The Evolution of Machine Tools

ETSU ENTC 3020
Technology & Society

Earliest Tools

- Primitive Hand tools
  - Weapons & Tools
  - Mineral, Bone, & Wood
- Stabbing, Cutting, Scraping, & Drilling

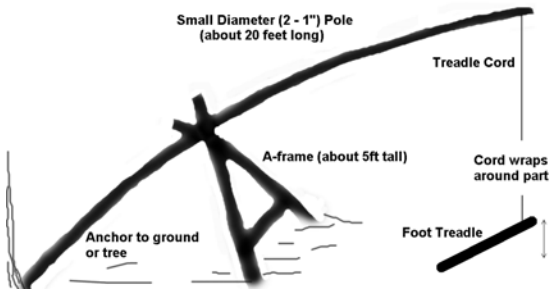
Early Tools

- Wheel
  - Efficient Transportation
- Lever
  - Mechanical Advantage
- Inclined Plane & Screw

Pole Lathe

- Medieval Machine
- Turned Round Parts
- "Bodgers"
  - Itinerant Woodworkers
- Carpenters
- Blacksmiths
- Metalworkers/Jewlers
- Made Furniture, Home, & Farm Implements

A-frame Pole Lathe



Pole Lathes

- Non-continuous Cutting Action
- "One man's foot power" motor
- Slow, Tedious Process

Wheel Lathe

- Replace Pole with a Wheel
- Hand-cranked by assistant
- Continuous Cutting & Contouring

Treadle Wheel Lathe

- Heavy Flywheel & Foot Treadle
- Solo Operation
- Continuous Cutting & Contouring

Treadle Lathe

Powered Lathes

- Continuous Turning
- Water wheels
  - Central, Overhead Shafts
  - Leather belts transfer power to individual machines
- Factory System

Engine Lathes

- Invented by the English Inventor Henry Maudsley in 1800
- First powered lathe with a "Lead Screw"
  - Couples rotation of the spindle to the movement of the carriage (tool holder)
  - Cut accurate screw (i.e., another lead screw)
  - A machine that builds itself, jump starts the…

Industrial Revolution

- Lathes
- Steam Engine
  - Accurate cylinders & pistons
- Steel
  - Tough for cutting tools
  - Ductile for boilers & rails

Modern Engine Lathe

- Electric Motor
- Geared Head
  - Variable Spindle Speeds (Rotation)
  - Variable & Accurate Feeds (Tool Movement)
- Tolerances of 0.001 inch
- Multiple Screws

Modern Vertical Mill

- Electric Motor
- Variable Spindle Speeds (Rotation)
- Accurate Table Position
  - 3-Axis (X, Y, & Z)
- Tilt "head"
  - 2 Degrees of Freedom
- Tolerance of 0.001"
- Multiple Tool shapes

Post-World War II Era

- Cold War with Soviet Union
- High Performance Aircraft
  - Jet engines & aircraft structures
  - Very complex forms, mathematically determined
- Computing Devices
  - Mechanical Using Gears and Cams
  - Electrical Using Circuits and Tubes
- Transistors
  - Invented in the mid-1940s at Bell Labs
- Integrated Circuits
  - Invented in the 1960s at Texas Instruments

Numerical Control

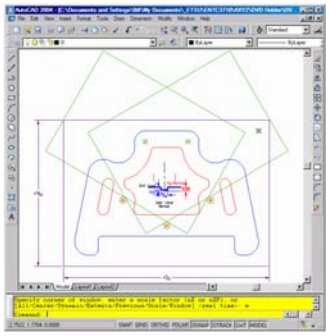
- Integrate machine tool with digital computer
  - Compute Complex Cutter Paths
  - Accurately Control Axes Motors
- Position feedback
  - Closed – Servo Motors & Position Sensors
  - Open – Stepper Motors
- Limited capability
  - Programmed Moves
  - Little Intelligence

CNC Devices

- CNC is "Computer Numerical Control"
- Increased Capability
- More Memory
- Longer Programs
- Complex Operations

CADD

- Computer-Aided Design & Drafting
- Workstation & PC-based Systems
- Accurate 2D and 3D Models
- Rapid Revisions
- Multiple Formats
  - Hardcopy Drawings
  - Application Data Sharing (e.g., CAM, FEA, animations, etc.)



CNC Vertical Mill

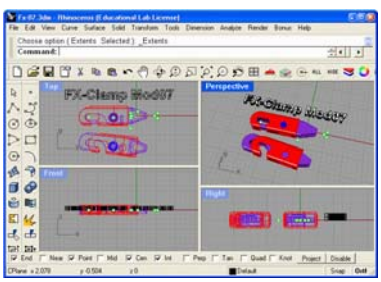
- Programs
  - Complex
  - Long
- Fast
- Accurate
- High Quality
- Adaptable

CNC Router

- Large Parts
  - 4'x8' Sign
- Wood, Plastics, & Soft Metals
- 2-½D & 3D Contouring
- CAD-CAM Software Interface
- Faster & Better

3D Modeling

- Surfaces & Solids
- Import
  - 2D Data
  - 3D Data
- Export
  - Virtual Models
  - FEA
  - STL
  - Animations



3D Rapid Prototyping

- Stereolithography
  - 3D Printing
- Start with a 3D CADD Model
  - "Slice" Each Z-axis Level
  - X-Y Part Paths & Supports
- Multiple Materials
  - Metal, Polymers (ABS, Nylon), Wax, Paper, etc.
- "Real" Parts for Form, Fit & Function

3 Questions

- Does automation kill or create jobs?
- What's more important: Quality or Speed?
- Why Customize Products?

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- Image of Pole Turner from the "Mendel Housebook," c. 1436. Available URL: http://www.his.com/~tom/sca/lathes.html
- A-frame Pole Lathe image from http://www.bodgers.org.uk/images/lathe7.gif
- Images of Pole Lathe workers from http://www.fencible.org.nz/avillagelife/crafts_bodger2.htm
- Image of Pewterer using a Great Wheel lathe from the "Book of Trades," 1568. Available URL: http://www.his.com/~tom/sca/lathes.html
- Treadle Wheel (Flywheel) Lathe built by Thomas Rettie. Images available from http://www.his.com/~tom/sca/lathes2.html
- Maudsley portatit from http://www.banki.hu/~tkt/html/kiadv/szgt/machines/eszt2_main.htm
- Images of modern era engines lathes, vertical milling machines, CNC mills & routers, CADD screenshots, and stereolitographic parts courtesy of East Tennessee State University Department of Technology & Geomatics http://www.etsu.edu/scitech/entc

Presentation created by Bill Hemphill Feb. 18, 2005