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ADVANTAGES OF CNC MACHINE OPERATED BY USING CAD/CAM SOFTWARE GENERATED PROGRAMMING (UNIGRAPHICS NX), CODING AND PROGRAMMING

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***Abstract*— CNC machines are widely used in production fields since they produce similar parts in a minimum time, at higher speed and with possibly minimum error. This paper suggests to operate the CNC machine by using the CAD/CAM software programming for maximum production in less time with good flexibility & its advantages. In modern world the demand of products (different type of product) is too much. To complete the demand of people is possible by growing the production rate. And the CAD/CAM software reduces time and it grow the production rate of any product.**

Keywords— **CNC-machine, CAD/CAM software (unigraphics-NX), CAD/CAM software programming.**

I. INTRODUCTION

CNC machine is the most widely used subtractive manufacturing technology. In CNC, material is removed from a solid block using a variety of cutting tools to produce a part based on a CAD model. Both metals and plastics can be machined with CNC. CNC produces parts with tight tolerances and excellent material properties. CNC is suitable for one-off jobs and low-to-medium volume production (up to 1000 parts), due to its high repeatability.

The properties of modern manufacturing systems are high automation, flexibility and autonomy. In spite of many efforts the preparation of the machining process remains a bottleneck during automated manufacturing processes. An experienced expert is still always needed for the programming of CNC machine tools to contribute his/her know-how and experience to improve the machining quality.

Today, two methods are used for preparing CNC machining programs, i.e., the seldom used manual preparation of CNC machining program and the use of CAM program packages. Programming of machine tools is a complex process consisting of several problems that are mutually dependent and related. Research into the automatic programming of machine tools has been very topical in the past but researchers focused mainly on solving individual problems within a set of problems which only together represent the complex multi-criterion problem of automatic programming of CNC machine tools [2].

THERE ARE MANY TYPE OF CNC MACHINE-

- MILLING MACHINE

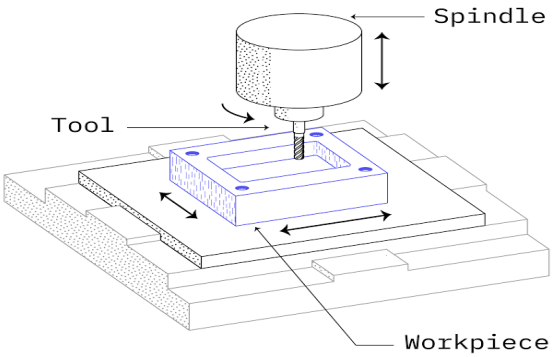

Figure1. Schematic Of a Typical CNC Milling Machine

Figure2. Modal Created on the CNC Milling Machine

- LATHE OR TURNING MACHINE

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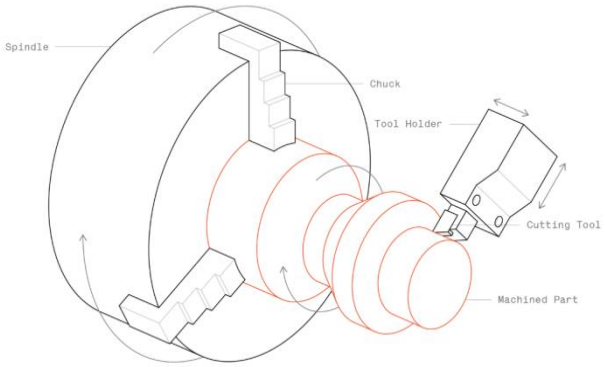

Figure3. Schematic of a typical Turning Machine

Figure4. Modal created on the CNC Turning Machine

- CNC ROUTERS MACHINE
- CNC PLASMA CUTTER MACHINE
- CNC LASER CUTTER MACHINE
- AXIS CNC MACHINE
- 3D PRINTER

CNC MACHINES ON THE BASIS OF CONTROLLER SYSTEM:-

- (SIEMENS CONTROL CNC MACHINE) &
- (FANUC CONTROL CNC MACHINE)

Both machines do similar work. But the basic difference between Siemens control CNC machine and Fanuc control CNC machine is in coding and in programming. For example, in Siemens control CNC machine the sub program is end by code M17 and input in mm by code G71. But in Fanuc control CNC machine the sub program is end by code M99 and input in MM in by code G21. The main program file and sub program file start with any name in Siemens control CNC machine. But in Fanuc control CNC machine, the main program file and sub program file start with any number.

II. PROPOSED ALGORITHM

1. CAD/CAM SOFTWARE

CAD (Computer Aided Design) is used to design components in virtual environment. So you create 3D models and 2D drawings instead of hand drawn technical drawings. Examples of CAD software: Autodesk AutoCAD, Autodesk Inventor, Autodesk Fusion, Solid Works, CATIA, Solid Edge, NX CAD, Creo (formerly ProEngineer).

CAM (Computer Aided Manufacturing) is used to prepare manufacturing process for previously created virtual model (the one from CAD software). Usually that process is some kind of machining (milling or turning). Preparations in CAM consist of setting paths for tool and watching animations of the process. Examples of CAM software: NX CAM, Edge CAM, CAM Works, Master CAM. Also most of the CAD software have CAM module too[6].

1.1 Unigraphics NX CAD software

NX, formerly known as "UG", is an advanced high-end CAD/CAM/CAE, which has been owned since 2007 by Siemens PLM Software. In 2000, Unigraphics purchased **SDRC I-DEAS** and began an effort to integrate aspects of both software packages into a single product which became **Unigraphics NX** or **NX. [7]**

It is used, among other tasks, for:-

- Design (parametric and direct solid/surface modeling)
- Engineering analysis (static; dynamic; electro-magnetic; thermal, using the finite element method; and fluid, using the finite volume method).
- Manufacturing finished design by using included machining modules.
- Able to generate the Code (G codes & M codes) and program of CNC machine.

2. Coding And Programming:-

CNC machine has its special language, which guide the CNC machine and also follow the given path in the form of codes and programming. And then CNC Machine gives good result according to our wish. CNC codes also used to define the position of tool, shape of the modal and coding help to do number of operation (ex. Milling, Tapping, Drilling etc.). Coding (G code & M code) & offset generate automatically in software programming. But in manually CNC programming offset is taken.

CNC machine has two type of coding –

- M-code (machine code)
- G-code (general code)

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2.1 M-code (MACHINE CODE)

M-codes deal with the configuration of the machine tools Such as On/off commands and bringing back the machine to the origin or the cutting point. These codes are different for each CNC machine. M code in CNC programming control miscellaneous machine function including starting and stopping specific actions sectors.

Table1. M Code of CNC Milling Machine

M CODE	DISCRIPTION
M00	Program stop
M01	Optional program stop
M02	End of program
M03	Spindle start forward CW
M04	Spindle start reverse CCW
M05	Spindle stop
M06	Too change
M07	Coolant ON – Mist coolant/Coolant thru spindle
M08	Coolant ON – Flood coolant
M09	Coolant OFF
M19	Spindle orientation
M28	Return to origin
M29	Rigid tap
M30	End of program (Reset)
M41	Low gear select
M42	High gear select
M94	Cancel mirror image
M95	Mirror image of X axis
M96	Mirror image of Y axis
M98	Subprogram call
M99	End of subprogram

Table2. M Code of CNC Lathe Machine

M CODE	DISCRIPTION
M00	Program stop
M01	Optional program stop
M02	End of program
M03	Spindle start forward CW
M04	Spindle start reverse CCW
M05	Spindle stop
M08	Coolant on
M09	Coolant off
M29	Rigid tap mode
M30	End of program reset
M40	Spindle gear at middle
M41	Low Gear Select
M42	High Gear Select
M68	Hydraulic chuck close
M69	Hydraulic chuck open
M78	Tailstock advancing
M79	Tailstock reversing
M94	Mirrorimage cancel
M95	Mirrorimage of X axis
M98	Subprogram call
M99	End of subprogram

2.2 G-code (GENERALCODE)

G-code deals with the geometry of the hardware, for example, straight cutting developments, penetrating tasks and determining the units of estimation. A G code in CNC programming, control the movements of a machine, dictating how and where a machine should to fabricate a part.

Table3. G Code of CNC Milling Machine

G CODE	DISCRIPTION
G00	Rapid traverse
G01	Linear interpolation
G02	Circular interpolation CW
G03	Circular interpolation CCW
G04	Dwell
G17	X Y plane selection
G18	Z X plane selection
G19	Y Z plane selection
G28	Return to reference position
G30	2nd, 3rd and 4th reference position return
G40	Cutter compensation cancel
G41	Cutter compensation left
G42	Cutter compensation right
G43	Tool length compensation + direction
G44	Tool length compensation – direction
G49	Tool length compensation cancel
G53	Machine coordinate system selection
G54	Workpiece coordinate system 1 selection
G55	Workpiece coordinate system 2 selection
G56	Workpiece coordinate system 3 selection
G57	Workpiece coordinate system 4 selection
G58	Workpiece coordinate system 5 selection
G59	Workpiece coordinate system 6 selection
G68	Coordinate rotation
G69	Coordinate rotation cancel
G73	Peck drilling cycle
G74	Left-spiral cutting circle
G76	Fine boring cycle
G80	Canned cycle cancel
G81	Drilling cycle, spot boring cycle
G82	Drilling cycle or counter boring cycle
G83	Peck drilling cycle
G84	Tapping cycle
G85	Boring cycle
G86	Boring cycle
G87	Back boring cycle
G88	Boring cycle
G89	Boring cycle

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G90	Absolute command
G91	Increment command
G92	Setting for work coordinate system or clamp at maximum spindle speed
G98	Return to initial point in canned cycle
G99	Return to R point in canned cycle

Table4. G Code of CNC Lathe Machine

G CODE	DISCRIPTION
G00	Rapid traverse
G01	Linear interpolation
G02	Circular interpolation CW
G03	Circular interpolation CCW
G04	Dwell
G09	Exact stop
G10	Programmable data input
G20	Input in inch
G21	input in mm
G22	Stored stroke check function on
G23	Stored stroke check function off
G27	Reference position return check
G28	Return to reference position
G32	Thread cutting
G40	Tool nose radius compensation cancel
G41	Tool nose radius compensation left
G42	Tool nose radius compensation right
G70	Finish machining cycle
G71	Turning cycle
G72	Facing cycle
G73	Pattern repeating cycle
G74	Peck drilling cycle
G75	Grooving cycle
G76	Threading cycle
G92	Coordinate system setting or max. spindle speed setting
G94	Feed Per Minute
G95	Feed Per Revolution
G96	Constant surface speed control
G97	Constant surface speed control cancel

III. EXPERIMENT AND RESULT

3.1 CNC Programming:-

A) Turning:-

Tool Holder: PDJNL 25*25
Insert: DNMG 150604
N5 G54;
N10 M42;
N20 G95 S300 M4;
N25 LIMS=600;
N30 T01 D1 M8;
N35G00 X80 Z0;
N40 X70;
N45 G01 Z-75 F0.2;
N50 G00 X71 Z0;
N55 X60;
N60 G01 Z-50 R0.2;
N65 X70;
N70 G00 X200 Z200;
N75 M30;

B) Step turning:-

N5 G54;
N10 M42;
N15 G95 S300 M0.4;
N20 T01 D1 M8;
N25 G00 X30 Z0;
N30 G00 X40 Z0;
N35 CYCLE95;
CYCLE95 (“STEP TURN”, 5, 0.1, 0.1 . . .) X40
N40 G00 X200 Z200 M17;
N45 M30;
STEP TURN: (SUB PROGRAM)
N05 G01 X0 Z0 F0.2;
N10 G01 X20 Z-10;
N15 G01 X20 Z-30;
N20 G01 X30 Z-30;
N25 G01 X30 Z-45;
N30 G01 X40 Z-45;
N35 G01 M17;

C) Tapper turning:-

N5 G54;
N10 M42;
N15 G95 S300 M.4;
N20 T01 D1 M8;
N25 G00 X01 Z0;
N30 G01 X80 Z-45 F0.2;
N35G00 X81 Z0;
N40 G01 X60 Z-30 F0.2;
N45 G00 X81 Z0;
N50 X50;
N55 G01 Z-68 F0.2;
N60 X60 Z-15;
N65 G00 X51 Z0;
N70 X40;
N75 G01 X50 Z-6.5 F0.2;
N80 G00 X200 Z200;
N85 M30;

3.2 Drilling:-

Program file:-
File name:-O0001

O0001;
G80 G40 G17;

```
G21 G94 G64;
G91 G28 X0 Y0 Z0;
T01;
M03 S2000;
G00 G54 G90 X0 Y0;
G00Z5;
G83 X0 Y0 R0 Z-5 Q1 F300;
X30 Y-20;
X0 Y-20;
X-30 Y-20;
X30 Y0;
X-30 Y0;
X-30 Y20;
X0 Y20;
X30 Y20;
G80;
G00 Z100;
M05;
M30;
```

Figure5. Drilling operation on CNC machine

3.3 Advantages of operate the CNC machine by using CAD/CAM software generated program:-

a. It increases the production rate of CNC machine as compare to manually programming.
b. Pre visualization of manufacturing process of CNC machine in software.
c. Take Less time and give accurate result as the program.
d. All type of three axis and multi axis manufacturing work is possible. But in manually programming, multi axis work is not possible.
e. It can generate three axis and multi axis program with pre visualization.
f. Cam software makes critical machine programming simple & and cost effective
g. Increase the programming potential [9].
h. Getting the most output of CNC machine [10].
i. Eliminate costly mistakes & waste p[11]
j. Turn art in to CNC programs & finish parts easily [12]
k. Possibilities of error in software program, is very less [13]

3.4 Limitations of operate the CNC machine by using CAD/CAM software generated program:-

a. Spindle speed can be put once for whole program.
b. Possibilities of tool break is more in software programming as compare to manually programming
c. High level skills (high skills about CNC machine and its coding, programming & good knowledge about CAD/CAM software NX and its commands) is required in operator (worker or engineer).

IV. CONCLUSION

This article presents a new approach to automatic programming of the CNC machine by the use of CAD/CAM software unigraphics NX. The proposed CAD/CAM model is suitable for solving 3D as well as 2D machining problems. The CNC programming by using CAD/CAM software, help to increasing the production rate as well as the flexibility. Difficult CNC programming of (2axis, 3 axis or multi axis) can be done easily and it minimize the errors CNC machine. The G code and M code automatic generated in the unigraphics software and perform on the CNC machine.

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