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Research Paper

A Feature Based Machining Of A Prismatic Part For Computer Aided Process Planning System

Engineering

KEYWORDS : Modeling,Feature, Computer aided Manufacturing, Design, and Prismatic

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ABSTRACT

The global competition and increasing demand for higher quality products at lower prices with shorter lead times have led to a growing focus on development of Computer Integrated manufacturing (CIM) systems in manufacturing industries. In developing a CIM system, an automated process planning interface can play a key role especially in integrating Computer-Aided Design and Computer-Aided Manufacturing. The analysis of the machining features, machining operations, Cutting speed, Feed rate, Depth of cut, tool material of the real prismatic part is done and presented in this paper. This research paper also presents the work proposes to generate process plan from feature-based modeling, based on creo/proE and NC mill 5.0 soft wares.

INTRODUCTION

Features are generic shapes with which engineers associate certain attributes and knowledge useful in reasoning about the product [18]. Features encapsulate the engineering significance of portions of the geometry and, as such, are important in product design, product definition, and reasoning for a variety of applications. Many researchers in the past have proposed a lot of definitions for a feature and some of them are listed as follows.

- A specific geometric configuration formed on the surface, edge, or corner of a work piece intended to modify outward appearance or to achieve a given function.

- A characteristic volume that describes a portion of a part such as a hole, boss, pocket, etc. Hence features designate or are related to some physical, geometric aspects of a part or assembly. They are semantically significant and distinct entities in one or more engineering viewpoints. On this basis, we can characterize a "feature" as follows [17].

- A feature is a physical constituent of a part.
- A feature is capable to a generic shape.
- A feature has engineering significance.
- A feature has predictable properties.

A feature model is a data structure that represents a part or assembly mainlyin terms of its constituent features. Each feature in the feature model is an identifiable entity that has some explicit representation [16]. The shape of a feature maybe expressed in terms of dimension parameters and enumeration of geometric and topological entities and relations, or in terms of construction steps needed to produce the geometry corresponding to the feature. The collection of features chosen to represent a part depends on the part type and the applications that the feature model is intended to support. New requirements are likely to lead to the introduction of new features. Nevertheless, within a chosen domain of applications, companies can choose a particular range of features that captures the geometry and the meaning of the geometry. It is precisely this customizability that makes features powerful.

2 Feature-Based Design and Feature Recognition:

Feature-based design has sometimes been regarded as an alternative to feature recognition. Instead of simply searching the CAD geometric models for features, feature-based design incorporates the features directly into the CAD description [15]. However, several difficulties have been encountered. First, feature- based design does not provide a mechanism for alternative feature descriptions of a prismatic part. That is, when a designer draws a part using feature based design, feature interactions can result in the existence of new, alternative features within the part. These features may or may not have been intentionally introduced by the designer, but in either case, they may not exist within the CAD model. Second, the features used for design may not correspond to the features used for other applications (e.g., manufacturing). Moreover, if the designer is required to work with features specifically suited to an application domain, say manufacturing, this may require too much knowledge on the part of the designer or impose too many design limitations [14]. Nevertheless, design for manufacture is quite popular now, in view of the lack of robust commercial feature-recognition systems. There has been work that addresses these shortcomings but does not use feature recognition. For example, some recent work in feature-based design has allowed a user-definable set of features or has helped in the maintenance of manufacturing consistency [13]. The general strategies for enhancing feature-based design utilizing feature recognition have been either to map the features. Chamberlain et al. [2003] describe a system to map protrusion features to depression features within a feature based design framework so that, during the design of a part, a designer can create both depression and protrusion features[12]. However, only depression features roughly correspond to manufacturing features. Protrusion features, on the other hand, are not directly manufacturable (i.e., they do not directly correspond to manufacturing features) since they are produced by removing surrounding material, not material within the feature itself. The mapping process from protrusion features to depression features consists of two major elements: extending the stock of the part and recognizing depression features within this extension [1]. However, this extension may create material in addition to the protrusion feature, so this extra material needs to undergo a feature-recognition process. In work integrating feature-based design and feature recognition, there has been some research in a modeling system based on incremental feature recognition. . If a feature is added through feature-based design methods, not only is the geometric model updated, but new features created from the interactions of old features with this new feature are recognized. De Martino et al. [2006] provide an approach to integrating feature-based design and feature recognition. This approach also maintains geometric and feature-based design data, but this work maintains consistency between the two by also storing an intermediate feature model.

2.1 TYPES OF FEATURES

Theterm "feature"isusedtodenotemodelingawidevarietyofphysical characteristicsofparts.Thereforeitisuseful to distinguish between various types of featuresbyusingasub-classificationof featuressuchasthefollowing [9]

Form featuresPortions of nominal geometry; recurring, stereotypical shapes.

Tolerance featuresDeviations fromnominal form/size/location.

AssemblyfeaturesGroupingofvariousfeaturestypestodefineassembly relations, such as mating conditions, part relative position

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and orientation, various kinds of fits, and kinematic relations.

FunctionalfeaturesSetsoffeaturesrelatedtospecificfunction;mayinclude design intent, non-geometric parameters related to function, performance, etc.

Material featuresMaterial composition, treatment, condition, etc.

Formfeatures,tolerancefeatures,andassemblyfeaturesareallclosely related to the geometry of parts, and are hence called collectively geometric features. Features can also be broadly classified into two main categories, as follows:

Explicit featuresall the details of the feature are fully defined.

Implicitfeaturessufficientinformationissuppliedtodefinethefeaturebut the full details have to be calculated when required.

2 . 2 Feature mapping

In developing a product, many types of design, analysis, planning, and decision-making tools and software areused [8].Traditionallythesetasksaredone sequentially.Inrecentyearstherehasbeenincreasinginteresttoperform thesetasks concurrently in order to cut down the product development time. Regardless of the design process organization, sequential or concurrent,thereisaneedtoshareproduct databetweenvariousapplicationsused duringtheprocess [2].Anumberofstandards havebeendevelopedfortransferringproduct data, such as IGES and STEP. These standards specify the format and contents of physical files that are used in exchangingproductdata [7].Whendealingwithfeatures, there is a further complication: viewpointdependenceoffeatures. How apartisviewedintermsoffeaturesvaries from applicationtoapplication.Thedesign,ormoreappropriately,theproduct definitionviewsthegeometryconstructionunitsinterms ofwhichitisconvenientto definethepart.Theprocessplanningviews features as volumes to be removed by separate machiningoperations [6]. The inspection views the paths that are to be traversedbyaCMMprobeandthedimensionsto be gauged. Therefore the same part could be viewed as having different features, dependingupon the engineeringtask beingundertaken.Thisimpliesthatfeaturedataneedstobetransformedfrom one viewpoint to another when exchanging product data between two dissimilar applications ,suchasdesignandmanufacturing.

2.3 FEATURES CREATION TECHNIQUES

Many alternative techniques have been devised for creating feature-based models.Wecandividethem intotwomain categoriesbasedonwhetherfeaturesare extractedfromgeometryoronwhethergeometryiscreatedfrom thefeatures.Theprocedurefollowedincreatingfeature models, in each of the above cases can be described as follows [5]:

1. In the Interactive featurerecognition, the geometricmodeliscreatedfirst, thenfeaturesarecreatedbyhumanusers, suchasbypickingentitiesinanimage of the part
2. In the Automaticfeaturerecognition, the geometricmodeliscr eatedfirst,thena computer program processes the resulting model to automatically find features

3 FEATURE-BASED INTEGRATED SOLID MODELING TECHNIQUE

Solid modeling was developed in the early 1970'. Solid modeling is anunambiguous and informational complete description of the object beingrepresented [3]. There is several representation schemes used in the solid modeling software such as constructive solid geometry (CSG), boundary representation (B-rep). The design module provides inbuilt features of prismatic part to generate the model. Algorithms are developed for individual features and these algorithms are embedded in solid modeling software. Required dimensions of the selected feature are specified by the user in the user interactive mode. The algorithm for modeling and storing thedimensions entered by the user is represented below [4].

Length, radius of prismatic part is considered and stored in information storage module.

If the machining feature is first operation, it is created from reference point Otherwise, end point of the previous machining feature is considered as starting point for the present one.

The starting point of the feature is computed from the previous feature history of the model. If the previous history is null then start from reference point.

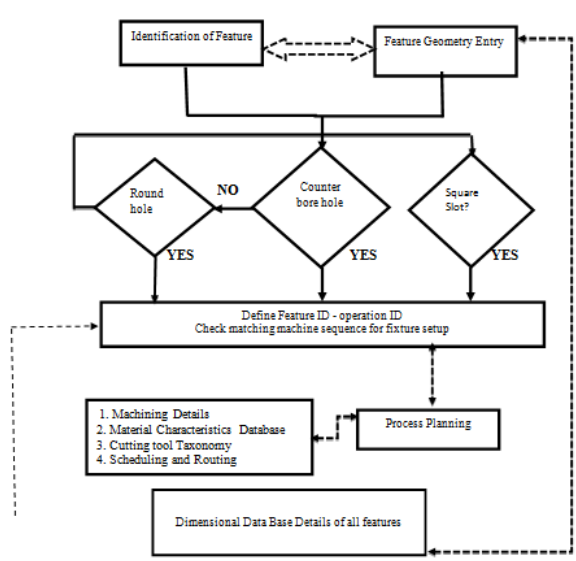
Nodes indicating the starting point of the feature, radius, and length of the prismatic part in the information storage module. All the features are considered co-axial.

Dimensions of the machining feature like length, radius, and reference point are shown differently

4 PROCESS PLAN GENERATION

The CAD systems commonly represent geometric models in terms of elementary geometric entities of the prismatic part. While generating process plan it is necessary to convert the CAD data into design oriented geometric entities, into manufacturing related features of the part. Ideal CAD/CAM integration requires machining processes and sequence of operations should be generated automatically. The CAPP system developed is composed of different activities [15]

1. Machining features generated in the design stage are recognized
2. The feature list recognized and stored is utilized to develop the process plan by linking with main source file. Based on the part body recognized from the feature list, respective knowledge base is used for the respective features of the prismatic part.
3. Determination of the machining operations for the identified features and considers the constraints associated with the dimensions from the main data base.
4. Determination of the machining sequence for fixturing the prismatic part.
5. Determination of the cutting tools considering the machine-tool, dimensions and tool geometry.
6. Determination of the tool taxonomy, cutting conditions considering the tool parameters, machining features material, machine capacity.
7. Generation of the process plan.



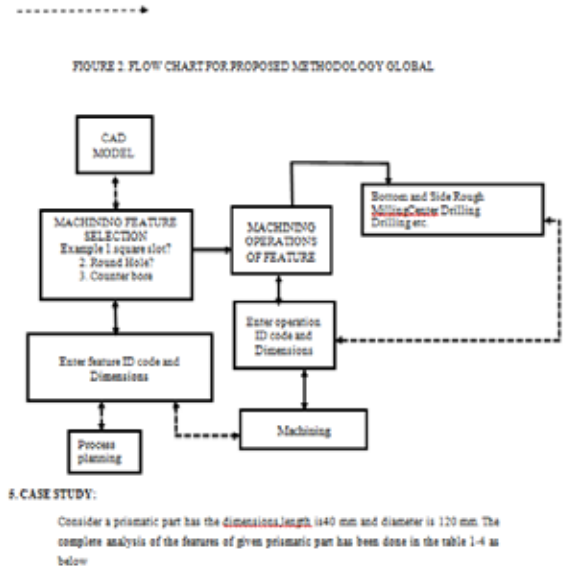


FIGURE 1. FLOW CHART FOR PROPOSED METHODOLOGY
GURE 2. FLOW CHART FOR PROPOSED METHODOLOGY GLOBAL

5. CASE STUDY:
Consider a prismatic part has the dimensions,length is40 mm and diameter is 120 mm. The complete analysis of the features of given prismatic part has been done in the table 1-4 as below

Enter feature ID code and Dimensions



TABLE 2: MACHINING OPERATION OF PRISMATIC PART

S.N	Operation Name	Operation I.D	Feature I.D	Length mm	Width mm	Depth mm
1	Bottom and Side Rough Milling	SQ1-BSRM-R	SQ1	155	45	4
2	Bottom and Side Rough Milling	SQ2-BSRM-R	SQ2	25	22	6.5
3	Bottom and Side Rough Milling	SQ3-BSRM-R	SQ3	25	22	6.5
4	Bottom and Side Rough Milling	SQ4-BSRM-R	SQ4	25	22	6.5
5	Bottom and Side Rough Milling	SQ5-BSRM-R	SQ5	25	22	6.5
6	Center Drilling	CB65-CDR	CB65	3	8.2	N/A
7	Center Drilling	TH1-CDR	TH1	3	3.8	N/A
8	Center Drilling	TH2-CDR	TH2	3	3.8	N/A
9	Center Drilling	TH3-CDR	TH3	3	3.8	N/A
10	Center Drilling	TH4-CDR	TH4	3	3.8	N/A
11	Drilling	CB65-DR1	CB65	31	12.5	N/A
12	Drilling	TH1-DR1	TH1	22	10.5	N/A
13	Drilling	TH2-DR1	TH2	22	10.5	N/A
14	Drilling	TH3-DR1	TH3	22	10.5	N/A
15	Drilling	TH4-DR1	TH4	22	10.5	N/A
16	Drilling	CB65-DR2	CB65	31	24	N/A
17	Counter boring	CB65-CB	CB65	14	40	N/A

Figure 3(a). Design of prismatic part of a coupling joint

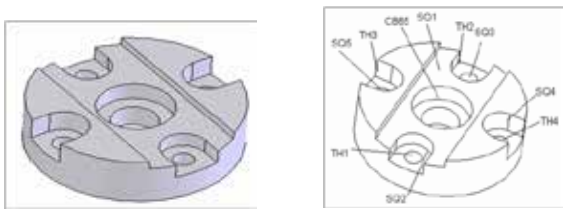


Figure3b.The prismatic part with different features

TABLE1: MACHINING FEATURES OF PRISMATIC PART

Sr.No	Feature Name	Feature I.D	Dimension
1	Square slot	SQ1	L=120, w=60, h=7
2	Counter bore hole	CB65	D=50, L1=18,d=30, L2=20.
3	Square slot	SQ2	L=30,w=30, h=16
4	Square slot	SQ3	L=30,w=30, h=16
5	Square slot	SQ4	L=30,w=30, h=16
6	Square slot	SQ5	L=30, w=30, h=16
7	Round hole	TH1	D=12.5, L=16
8	Round hole	TH2	D=12.5, L=16
9	Round hole	TH3	D=12.5, L=16
10	Round hole	TH4	D=12.5, L=16

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18	Reaming	CB65-R	CB65	31	25	0.5
19	Reaming	TH1-R	TH1	22	11.5	0.5
20	Reaming	TH2-R	TH2	22	11.5	0.5
21	Reaming	TH3-R	TH3	22	11.5	0.5
22	Reaming	TH4-R	TH4	22	11.5	0.5
23	Bottom and Side Finish Milling	SQ1-BSFM-F	SQ1	16	5	1
24	Bottom and Side Finish Milling	SQ2-BSFM-F	SQ2	25	3	1
25	Bottom and Side Finish Milling	SQ3-BSFM-F	SQ3	25	3	1
26	Bottom and Side Finish Milling	SQ4-BSFM-F	SQ4	25	3	1
27	Bottom and Side Finish Milling	SQ5-BSFM-F	SQ5	25	3	1

TABLE 3: MACHINING PARAMETERS OF PRISMATIC PART

S.N	Operation I.D	Cutting speed m/min	Feed rate mm/r	Feed Speed mm/min	RPM	Machined time min	Removal rate mm3/min
1	SQ1-BSRM-R	30.89	0.051	33.63	222	4.61	6,125.17
2	SQ2-BSRM-R	30.11	0.049	63.79	440	0.78	8912.50
3	SQ3-BSRM-R	30.11	0.049	63.79	444	0.78	8912.50
4	SQ4-BSRM-R	30.11	0.049	63.79	444	0.78	8912.50
5	SQ5-BSRM-R	30.11	0.049	63.79	444	0.78	8912.50
6	CB65-CDR	30.75	0.351	419.65	299	0.01	22,161.57
7	TH1-CDR	31.14	0.288	751.01	620	0	8,620.34
8	TH2-CDR	31.14	0.288	751.01	620	0	8,620.34
9	TH3-CDR	31.14	0.288	751.01	620	0	8,620.34
10	TH4-CDR	31.14	0.288	751.01	620	0	8,620.34
11	CB65-DR1	19.64	0.33	165.03	515	0.19	20,251.90
12	TH1-DR1	20.1	0.289	175.94	620	0.13	15,234.40
13	TH2-DR1	20.1	0.289	175.94	620	0.13	15,234.40
14	TH3-DR1	20.1	0.289	175.94	620	0.13	15,234.40
15	TH4-DR1	20.1	0.289	175.94	620	0.13	15,234.40
16	CB65-DR2	19.64	0.447	116.3	270	0.27	38,342.16
17	CB65-CB	20.54	0.523	85.32	168	0.16	68,615.90
18	CB65-R	19.64	0.447	111.83	258	0.28	4,303.77
19	TH1-R	19.67	0.306	166.25	539	0.13	2,872.60
20	TH2-R	19.67	0.306	166.25	539	0.13	2,872.60
21	TH3-R	19.67	0.306	166.25	539	0.13	2,872.60
22	TH4-R	19.67	0.306	166.25	539	0.13	2,872.60
23	SQ1-BSFM-F	30.11	0.049	28.09	202	0.57	140.46
24	SQ2-BSFM-F	30.11	0.049	56.04	400	0.45	174.12
25	SQ3-BSFM-F	30.11	0.049	56.04	400	0.45	174.12
26	SQ4-BSFM-F	30.11	0.049	56.04	400	0.45	174.12
27	SQ5-BSFM-F	30.11	0.049	56.04	400	0.45	174.12

TABLE 4: ANALYSIS OF CUTTING TOOL USED IN PRISMATIC PART

Sr.No	Operation I.D	Tool Name	Tool I.D	Tool Diameter mm	Flute Length mm	Tool material
1	SQ1-BSRM-R	End Mill	SEM-22	49	158	HSS
2	SQ2-BSRM-R	End Mill	SEM-16	26	114	HSS
3	SQ3-BSRM-R	End Mill	SEM-16	26	114	HSS
4	SQ4-BSRM-R	End Mill	SEM-16	26	114	HSS
5	SQ5-BSRM-R	End Mill	SEM-16	26	114	HSS
6	CB65-CDR	Center Drill	CD-23	8.2	0	HSS
7	TH1-CDR	Center Drill	CD-5	3.8	0	HSS
8	TH2-CDR	Center Drill	CD-5	3.8	0	HSS
9	TH3-CDR	Center Drill	CD-5	3.8	0	HSS
10	TH4-CDR	Center Drill	CD-5	3.8	0	HSS
11	CB65-DR1	Twist Drill	TWD-39	12.5	182	HSS
12	TH1-DR1	Twist Drill	TWD-31	10.5	168	HSS
13	TH2-DR1	Twist Drill	TWD-31	10.5	168	HSS
14	TH3-DR1	Twist Drill	TWD-31	10.5	168	HSS
15	TH4-DR1	Twist Drill	TWD-31	10.5	168	HSS
16	CB65-DR2	Twist Drill	TWD-85	24	281	HSS
17	CB65-CB	Counter bore	CB-133	40	0	HSS

18	CB65-R	Reamer	RM-89
19	TH1-R	Reamer	RM-35
20	TH2-R	Reamer	RM-35
21	TH3-R	Reamer	RM-35
22	TH4-R	Reamer	RM-35
23	SQ1-BSFM-F	End Mill	SEM-22
24	SQ2-BSFM-F	End Mill	SEM-16
25	SQ3-BSFM-F	End Mill	SEM-16
26	SQ4-BSFM-F	End Mill	SEM-16
27	SQ5-BSFM-F	End Mill	SEM-16

SIMULATION RESULT

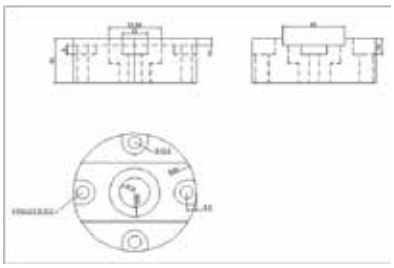
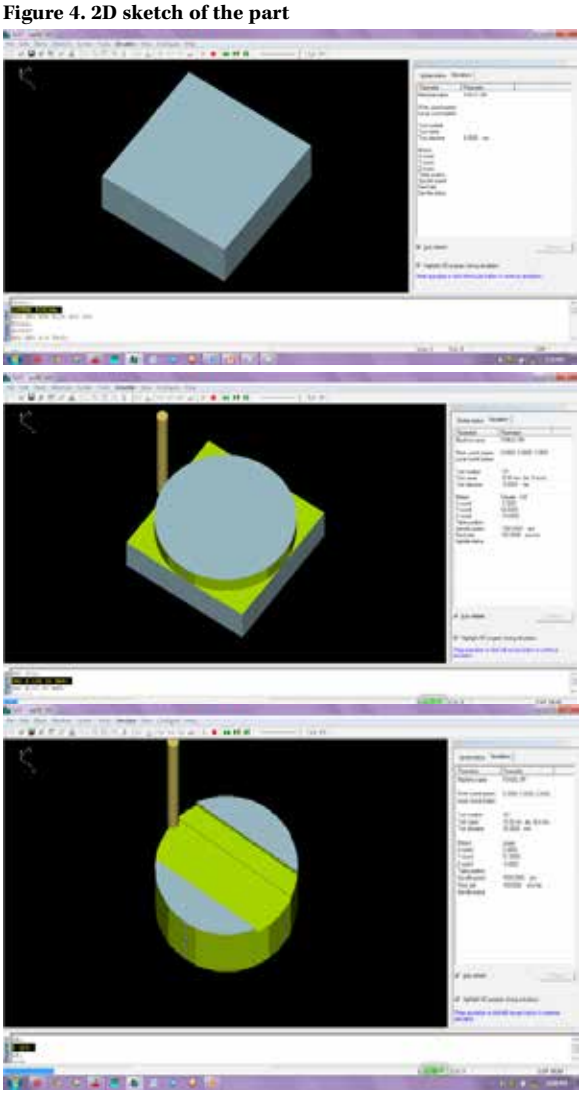
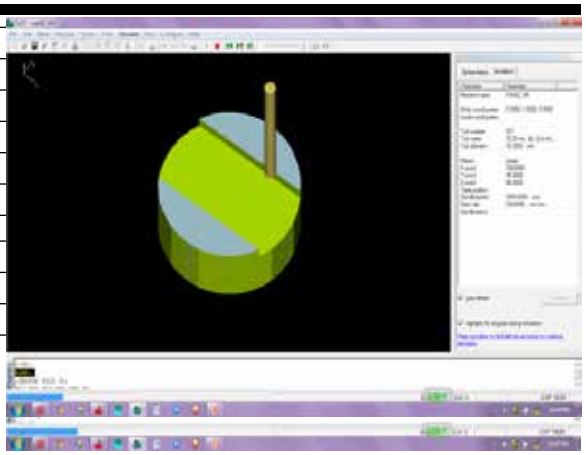
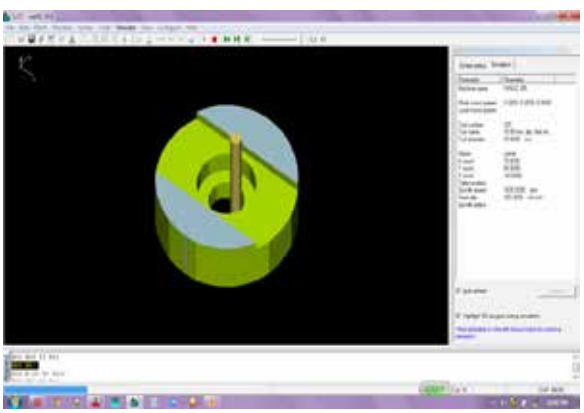
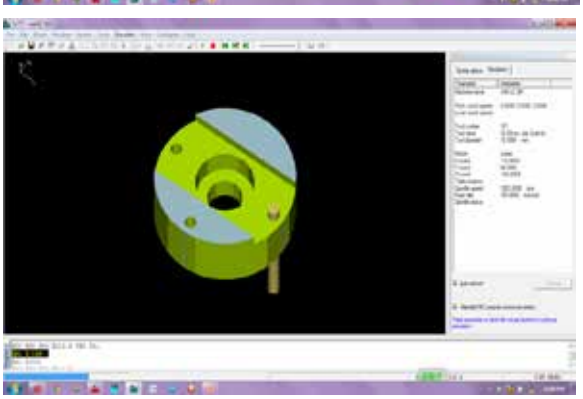


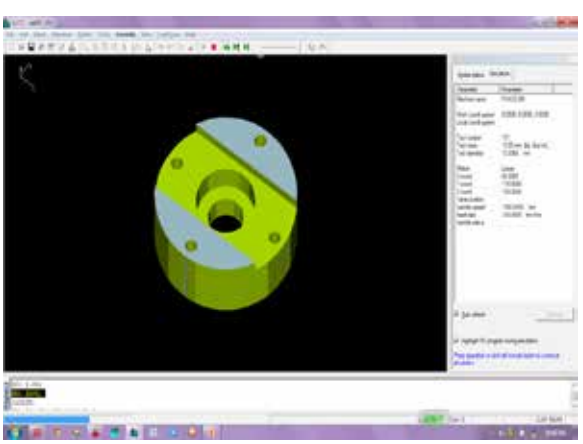
Figure 4. 2D sketch of the part











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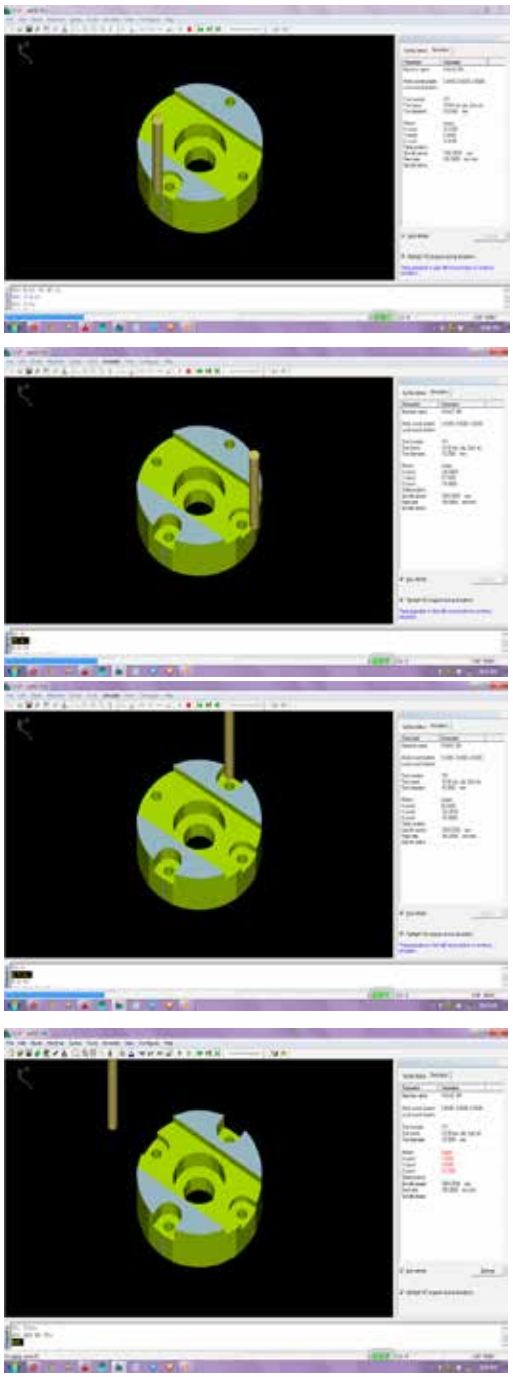

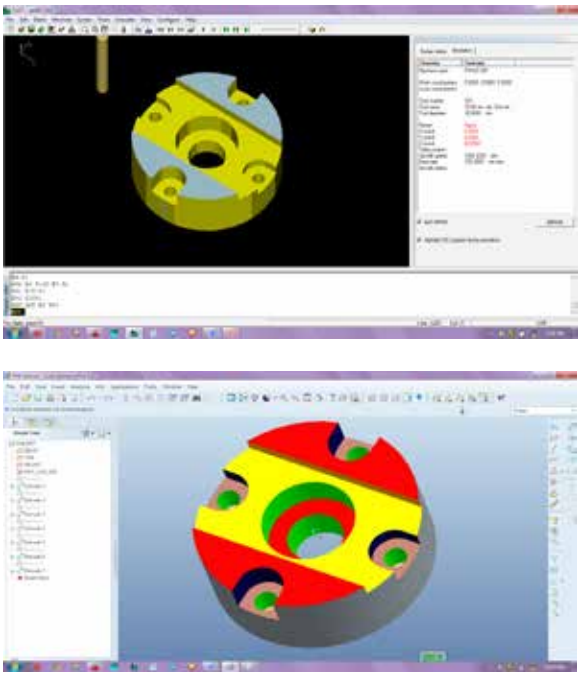

Figure 5. Images of coupling simulation

7. CONCLUSION

The Present system is developed only in prismatic part and limited to selective machining features. The feature based approach described is capable to perform process plan generation for the prismatic parts based on the input features given in modeling. The Machining operations, machining features, material removal rate of real prismatic part is analyzed in the research paper. However, in the present study takes up only few machining features, and can be extended for more features.

REFERENCE

[1] Kwangsoo Kim, (2008). "A feature-based approach to extracting machining features", Computer aided design, Vol. 3(11), 101-135 | [2] Aristides AG Requicha, (2007). "Integration of feature based design and feature recognition", Computer aided design, Vol. 9(2), 93-104 | [3] J Ovtcharova, (2009). "Feature-based modelling by integrating design and recognition approaches", Computer aided design, Vol. 2(4), 46-65 | [4] MarttiMantyla, (2007). "Feature modelling by incremental feature recognition", Computer aided design, Vol. 5(2), 47-59 | [5] JZhou, (2008). "FSMT: a feature solid-modelling tool for feature-based design and manufacture", Computer aided design, Vol. 3(1), 2-12 | [6] Anthony Dean (2010). "Assembly CAD Design using Position Tolerance in Geometric Dimensioning & Tolerancing", SME- Technical Papers, 6-10 | [7] Abu Bakar N and Juri AH, (2008). "Recognition of cylindrical based features using edge boundary technique for integrated manufacturing", Robotics and Computer Integrated Manufacturing, Vol. 10 (2), 41- 62 | [8] Cicirello Vand Regli W C, (2012). "An approach to feature based comparison of solid models of machined parts", Journal of Artificial Intelligence for engineering design analysis and manufacturing, Vol. 6(5), 385-399 | [9] Karnik M V, Gupta S K, Magrab EB, (2005). "Geometric Algorithms for containment analysis of rotational parts", Computer aided design, Vol. 37(2), 213-230 | [10] Chamberlain et al. (2003). "Feature- based shape similarity measurement for retrieval of mechanical parts", Journal of computing and information science in engineering, Vol. 1(3), 245-256 | [11] De Martino et al. (2006), "A multi-scale hierarchical 3D shape representation for similar shape retrieval", International symposium on tools and methods of competitive engineering, 1117-1128 | [12] Lou K, Prabhakar S, Ramani S, (2004). "Content based three dimensional engineering shape search", Proceedings of the 20th International Conference on Data Engineering, 754-765 | [13] Sven J. Dickinson and Steven W. Zucker, (2009). "Shock graphs and shape matching", International journal of Computer vision, Vol. 5(1), 10-13 | [14] Shokoufandeh, A, (2003). "Reeb graph based shape retrieval for CAD", Proceedings of 23rd ASME DETC Computers and Information in Engineering (CIE) conference | [15] Roerdink JB, (2002). "Similarity measures for convex polyhedra based on Minkowski addition", Pattern Recognition, Vol. 3(6), 99-110 | [16] Satyandra K Gupta, (2010). "Machining feature-based similarity assessment algorithms for prismatic machined parts", Computer aided design, Vol. 3(8), 94-97. | [17] Devireddy CRand Ghosh K, (2010). "Feature-based modeling and neural networks-based CAPP for integrated manufacturing", International Journal of Computer Integrated Manufacturing, Vol. 2 (1), 51-59 | [18] Pande S.S, (2010). "An intelligent feature-based process planning system for prismatic parts", International Journal of Production Research, Vol. 4(2), 431–447 |