Modern Manufacturing Processes

Dr. Vikas Gupta
Assistant Professor
CDLSIET, Panniwala Mota

Need For Unconventional Machining Methods

- Harder and difficult to machine metal and alloys.
- Difficult to machine by conventional methods, cost is high but also results into poor surface finish and shorter tool life.
- To overcome these difficulties a number of Newer Machining Methods have been developed.

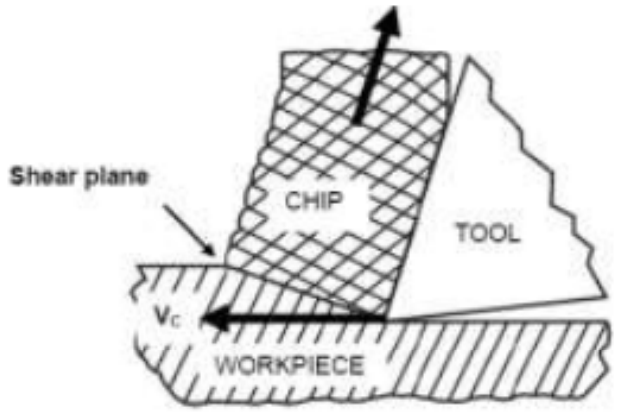
•Machining of intricate and complicated shapes, thin and fragile components and accurate and economical forming of very hard, high strength materials which are being extensively used in aerospace and nuclear industries, have forced the scientists, engineers and technologists to search for new techniques of machining which can readily provide an effective solution to these problems.

•As a result of research and development for the last fifty years or so, several new methods of machining have emerged which can be grouped under the name of:

- Unconventional machining methods, or
- Non-traditional machining methods, or
- Physical machining process, or
- New technologies, or
- Modern machining methods

Conventional Manufacturing Processes

1. Generally macroscopic chip formation by shear deformation.



2. There may be a physical tool present. for example a cutting tool in a Lathe Machine,

Non-Conventional Manufacturing Processes

1. Material removal may occur with chip formation or even no chip formation may take place. For example in AJM, chips are of microscopic size and in case of Electrochemical machining material removal occurs due to electrochemical dissolution at atomic level

2. There may not be a physical tool present. For example in laser jet machining, machining is carried out by laser beam. However in Electrochemical Machining there is a physical tool that is very much required for machining.

3. Cutting tool is harder than work piece at room temperature as well as under machining conditions	3. There may not be a physical tool present. For example in laser jet machining, machining is carried out by laser beam. However in Electrochemical Machining there is a physical tool that is very much required for machining.
4. Material removal takes place due to application of cutting forces – energy domain can be classified as mechanical	4. Mostly NTM processes do not necessarily use mechanical energy to provide material removal. They use different energy domains to provide machining. For example, in USM,

5. Conventional machining involves the direct contact of tool and work –piece	5. Whereas unconventional machining does not require the direct contact of tool and work piece.
6. Lower accuracy and surface finish.	6. Higher accuracy and surface finish.
7. Suitable for every type of material economically	7. Not Suitable for every type of material economically
8. Tool life is lessdue to high surface contact and wear.	8. Tool life is more

9. Higher waste of material due to high wear.	9. Lower waste of material due to low or no wear.
10. Noisy operation mostly cause sound pollutions	10. Quieter operation mostly no sound pollutions are produced.
11. Lower capital cost	11. Higher capital cost
12. Easy set-up of equipment.	12. Complex set-upequipment.
13. Skilled or un-skilled operator may required	13. Skilled operator required.

14. Generally they are manual to operate.	14. Generally they are fully automated process.
15. They cannot be used to produce prototype parts very efficiently and economically.	15. Can be used to produce prototype parts very efficientlyAnd economically.

Modern Machining / Unconventional Machining Process

- ✓ As the world advancing forth technically in the field of space research, missile and nuclear industry; very complicated and precise component having some special requirements are demanded by these industries.

- ✓ Some metals like hastalloy, nitralloy, nimonics etc , are such that they can't be machined by conventional methods but required some special techniques.

Hastalloy C-276		Uses
Element	Content	1. Pollution control 2. Chemical processing 3. Waste treatment 4. Marine engineering 5. Pulp and paper production
Ni	55 %	
Mo	15 – 17 %	
Cr	14.5 – 16.5 %	
Fe	4 – 7 %	
W	3 – 4.5 %	

Modern Machining / Unconventional Machining Process(cont..)

- The method are not limited by hardness, toughness, and brittleness of material
- It can produce any intricate shape on any work piece.
- It has suitable control over the various physical parameters of the processes.
- It is only complementing the conventional machining methods.

Basic Principle of New Machining Methods

The basic principle of machining by these new methods is to apply some form of energy to the work piece directly without almost any physical contact between the tool and the work piece and have the desired shape by material removal from the work piece.

Abbreviations used for Unconventional Machining Methods

USM - Ultrasonic machining
ECM - Electro-chemical machining
AJM - Abrasive Jet Machining
EDM - Electro-discharge machining
LBM - Laser-Beam machining
EBM – Electron-Beam machining
PAM – Plasma-Arc machining
ECG – Electrochemical grinding

Classified into various groups

1. Basic mechanism involve in the process

- **Erosion**
- **Ionic dissolution**
- **Vaporization**

Machining Process	Predominant Mechanism of Metal Removal
1. Conventional Machining Process (e.g. turning, milling)	1. Shear failure of work material
2. Abrasive jet machining (AJM)	2. Erosion of work material.
3. Ultrasonic Machining	3. Erosion of work material. Cavitation phenomenon.
4. Chemical Machining	4. Etching
5. Electrochemical M/cing	5. Ion Displacement
6. Electrochemical Grinding	6. Ion Displacement, Erosion of material
7. Spark Erosion Machining	7. Vaporization of work metal
8. Electron beam machining	8. Vaporization of work metal
9. Laser beam machining	9. Vaporization of work metal
10. Ion beam machining	10. Vaporization of work metal
11. Plasma Arc Machining	11. Fusion of work metal

2. Types of energy required to shape the material

- Mechanical
- Thermal
- Electro thermal
- Chemical and electro chemical

Mechanical Energy	Electrical Energy
· Conventional machining · Abrasive Jet Machining (AJM) · Water Jet machining (WJM) · Ultrasonic machining (USM)	· Electro-chemical machining · Electro-chemical grinding · Electro-chemical Deburring · Electro-chemical Honing
Thermal Energy	**Chemical Energy**
· Spark erosion machining (EDM) · Electron-Beam machining (EBM) · Ion-Beam machining · Laser-Beam machining · Plasma-Arc machining	· Chemical machining · Electro-polishing · Photo-chemical machining

Classification(cont..)

- ✓ In thermal and electro thermal method- heat energy is concentrated on a small area of the work piece, to melt and vaporize the tiny bits of work material. (EDM, LBM, PAM, EBM, IBM)

- ✓ In chemical and electro chemical method- the work piece material in contact with a chemical solution is etched in a controlled manner. (ECM, ECG, ECH and ECD)

- ✓ In mechanical method- the material is removed by mechanical erosion of the work piece material. (USM, AJM, and WJM)

Advantages of Non-traditional

✓Material removed without mechanical contact with the work piece. **(ECM, EDM,LBM,CHM)**

✓Material removal rate is independent of work piece hardness. **(ECM, EDM,LBM)**

✓Cutting forces are independent of work piece hardness. **(ECM, EDM,LBM,CHM)**

✓Tool material need not be harder than work piece material. **(ECM, EDM,LBM,CHM,USM)**

✓Tool wear is not a problem. **(ECM, LBM,CHM)**

✓Ability to machine any material. **(LBM)**

✓Burr-free machining. **(ECM,EDM,CHM)**

✓Stress-free machining. **(ECM, ECG, CHM)**

✓Uniform material removal over the entire area below the tool surface simultaneously. **(ECM,CHM)**

✓Superior surface integrity possible. **(ECM,CHM,ECG)**

✓Intricately shaped, very hard and fragile materials can be machined. **(USM)**

✓Finely focused micro-machining possible. **(EDM,LBM,EBM)**

✓Easy compatibility with numeric control and computer controls. **(EDM,LBM,EBM,ECM)**

Limitations of Non-traditional Machining Processes

All modern machining processes are generally costly. Their specific power consumption(kW/cm3/min) is quite high. The following are some of the specific limitations of the nontraditional machining process:

- ✓**Work piece and tool must be electrically conductive (EDM,ECM)**
- ✓**Depth of hole drilled is limited. (LBM)**
- ✓**Heat-affected zones (HAZ) produced are not desirable. (EDM,LBM,EBM). For this purpose the compatibility of the process with the metallurgical state of the work piece material can be studied before using a particular non- traditional machining process for production work.**
- ✓**There may be taper in the sidewalls of holes or cavities (EDM,LBM)**
- ✓**Most of these limitations can be overcome and controlled, that advantages can be obtained with good product quality assurance**