COMPUTER NUMERICALLY CONTROLLED (CNC) MACHINING

This study file was produced by the Engineering Department, Yeovil College of Further Education.

INTRODUCTION TO CNC

Numerical control means quite simply, control by numbers. Numerically controlled machine tools, are those lathes, milling machines, drilling machines and punch presses that have their movements and other functions controlled by instructions or data received as a series of numbers. The numbers are interpreted electronically by the machine tool and are then acted upon.

Machine tools that include a computer, able to make calculations and decisions based upon data received are called **computer numerically controlled (CNC).**

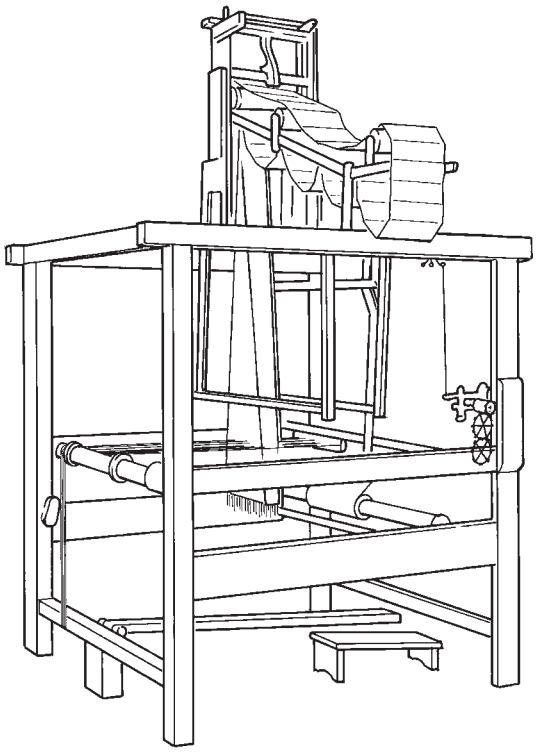
Data or information, flows from the computer, and the CNC milling machine sends feedback data back to the computer.

A CNC machine runs under the control of a computer, and the moving parts are driven by special electric motors called stepper motors. The computer switches these on and off, and controls their direction and speed. After the computer has been programmed to make the machine tool perform a sequence of operations, the program can be run over and over again to produce many identical components.

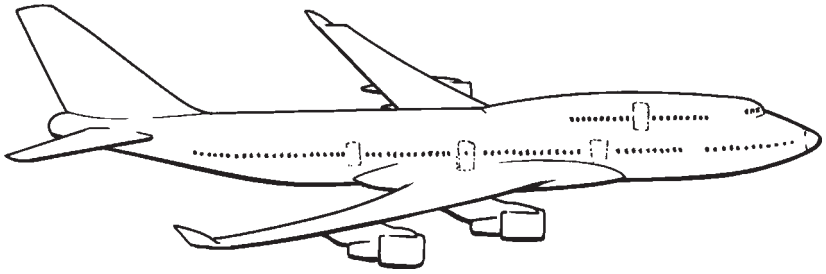
There are software packages that enable the programmer simply to draw an outline of the required component on the screen, and the software then converts this image automatically into a set of codes in the form of a program.

HISTORY OF CNC

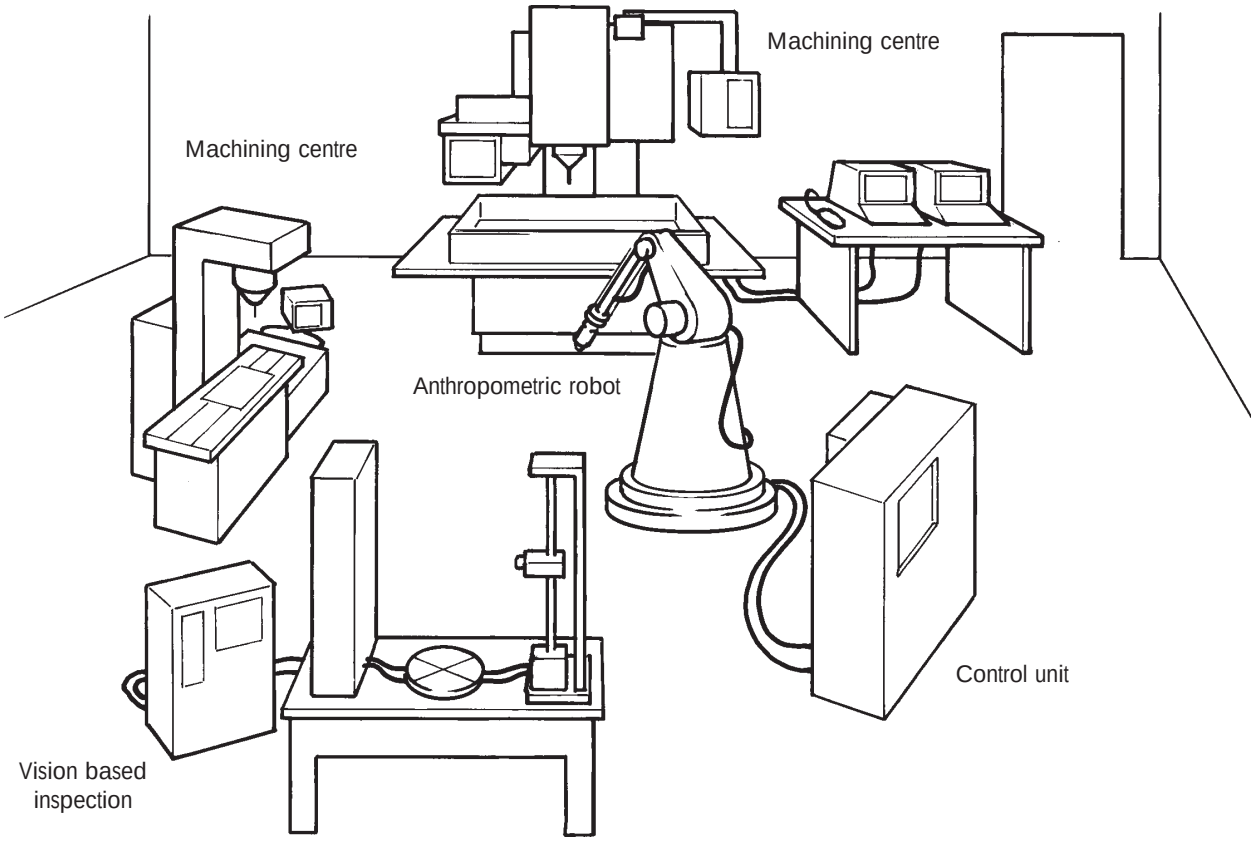
First NC machines: 1801 Jacquard loom



First NC/CNC cutting machines:
Large curved surfaces in aerospace components

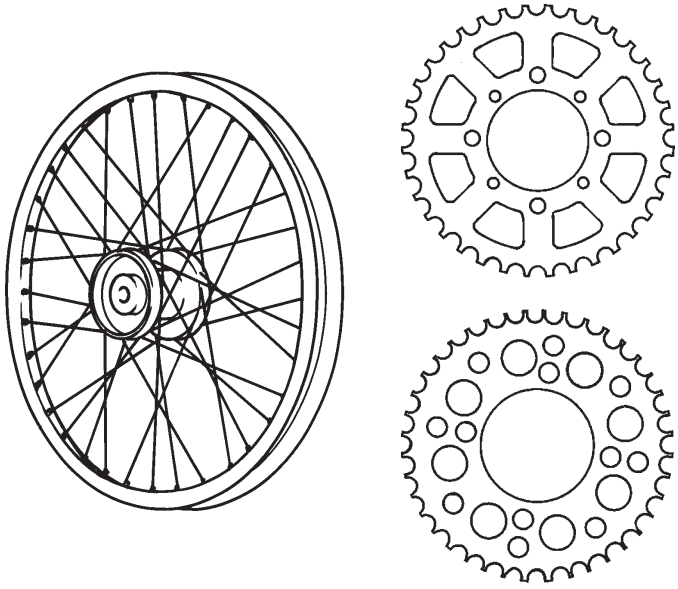


Flexible manufacturing systems

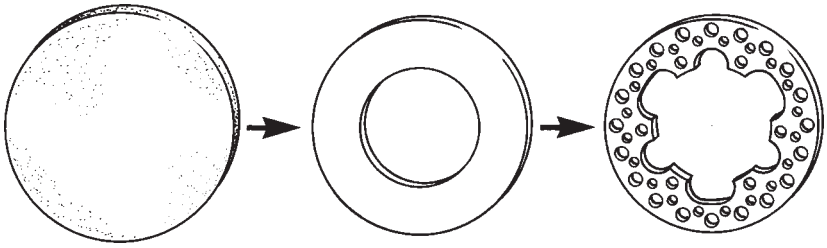


TYPICAL CNC PRODUCTS

Motor Cross is a 'high tech' sport using suitably 'high tech' materials. The examples show parts manufactured by CNC machine - hubs, brake discs, chainrings and even sprockets. Even though the amounts of material removed are very significant as a result of machining from solid blocks, it is still cheaper, and a better quality finished product results.



An example of component production for a motor cycle in the form of a disc pad is given.



COMPARISON OF CNC WITH CONVENTIONAL MACHINING

MANUFACTURING COSTS

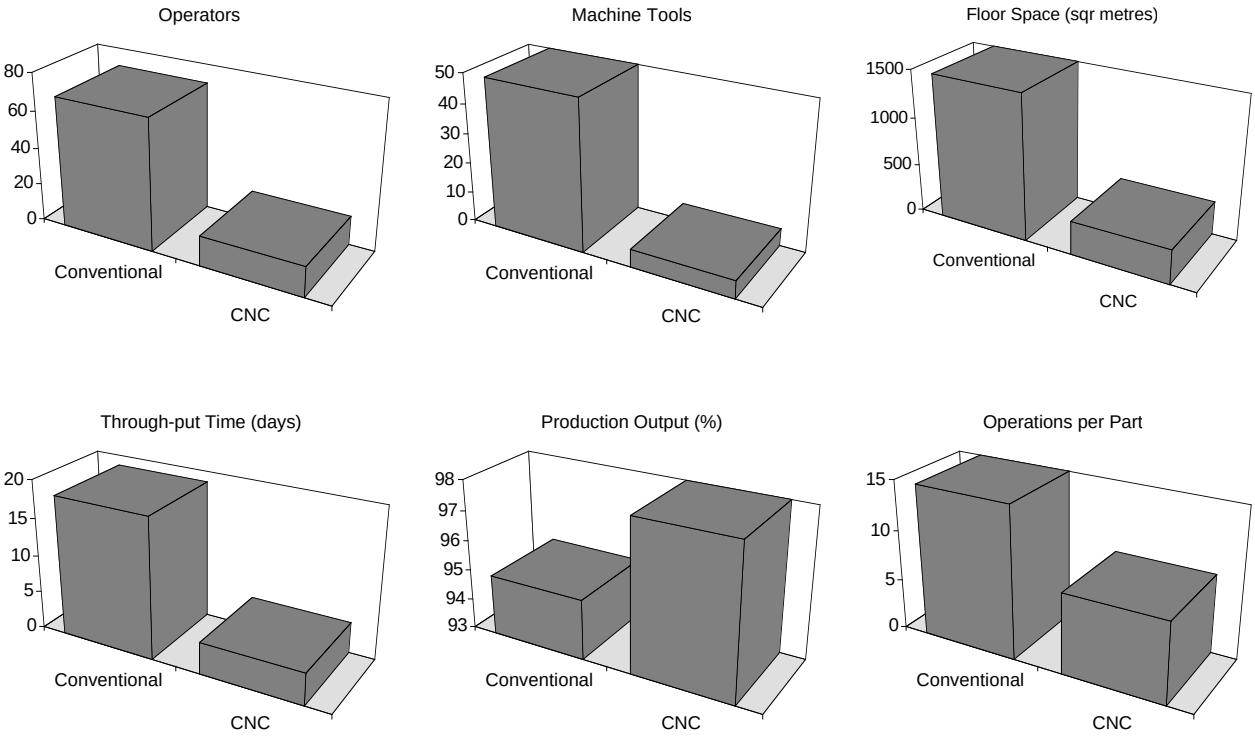
Cost of preparing for production	Production costs	Related costs
Planning	Costs of machines	Machine set up
Programming Costs		Tooling cost
Tape production		Pre-setting
Jigs fixtures		Re-sharpening
Design manufacture		
Proving costs		

ADVANTAGES OF CNC

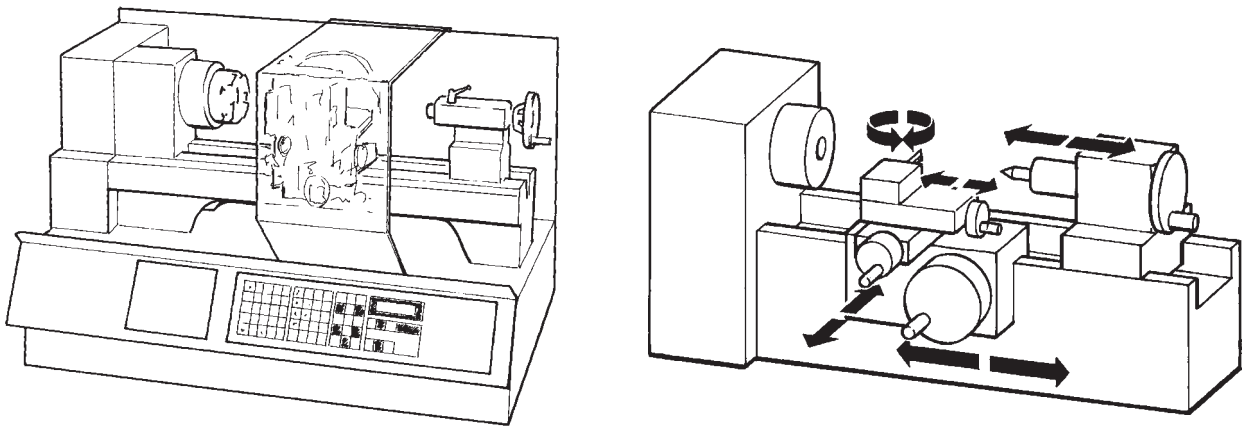
1 Consistent accuracy - repeatability
2 Increased productivity
3 Less operator involvement
4 Complex shapes easily machined
5 Reduced tooling costs
6 Reduced component rejection
7 Uniformity of product
8 Can work unattended - unsocial times
9 Improved Management control

DISADVANTAGES OF CNC

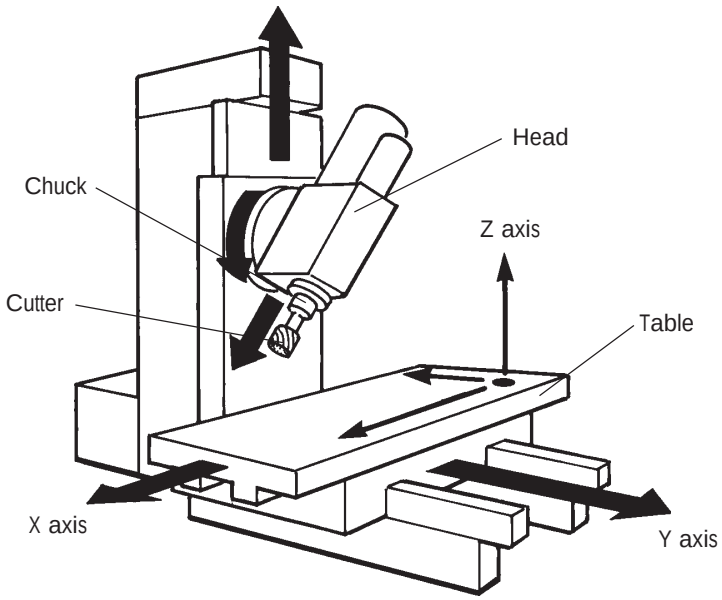
1 Cost of machines (initial)
2 Cost of maintenance and servicing
3 Installation costs
4 Training of operators



Comparisons between conventional and CNC machining



A typical CNC lathe



Vertical milling machine

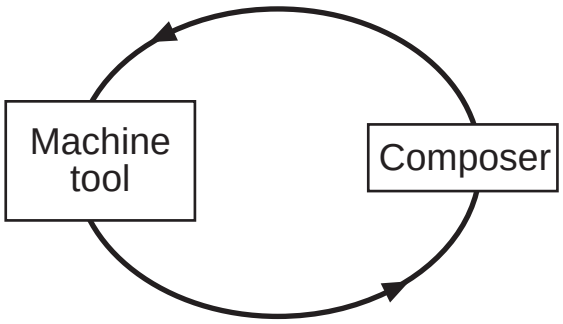
PROGRAM WRITING

Before CNC machining can take place, we have to write a program to tell the machine tool what you want it to do.

What do we need to know?
1. Where the tool starts from - DATUM
2. Where the tool moves to - X, Y, Z (axis)
3. What path will the tool trace?
4. How is it getting there? - G CODES
5. How does it know it has got there? - FEEDBACK
6. How does the machine know how to start and stop? - M CODES
7. How do we turn on the coolant? - M CODES

PROGRAMMING LANGUAGE

FEEDBACK - This tells the machine where to go and how to get there. Feedback tells the composer where the tool is and when to move to the next line in the program.



G CODES - These tell the control the facilities required for machining to be carried out and how to move to the target point. Here are a selection of G CODES:

G00	Rapid positioning - moves the tool quickly to its required position without removing material
G01	A linear move - moves the tool in a straight line whilst removing material
G02/G03	Circular move - to a position around a radius while removing material

M CODES - These tell the control when to start or stop coolant or when to switch the machine on or off. Here are a selection of M CODES:

M00	Program Stop
M01	Program Optional Stop
M03	Start Spindle
M08	Start Coolant

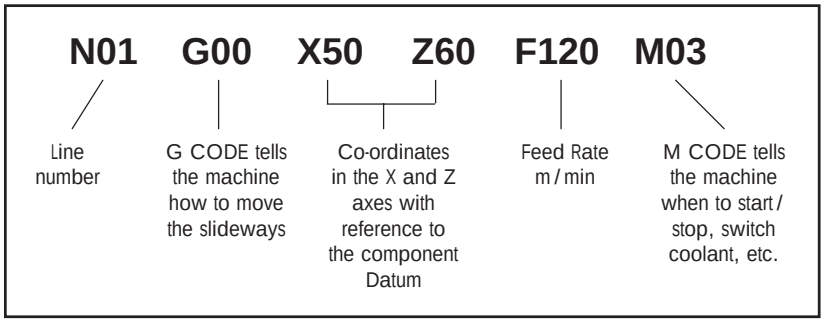
A typical line of program would be:

N01 G00 X50 Z60 F120 M03

This is called 'Word Address'.

The word is, for example, **G00**
X50

The line of program is called a block. Note that in the block above the 'F' refers to the feed rate of the machine.



SAFETY PROCEDURES

1. Always ensure guards are in use
2. Always ware safety glasses when using the machinery
3. Do not wear loose or baggy clothing when operating the machines
4. All long hair must be tied back or covered with a hat
5. All tools must be treated with respect
6. The machine must be cleaned and tidied before leaving the workshop
7. Oil and coolant can be dangerous if spilt on the floor. Always ensure any spillage is cleaned up