History & development of CNC

About Me

What is it

- NC Numerical control – Automatic control of a machine tool typically from paper tape. Hardware only using relays, or solid state.
- CNC – Computerised Numerical Control – as above but enhanced by software, and modern data input methods such as floppy discs and internal memory

From the Beginning

- 1948 Parsons develops numerical definition of a component
- 1949 Major developments by MIT
- 1951 Supported by US Airforce
- 1952 3 axis milling machine control developed.
- 1952 Alfred Herbert had their first NC machine running in the UK
- 1956 Plessey enters NC market
- 1959 Airmec start making a simple Point to Point NC
- 1964 Plessey licences Bendix
- 1965 Plessey Licences Bunker-Ramo (USA) System
- 1967 Airmec merge with AEI
- 1969 Airmec, Ferranti & Plessey merge to form PNC
- 1979 Allen-Bradley buys PNC
- 1982 Allen-Bradley & Olivetti form joint venture – OSAI
- 1985 Rockwell acquires Allen Bradley
- 1997 OSAI splits from A-B

First NC Machine

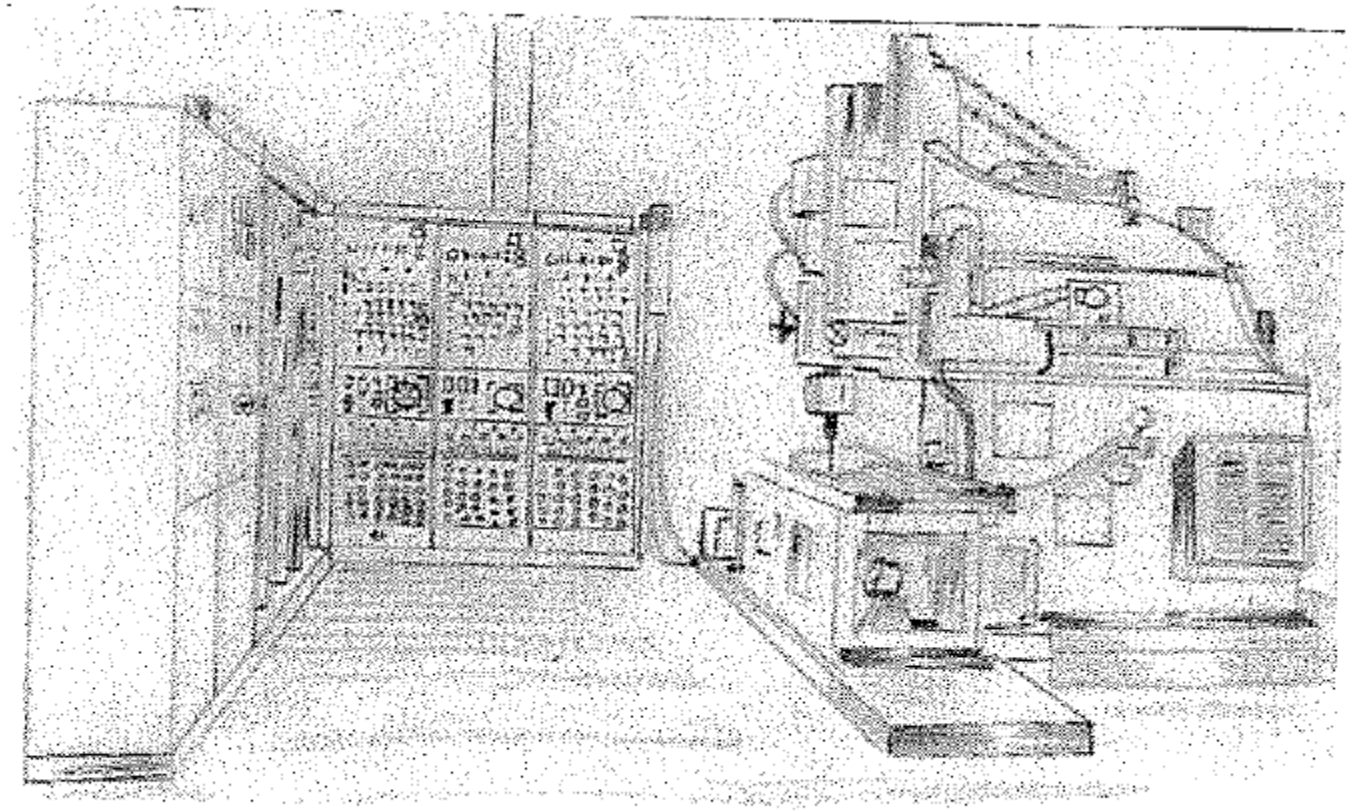
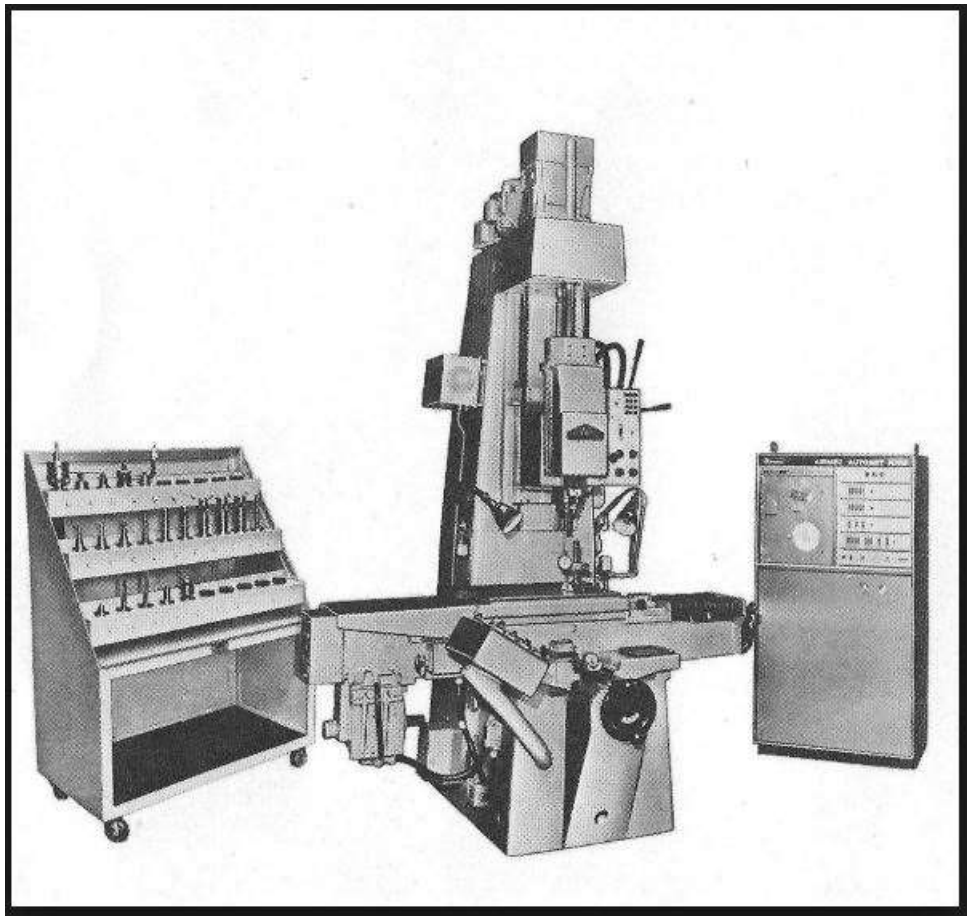


Fig 3. Artist's impression of the first nc machine tool.

“UK” Controls

- Airmec N271 Autoset Point To Point
- Airmec N410 Autoset Point To Point
- AEI Axiomatic Point To Point
- AEI Planetrol Continuous Path Magnetic Tape, Core Store.
- Plessey Mk1, Mk2, Mk3 Magnetic Tape, Core Memory.
- 1970 Airmec-AEI PTL100 Point To Point
- Ferranti Scope Point To Point
- Ferranti Mk4 Continuous Path (Magnetic Tape)
- Plessey NC1100 Pt to Pt, NC1130 Continuous
- 1976 Plessey RUSC 1st Microprocessor system, Ram Memory, tape, cassette, disk, Eprom for Exec SW

Newall Jig Borer with Airmec N410



USA Influence

- Bunker-Ramo 3100 Paper Tape – Continuous path
- AB 4500, 4600 paper tape - Continuous
- AB7300 CNC Paper Tape
- AB8200 CNC Paper Tape or Bubble memory
- AB8400 (from Dana)

A-B 7300 Double Bay

Italian Influence

- Olivetti Contor (Lathe) & Vector (Mill)
- OSAI-AB 8600
- OSAI-AB 10/series
- OSAI Open Series

The Rest

- USA GE 120, 100s, 103P, 1050
- USA UMAC
- USA Westinghouse
- USA Cincinatti
- Japan Fanuc / Toshiba / Hitachi
- Germany Siemens / Heidenhein
- Norway Kongsberg
- France Num

Is Size Important?

- Airmec controls were 1.5 – 1.8m high and approx 0.8m square
- AB7300 was 2m high, 1m square or 2m wide
- 8600 was a rack system 19” rack approx 12” deep & 18” high with up to 30 PCBs
- 8601 was 0.5m square and 100mm deep 1 PCB
- 10s initially 9” wide and 18” high with 6 PCBs
- 10s later versions 9x6x6 inches 2-3 PCBs
- Open 10x6x4 1PCB

Early machines

- Hydraulic control
- Switched axes
- “Bang Bang” axes – stepped speed control by clutches.
- Continuous path
- Stepper Motors
- Full Servo

Machine Components

- Control System
- Interface
- Axis Control
  - Servo drives
  - Motors
- Spindle Control
- Tool management
- Work piece management

Control System

- Relays
- Solid state
- DTL
- TTL

Programming

- Magnetic Tape
- Paper tape
- X, Y, Z coordinates
- S for spindle control
- T for tool selection
- M for Miscellaneous

Interface

- How the control system integrates with the machine
- Outputs for control or indication
  - Binary, BCD, Discrete
  - Solid State
    - Transistors, Thyristors
  - Relays
  - Contactors
  - Voltages
  - Analog

Interface continued

- Inputs
- Usually discrete inputs – axis limits, overloads, errors, start, stop, reset, overrides.

Axis Control

- “Bang Bang” – selection of a fixed speed depending on the distance to travel
  - Selects clutches or motor speeds and brakes

- Proportional control, an analogue voltage controls the speed proportional to the distance.

Feedback Devices

- Resolver
- Inductosyn
- Linear Scales
- Encoder
- Absolute devices

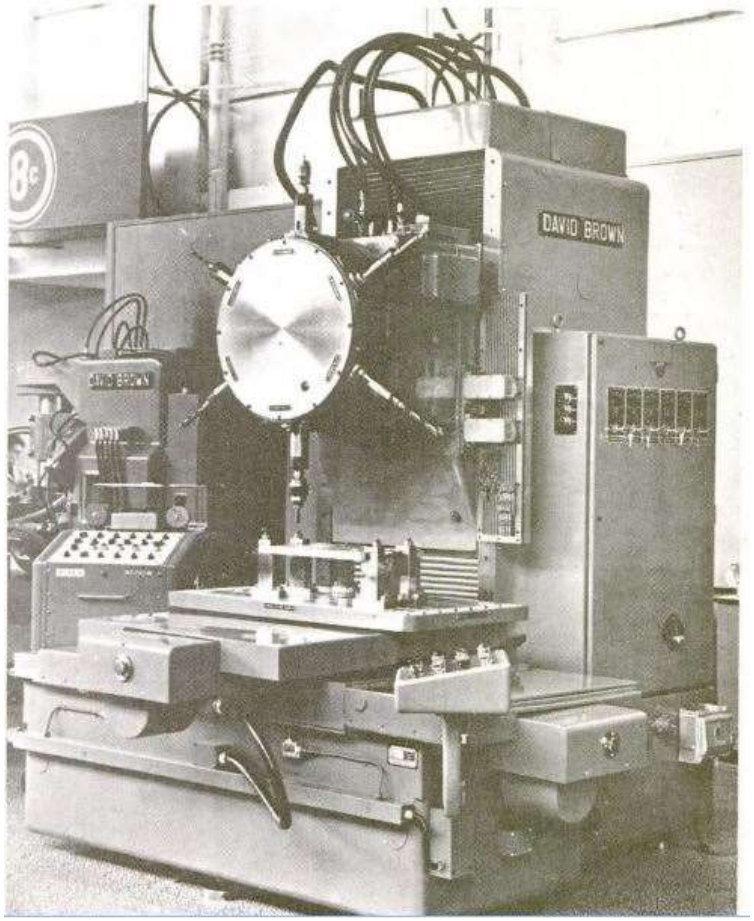
Spindle Control

- Typically controlled by “S” word
- Fixed speed – controls relays or clutches
- Continuously variable speed

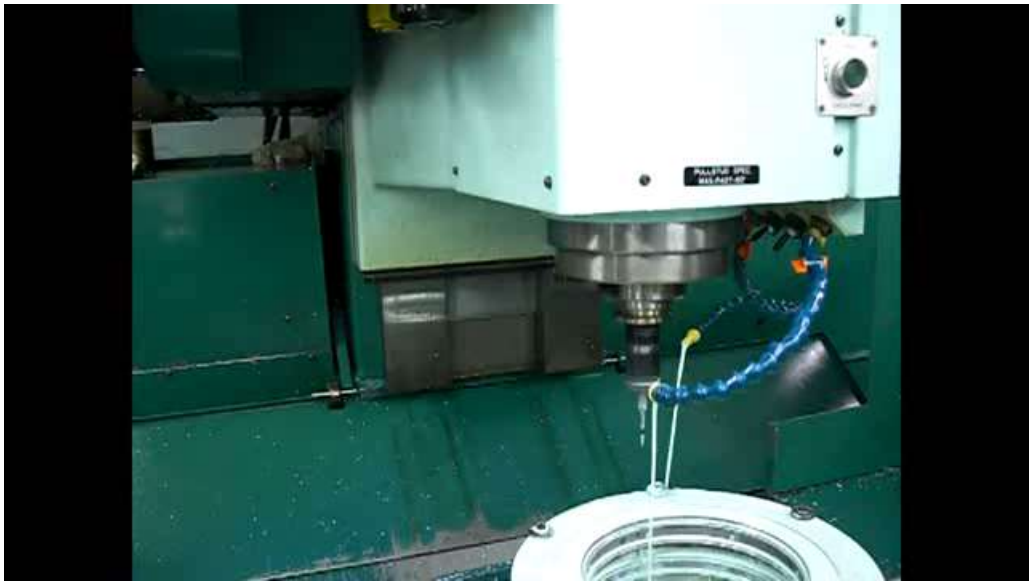
Tool Management

- Manual – indicate to operator that a tool change is needed
- Turret a rotary device that rotates to select a tool 6, 8 10 clearance between tools & work
- Tool-changer, rotary, Linear - racks, crates, chains
- Intermediate arms

Turret



Toolchanger



Workpiece management

- Manual – operator changes part as required
- Pallet Management Automatic change of the fixture.

Axis Drives

- Motors & Clutches
- Stepper Motors
- Hydraulic Servo
- Electric Servo

Data Input methods

- Manual MDI
- Paper tape
- Floppy Disc
- DNC
- Networking

CNC Additions

- Enhanced displays Customised operator panel
- Simulation Video, Test mode
- Tool size compensation
- Software interface – simplifies the machine
- Enhanced axis control VFF
- Geometric & Volumetric correction
- Higher Speeds
- Tool Life Management

CNC Additions

- Enhanced diagnostics
- Digital Drive connections
- Conversational editing
- Tool centre point
- Jerk
- Spline
- Gantry & Dual Axes
- Multi Process
- EtherCat serial interface

Technolgies

- Metalworking
- Glass
- Stone
- Wood
- Plastics
- Laser
- Plasma
- Punching
- Bending
- Electron Beam Welding
- Water Jet