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The Simulation of Tool Path Generation in Milling for Machining Processes

Rickey W. Jennings

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Department of Mechanical Engineering

ABSTRACT

This paper is a report on the progress of this project to create a complete CAD/CAM system. The paper describes the introduction to the simulation package called Vericut. It also discusses the integration of the three packages: AutoCad version 11, PCAPT with APTGEN, and Vericut. The progress of the project to this point is only to the integration of the three packages. The paper also indicates the work which still needs to be completed. The key point of which is the menu system which is the final step in the project.

INTRODUCTION

The purpose of this paper is to give the progress on my project of "The Simulation of Tool Path Generation in Milling for Machining Processes". The objective of this project is to create a CAD/CAM system for use in Computerized Numerically Controlled (CNC) milling processes. This project involves the integration of several PC based software packages which can perform the desired function of the system. The system is ran on an IBM P/S 2 and the entire system is to be contained in the one unit. The main function of this system is to simulate tool paths for milling processes and the Vericut tool path simulation program [1] is used to perform this function of the system. Several possible packages or combinations of packages can be used to create the geometry and tool path data for the system. The initial package chosen to create the necessary geometry and tool path data for input into Vericut is E-Z-Mill [2]. The E-Z-Mill package, however, has a limited geometrical capabilities and is loaded on the IBM AT computers in the computer lab which makes it a less than ideal choice for the system. For these reasons I only used the E-Z-Mill package as a method for an introduction to the Vericut package.

In order to create the complete system the combination of AutoCad version 11 [3] and PCAPT [4] is used to create the necessary input into Vericut. The diagram of the method of integration of the three packages is shown in figure 1 on the next page.

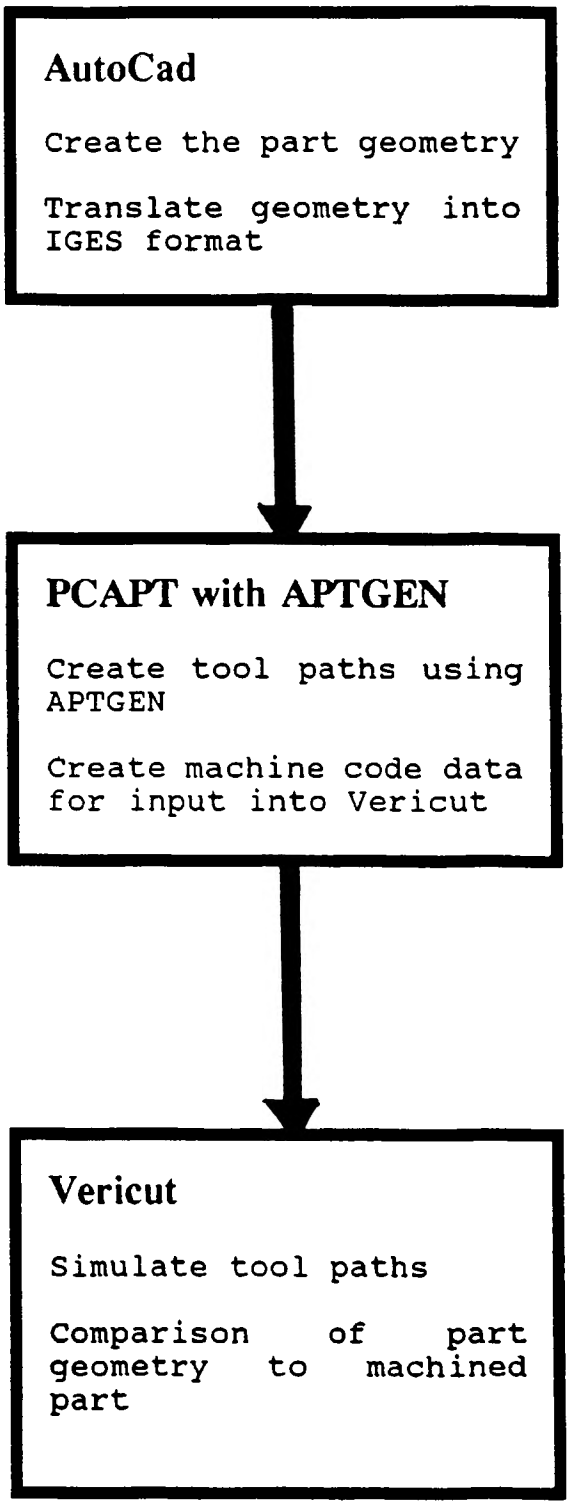

Figure 1. Schematic Of CAD/CAM System

AutoCad is a very flexible system with solid modelling capability and creates the necessary Initial Graphics Exchange Specification (IGES) format for input into PCAPT. PCAPT is the package which produces the tool path information which is used as the input into Vericut and eventually the input into the NC milling machine. PCAPT takes the IGES input from AutoCad and through the use of the AptGen program within creates the tool paths.

INTRODUCTION TO VERICUT

Creation of Geometry and Tool Paths Using E-Z-Mill

The first step of the project was to familiarize myself with the Vericut package. This was accomplished by creating simple objects using E-Z-Mill located in the AT computers in room ME 217. The geometric entities were created using the geometry function of E-Z-Mill [2].The geometric entities were created by defining the points, lines, and circles which make up the entity. The geometry created by E-Z-Mill was then used to create the tool paths.

The tool paths were created next using the geometry already created. The next step was to enter the part program section of E-Z-Mill [2] in which the tool paths were defined. The type of cutting operation must be chosen first upon entrance into this section. Then the tool parameters and the depth of cut must be set-up using the appropriate menu choices. Once the tool parameters have been set the tool path can be defined. This was accomplished by choosing the points and other geometric entities in a clockwise direction around the object. This process was repeated multiple times, each time moving the cutter in a distance equal to the cutter radius, to cut the part to its final dimensions.

Once the tool paths were defined the Post module of E-Z-Mill [2] was entered and the CNC program was created. The program was created by using the file BOSS8I [2] which contain the necessary CNC information which was required by E-Z-Mill [2]. The output was a listing of machine code. A sample of this machine code is shown below.

```
N5G70G75G90
'BLOCK1      23-FEB-92'
'MILL1'
'TOOL NUMBER:1       SPINDLE RPM:1000'
N25G0X0Y0T1M6
N30X-1.25Y2.0
N35Z0.05
N40G1Z-2.0F5.0
```

Figure 2. Machine Code Produced By E-Z-Mill

This machine code can then used as the input for Vericut.

Tool Path Simulation Using Vericut

The code which Vericut uses to simulate the machining process is an ASCI file, which is similar to the clprint file created by many APT programs, and an example is shown below [1].

```
PARTNO THIS IS A SAMPLE TOOL PATH FILE
COOLNT/ON
SPINDL/500,CLW
CUTTER/10,0,0,0,0,0,18
FEDRAT/100.0
FROM/10.,-6.,5.
GOTO/10.,0.,5.
GOTO/40.,0.,16.
FEDRAT/10.0
GOTO/40.,5.,16.
GOTO/10.,5.,16.
GOTO/10.,10.,16.
GOTO/40.,10.,16.
GOTO/40.,21.,16.
GOTO/10.,21.,16.
COOLNT/OFF
SPINDL/OFF
```

Figure 3. Example Of The ASCI File Used By Vericut

The file created by E-Z-Mill, however, is in machine code which is not directly readable by Vericut. Therefore the machine code from E-Z-Mill must be converted into an ASCI file and this is accomplished though the use of the Revpost program in Vericut [1]. Before the Revpost program can be ran the proper codes for the specific post-processor which is used to create the machine code. Upon entering the Revpost program the codes can be checked and changed to match those used by the post-processor. A file corresponding to the post-processor is now created and is used to convert the machine code into an equivalent ASCI file as shown above. It is now necessary to create a tool library for Vericut to access when running the part program. The tool library is created using the MS-DOS editor [5] and is as follows.

```
CUTTER/1,0,0,0,0,0,5
CUTTER/.5,0,0,0,0,0,5
CUTTER/.5,.25,0,0,0,0,5
CUTTER/1,.125,0,0,0,0,5
```

Figure 4. Tool Library File For Vericut

The tool library file contains the specifications for the cutters which are used in the part program.

Once the file is translated we are ready to enter Vericut. Upon entering Vericut you are presented with the following screen [1].

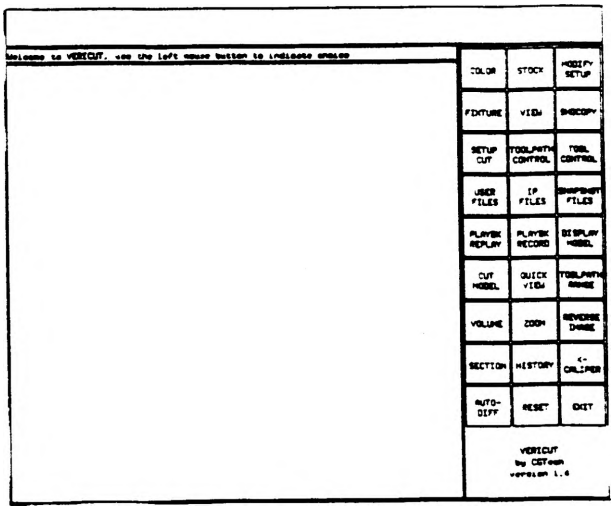

Figure 5. Vericut Screen

The Vericut program is ran using the mouse as the main interface tool. The first step once in Vericut is to indicate the appropriate tool path and tool library files. Once these have been entered in the proper areas in the Vericut the program is ready to be executed. First, however, you must input the stock dimensions into the stock set-up. Next click the display model icon to display the stock for machining.

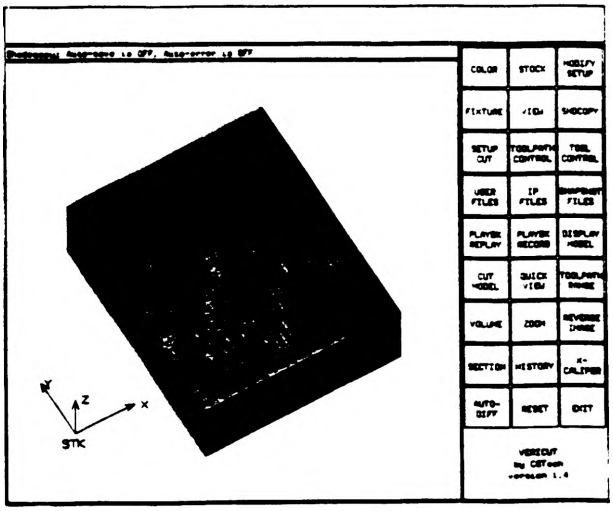

Figure 6. Stock Display

Once the stock is displayed the cut model icon is clicked to execute the machining process. Once the machining is complete the finished part is displayed.

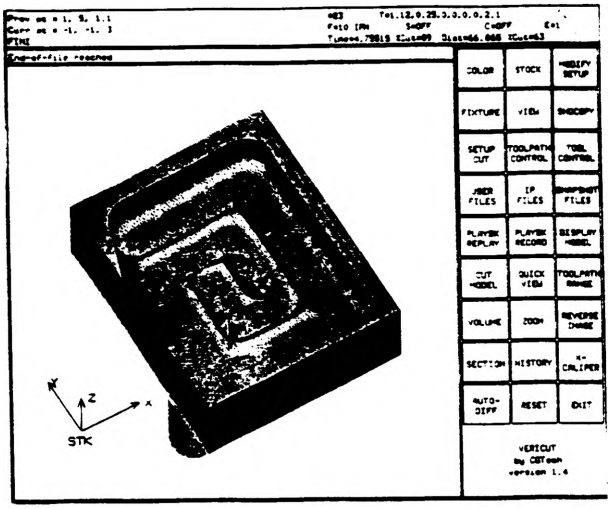

Figure 7. Finished Part

This concluded the introduction to Vericut and the skills developed are used in the integration of the three software packages chosen for the CAD/CAM system.

INTEGRATION OF SOFTWARE

The purpose of this project was to create a complete CAD/CAM system and for this the following packages were used.

1. AutoCad version 11
2. PCAPT with APTGEN
3. Vericut

Creation of Geometry Using AutoCad

The use of AutoCad to create the required geometry is because AutoCad is a very versatile CAD package with solid modeling capabilities. The geometry created using AutoCad must be converted to IGES format for input into APTGEN in PCAPT. At this time I have not completed the work for the AutoCad portion of the system. This section of the integration is to be finished by the end of April.

Creation of Tool Paths Using PCAPT With APTGEN

Once the geometry has been completed in AutoCad and has been converted into IGES format we are ready define the tool paths. In order to gain an understanding of the workings of PCAPT and APTGEN sample parts were designed using the geometry function with in APTGEN. Creating the required geometry in APTGEN is a tedious

process which can be accomplished much more easily in AutoCad. An example of the geometry created by APTGEN is shown below.

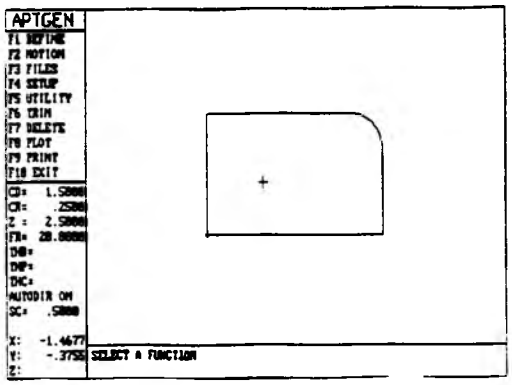

Figure 8. Geometry Produced by APTGEN

The advantage to using APTGEN comes in the easy of defining the tool paths. The method of assigning tool paths in APTGEN is as follows. The cutter size is defined using the "TOOLCHG" function [4]. First you must assign the starting point of the tool and then you use the "Startup" command to bring the cutter to the cutting surface [4]. Then the cutter path is created by simply picking the surfaces which are to be machined in the process with the mouse. A tool path which was defined is shown below.

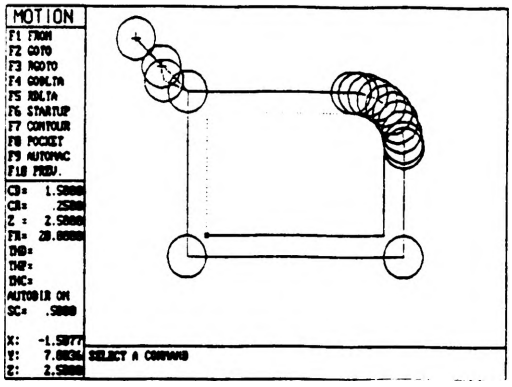

Figure 9. Tool Path Defined by APTGEN

Once the tool path was defined by APTGEN the part program was executed and the machine code was produced by PCAPT. The post processor which created the machine code was GMILL1 [5]. This code created by GMILL1 is much the same as the machine data produced by E-Z-Mill and can be translated using the Revpost [1].
Once the code is converted it can be executed in Vericut to see the machining which has been defined.

FUTURE WORK TO COMPLETE THE SYSTEM

The intention of this project is to create a complete CAD/CAM system including the simulation of the cutting process. In order to complete the system a menu system and program is to be designed so that the three packages will act as a single system. The menu and program will access each package when the appropriate number is chosen and will facilitate the transfer of the files between the packages. The menu is intended to be very user-friendly and to simplify the design process.

The other addition to the system will be the use of the geometric interface which is in Vericut [1]. This interface will take a solid model created by AutoCad and convert into the format recognized by Vericut. This solid model will be used in the "auto-difference" function [1] in Vericut to compare the desired shape to what is obtained in the cutting process.

CONCLUSIONS

The purpose of the project is to produce a complete CAD/CAM system. Once the project is finished a very complete CAD/CAM system will be produced. The system will have very wide uses including use as an aide in design projects and use as a teaching aide in manufacturing and design classes.

ACKNOWLEDGMENTS

I would like to thank my advisor Dr. Lu for his help and support of this project.

REFERENCES

1) Vericut Manual version 1.4, CGTech, 1991

2) E-Z-Mill Manual

3) AutoCad version 11 Manual

4) PCAPT Manual version 3.2, N/C Software, 1990

5) GMILL1 Manual