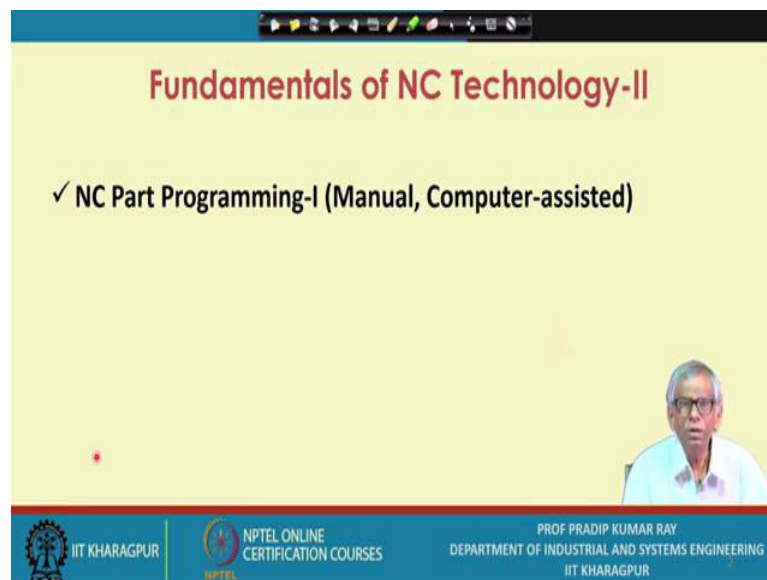**Automation in Production Systems and Management**
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Fundamentals of NC Technology - II
Lecture - 22
NC Part Programming - I (Manual, Computer - Assisted)

During the 5th week we are discussing a number of the fundamental issues of NC Technology.
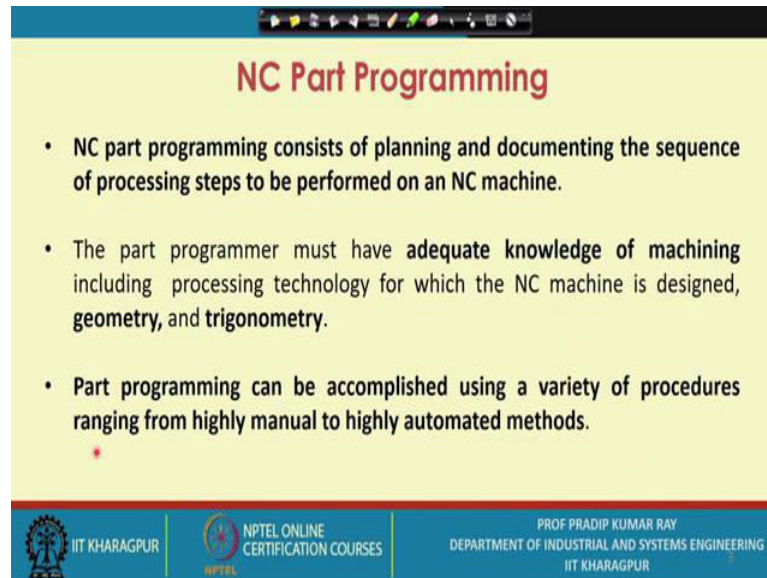
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This week we have specifically identified a number of issues like the configuration of as a distributed numerical control, whether it is an original NC system or computer numerical control or extension of computer numerical control called distributed numerical control, the program of instruction, etc.

Related to program of instruction, there is an important topic called NC part programming. During this week we are going to discuss several types of NC part programming and there are four important methods you can use for NC part programming. Given a part or given a component with its process plan and operation details known and you have to use the NC technology, the first thing, as a part programmer, you have to write down the program, .

For writing down the program for a given part, there are many types of languages. Let me first discuss a few NC part programming methods.

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When you the classify NC part programming methods, there are four methods you come across. First one is the manual experience-based part programming. The person who writes this part program is referred to as part programmer. The part programmer plays a very important role and as a part programmer you must have knowledge about the process particularly with the process plans.

Then you will be dealing with several kinds of shapes and sizes of the component for which you have to write down the program. So, you must have knowledge in geometry as well as in trigonometry and you must have knowledge in operations and plus the kinds of the machine tools you use.

NC part programming consists of planning and documenting the sequence of processing steps to be performed on an NC machine. The process knowledge is a necessary condition.

The part programmer must have adequate knowledge of machining, or another different kind of processes including processing technology for which NC machine is designed to define the shapes and the sizes of different types of the product or the component.

Part programming can be accomplished using a variety of procedures ranging from highly manual experience based to highly automated methods.

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Essentially there are four methods. First one is the manual part programming, second one is the computer assisted part programming. It is basically the interface between the part programmer and the computer. As a part programmer manually, you do certain activities and then you hand over the job to the computer. The computer will assist you in completing the entire exercise called part programming.

The third method is you can also opt for part programming using CAD, CAM. And the last one that is the manual data inputs. This method is particularly prescribed for the workers.

For certain parts or the components, the worker is aware of the part programming technique. So, why do not we allow him or her to act as a part programmer so that he or she will write down the program and then those programs will be the basic inputs?

For this particular manual the data input method or the MDI touch screen you can work.

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For the jobs or the for the parts which are repetitive in nature, MDI technique may be used. It is not that you expect that the worker or the operator will be acting as a part programmer for a new product. Once this part program is established and the job becomes repetitive then you can train your operator to as a part programmer.

Let us talk about the manual part programming. In manual part programming the programmer prepares the NC code using the low-level machine language.

The coding system is based on binary numbers. This coding is the low-level machine language that can be understood by the machine control unit, like CPU or the computer. The configuration is known to you. When higher level languages are used such as APT, the statements in the program are converted to this basic code.

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In this case, two types of the coding are very popular: one is the M code, another one is the G code. NC uses a combination of the binary and decimal number system.

Binary Coded Decimal system you have to adopt or you have to use.

Here each of the 10 digits in the 0 to 9 decimal system is coded as a four-digit binary number. These binary numbers are added in sequence as in the decimal number system.

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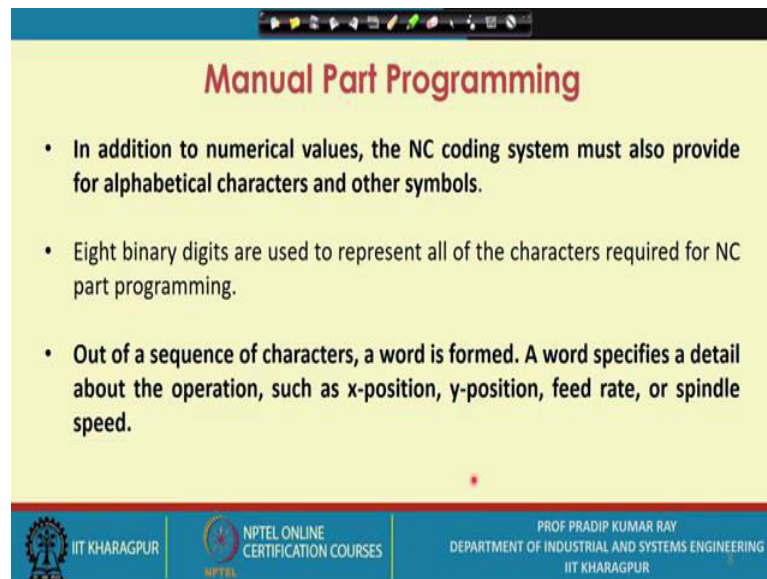
Now, let me give you one example. Suppose, your decimal value is 1250. that means, 1000+200+50+0. So, corresponding binary number that is 0001, and then the second one is 2; that means, 0010.

The third one 0101, and the last one is 0000.

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For coding purpose, the BCD system we follow. In addition to the numerical values, the NC coding system must also provide for alphabetical characters and other symbols.

Eight binary digits are used to represents all of the characters required for NC part programming. Out of a sequence of characters, a word is formed.

We have to give instruction or specify the operations. A word specifies detail about the operation such as x position, y position; x axis is there, y axis is there, z axis is there, then a b c, the rotational axis, all these are there.

Feed rate you have to specify. For a typical metal machining work the feed rate is 0.01 mm per evolution. The measuring unit is also known or spindle speed in rpm.

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Manual Part Programming

- Out of a collection of words, a block is formed. A block is one complete NC instruction.

- For example, an instruction block for a two-axis NC milling machine may include: (i) x- and y- coordinates to which the machine table should be moved, (ii) type of motion to be performed (linear or circular interpolation), (iii) rotational speed of the milling cutter, and (iv) feed rate at which the milling operation should be performed.
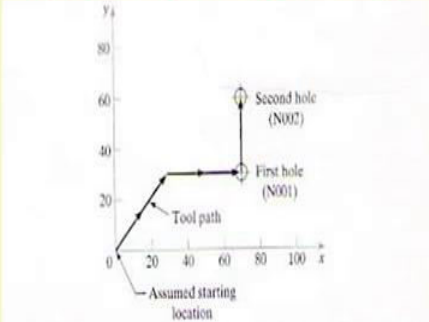
The range you have to mention. Depending on kind of cutting tool you used, kind of material you have used, what is their assumption regarding your surface hardness. Out of a collection of words a block is formed. A block is one complete NC instruction.

For example, an instruction blocks for a two axis NC milling machine. This may include x and y coordinates to which the machine table should be moved.

The type of motion to be performed is linear or circular interpolation. Rotational speed of the milling cutter and feed rate at which the milling operation should be performed. These values we have to specify.

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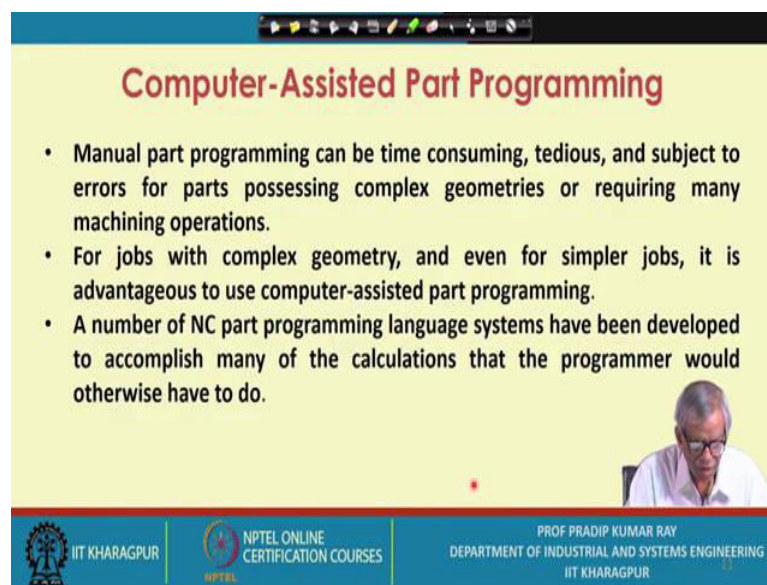

Manual Part Programming

Figure 7.16 Drilling sequence for word address format example. Dimensions are in millimeters.

This is one example. A drilling sequence you have for which the word address format example. dimensions are in millimeters. Starting location you have to specify on x axis y axis. Then the tool path you have to define, then it reaches another point or if it takes a turn, you have to define this tool path. This is the first hole position or the location then you again you go to the next hole location and there you do the drilling. So, this is the first hole location and this is the second hole location. The coordinate axis system you have to follow. Once this information on this figure is in front of you, you have to write down the code.

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What is computer assisted part programming? Sometimes manual part programming is definitely a feasible method, but then again you are not only going for writing the programs for one part, you are going to writing down the programs for hundreds of parts. So, why do not we you follow a method where certain activities you carry out and the remaining activities will be taken up by the computer. So, when you have this alternative, this is referred to as the computer assisted part programming.

The manual part programming can be time consuming, tedious and subject to errors for parts processing complex geometries or requiring many machining operations. There could be human error also for jobs with complex geometry. Even for simpler jobs it is advantageous to use computer assisted part programming.

A number of NC part programming language systems have been developed to accomplish many of the calculations that the programmer would otherwise have to do.
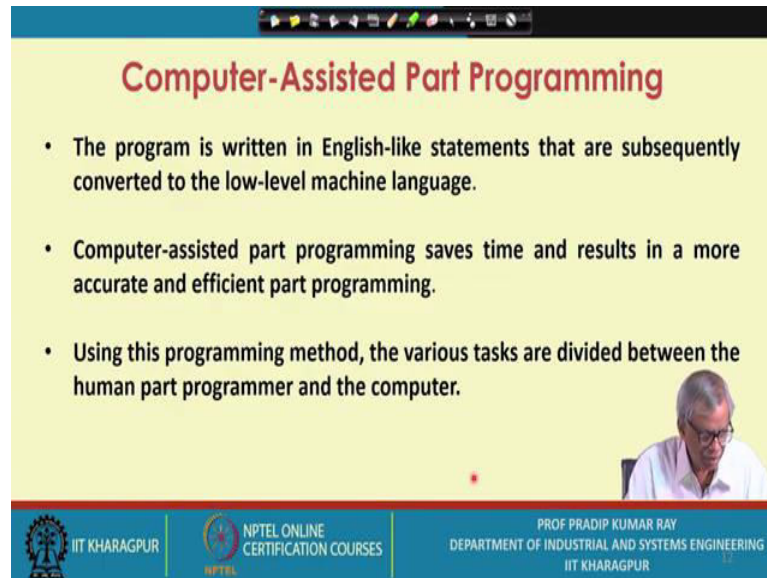
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The program is written in English like statements that are subsequently converted to the low-level machine language.

Computer assisted part programming saves time and results in a more accurate and efficient part programming when work becomes repetitive or your workload is more. Using this programming method the various tasks are divided between the human part programmer and the computer.
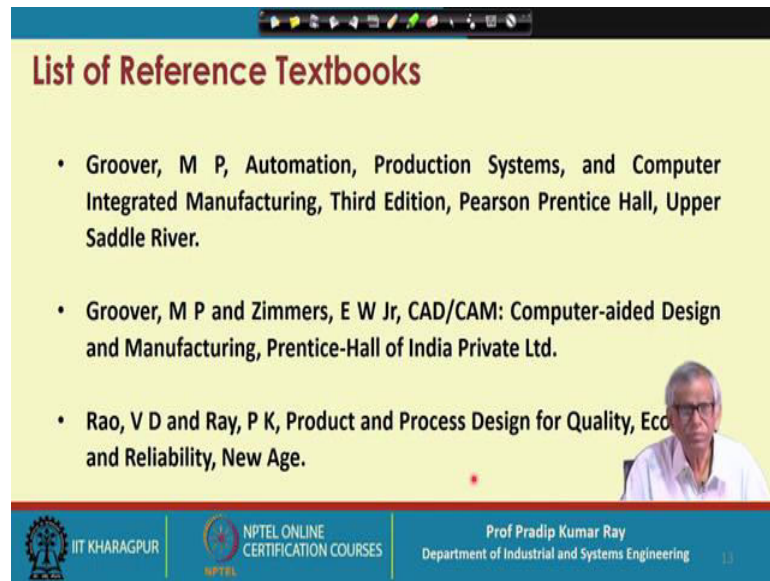
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In the subsequent the lecture sessions we will be the referring to the activities you are supposed to carry out and the activities a computer should carry out. And then you will have the knowledge about the framework you have for using computer assisted part programming.