea is to incorporate parameterized geometry of features; the feature is produced by description of the manufacturing process. (including cutting tool, machine tool, possible fixtures, cutting conditions, and production volume), design limitations, relative cost information, functionality rules, and links to Design-for-manufacture rules at the early stages of design. The designers use the feature library to select the manufacturing features. Upon insertion, the system ensures that Design functionality and Design-for-manufacture rules are applied in real time during the actual design process. The designers are warned if they attempt to include features that are difficult to manufacture or violate functionality rules.

Hendry et al [07] have also proposed a feature library that is able to manage the knowledge of process planners. By enabling the management of the knowledge of process planners, the proposed feature library may be helpful to carry the generation of process plans. Bramall et al [05] have introduced an aggregate planning method, which translates early product characteristics into manufacturing necessities, forms the basis of a new intelligent support system for which the manufacturing evaluation, optimization and reporting functions are described. For the early evaluation of manufacturing scenarios, it allows integrated product and process design teams to evaluate rapidly the manufacturing requirements of a partially specified design based on these important criteria The system 'intelligently explores' the many alternative processing technologies and equipment choices available, seeking solutions that best satisfy a multi-criteria objective function encapsulating quality, cost, delivery and knowledge criteria. The designer is thus presented with the opportunity to redefine the design elements or process specifications, which would yield the greatest improvements in production

Xue and Dong [06] have taken two types of features called design feature and manufacturing features for considering the two product life cycles. The mechanical and mechanisms are represented to satisfy the design function for modeling of a design candidate. The analysis of a design function is based on Design feature coding system. A algorithm called fuzzy pattern clustering is used for design feature library into hierarchical feature group. A graph based search is used for required design feature. A geometric element is produced for manufacturing feature a coding system is developed for manufacturing feature based on product geometry and production operation. For the manufacturing code a group technology approach is used to recognize using fuzzy clustering algorithm. A special optimization module is used for production operations.

In a feature based integrated concurrent design system two coding systems for Generating the design candidates and planning Production process is implemented. Owodunni et al [09] have also presented an Extendible Classification of Design and Manufacturing Features. Salomons, et al [11] have reviewed pointed out In a feature based ,states that for the process planning point of view a feature based design is regarded as a key factor towards CAD/CAPP integration. For supporting design process a feature based design offer better than current CAD system do. In a design Process feature and their rule, design object and design object knowledge are discussed. In a feature based design the main research issues are listed out they are; feature validation, features and tolerances, feature representation, multiple view points of a features and feature standardization. The conclusion is that in the design process better integration with manufacturing is required. In this area more research is needed even though major advances have already been done.

T. Szecsi [12] has pointed out a new design system For development of a design from manufacturing features the system has many modules like manufacturing feature library, manufacturing rule system, manufacturing feature based design module, manufacturing feature recognition module, design advisory module and design analysis module.

Chen and Wei [14] have stated that to support the practice of concurrent engineering a feature based design for manufacturing frame work is used.To develop a design evaluation facilities,object oriented modeling technologies and knowledge based are used.For design evaluation an embedded.

With product design, process knowledge and object oriented product model to recognize area is consructed and used.For a overall shape geometric reasoning is performed on feature, feature interaction with a design principle.

III. System Developed for Manufacturabilty Evaluation

Your paper At present which is recognized as era of automation, it is usual practice to present a designed part through its CAD representation. From the CAD data of the product, it is possible to recognize the manufacturing features of the given part with help of automated procedures and reconstruct the part model

in the form of feature based product model. Then it becomes feasible to conveniently associate the manufacturing knowledge and data to the recognized features in order to determine the manufacturability of the given part. The research work carried out for this purpose includes;

- Classification of the manufacturing features systematically and identification of a scheme of representation with help of a set of characteristics of features which play an important role in associating a given feature with necessary manufacturing information.
- A systematic plan to compile, organize and store the manufacturing knowledge and information in well defined databases and also presenting it in the required formats.
- Prepare a feature library which the design personnel can use for consideration during the process of product design.
- Development of a feature based operational library which readily provide the information about the feasible operations for both rough cut and finishing.
- Operations for a given feature. Along with the list of operation for a given feature the associated manufacturing resources are also specified.
- Representation of the manufacturing recourses such as machine tool, cutting tool and fixtures through a set of individual characteristics.
- Utilize the available automated features recognition methodologies to recognize the manufacturing features of a given part.
- Development of computer assisted procedures to relate the characteristics of features with the manufacturing knowledge and information stored in the manufacturing databases.
- Scanning of the database of available resources to search for recourses whose characteristics matches or close to the expected characteristics in order to select most suitable resources for machining the given feature.
- Finally the application of the data gathered from above mentioned databases for determining the manufacturing time, cost and quality aspects (in terms of meeting dimensional and geometrical accuracy and surface finish requirements) to make an Assessment about the manufacturability of the given product.
- Report about the manufacturability of a given part certifying the product design as acceptable and producible or recommend for redesign with suitable suggestions.

In the present work, a system for determining the manufacturability of prismatic parts, has been developed for which the main input required is the CAD file of the given part. It collects the technical data about the tolerances and surface finish from interaction with the user and data about the available resources and machinability data from the databases are generated to support activities of the system. For performing the different functions related to the determination of machinabilty of given prismatic parts, a series of programs are written in C++ and arranged in different modules. For executing the programs one after other without interruption, they are grouped into main programs in which the individual programs are made as program segments of the related to main program. The lists of the programs are developed below

a) The main program that must be executed first for the proposed System is named as MENU.CPP, which welcomes the user and introduces to the system by displaying the menu indicating the necessary order in which the other programs can be executed.

b) The next major program is for the Feature Recognition which is named as FEAT-REC.CPP which performs all the activities related to feature recognition. This program has program segments to perform various activities starting from reading a CAD file to recognize the manufacturing features of the given part. The following are the important program segments of this program:

- Interfacing program segment to read the CAD data, interpret the CAD data in terms of lines and circles and circles into edges.
- Program segment to determine the geometry of each face.
- Program segment to recognize through depression type features.
- Program segment to recognize blind depression type features.
- Program segment to recognize protrusion type features.
- Program segment to recognize complex features.
- Program segment to determine dimensions of each feature.

c) Interactive Technical Data collection program is named as TECH-DATA.CPP, which first receives the output of the FEAT-REC.CPP program and then interacts with the user by displaying the details of the faces of the given part and collects the technical data, i.e., tolerance and surface finish information. It has program segment to add the technical data so collected to each feature.

d) FEAT-OPERATION.DAT is the data base to stores the data about the available manufacturing operations in a given system. The data is complied and arranged with respect to various manufacturing features of prismatic parts.

e) FEAT-OP-SELECTION.CPP is the program which permits the user to edit the information on Feature Based Operations.

f) MACHINE-TOOL-DB.DAT is the database in which details of the available machine tools are arranges in a pre determined format. The program which helps in editing the information on available machine tools is named as MACHINE-TOOL.CPP

g) CUTTING-TOOL-DB.DAT is the data base in which details of the available cutting tools are recorded. The main program which helps in editing the information on available cutting tools and determination of suitable code for each cutting tool is named as CUTTING- TOOL.CPP

h) WORKPIECE-DB.DAT is the database used for storing the information on available work pieces and MACHINING-DATA-DB.DAT is the database used for recording the machinablility data The main program which program permits the user to edit the information on Mach inability Data and available work piece sizes is named as MACHINING-DATA.CPP.

i) The main program of the Machining Planning is named as MACHINING-PLANNING.CPP, which has program segments to carry out the activities related to machining planning and present the list of recommended operations along with the machine and cutting tool and machining parameters for each feature. The following are the important functions performed by its program segments:

- Selection of the work piece.
- Selection of list of operations for each feature.
- Machine tool selection for each specific feature.
- Cutting tool selection for each specific feature.
- Parameter selection for each specific feature.
- Another major segment is for the Setup Planning Subsystem which is concerned with the display of optimal set plan along with the sequence of operations in each setup and the order of execution is setup.
- Related to the Setup planning activities it has a program segment to perform the fallowing activities.
- to list the feasible set up plans.
- to develop all the setup plans and choose the optimal setup plan.
- to evaluate the order of execution of setups.
- to determine the sequence of operations in each setup.
- The last segment is featured to present the report about the machinability of a given component.All the activities performed by the different programs of the system to generate a report about the machinability of the given prismatic part, which are shown in the following Flowchart.

Table 1 : Representation of Feature Through Slot

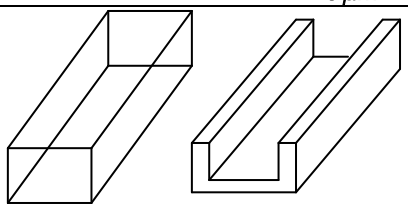
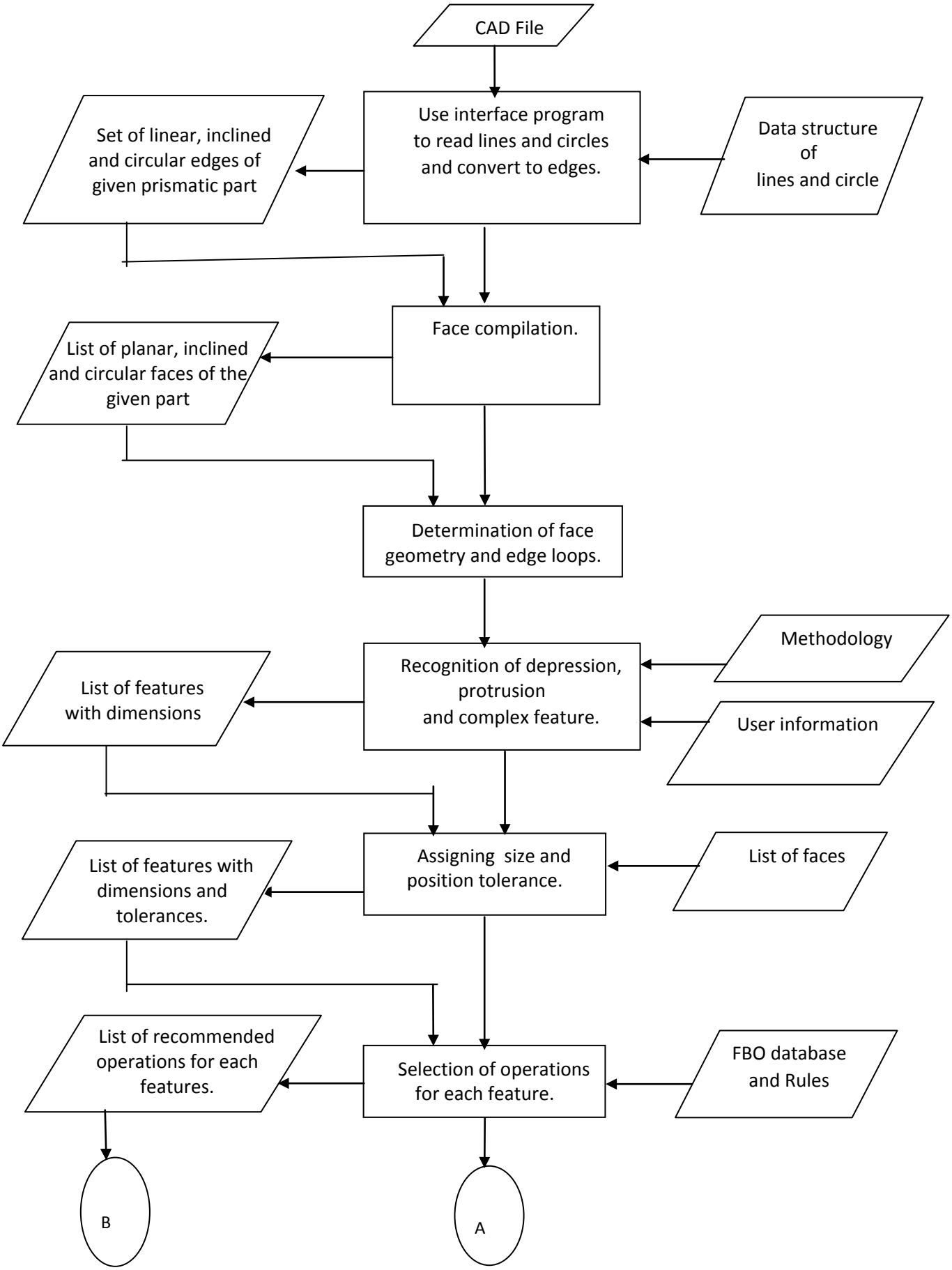
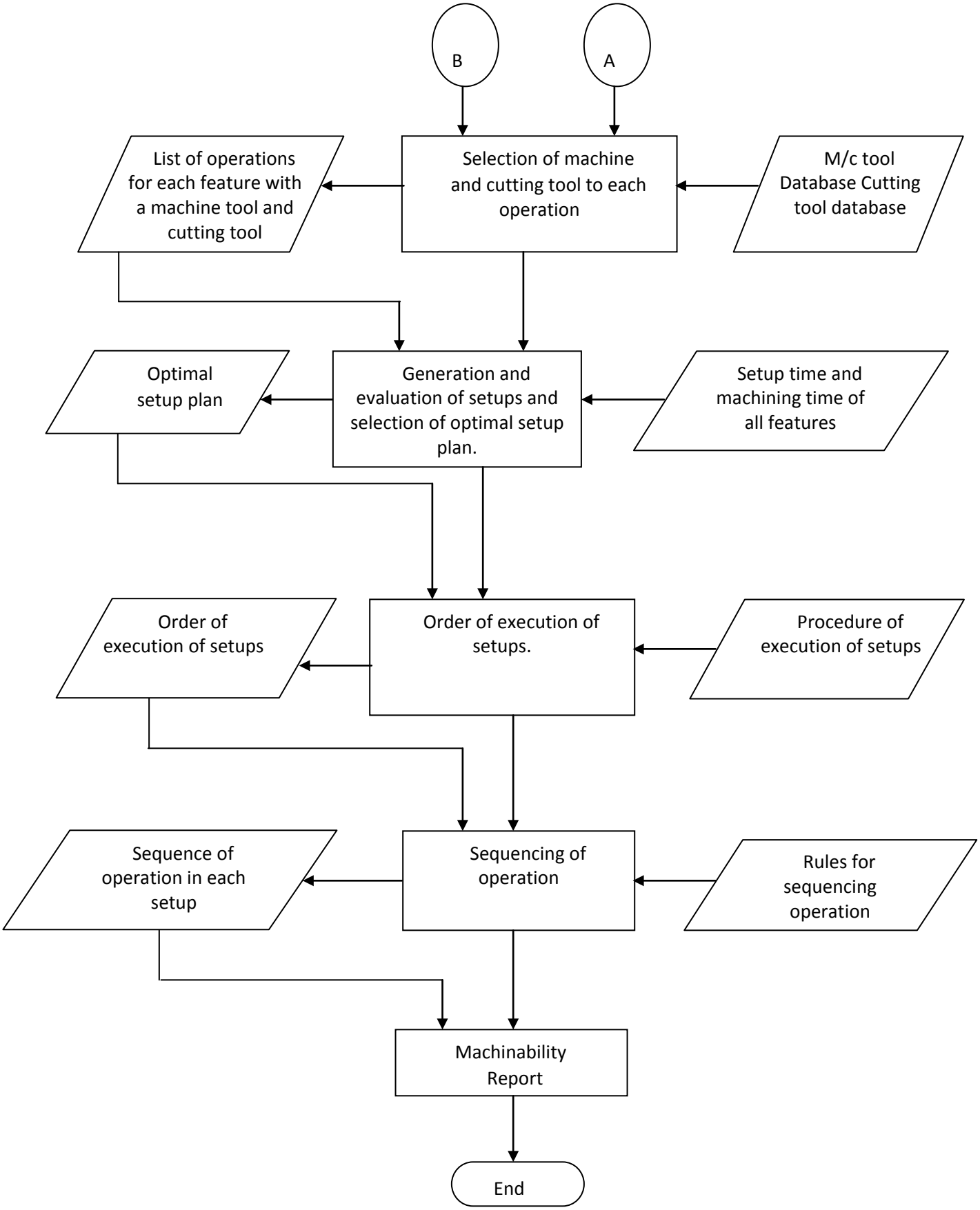
Representation of manufacturing feature-slot	
Feature Description : **Depression type -Through slot**	
Feature Characteristics	
Feature Dimensions	50 X 60 X 200
Faces providing access to feature	f_4 and f_5
Faces forming the feature	f_1 f_2 and f_3
Faces to be used as primary datum	f_6
Tool approach directions	X and Z
Feature designation	Primitive orthogonal
Feature Status	Independent
Surface finish	6 μm
Machinable Volumes for rough and finishing operations	
Dimensional and Geometrical tolerances	$\pm$ 0.01 , $\pm$ 0.01 for position of FFF
Operational References	f_7 for f_2 , f_1 for f_3, and f_8 for f_1
Manufacturing methods / operation	
1. **End Milling** 2. **Side Milling** 3. **Face Milling** 4. **Shaping**	

Table 2 : Sample Table Showing Feature Based Operational Data for Rough Cuts

Feature Name and its code	Operation	Machine tool	Cutting tool	Fixture
TSTPN (Normal)	Side milling	Horizontal. Milling M/C.	Side Milling Cutter	
	End milling	Vertical Milling M/c	End Mill	
TSTPD (Deep)	Side milling	Horizontal. Milling M/C.	Side Milling Cutter	
	End milling	Vertical Milling M/c	End Mill	
TSTPW (Wide)	Face Milling	Vertical Milling M/c	Face Milling Cutter	
	Shoulder Milling	Horizontal. Milling M/C.	Shoulder mill	





IV. Conclusions

For customer needs The integration of product and process design will be in a more producible, A faster and smoother transition to manufacturing leading to less time to market better quality with a reduced total cost. For controlling the cost and product quality integration of product and process design with resources capabilities is an important during its design. For achieving the concurrent and process design to identify the necessary manufacturing resources and to quantify the manufacturing variable is an important part. The computer assisted automation tools are expected to play a critical and a significant role which lead towards aiming and sustaining in a competitive advantage through the development of high quality products which are manufactured by the synergy of integrated product and process design. Therefore the current work which aims at automation and optimization of integration of design and manufacturing is expected to satisfy the needs of current manufacturing industries to meet challenges of global competition.

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