Introduction

- Without machine tools there would be no airplanes, automobiles, television sets, or computers.

- Industrial, medical recreational, and domestic products we take for granted would not have been developed.
Example

- If machine tools were not available to manufacture tractors and farming implements, farmers might still be plowing with oxen and hand forged plowshares.
The high-paying skilled jobs in manufacturing, such as tool and die making and precision machining, require aptitudes comparable to those of college graduates.
Name a Product

- That does not require, either directly or indirectly, the use of a machine tool somewhere in its manufacture.
The Evolution of Machine Tools
Machine Tools

- As a group, can reproduce themselves.
- Many variations of each type of machine tools
- Small enough to fit on a bench top to machines weighing several hundred tons
- How could there be machine tools when there were no machine tools to make them?
Early Machine Tools
1200 B.C.

- The first machine tools, the bow lathe and bow drill, were hand-made.
- Until the end of the 17th century the lathe could only be used to turn softer materials.
- Wood, ivory, soft metals like lead or copper.
Early Machine Tools

- All of them were human powered
- Bow lathes reciprocation motion gave way to treadle power.
- Work rotation was continuous in one direction.
Bow Drill

Modern machine tools owe their origins to the bow drill which has been in use since prehistoric times. The first drills were made of bone, then of flint. The drill shown was made of bronze.
The bow lathe was developed from the bow drill and like the bow drill is used even today in India, the Far East, and some areas in Africa.
The great wheel lathe permitted skilled workers to keep all of their attention on the work. While the artisan worked at the lathe, another worker turned the wheel by hand.
The spring pole lathe is thought to have been the next development in the evolution of machine tools. It was operated by the artisan’s foot and left both hands free to handle the cutting tool.
Treadle Lathe

The treadle lathe permitted the work to turn continuously. The lathe shown was designed by Leonardo Da Vinci in the early 1500s. It had a three bearing headstock which ensured greater rigidity under heavy cutting loads and consequently greater precision. The flywheel aided in providing a continuous level of power.
Early Machine Tools

- James Watt first experimented with his steam engine.
- This brought about the first true machine tool.
- Boring mill
- The water powered tool was developed in 1774 by Englishman John Wilkinson.
Early Machine Tools

- 1800 the first lathe capable of cutting accurate screw threads.
- Designed by Henry Maudslay, an English master mechanic and machine toolmaker.
- Maudslay’s lathe is considered the Granddaddy of all modern chip-making machine tools.
About AD 100, screw threads were made as part of screw presses used for pressing grapes and olives. At that time, the male threads could be cut on hard wood by hand. Making the nut was another matter. The device had a single-point cutting tool which was rotated through the workpiece (nut) to cut the threads shown. Later, a modified form of this device was used to cut threads in metal which was used as a die to make threads on longer metal rods.
Early Machine Tools

- Industrial Revolution could not have taken place if there had not been a cheap, convenient source of power; the Steam Engine.
- Industry had to locate near source of water power.
Early Machine Tools

- 1820 Eli Whitney, an American inventor and manufacturer, devised a system to mass produce muskets (guns).
- Whitney began using milling machine to make interchangeable musket parts.
- Whitney had problems.
Early Machine Tools

- Whitney used several armories producing gun parts.
- There was no standard of measurement at that time.
- The Mid 1860 the United States adapted a standard measuring system.
Early Machine Tools

- 1875 basic machine tools such as the lathe, the milling machine, and the drill press were capable of attaining accuracy's of one one-thousandth of an inch.
- America was well on its way to becoming the greatest industrial nation in the world.
Power Sources

- As machine tools were improved, so was the way they were powered.
- At first, the changes were very slow, taking hundreds of years.
- The changes have come only in the last 150 years or so.
Hand power

- The bow lathe and bow drill are examples.
- Direction of rotation changed at each stroke of the bow.
Foot Power

- A treadle or a treadmill made possible continuous rotation of the work in one direction.
Animal Power

- Treadmills were used to power early devices for boring cannon barrels.
- Human foot power was not sufficiently strong for this work.
Water Power

- Not always dependable as a power source, because of lack of water during dry seasons.
Steam Power

- The first real source of dependable power.
- A centrally located steam engine turned shafts and overhead pulleys that were belted to the individual machines.
Central Electrical Power

- Large electric motors simply replaced the steam engines.
- Power transmission to the machine did not change.
Individual Electrical Power

- Motors were built into the individual machine tools.
- Overhead belting was eliminated.
Basic Machine Tool Operation
Almost all machine tools have evolved from the lathe.

The lathe performs one of the most important machining operations.

It operates on the principle of work being rotated against the edge of a cutting tool.
Lathe

- Many other operations
- Drilling, boring, thread cutting, milling and grinding, can be performed on a lathe.
- The most advanced version of the lathe is the CNC turning center.
Drill Press

- Rotates a cutting tool against the material with sufficient pressure to cause the tool to penetrate the material.
- Used for cutting round holes.
- Some are designed to machine holes as small as 0.0016 in diameter.
Grinding Machines

- An operation that removes metal by rotating a grinding wheel or abrasive belt against the work.
- Offhand Grinding. Work that does not require great accuracy is hand held and manipulated until ground to the desire shape.
Grinding Machines

- Precision Grinding. Only a small amount of material is removed with each pass of the grinding wheel.
- Smooth, accurate surface
- Precision grinding is a finishing operation.
Band Machines

- A widely employed technique that makes use of a continuous saw blade.
- Chip removal is rapid and accuracy can be held to close tolerances.
- Elimination or minimizing many secondary machining operations
Milling Machine

- Rotates a multi-toothed cutter into the work.
- Variety of cutting operations can be performed on milling machines.
Broaching Machines

- Designed to push or pull a multi-toothed cutter across the work.
- Each tooth of the broach (cutting tool) removes only a small amount of the material being machined.
Nontraditional Machining Processes

- Machining operations that have not evolved from the lathe.
Electrical Discharge Machining (EDM)

- An advanced machining process that uses a fine, accurately controlled electrical spark to erode metal.
Electrochemical Machining (ECM)

- A method of material removal that shapes a workpiece by removing electrons from its surface atoms
- ECM is exactly the opposite of electroplating
Chemical Milling

- A process in which chemical are employed to etch away selected portions of metal.
Chemical Blanking

- A material removal method in which chemicals are employed to produce small, intricate, ultra-thin parts by etching away unwanted material.
Hydrodynamic Machining (HDM)

- A computer-controlled technique that uses a 55,000 psi water jet to cut complex shapes with minimum waste.
- The work can be accomplished with or without abrasives added to the jet.
Ultrasonic Machining

- A method that uses ultrasonic sound waves and an abrasive slurry to remove metal.
Electron Beam Machining (EBM)

- A Thermoelectric process that focuses a high-speed beam of electrons on the workpiece.
- The heat that is generated vaporizes the metal.
Laser Machining

- The laser produces an intense beam of light that can be focused onto an area only a few microns in diameter.
- It is useful for cutting and drilling.
Hexapods

- CNC has made possible unconventional machine tools that use new work positioning and tool-positioning concepts.
Automating the Machining Process

- 1940’s US Air Force was searching for ways to increase production on complex parts for the now jet aircraft and missiles.
- The Parsons Corporation, a manufacturer of aircraft parts, had developed a two-axis technique for generating data the check helicopter blade airfoil patterns.
Automating the Machining Process

- The Parsons Corporation system used punched-card tabulating equipment.
- To determine the accuracy of the data, a pattern was mounted on a Bridgeport milling machine.
Automating The Machining Process

- A dial indicator in place, the X and Y points were called out to a machinist operating the machines X-axis handwheel and another machinist who controlled the y-axis handwheel.
- With enough reference points established, the generated data proved accurate to +/- 0.0015"
The development on Numerical Control

- Parsons realized that the technique might also be developed into a two-axis or even three-axis machining system.
- 1952 Massachusetts Institute of Technology designed a control system and mounted it on a vertical spindle machine tool
- binary number system
- Coined the phrase NC
Computer Numerical Control

- 1970 introduction of the microchip.
- Use of onboard computers an individual machine tools
- Led to the introduction of computer numerical control (CNC)
- Programs could be made at the machine or downloaded by direct line from an external computer.
CNC

- Accuracy. It is capable of producing consistent and accurate work-pieces.
- Repeatability. It is able to produce any number of identical work-pieces once a program is verified.
- Flexibility. Changeover to running another type of part requires only a short period of nonproductive machine downtime.
Robotic Systems

- For loading and unloading permits some machine tools to operate unattended.
- Operate in hazardous and harsh environments.
- Perform operations that would be tedious for a human operator.
- Handle heavy materials.
- Position parts with great repetitive precision.
The Evolving Role of the Machinist

- Make a thorough study of the print
- Determine the machining that must be done
- Ascertain tolerance requirements.
- Plan the machining sequence.
- Determine how the setup will be made.
- Select the machine tool, cutters and other tools and equipment that will be needed.
Role of the Machinist

- Calculate cutting speeds and feeds.
- Select a proper cutting fluid for the material being machined.
Any Questions???