Trade of Toolmaking	
Module 6:	Introduction to CNC
Unit 3:	Data Input/Storage Program proving
	Phase 2

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Unit Objective

On completion of this unit you will be able to input a part program into computer simulation software, edit the program use various methods to prove the program.

Introduction

Module six of this course covers CNC machining. This is the third unit in module six and explains the various techniques of inputting part programs into the CNC machine. This can be performed manually by the CNC operator through the machine console, but this means that the machine remains idle, therefore other methods are used such as punched tape, magnetic tape, disc, direct numerical control (DNC).

When the part program has been prepared it is important to prove the program prior to machining the part or multiple parts. The part program can be proved by running it through a simulation package, where the computer graphics are used to simulate a test run. Other methods involve doing a dry run and single step machining. The ability to find faults in the part program and edit as required is a requirement.
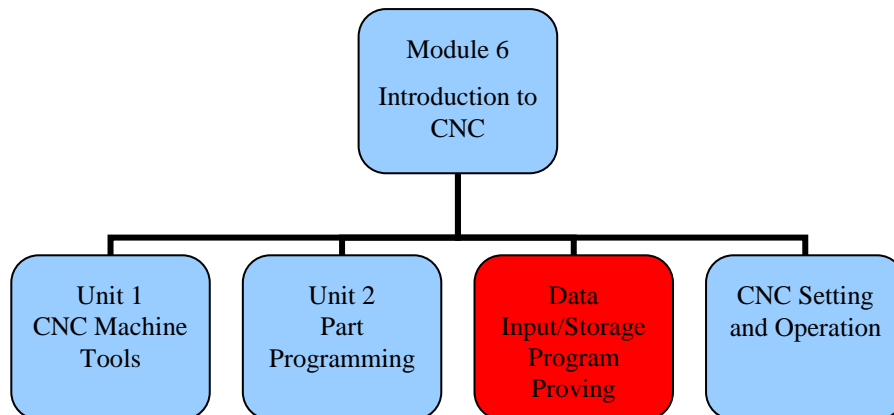
By the end of this unit you will be able to:

- Input a part program into a computer simulation software and CNC machine tool.
- Edit a part program using machine console or simulation software.
- Run, fault find and correct the program in the simulation package, i.e. prove part program.

1.0   Inputting A Part Program Into A Computer Simulation Software And CNC Machine

Key Learning Points

Methods of data input/storage: MDI (Manual Data Input), magnetic tape and disc, punched tape, DNC (master computer). Keyboard skills, computing skills computer and a CNC machine. Inputting of prepared part program (Unit 2: Part Programming) in the simulation package and the CNC machine.

1.1   Methods Of Data Input/Storage: MDI (Manual Data Input), Magnetic Tape And Disc, Punched Tape, DNC (Master Computer)

There are various methods for inputting data into the CNC control unit. The main methods are as follows:

- Manual Data Input (MDI)
- Punched Tape
- Magnetic Tape
- Magnetic Disc
- DNC (Direct Numerical Control)

Manual Data Input (MDI) – This is the term to describe the method of entering data into the machine control unit by using the console keypad on the machine. This method is not practical because the machine is idle while the program is being typed in. The most common use of MDI is for editing programs and for machine setup.

Punched Tape – This was the original data transfer method and is still in use today. It is a low cost method of data input. The tape is made from paper, polyester, paper/polyester laminates or polyester/aluminium foil laminates. The data in the program is represented by rows of holes punched across the width of the tape. The tape width is 25mm.

Magnetic Tape – This is a cheap and convenient method of storing large volumes of data in a small space. Tape cassettes are easy to handle and store. It can also be erased and re-written as required.

Magnetic Disc – The data transfer is faster for a disc than magnetic tape. The access time to the stored data is faster because the disc is a random access device.

DNC (Direct Numerical Control) – The program is prepared on a remote computer. The program can be checked by using the simulation software on the computer. The program can then be directly downloaded on the CNC machine.

Timings, R.L. 1998, *Manufacturing technology*, vol. 1, 3rd edn, Pearson Education Limited, chapter 5, *Numerical control part programming*, sec. 5.6, *Data input*, p. 179. ISBN-13: 9780582356931

1.2   Keyboard Skills, Computing Skills Computer And A CNC Machine

Experience in using a Personal Computer (PC) would be of benefit prior to an apprentice preparing a program for the first time. Tasks normally performed in a PC, such as typing on a keyboard, filing and retrieving files are also carried out when programming.

1.3   Inputting Of Prepared Part Program (Unit 2: Part Programming) In The Simulation Package And The CNC Machine

When the program has been prepared it needs to be checked, which is done on the remote PC or by loading it onto the CNC machine by one of the above methods. The part program can then be checked by running the simulation package. The part can be viewed on the screen in either 2-D or 3-D. The route of the cutter path around the part can then be viewed. It is important to run this simulation prior to running the CNC program on the machine.

2.0   Editing A Part Program Using Machine Console Or Simulation Software

Key Learning Points

Editing of programs, i.e. add/remove program lines.

2.1   Editing Of Programs, I.e. Add/Remove Program Lines

A part program can be edited on the machine console or on a remote computer. A program may need to be modified for a number of reasons such as, modifications to an existing design or problems highlighted while running the simulated software.

Using the keyboard, the part program is called up and displayed on the screen. The program is put into editing mode and the curser is moved down to the block or blocks that need to be edited. The program is edited as required and the program is saved. The part program is then checked by running the simulation package and viewing it on the screen.

3.0   Run, Fault Find And Correct The Program In The Simulation Package

Key Learning Points

Production of 'master' program from memory of machine. Dry run, Z axis lock, single step, graphic simulation, X Y plotter. Use of substitute materials for program verification. Fault finding on part programs. Information gathering and organisation of materials. Ability to adapt to new technology.

3.1   Production of 'master' program from memory of machine

Multiple programs can be stored in the memory of the CNC machine. When the part needs to be machined, the program number is called up using the keyboard and screen on the console of the CNC machine. The workpiece and the tools are then setup and the program can then be run.

3.2   Dry Run, Z Axis Lock, Single Step, Graphic Simulation, X Y Plotter

Dry Run - A dry run involves running in automatic mode without the component installed in the chuck or on the machine table. The purpose is to verify the tool path. *Plotter* – A relatively simple way of checking the programmed component profile is to substitute a pen tip for the cutting tool. For a milling operation a two dimensional trace of the cutter path can be produced on paper by placing a board on top of the table. *Single Step* – This involves stepping through the program line by line and actually cutting a component one stop at a time. *Graphic Simulation* – The computer graphics are used to simulate a test run. The correct size blank appears on the screen and using animated tool movements it is machined to final shape and size according to the program data.

3.3   Use Of Substitute Materials For Program Verification

Another method of proving the program is to clamp a substitute material such as machineable wax or plastic wood into the vice. The program is then run in automatic mode to verify the program. The substitute material can also be used to check measurements and modifications made to the program if required.

3.4   Fault Finding On Part Programs

When the part program is being run by using the simulation package or using a dry run, it will normally stop if there is a fault in the program. The block where the program stops can be checked and modified if required.

3.5   Information Gathering And Organisation Of Materials

G Code: These are preparatory functions used to change the mode of movement of the machine, such as rapid slide movement (G00), circular interpolation clockwise (G02), controlled feed rate (G01), absolute (G90) or incremental movements (G91) etc.

3.6   Ability To Adapt To New Technology

In the past it was adequate for the apprentice Toolmaker to be trained on conventional milling machines and the lathes. Nowadays the CNC machine is used through out industry. They can perform all the tasks of conventional machines, with the added advantage that parts can be consistently machined to a high degree of accuracy. They can also be programmed and run by semi-skilled operators. It is still very important to be proficient in all aspects of the conventional machines, but also in CNC programming and machining.

Summary

Inputting a part program into a computer simulation software and CNC machine:
There are various methods for inputting data into the CNC control unit. The main methods
are as follows: Manual Data Input (MDI), Punched Tape, Magnetic Tape, Magnetic Disc and
DNC (Direct Numerical Control)

When the program has been prepared it needs to be checked, which is done on the remote PC
or by loading it onto the CNC machine by one of the above methods. The part program can
then be checked by running the simulation package. The part can be viewed on the screen in
either 2-D or 3-D. The route of the cutter path around the part can then be viewed. It is
important to run this simulation prior to running the CNC program on the machine.

Editing a part program using machine console or simulation software: A part program
can be edited on the machine console or on a remote computer. A program may need to be
modified for a number of reasons such as, modifications to an existing design or problems
highlighted while running the simulated software.

Using the keyboard, the part program is called up and displayed on the screen. The program
is put into editing mode and the curser is moved down to the block or blocks that need to be
edited. The program is edited as required and the program is saved. The part program is then
checked by running the simulation package and viewing it on the screen.

Run, fault find and correct the program in the simulation package: Multiple program can
be stored in the memory of the CNC machine. When the part needs to be machined, the
program number is called up using the keyboard and screen on the console of the CNC
machine. The workpiece and the tools are then setup and the program can then be run.

The computer graphics are used to simulate a test run. The correct size blank appears on the
screen and using animated tool movements it is machined to final shape and size according to
the program data.

Another method of proving the program is to clamp a substitute material such as machineable
wax or plastic wood into the vice. The program is then run in automatic mode to verify the
program. The substitute material can also be used to check measurements and modifications
made to the program if required.

When the part program is being run by using the simulation package or using a dry run, it
will normally stop if there is a fault in the program. The block where the program stops can
be checked and modified if required.

Suggested Exercises

1. There are various methods for inputting data into the CNC control unit, list four of them

2. Explain the various methods used check the CNC program prior to machining the workpiece.

3. Enter a program from one of your drawings into the CNC control unit and

4. run the simulation graphics to check the program.

5. Call up the program that you just entered and edit it by changing some of the

6. co-ordinate values and run the simulation graphics again.

Questions

1.   Explain the term 'Manual Data Input (MDI)'.
2.   What is the disadvantage of using MDI on a CNC machine?
3.   How is a part program edited on a CNC machine?
4.   Explain the term 'Dry Run'.
5.   What is Graphic Simulation?

Answers

1.   Manual Data Input (MDI) – This is a method of entering data into the machine control unit by using the console keypad on the machine.

2.   This method of programming is not practical because the machine is idle while the program is being typed in. The most common use of MDI is for editing programs and for machine setup.

3.   The part program is called up and displayed on the console of the CNC machine. The program is put into editing mode and the curser is moved down to the block or blocks that need to be edited. The program is then edited as required and the program is saved.

4.   Dry Run - A dry run involves running in automatic mode without the component installed in the chuck or on the machine table. The purpose is to verify the tool path.

5.   The computer graphics are used to simulate a test run. The correct size blank appears on the screen and using animated tool movements it is machined to final shape and size according to the program data.

Recommended Additional Resources

Reference Books

Timings, R.L. 1998, *Manufacturing technology*, vol. 1, 3rd edn, Pearson Education Limited.

ISBN-13: 9780582356931

Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology.

ISBN-13: 9780750660730