

Lecture Notes
on
ADVANCE
MANUFACTURING PROCESSES
(Th.4b)



6th Semester, Mechanical Engg.

Prepared by
Dr. Biswajit Parida
Lecturer, Mechanical



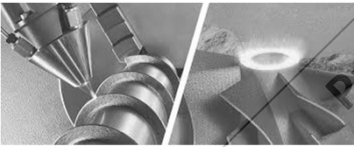

DEPARTMENT OF MECHANICAL ENGINEERING
GOVERNMENT POLYTECHNIC KENDRAPARA
Kendrapara 754289, Odisha, India

ADVANCE MANUFACTURING PROCESSES

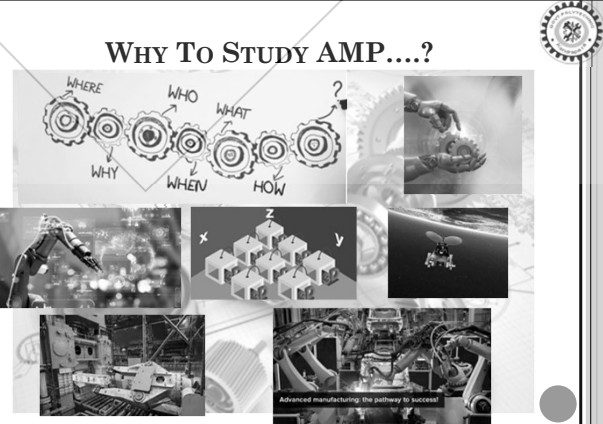
By
Dr. Biswajit Parida, Lecturer,
Mechanical Engg. Department,
Govt. Polytechnic Kendrapara

INTRODUCTION

By
Dr. Biswajit Parida, Lecturer,
Mechanical Engg. Department,
Govt. Polytechnic Kendrapara

WHY TO STUDY AMP....?



Advanced manufacturing: the pathway to success

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

WHY TO STUDY AMP....?

In a need of:

- Products with high levels of design
- Technologically complex
- Innovative
- Reliable, affordable, and available
- Newer, better, more exciting
- Products that solve a variety of problems
- Flexibility

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

WHAT WE ARE GOING TO COVER IN AMP....?

1.0 Modern Machining Processes:

- 1.1 Introduction – comparison with traditional machining.
- 1.2 Ultrasonic Machining: principle, Description of equipment, applications.
- 1.3 Electric Discharge Machining: Principle, Description of equipment, Dielectric fluid, tools (electrodes), Process parameters, Output characteristics, applications.
- 1.4 Wire cut EDM: Principle, Description of equipment, controlling parameters; applications.
- 1.5 Abrasive Jet Machining: principle, description of equipment, Material removal rate, application.
- 1.5 Laser Beam Machining: principle, description of equipment, Material removal rate, application.
- 1.6 Electro Chemical Machining: principle, description of equipment, Material removal rate, application.
- 1.7 Plasma Arc Machining – principle, description of equipment, Material removal rate, Process parameters, performance characterization, Applications.
- 1.8 Electron Beam Machining - principle, description of equipment, Material removal rate, Process parameters, performance characterization, Applications.

2.0 Plastic Processing:

- 2.1 Processing of plastics.
- 2.2 Moulding processes: Injection moulding, Compression moulding, Transfer moulding.
- 2.3 Extruding; Casting; Calendering.
- 2.4 Fabrication methods-Sheet forming, Blow moulding, Laminating plastics (sheets, rods & tubes), Reinforcing.
- 2.5 Applications of Plastics.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

WHAT WE ARE GOING TO COVER IN AMP....?

3.0 Additive Manufacturing Process:

- 3.1 Introduction, Need for Additive Manufacturing
- 3.2 Fundamentals of Additive Manufacturing, AM Process Chain
- 3.3 Advantages and Limitations of AM, Commonly used Terms
- 3.4 Classification of AM process, Fundamental Automated Processes, Distinction between AM and CNC, other related technologies.
- 3.5 Application –Application in Design, Aerospace Industry, Automotive Industry, Jewelry Industry, Arts and Architecture. RP Medical and Bioengineering Applications.
- 3.6 Web Based Rapid Prototyping Systems.
- 3.7 Concept of Flexible manufacturing process, concurrent engineering, production tools like capstan and turret lathes, rapid prototyping processes.

4.0 Special Purpose Machines (SPM):


- 4.1 Concept, General elements of SPM, Productivity improvement by SPM, Principles of SPM design.

5.0 Maintenance of Machine Tools:

- 5.1 Types of maintenance, Repair cycle analysis, Repair complexity, Maintenance manual, Maintenance records, Housekeeping. Introduction to Total Productive Maintenance (TPM)

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

**CHAPTER-01:
MODERN MACHINING
PROCESSES**




By
**Dr. Biswajit Parida, Lecturer,
Mechanical Engg. Department,
Govt. Polytechnic Kendrapara**

Chapter-01: Modern Machining Processes

MACHINING

Traditional Machining

Traditional, also termed **conventional machining** processes remove material in the **form of chips** by **applying forces** on the work material with a wedge-shaped cutting tool that is harder than the work material under machining condition.



Limitations

- In conventional machining, metal is removed by chip formation which is an **expensive and difficult** process.
- Chips produced during this process are **unwanted by-products** and removal of these chips and their **disposal and recycling** is a very tedious procedure, involving energy and money.
- Very **large cutting forces** are involved in this process, so proper holding of the workpiece is most important.
- Due to the large cutting forces and **large amount of heat** generated between the tool and the workpiece interface, **undesirable deformation and residual stresses** are developed in the workpiece.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

Chapter-01: Modern Machining Processes

MACHINING

Non-Traditional Machining

Non-Traditional/Unconventional machining is defined as a group of processes that remove excess material by various techniques involving mechanical, thermal, electrical or chemical energy or combinations of these energies but **do not use a sharp cutting tools**.

<https://www.youtube.com/watch?v=Vw-cUiBLuHw>

Merits

- It increases productivity
- It reduces number of rejected components
- Close tolerance is possible
- The tool material need not be harder than workpiece material as in conventional machining
- Harder and difficult to machine materials can be machined by this process
- The machined surface does not have any residual stresses.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ULTRASONIC MACHINING (CONTD...)

Tool Holder or Horn

- The tool holder holds and connects the tool to the transducer.
- It virtually transmits the energy and in some cases, amplifies the amplitude of vibration.
- Material of tool should have good acoustic properties, high resistance to fatigue cracking.
- Due measures should be taken to avoid ultrasonic welding between transducer and tool holder.
- Commonly used tool holders are Monel, Titanium, Stainless Steel.
- Tool holders are more expensive, demand higher operating cost.

Tool

- Tools are made of relatively ductile materials like Brass, Stainless steel or Mild steel so that Tool wear rate (TWR) can be minimized.
- The value of ratio of TWR and MRR depends on kind of abrasive, work material and tool materials.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ULTRASONIC MACHINING (CONTD...)

Applications

- Machining of cavities in **electrically non-conductive** ceramics
- Used to machine **fragile components** in which otherwise the scrap rate is high
- Used for **multistep processing** for fabricating silicon nitride (Si3N4) turbine blades
- **Large** number of holes of **small diameter**. (930 holes with 0.32mm has been reported (Benedict, 1973) using hypodermic needles)
- Used for machining **hard, brittle** metallic alloys, semiconductors, glass, ceramics, carbides etc.
- Used for machining round, square, **irregular** shaped holes and surface impressions.
- USM enables a dentist to drill a hole of any shape on teeth without any pain
- Ferrites and steel parts, precision mineral stones can be machined using USM
- USM can be used to cut industrial **diamonds**
- USM is used for grinding Quartz, Glass, ceramics



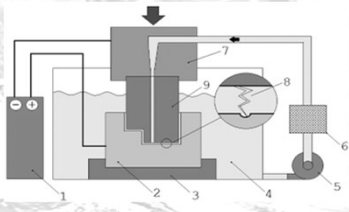
Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRIC DISCHARGE MACHINING

Electrical Discharge machining is the process of metal removal from the work surface due to an erosion of metal caused by electric spark discharge between the two electrodes tool (cathode) and the work (Anode).

Process Principle

- The workpiece is fixed in the dielectric container using a fixture.
- The tool is fed up by the Servo Feed Unit which can move downward in a vertical direction.

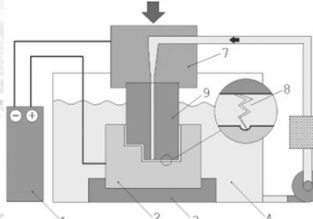


1. A pulse generator (DC). 2 Workpiece. 3 Fixture. 4 dielectric fluid. 5 Pump. 6 Filter. 7 Tool holder. 8 Spark. 9 Tool.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRIC DISCHARGE MACHINING (CONTD...)

- The tool and workpiece are separated using dielectric fluid and an optimum gap is maintained between them.
- As stated above, that at normal conditions, the dielectric fluid acts as an insulator. In this sense, no electrical conductivity is taking place.
- But, by an increase of high pressure, the dielectric fluid ionizes into Negative and Positive Ions.

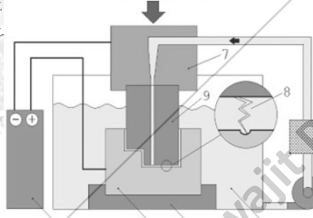


1. A pulse generator (DC). 2 Workpiece. 3 Fixture. 4 dielectric fluid. 5 Pump. 6 Filter. 7 Tool holder. 8 Spark. 9 Tool.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRIC DISCHARGE MACHINING (CONTD...)

- The positive ions are attracted to negative ions and negative ions are attracted to positive ions and thereby the heat is generated.
- When positive and negative ions collide with each other then the spark is generated between the tool and workpiece which can remove the material from the surface of the workpiece.
- <https://www>
- <https://www>



1. A pulse generator (DC). 2 Workpiece. 3 Fixture. 4 dielectric fluid. 5 Pump. 6 Filter. 7 Tool holder. 8 Spark. 9 Tool.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRIC DISCHARGE MACHINING (CONTD...)

Equipments

- a) **DC Pulse Generator:**
This is a power source for the machining operation. DC power is supplied.
- b) **Voltmeter:**
We know that the voltmeter measures the voltage. Here in this device the same for use.
- c) **Ammeter:**
It measures or checks the flow of the current. If Ammeter is not connected we might not see or check current is flowing or not.
- d) **Tool:**
 - A tool is connected to negative sources of power whereas the workpiece is connected to positive sources. From the filter, the fluid comes to the tool for the operation.
 - When Power supply will increase, between tools workpiece the spark generates and then machining starts.
- e) **Dielectric fluid:**
 - It has a property like insulation and we know what insulation means?
 - Insulation means no current flows from one to another.
 - The Dielectric fluid will be ionized in the form of ion which will help between the tool and workpiece again when power supply stops the fluid comes to its initial position.
 - Dielectric fluids used in EDM process are hydrocarbon oils, kerosene and deionised water.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRIC DISCHARGE MACHINING (CONTD...)

The functions of the dielectric fluid are to:

- o Act as an insulator between the tool and the workpiece.
- o Act as coolant.
- o Act as a flushing medium for the removal of the chips.
- o Kerosene acts as a Dielectric Fluid in Electrical Discharge Machining process.
- o The Optimum gap between the tool and the workpiece is 0.03 mm.
- o Voltage - 70V

f) Pump:

The pump is connected there for sending the fluid to the filter. This works like flowing the fluid from one source to another one.

g) Filter:

- o As the name indicates the filter, is used to filtrate the different particles like:
- o In this device, if there is dust particles presence the filter will remove that particle and then it will send to the tool for the operation.

h) Servo controlled feed:

The constant feed will be supplied by the servo for the operation.

i) Fixture:

To hold the table.

j) Table:

To hold the workpiece.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRIC DISCHARGE MACHINING (CONTD...)

Process Parameters

- a) Voltage
- b) Current
- c) Spark Gap
- d) Polarity
- e) Dielectric medium
- f) External flushing

Output Characteristics

- o The process can be used to machine any work material if it is electrically conductive
- o Material removal depends on mainly thermal properties of the work material rather than its strength, hardness etc.
- o In EDM there is a physical tool and geometry of the tool is the positive impression of the hole or geometric feature machined.
- o The tool has to be electrically conductive as well.
- o The tool wear once again depends on the thermal properties of the tool material.
- o However rapid heating and cooling and local high temperature leads to surface hardening which may be desirable in some applications.
- o Though there is a possibility of taper cut and overcut in EDM, they can be controlled and compensated..

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRIC DISCHARGE MACHINING (CONTD...)

Application

- o *Drilling for micro holes in the nozzle.*
- o *his is used in thread cutting.*
- o *Used in wire cutting.*
- o *Rotary form cutting.*
- o *Helical profile milling.*
- o *Curved hole drilling.*
- o *Engraving operation on harder materials.*
- o *Cutting off operation.*
- o *The shaping of alloy steel and tungsten carbide dies*

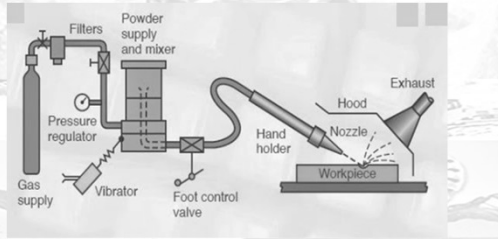
Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ABRASIVE JET MACHINING

Abrasive jet machining is the process of impinging the high-speed stream of abrasive particles by high-pressure gas or air on the work surface through a nozzle and metal removal occurs due to erosion caused by high-speed abrasive particles.

Process Principle

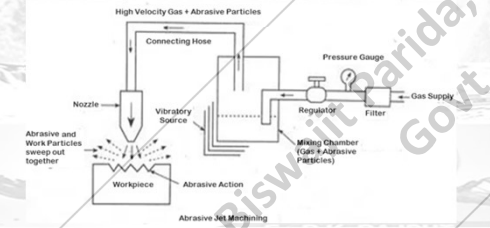
- It consists of a mixing chamber, gas filter, pressure gauge, regulator, and the nozzle.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ABRASIVE JET MACHINING (CONTD...)

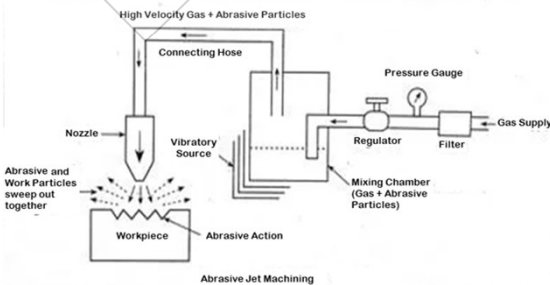
- The filtered gas at a pressure of 2 to 8 kgf/cm² is supplied to the mixing chamber containing the abrasive powder and vibrating at 50 Hz, where it mixes with abrasive particles and then enters into the connecting hose. <https://www.youtube.com/watch?v=EqpdPc7urGQ>
- The abrasive and gas mixture comes out from the nozzle at a high velocity ranging from 150 to 300 meters/minute and impinges over the work surface causing abrasion action by repeated impacts and the material is removed by the erosion.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ABRASIVE JET MACHINING (CONTD...)

- Abrasive power feed rate can be controlled by the amplitude of vibration of the mixing chamber.
- <https://www.youtube.com/watch?v=Vr1CH1FZSJM>
- A pressure regulator controls the gas flow and pressure.
- To control the size and shape of the cut, either workpiece or nozzle is



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

LASER BEAM MACHINING (CONTD...)

How Laser is Produced

- o A high voltage power supply is applied across the flash tube.
- o A capacitor is used to operate the flash tube at pulse mode.
- o As the flash is produced by the flash tube, it emits light photons that contain energy.
- o This light photons emitted by the flash tube is absorbed by the ruby crystal.
- o The photons absorbed by the atoms of the ruby crystals excite the electrons to the high energy level and population inversion (situation when the number of excited electrons is greater than the ground state electrons) is attained.
- o After short duration, this excited electrons jumps back to its ground state and emits a light photon. This emission of photon is called **spontaneous emission**.
- o The emitted photon stimulates the excited electrons and they starts to return to the ground state by emitting two photons.
- o In this way two light photons are produced by utilizing a single photon. Here the amplification (increase) of light takes place by stimulated emission of radiation.
- o Concentration of the light photon increases and it forms a laser beam.
- o 100 % reflecting mirror bounces back the photons into the crystal.
- o Partially reflecting mirror reflects some of the photons back to the crystal and some of it escapes out and forms a highly concentrated laser beam.
- o A lens is used to focus the laser beam to a desired location.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

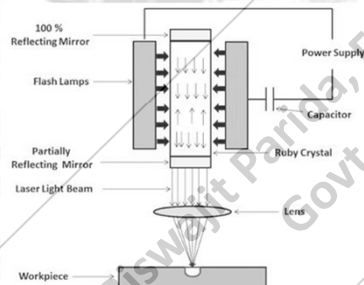
LASER BEAM MACHINING (CONTD...)

a) Power Supply

- o The electric current or power is supplied to the system.
- o A high voltage power system is used in laser beam machining.
- o There is a high voltage supply so that pulses can be initiated easily.

b) Capacitor:

- During the major portion of the cycle, a capacitor bank charges and releases the energy during the flashing process.
- The capacitor is used for the pulsed mode for charging and discharging.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

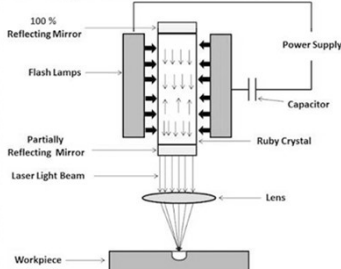
LASER BEAM MACHINING (CONTD...)

c) Flash Lamps:

- o It is the electric arc lamp that is used to produce extremely intense production of white light which is a coherent high-intensity beam.
- o It is filled with gases that ionize to form great energy that will melt and vaporizes the material of the workpiece.

d) Reflecting Mirror:

- o Reflecting Mirror are two main types of internal and external.
- o Internal mirrors also called a resonator that is used to generate maintain and amplify the laser beam.
- o It is used to direct the laser beam towards the workpiece.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

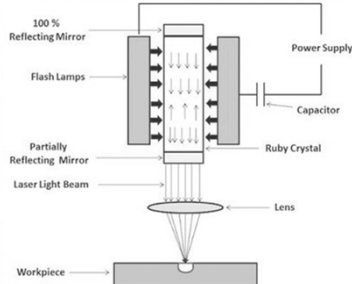
LASER BEAM MACHINING (CONTD...)

e) Laser Light Beam:

It is the beam of radiation produced by the laser through the process of optical amplification based on the coherence of light created by the bombarding of active material.

f) Ruby Crystal:

- o Ruby laser produces a series of coherent pulses which is deep red in color.
- o It is a three-level solid-state laser.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

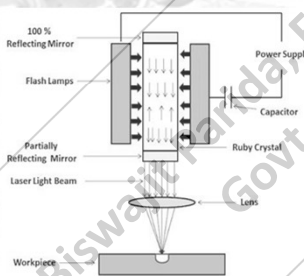
LASER BEAM MACHINING (CONTD...)

g) Lens:

- o Lenses are used to focus the laser beam onto the workpiece.
- o First laser light will enter into the expanding lens and then into the collimating lens which makes the light rays parallel and the expanding lens expands the laser beams to the desired size.

h) Workpiece:

- o The workpiece can be metallic or non-metallic.
- o In this machining process any material can be machined

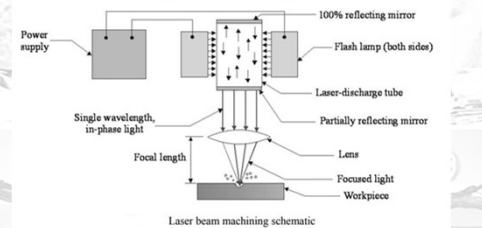


Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

LASER BEAM MACHINING (CONTD...)

Process Principle

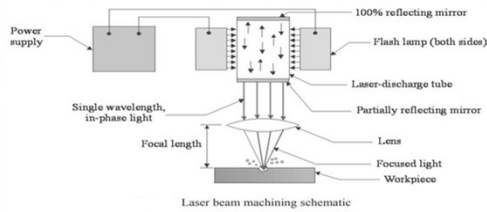
- o Laser Machining is based on the LASER and conversion or process of Electric Energy into Light Energy and into Thermal Energy.
- o Negatively charged electrons in the atomic model rotate around the positively charged nucleus in orbital paths.
- o It depends on the number of electrons, electron structure, neighboring atoms, and the electromagnetic field.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

LASER BEAM MACHINING (CONTD...)

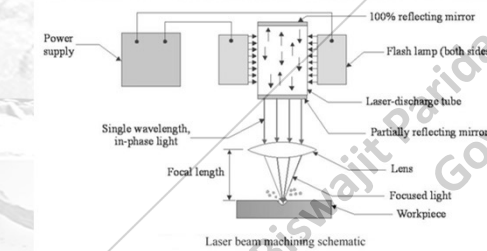
- Every orbital of electrons is associated with different energy levels.
- An atom is considered to be at ground level at absolute zero temperature at this, all electrons occupy their lowest potential energy.
- The electrons at the ground state move to a higher state of energy by absorbing energy like an increase in electronic vibration at elevated temperatures. <https://www.youtube.com/watch?v=s3gYgMjKkMc>
<https://www.youtube.com/watch?v=tTnXn498F90>
<https://www.youtube.com/watch?v=69WtdHAg3g0>



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

LASER BEAM MACHINING (CONTD...)

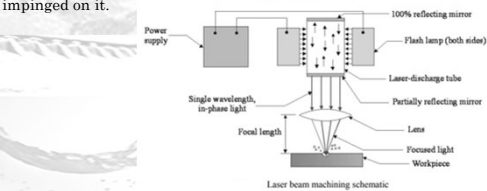
- High voltage is applied at the ends that leads to discharge and gas plasma will be formed.
- The laser has one 100% reflector and the other one is partial reflector. 100% the reflector directs the photons inside the gas tube and the partial reflector allows only some part of the laser beam that will be used for processing of materials.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

LASER BEAM MACHINING (CONTD...)

- The laser beam produced is focused on the workpiece that has to be machined.
- When the laser strikes the workpiece, the thermal energy impinges on the workpiece. This will heat, then melt, vaporize, and finally, the material will be removed from the workpiece.
- So laser machining is a thermal material removal process that uses a coherent beam of light to machine the workpiece very precisely.
- In the laser machining process, MRR (Material Removal Rate) depends on the wavelength used because it will decide the amount of energy impinging on it.

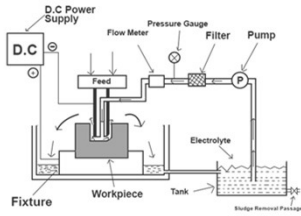


Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRO CHEMICAL MACHING (CONTD...)

Process Principle:

- o The electrolyte is supplied to the system of anode and cathode i.e workpiece and tool using the pump.
- o In between the pump and the system a filter is placed which is used to filter the electrolyte before reaching the system.
- o After passing through the filter and flow regulator, the electrolyte reaches the space between the workpiece and the tool.

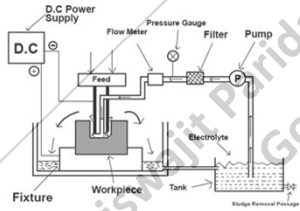


Electrochemical Machining

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRO CHEMICAL MACHING (CONTD...)

- o As the electrolyte reaches the gap between anode and cathode, electrical contact is established between the anode and the cathode.
- o After the electrical contact is established, the positive ions start flowing from the workpiece towards the tool and negative ions start flowing from the tool towards the workpiece.
- o When the positive ions flow from the workpiece towards the tool, the electrolyte carries away the positive ions with it and stops it from reaching the tool.

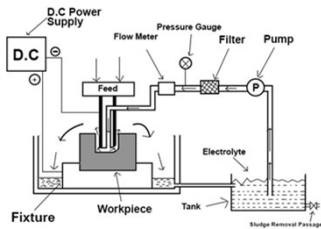


Electrochemical Machining

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRO CHEMICAL MACHING (CONTD...)

- o So the materials start removing from the workpiece as positive ions from the workpiece are dissolve and carried away by electrolyte and materials are also removed due to the striking power of the negative ions coming from the tool. <https://www.youtube.com/watch?v=b1nX7WVIN7U>
- o This material removal process from the workpiece is continued until a cavity is created in the workpiece which is a replica of the tool used in this process.



Electrochemical Machining

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRON BEAM MACHINING (CONTD...)

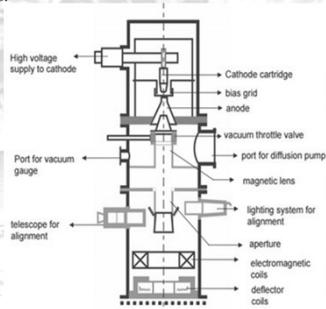
Equipments

Electron gun:

- It generates the beam of an electron which is further used to remove material from the workpiece.
- This electron gun contains tungsten or tantalum filament which acts as cathode.
- And then a high quality electron beam is made to pass through the electromagnetic lens and deflector coils.

Bias Grid:

This bias grid is used to control the flow of electrons which is generated by an electron gun.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRON BEAM MACHINING (CONTD...)

Anode:

It is used to accelerate the electrons to very high velocity.

Electromagnetic Lens:

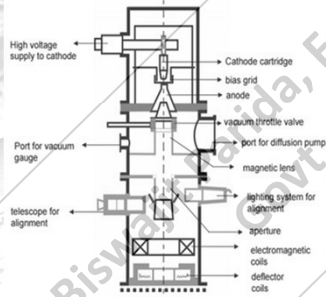
The electromagnetic lens is finally used to focus the electrons beam on the workpiece

Magnetic Lens:

The main function of this magnetic lens is the same as that of an optical lens that is to concentrate the beam of electrons.

Aperture:

This aperture is used to capture the stray electrons so that only focused and concentrated beam of electrons beam passes through the aperture.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRON BEAM MACHINING (CONTD...)

Diffusion Pump:

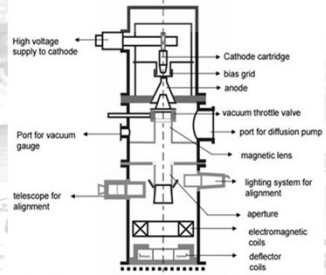
- The diffusion pump is used for maintaining the vacuum within the electron beam chamber.
- The level of vacuum in this chamber is from 10^{-4} to 10^{-6} torque.

Electromagnetic Lens:

The electromagnetic lens is used to focus the electrons beam on the workpiece.

Deflector Coil:

This deflector coil is used to deflect the electron beam by a small amount in case a proper hole is not being created by an electron beam.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

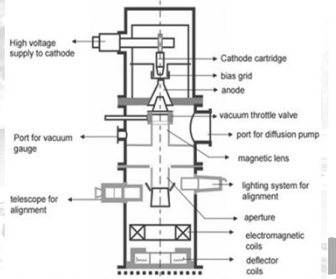
ELECTRON BEAM MACHINING (CONTD...)

Optical Viewing System:

- Optical Viewing System is used by the operator to check whether the process is under control or not.
- This optical viewing system consists of a telescope and illumination system.

Slotted Disc:

- This slotted disc is used to remove the vapour and fumes created while machining the workpiece using electron beam machining so that this vapour and fumes do not obstruct the optical windows if the electron beam gun.
- This slotted disc is synchronized with the electron beam.

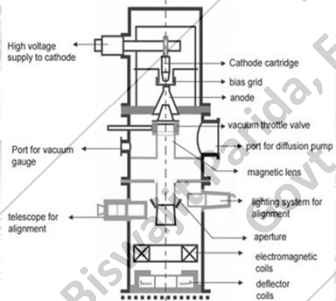


Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRON BEAM MACHINING (CONTD...)

Process Principle

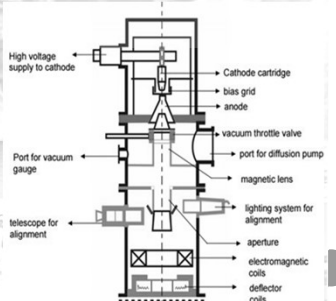
- In EBM, first the electron is generated by the cathode and an annular biased grid does not allow the electron to diverge.
- From the annular bias grid, the electron produced by the cathode is attracted towards the anode and gradually its velocity increases.
- As the electron beam leaves the anode section, its velocity reaches to half of the velocity of the light.
- After that, it passes to the series of magnetic lenses.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

ELECTRON BEAM MACHINING (CONTD...)

- The magnetic lenses allow only convergent beam to pass through it and capture the divergent beam from the fringes.
- And then a high quality electron beam is made to pass through the electromagnetic lens and deflector coils.
- The electromagnetic lens focuses the electron beam to the desired spot on the workpiece.
- The deflector carefully guides the beam to the desired locations and improves the shape hole.




Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

THANK YOU



By
Dr. Biswajit Parida, Lecturer,
Mechanical Engg. Department,
Govt. Polytechnic Kendrapara

CHAPTER-02: PLASTIC PROCESSING



By
Dr. Biswajit Parida, Lecturer,
Mechanical Engg. Department,
Govt. Polytechnic Kendrapara

Chapter-02: Plastic Processing

PLASTICS

If you are going to understand plastics you are going to have to learn a lot of new terms. Some of these terms are not particularly easy to pronounce but you will learn them with practice.

Try saying 'oxybenzylmethyleneglycolanhydride'. Perhaps it is easier to call this plastic by its other name, which is Bakelite.

The word plastic itself comes from the Greek word PLASTICOS, which means to be able to be shaped or moulded by heat. As we will see, shaping plastics by using heat is a basic part of nearly all plastics manufacturing processes.

These are moldable organic resins and consists of **large molecules**.

Plastic is the general common term for a wide range of synthetic or semi synthetic **organic amorphous solid materials** suitable for the manufacture of industrial products.

Plastics are typically polymers of **high molecular weight**, and may contain other substances to **improve performance** and/or **reduce costs**.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

PROCESSING OF PLASTICS

- o Plastic processing can be defined as the process of **converting** the plastics **raw material** into **semi-finished** products.
- o Ex: Buckets, Automobile Parts, Crates, Tanks, Pipes, Bottles, Carry bags, Ropes, Profiles etc.

Processability:

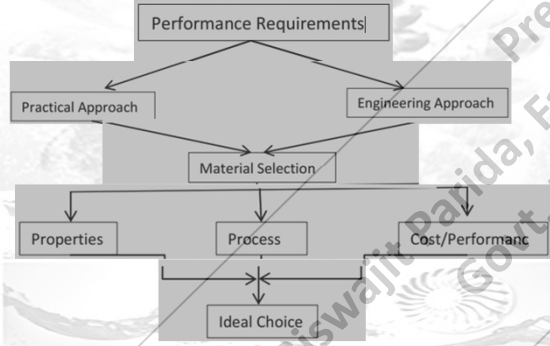
- o Processability is generally the **ease or difficulty** with which a plastic can be handled during its fabrication into film, moulded products, pipe, profile etc.
- o A plastic with good processability possesses the properties necessary to make it **easy to process** the plastics into desired shapes.
- o The main characteristics or the properties which determine a plastic's **processability** are molecular weight, uniformity, additive type, content and plastic feed rates.

Classification of processing methods

- 1) *Primary Processing Methods:* Injection, Extrusion, Blow, Compression and transfer moulding.
- 2) *Secondary Processing Methods:* Roto, Thermoforming, Coating, Casting, Fabrication and Calendaring etc.
- 3) *Tertiary Processing Methods:* Cutting, Drilling, Welding and Bending etc.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

PROCESSING OF PLASTICS Fundamentals of Processing



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

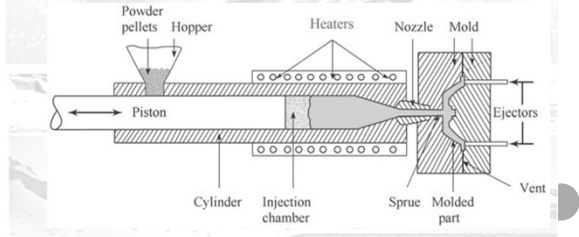
PROCESSING OF PLASTICS Plastic Processes

Process	Characteristics
Extrusion	Long, uniform, solid or hollow complex cross-sections; high production rates; low tooling costs; wide tolerances.
Injection molding	Complex shapes of various sizes, eliminating assembly; high production rates; costly tooling; good dimensional accuracy.
Structural foam molding	Large parts with high stiffness-to-weight ratio; less expensive tooling than in injection molding; low production rates.
Blow molding	Hollow thin-walled parts of various sizes; high production rates and low cost for making containers.
Rotational molding	Large hollow shapes of relatively simple shape; low tooling cost; low production rates.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INJECTION MOULDING (CONTD...)

- o The cooling system is also used to maintain the temperature of the injection chamber.
- o The molten plastic material is then injected into the mold cavity through a nozzle.
- o The molded part is cooled quickly in the mold. Thereafter, the final plastic part is removed from the mold cavity.
- o The process cycle for injection molding is very short, typically between 2 to 60 seconds.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INJECTION MOULDING (CONTD...)

The complete injection molding process is divided into four stages: clamping, injection, cooling and ejection.

Classification of processing methods

- 1) **Clamping:** The two halves of the mold must be tightly closed, before the molten plastic material is injected into the mold. One half of the mold is attached to the injection unit (nozzle) and other half is allowed to slide on the guide ways. .
- 2) **Injection:** During this process, the plastic material is melted by the application of heat and forwarded through the piston towards the nozzle and finally into the mold.
- 3) **Cooling:** The injected molten plastic begins to cool as soon as it comes in contact with the mold surfaces and solidify into the desired shape of the product..
- 4) **Ejection:** The molded part, which is attached to the rear half of the mold has to be ejected from the mold. A mold release agent should be sprayed onto the mold surfaces prior to injection of the material. Once the molded part is ejected, the mold will be closed for the next shot to be injected.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INJECTION MOULDING (CONTD...)

Materials Used

The injection molding process can be used to process materials such as Acetal, Acrylic, Acrylonitrile Butadiene Styrene (ABS), Cellulose Acetate, Polyamide (Nylon), Polycarbonate, Polyester, Polyether Sulphone (PS), Polyetheretherketone (PEEK), Polyetherimide, Polyethylene, Polyphenylene Oxide, Polyphenylene Sulphide (PPS), Polypropylene (PP), Polyvinyl Chloride (PVC), and Elastomers.

Advantages

- o Higher production rate
- o Close tolerances on small intricate parts
- o Minimum wastage of material
- o Complex geometry can be easily produced

Disadvantages

- o Higher cost
- o High setup cost
- o Large undercuts can't be formed

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INJECTION MOULDING (CONTD...)

Applications

- o This process can be used to manufacture thin walled plastic housing products which require many ribs and bosses on the interior surfaces.
- o These housings are used in a variety of products including household appliances, electronics, and automotive dashboards.
- o Other common thin walled products include different types of open containers, such as buckets.
- o It is also used to produce several daily use items such as toothbrushes or small plastic toys, many medical devices, including valves and syringes



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MOULDING PROCESSES

Compression Molding

- o Compression molding process is one of the low cost molding methods as compared to injection molding and transfer molding.
- o It is a high pressure forming process in which the molten plastic material is squeezed directly into a mould cavity by the application of heat and pressure to conform to the shape of the mold. The schematic of compression molding process is shown in figure.

<https://www.youtube.com/watch?v=pOGpXZ-UMfo>



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

COMPRESSION MOULDING (CONTD...)

Working Principle:

- o In this process, the predetermined amount of charge of plastic material is placed in the lower half of a heated mold cavity.
- o The plastic material is preheated before inserting into the mold cavity to reduce the temperature difference between the material and the mold cavity. <https://www.youtube.com/watch?v=VscL0Uw7GRI>
- o The mold cavity is closed with upper movable half mold and pressure is applied to compress the material in to the mold cavity.

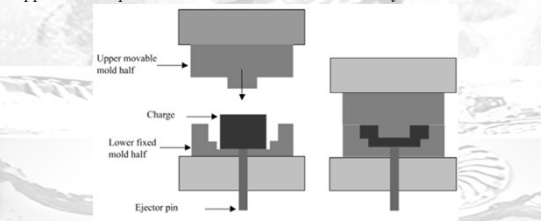


Figure 2 Compression molding setup

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

COMPRESSION MOULDING (CONTD...)

- This causes the raw material to be squeezed out to take the shape of the mold cavity. <https://www.youtube.com/watch?v=yuH9NNz-Gc8>
- The application of the heat and pressure increases the polymerization process. Hence, plastic material is cured.
- The temperature of the mold cavity is usually in the range of 130-200°C.
- Generally, the hydraulic pressure is required in the range of 7-25 MPa to squeeze the plastic material.
- The mold cavity is then cooled for sometimes so that molded plastic part gets solidified.
- The mould cavity is then opened and the final product is taken out with the help of ejector pin.
- The molded part may require the finishing operation.

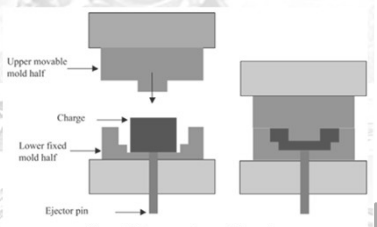


Figure 2 Compression molding setup

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

COMPRESSION MOULDING (CONTD...)

Materials Used

Different types of thermosets and thermoplastics materials can be used for compression molding process. For example: Epoxies, Urea formaldehyde (UF), Melamine formaldehyde (MF), Phenolics (PF), Polyester, Polyamide (PI), Polyamide-imide (PAI), Polyphenylene sulfide (PPS), Polyetheretherketone (PEEK), Torlon, and Vespel..

Advantages

- Low initial setup costs and fast setup time
- Heavy plastic parts can be molded
- Complex intricate parts can be made
- Good surface finish of the molded parts
- Wastes relatively little material as compared with other methods
- The molding process is cheaper as compared to injection molding

Disadvantages

- Low production rate
- Limited largely to flat or moderately curved parts with no undercuts

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

COMPRESSION MOULDING (CONTD...)

Applications

- is used for manufacturing electrical and electronic equipments (electrical wall receptacles, circuit breakers, television cabinets, radio cases, electric plugs and sockets, electrical switch, fuse box, electricity meter housing), brush and mirror handles, trays, cookware knobs, clothes dryer blower fan blade, cooking utensils, milling machine adjustment wheel, water testing equipment buttons, dinnerware, appliance housings, aircraft main power terminal housing, pot handles, dinnerware plates, automotive parts (such as hoods, fenders, scoops, spoilers, gears), flatware, buttons, buckles, and large container.
- Compression molding is also suitable for heavy molding applications.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

TRANSFER MOULDING (CONTD...)

Materials Used

Generally, thermoset plastics (such as epoxy, polyester, phenol-formaldehyde, vinyl ester, silicone) are processed by transfer molding process, but certain thermoplastic materials can also be processed.

Advantages

- o Fast setup time and lower setup costs
- o Low maintenance cost
- o Plastic parts with metal inserts can be made
- o Design flexibility
- o Dimensionally stable
- o Uniform thickness of parts
- o Large production rate

Disadvantages

- o Wastage of material
- o Production rate lower than injection molding
- o Air can be trapped in the mold

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

TRANSFER MOULDING (CONTD...)

Applications

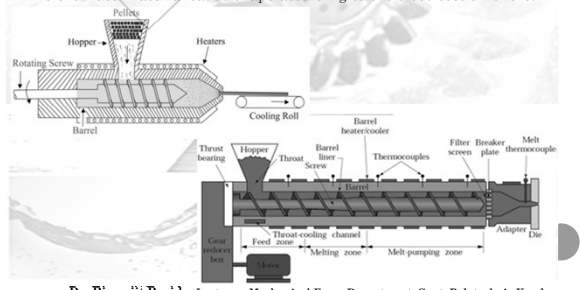
- o This process is widely used to encapsulate items such as integrated circuits, plugs, connectors, pins, coils, and studs.
- o It is suitable for molding with ceramic or metallic inserts which are placed in the mold cavity.
- o When the heated polymer fills the mold it forms bonding with the insert surface.
- o Transfer molding is also used for manufacturing radio and television cabinets and car body shells.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

EXTRUDING

- o Extrusion is a **high volume** manufacturing process.
- o The plastic material is melted with the **application of heat** and extruded through die into a desired shape.
- o A cylindrical rotating screw is placed inside the barrel which **forces out** molten plastic material through a die.
- o The extruded material takes shape according to the cross-section of die.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

EXTRUDING (CONTD...)

Working Principle

- o In this process, plastic material in the form of pellets or granules is gravity fed from a top mounted hopper into the barrel.
- o Additives such as colorants and ultraviolet inhibitors (liquid or pellet form) can be mixed in the hopper.
- o The plastic material enters through the feed throat and comes into contact with the rotating screw.
- o The rotating screw pushes the plastic beads forward into the barrel.
- o The barrel is heated using the heating elements up to the melting temperature of the plastic.

Extrusion Process Parameters

There are five important process parameters to be considered before extrusion process:

- o Melting temperature of plastic
- o Speed of the screw
- o Extrusion pressure required
- o Types of die used
- o Cooling medium

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

EXTRUDING (CONTD...)

Screw Design:

- o The design of screw is important for plastic processing.
- o It has mainly three different functions: namely, feeding mechanism; uniform melting and mixing of plastic and finally it generates the pressure to push the molten material through die.
- o A screw length (L) is referenced to its diameter (D) as L/D ratio. Generally, L/D ratio is used as 24:1, but for more mixing and output, it may increase up to 32:1.

There are three possible zones in a screw length i.e. feed zone, melting zone, and metering zone.

- (a) **Feed zone:** In this zone, the resin is inserted from hopper into the barrel, and the channel depth is constant.
- (b) **Melting zone:** The plastic material is melted and the channel depth gets progressively smaller. It is also called the transition or compression zone.
- (c) **Metering zone:** The molten plastic is mixed at uniform temperature and pressure and forwarded through the die.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

EXTRUDING (CONTD...)

Types of Extrusion Process

The extrusion process is broadly classified into seven different types depending upon the specific applications.

(a) Sheet/Film Extrusion

- o In this extrusion process, the molten plastic material is extruded through a flat die.
- o The cooling rolls are used to determine the thickness of sheet/film and its surface texture.
- o The thickness of sheet can be obtained in the range of 0.2 to 15 mm.
- o Generally, polystyrene plastic is used as a raw material in the sheet extrusion process.

(b) Blown Film Extrusion

- o In the blown film process, the die is like a vertical cylinder with a circular profile.
- o The molten plastic is pulled upwards from the die by a pair of nip rollers.
- o The compressed air is used to inflating the tube.
- o Around the die, an air-ring is fitted. The purpose of an air-ring is to cool the film as it travel upwards.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

EXTRUDING (CONTD...)

Materials Used

The different types of plastic materials that can be used in extrusion process are Polyethylene, Polypropylene (PP), Acetal, Acrylic, Nylon (Polyamides), Polystyrene, Polyvinyl Chloride (PVC), Acrylonitrile Butadiene Styrene (ABS) and Polycarbonate.

Applications

The extrusion process is used for manufacturing rods, plates and tubes, wire and cable coating, hose liners, hose mandrels, filaments, sheet, multilayer film, medical packaging and food packaging, etc.

Advantages

- o High production volumes
- o Relatively low cost as compared with other molding process
- o Design flexibility
- o Short lead times
- o Coating of wire can be done to achieves desired properties
- o Continuous part can be produced

Disadvantages:

- o Limited complexity of parts
- o Uniform cross section can only be produced

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

CASTING

- o Some thermoplastics (such as nylons and acrylics) and thermosetting plastics (epoxies, phenolics, polyurethanes, and polyester) can be cast into a variety of shapes using either rigid or flexible molds (Fig. 19.19).
- o Compared with other methods of processing plastics, casting is a slow, but simple and inexpensive, process.
- o However, the polymer must have sufficiently low viscosity in order to flow easily into the mold.
- o Typical parts cast are gears (especially nylon), bearings, wheels, thick sheets, lenses, and components requiring resistance to abrasive wear.
- o In the basic conventional casting of thermoplastics, a mixture of monomer, catalyst, and various additives (activators) is heated to above its melting point, and poured into the mold.
- o The part is formed after polymerization takes place at ambient pressure. Degassing may be necessary for product integrity.
- o Intricate shapes can be produced using flexible molds, which are then peeled off (in a manner similar to using rubber gloves) and reused. As with metals, thermoplastics may be cast continuously, with the polymer carried over continuous stainless-steel belts and polymerized by external heat.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

CASTING (CONTD...)

Centrifugal Casting.

Calendering is a process for producing sheet and film stock out of rubber or rubbery thermoplastics such as plasticized PVC. This process, similar to centrifugal metal casting, is used with thermoplastics, thermosets, and reinforced plastics with short fibers.

Potting and Encapsulation.

- o As a variation of casting that is important, particularly to the electrical and electronics industry, potting and encapsulation involve casting the plastic material (typically a liquid resin, such as epoxy) around an electrical component (such as a transformer) to embed it in the plastic.
- o Potting is carried out in a housing or case, which becomes an integral part of the component and fixes it in position.
- o In encapsulation, the component is coated with a layer of the plastic, surrounding it completely and then solidifying.
- o In both of these processes, the plastic material can serve as a dielectric (nonconductor); consequently, it must be free of moisture and porosity, which would require processing in a vacuum.
- o Mold materials may be metal, glass, or various polymers.
- o Small structural members (such as hooks, studs, and similar parts) may be encapsulated partially by dipping them in a hot thermoplastic using polymers of various colors.

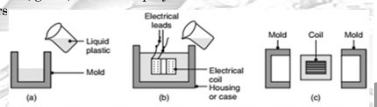
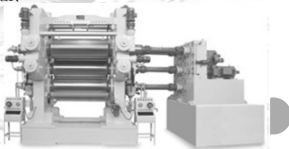
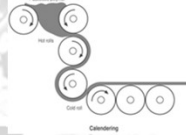


FIGURE 19.19 Schematic illustration of (a) casting, (b) potting, and (c) encapsulation processes for plastics and electrical assemblies, where the surrounding plastic serves as a dielectric.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

CALENDERING

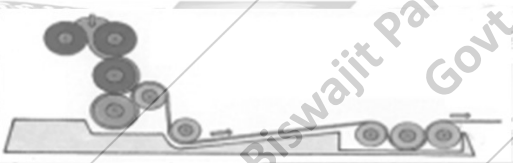
- o Calendering is used to produce plastic sheeting and products such as floor tiles, coated fabrics and coverings for car interiors.
- o Fused thermoplastic is extruded on to heated rotating rollers that squeeze the material into a continuous sheet or film.
- o The film is cooled by jets of air or water, before being cut to suitable lengths or loaded onto rolls.
- o Dough-consistent thermoplastic mass is formed into a sheet of uniform thickness by passing it through and over a series of heated or cooled rolls.
- o Calenders are also utilized to apply plastic covering to the backs of other materials.
- o Types of Products: Luggage, Rain wear, Tank lining, Credit cards, Trays, Helmet liner etc.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

CALENDERING (CONTD...)

- o A PVC blend is laminated through a series of cylinders and transformed into a continuous sheet, which is cooled and then rolled up.
- o The sheets may be mono-oriented during the process.
- o It is a finishing process used on cloth where fabric is folded in half and passed under rollers at high temperatures and pressures.
- o In preparation for calendaring, the fabric is folded lengthwise with the front side, or face, inside, and stitched together along the edges.
- o The fabric is then run through rollers that polish the surface and make the fabric smoother and more lustrous.
- o High temperatures and pressure are used as well. Fabrics that go through the calendaring process feel thin, glossy and papery.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

SHEET-FORMING

Thermoforming

- o It is a plastic manufacturing process in which the thermoplastic sheets are formed with the application of heat and pressure in a mold.
- o The thermoplastic sheet is held horizontally over a mold surface and clamped with a holding device.
- o The sheet is heated up to predetermined temperature using a heating element called heater.
- o The thermostat is used to maintain the temperature of the heater.
- o When the temperature becomes substantially high in the mold, the temperature is controlled by adjusting the heater and providing the cooling air.
- o The thermoplastic sheet softens with the application of heat and is pressed into or stretched over the mold surface by application of air pressure or by any other means.
- o The softened sheet conforms to the mold shape and it is held in place until it cools.
- o The mold cavity is opened and the thermoformed part is released.
- o Some of the plastic materials require air cooling in order to make those rigid quickly, because plastic materials have low thermal conductivity.
- o The excess material is then trimmed out from the formed part and can be reground, mixed with unused plastic, and again reformed into thermoplastic sheets.
- o Thin sheet (up to 1.5 mm) and thick sheet (about 3 mm) can be formed easily

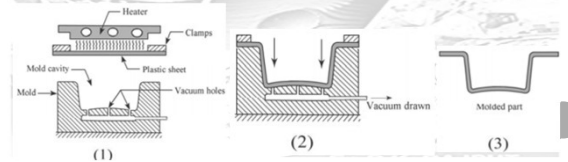
Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

THERMOFORMING (CONTD...)

There are mainly three different types of thermoforming process depending upon the pressure required.

(a) Vacuum Forming

- o In this process, the vacuum pressure is used to form the heated thermoplastic sheet into the desired shape.
- o The thermoplastic sheet is placed on the mold surface and fixed with the help of clamping unit.
- o The sheet is heated until it is softens and thereafter vacuum needs to be applied quickly.
- o A surge tank is used to quickly pull the air out between the mold cavity and the sheet.
- o When the vacuum is created, the sheet conforms to the shape of the mold cavity.
- o The formed part is cooled and then ejected from the mold cavity.

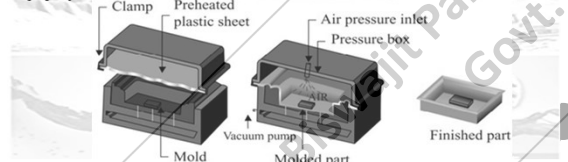


Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

THERMOFORMING (CONTD...)

(b) Pressure Forming

- o In this process, the air pressure required is much higher as compared to the vacuum forming.
- o The preheated plastic sheet is placed on the mold surface, and then air pressure is applied quickly above the sheet.
- o The high pressure is developed in between the softened sheet and the pressure box.
- o Due to high pressure, the preheated plastic sheet can be deformed into the mold cavity in a fraction of a second.
- o The formed sheet is held in the mold cavity for cooling for a few seconds.
- o The formed part thereby solidifies and is ejected from mold cavity.
- o Prototype parts can also be made using pressure forming process and papery.

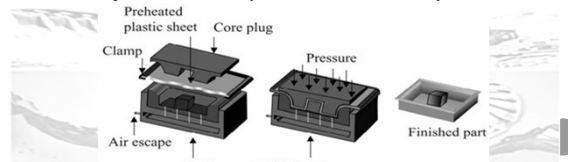


Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

THERMOFORMING (CONTD...)

(c) Matched die Forming

- o Matched die forming is also called mechanical forming.
- o In this process, mold consists of two parts i.e. die and punch as.
- o The thermoplastic sheet is heated with the application of heat until it softens.
- o The preheated sheet is placed into the mold surface (that is called die) and through punch pressure is applied on the hot sheet.
- o The air in between the die and softened sheet is evacuated by using vacuum pump, and therefore the thermoplastic sheet conforms to the mold shape.
- o The formed part is cooled and ejected from the mold cavity



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

THERMOFORMING (CONTD...)

Process Parameters

The important process parameters that are considered during the thermoforming process are

- o Heating Temperature,
- o Heating Time,
- o Vacuum Pressure,
- o Air Pressure,
- o Mechanical Pressure,
- o Cooling Time,
- o Ejection Mechanism.



Materials Used

The different types of thermoplastic materials which can be processed using thermoforming process are: Acrylic (PMMA), Acrylonitrile butadiene styrene (ABS), Cellulose acetate, Low density polyethylene (LDPE), High density polyethylene (HDPE), Polypropylene (PP), Polystyrene (PS), Polyvinyl chloride (PVC)

Applications

Thermoforming process is used for variety of applications, for example,

- o Food packaging, automotive parts, trays, building products and aircraft wind screens.
- o Thin gauge parts are primarily used to package or contain a food item, disposable cups, containers, lids, blisters and clamshells

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

THERMOFORMING (CONTD...)

- o Thick gauge parts are used as cosmetic surfaces on permanent structures such as trucks, medical equipment, material handling equipment, electrical and electronic equipment, spas and shower enclosures, vehicle door and dash panels, refrigerator liners, utility vehicle beds, and plastic pallets

Advantages

- o Extremely adaptive to design requirement
- o Rapid prototype development
- o Low initial setup costs
- o Low production costs
- o Less thermal stresses than injection molding and compression molding
- o Good dimensional stability

Disadvantages

- o Poor surface finish
- o Parts may have non-uniform wall thickness.
- o All parts need to be trimmed
- o Ribs and bosses cannot be molded easily
- o Limited number of materials can be used
- o Very thick plastic sheets can't be formed



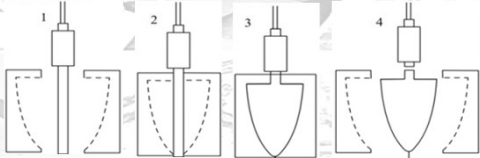
Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

BLOW MOLDING

Blow molding is a manufacturing process that is used to produce hollow plastic parts by inflating a heated plastic until it fills a mold and formed the desired shape.

Working Principle

- o In this process, the thermoplastic in the form of small pellets or granules is first heated above the melting temperature and molded into a preform using injection molding process.
- o These preforms are used to feed into the blow mold.
- o The preform is heated above the glass transition temperature and formed into a hollow tube which is called parison.
- o The parison is then clamped between two mold halves and inflated by high air pressure until it conforms to the inner shape of the mold.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

LAMINATING PLASTICS (CONTD...)

Advantages

- o is stain and grease resistant, and durable if properly cared for.
- o Forming shapes with plastic laminate is possible.
- o is relatively easy to manufacture
- o Plastic laminate modular is less expensive than other.
- o In situations where the design aesthetic is important, the wide varieties of colors, textures, and patterns available in plastic laminate make it an attractive choice.
- o Has a lower noise level than stainless steel modular works, and is a good choice for situations that require a quieter atmosphere.

Disadvantages

- o Tearing of the plastic laminate results in jagged and razor sharp edges and can cause serious injuries.
- o Delamination can be caused by improper fabrication techniques.
- o They lack the ultra violet protection in most products and the changes in heat and cold often create differential expansion problems between the substrate and the plastic laminate itself.
- o It should not be used in areas with extremely high moisture, humidity, extreme heat or cold.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

LAMINATING PLASTICS (CONTD...)

Application

- o Floors, walls and roofs
- o Vehicle internal body work
- o Packages and boxes
- o Road cases
- o Residential countertops and cabinetry, Office work areas
- o Public restrooms
- o Department store wall panels, Corporate offices, Retail stores and malls,
- o Hospitality environments, Healthcare settings, Educational institutions, Casino slot bases, Airplanes, Mass transit seats, Theme park rides, Furniture, Interior doors, Marker boards, In high-traffic areas, Cashier/checkout stations, Kick plates, Pony walls, Retail fixtures, Bar tops.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

REINFORCING

- o Polymer-matrix Composites (PMCs) (also called reinforced plastics) are engineered materials with unique mechanical properties, especially high strength-to-weight ratio, stiffness-to-weight ratio, fatigue strength, creep resistance, and directional properties.
- o Because of their complex structure, reinforced plastics require special methods to shape them into consumer and industrial products.
- o Reinforcements, as the name suggests, are used to enhance the mechanical properties of a plastic.
- o Finely divided silica, carbon black, talc, mica, and calcium carbonate, as well as short fibres of a variety of materials, can be incorporated as particulate fillers. (The use of long or even continuous fibres as reinforcement, especially with thermosets, is described below in Fibre reinforcement.)
- o Incorporating large amounts of particulate filler during the making of plastics such as polypropylene and polyethylene can increase their stiffness.
- o RPs, also called plastic composites or composites, are tailor-made materials which provide the designer, fabricator, equipment manufacturer, and consumer, engineered flexibility to meet different properties, environments, and create different shapes.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

REINFORCING (CNTD...)

- Papers are the lowest-cost reinforcing materials used in making laminates. Types include kraft, alpha, cotton linter, and combinations of these. Papers provide excellent electrical properties, good dimensional stability, moderate strength, and uniform appearance.
- Cotton cloth is used for applications requiring good mechanical strength. The lighter-weight fabrics are not as strong but have excellent machinability.
- Asbestos, in the form of paper, mat, or woven fabric, provides excellent resistance to heat, flame, chemicals, and wear.
- Glass-fiber reinforcements, in woven fabric or mat, form the strongest laminates. These laminates also have low moisture absorption and excellent heat resistance and electrical properties.
- Nylon fabrics provide excellent electrical and mechanical properties and chemical resistance, but laminates reinforced with these materials lack dimensional stability at elevated temperatures.



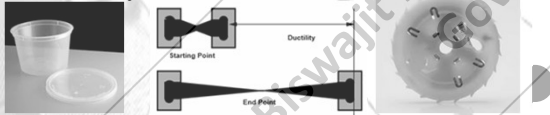
Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

PLASTIC

These are moldable organic resins and consists of large molecules

Properties

- Appearance : Transparent
- Chemical resistance : The plastics offer great resistance to moisture, chemicals and solvents, excellent corrosion resistance.
- Dimensional stability.
- Ductility : The plastic lacks ductility. Hence its members may fail without warning.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

PLASTIC

- Durability : The plastics are quite durable, if they possess sufficient surface hardness.
- Electric insulation : They are far superior to ordinary electric insulators.
- Finishing : Any surface treatment may be given to the plastics.
- Fire resistance : All plastics are combustible.
- Fixing : Can be easily fixed in position
- Humidity : PVC plastics offer great resistance to the moisture



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

PLASTIC

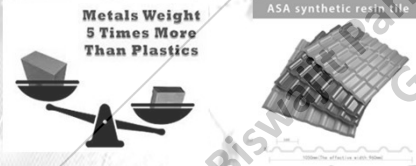
- Maintenance : It is easy to maintain plastic surfaces. They do not require any protective coat of paints.
- Melting point : Most of the plastics have low melting point and MP of some plastics is only about 50°C.
- Optical property : Several types of plastics are transparent and translucent.
- Recycling : It does not give a serious problem to pollution as generated by a host of other industries.
- Sound absorption : The acoustical boards are prepared by impregnating fibre-glasses with phenolic resins.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

PLASTIC

- Strength : The tensile members are generally made of plastics as their strength to weight ratio in tension very nearly approaches to that of metals.
- Thermal property : The thermal conductivity of plastics is low and it can be compared with that of wood.
- Weather resistance : Certain plastics are seriously affected by sun light, but other plastic can resist weather which as prepared from phenolic resins.
- Weight : The plastics, whether thermo-plastic or thermo-setting have low specific gravity being 1.30 to 1.40.



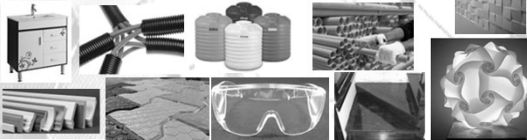
Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

PLASTIC

Applications

The typical use of plastics in building are as follows :

- Bath and sink units.
- Cistern ball floats.
- Corrugated and plain sheets.
- Decorative laminates and mouldings.
- Electrical conduits.
- Electrical insulators.
- Floor tiles.
- Foams for thermal insulation.
- Joint less flooring.
- Lighting fixtures.
- Overhead water tanks.
- Paints and varnishes.
- Pipes to carry cold water.
- Roof lights.
- Safety glass.
- Wall tiles.




Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

THANK YOU



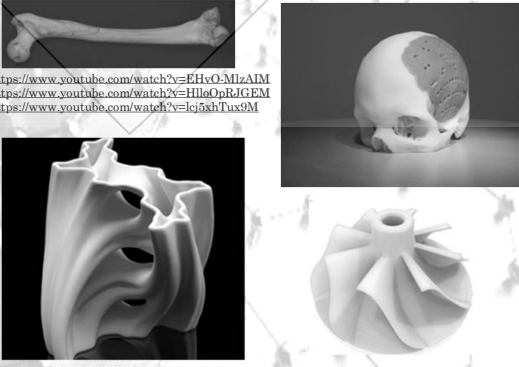
By
Dr. Biswajit Parida, Lecturer,
Mechanical Engg. Department,
Govt. Polytechnic Kendrapara

**CHAPTER-03:
ADDITIVE
MANUFACTURING PROCESS**



By
Dr. Biswajit Parida, Lecturer,
Mechanical Engg. Department,
Govt. Polytechnic Kendrapara

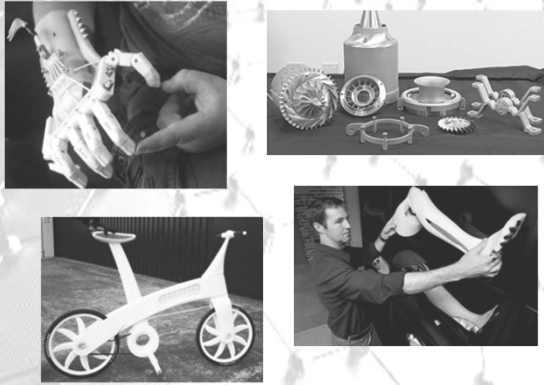
Chapter-03: Additive Manufacturing Process
INTRODUCTION



<https://www.youtube.com/watch?v=EHvO-MizAM>
<https://www.youtube.com/watch?v=Hll6OpBJGEM>
<https://www.youtube.com/watch?v=IcJ5xHTux9M>

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INTRODUCTION



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INTRODUCTION

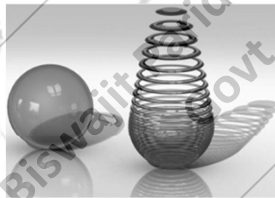
Additive vs Subtractive Manufacturing



- Part Complexity;
- Material;
- Speed;



- Part Quantity;
- Cost.

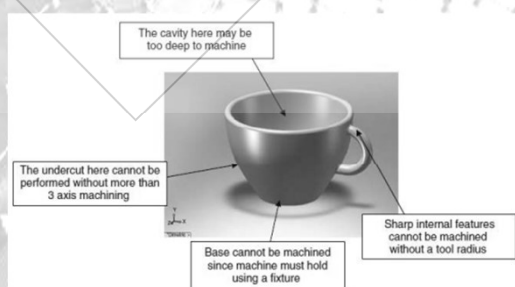


Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

Prepared by Dr. Biswajit Parida, Faculty of Mechanical Engg. Dept. Govt. Polytechnic Kendrapara

NEED

Additive vs Subtractive Manufacturing

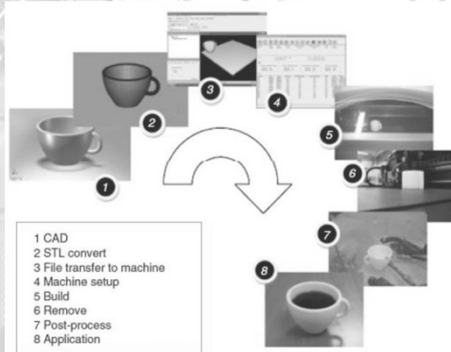


<https://www.youtube.com/watch?v=0Xy99iSKQ5g>
<https://www.youtube.com/watch?v=9jc2K37wY34>

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INTRODUCTION

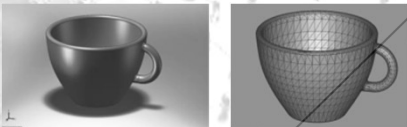
Generic AM Process



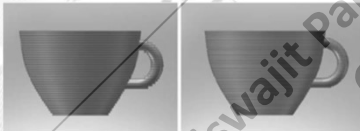
Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INTRODUCTION

CAD Model into STL Format



STL uses triangles to describe the surfaces to be built. Each triangle is described as three points and a facet normal vector indicating the outward side of the triangle, in a manner similar to the following:



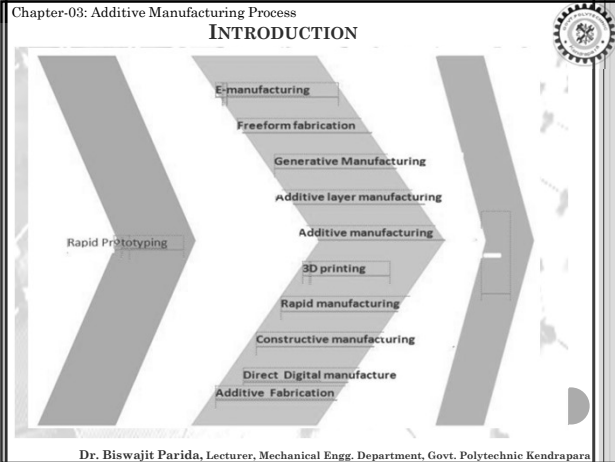
Effects of building using different layer thicknesses

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INTRODUCTION

- Additive Manufacturing (AM) technology, which is referred as three dimensional printing technology which produces objects layer-by layer (additively), rather than subtracting similar to a two dimensional printer with the only difference that a third dimension (z-axis) is added, which is also called the building direction.
- AM refers to a group of technologies that build physical objects directly from three dimensional CAD data.
- AM adds liquid, sheet, wire or powdered materials, layer-by layer, to form component parts with little or no subsequent processing requirements.
- This approach provides a number of advantages including near 100% material utilisation, short lead times and un-rivalled geometric freedom of design.
- Additive Manufacturing (AM) refers to a process by which digital 3D design data is used to build up a component in layers by depositing material. (from the International Committee F42 for Additive Manufacturing Technologies, ASTM)

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara



Chapter-03: Additive Manufacturing Process

FUNDAMENTALS

Basic Steps of Additive Manufacturing

Computer Aided Design

- o AM starts with designing a model with any professional CAD software.
- o The output model has to be a 3D or surface representation of the actual part.
- o Scanning and reverse engineering equipment could be also be used to generate this model.

Conversion for AM Accepted File Type

- o STL is the standard file type for the AM machines.
- o Once a CAD model is created it should be saved in STL format through the CAD software.
- o STL file translates the surface in the CAD model to a mesh of triangles.
- o The number of the triangles controls the precision of the rounded surfaces.
- o The CAD software allows the user to control the number and the size of those triangles.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

Chapter-03: Additive Manufacturing Process

FUNDAMENTALS

Transfer STL Files to AM Machine

- o The STL file should be transferred to the machine.
- o The file should be verified for its right size and build orientation.
- o Also if there are multiple parts they should be properly placed so they wouldn't overlap with other parts.

AM Machine Setup

- o Machine setup is a crucial step in the process.
- o The parameters should be properly set up to achieve the tolerances of the manufactured part.
- o Layer thickness, orientation, energy provided, timing and roller speeds can be named as some of these parameters.

Build Phase

- o This is step is more of automated process done by the machine.
- o Partial monitoring will be required to ensure there are no errors and the machine would not run out of material..

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

FUNDAMENTALS

Removal

- o In this phase the machine is done producing the part and the user has to take it out.
- o The user should follow the safety protocols and proper shut down procedures.
- o This will ensure the safety of the user and the machine.

Post Processing of AM Parts

- o Once the parts are produced they might need some additional treatment such as curing, sintering and cleaning.
- o At these stages parts may be weak and they should be handled with care.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INTRODUCTION Pros and Cons

Pros	Cons
Freedom to design and innovate without penalties	Unexpected pre- and post-processing requirements
Rapid iteration through design permutations	High process cost
Excellent for mass customization	Lack of industry standards
Elimination of tooling	Low speed, not suitable for mass production
Green manufacturing	Inconsistent Materials
Minimal material waste	Limited number of materials
Energy efficient	High equipment cost for high-end manufacturing
Enables personalized manufacturing	

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

NEED

AM benefits: Weight reduction

TRADITIONAL DESIGN

Source: SAVING project



- > A conventional steel buckle weighs 155 g¹⁾
- > Weight should be reduced on a like-for-like basis within the SAVING project
- > Project partners are Plunkett Associates, Crucible Industrial Design, EOS, 3T PRD, Simpleware, Delcam, University of Exeter

AM OPTIMIZED DESIGN

Source: SAVING project



- > Titanium buckle designed with AM weighs 70 g – reduction of 55%
- > For an Airbus 380 with all economy seating (853 seats), this would mean a reduction of 72.5 kg
- > Over the airplane's lifetime, 3.3 million liters of fuel or approx. EUR 2 m could be saved, assuming a saving of 45,000 liters per kg and airplane lifetime

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INTRODUCTION TO 3D PRINTING

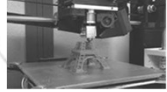
A method of manufacturing known as 'Additive manufacturing', due to the fact that instead of removing material to create a part, the process adds material in successive patterns to create the desired shape.

Main areas of use: <https://www.youtube.com/watch?v=O-Aui6z08vY>
<https://www.youtube.com/watch?v=IRG4gg8UXus>
<https://www.youtube.com/watch?v=XHSYEHI39HA>

- o Prototyping
- o Specialized parts – aerospace, military, biomedical engineering, dental
- o Hobbies and home use
- o Future applications– medical (body parts), buildings and cars .

Process

- o 3D Printing uses software that slices the 3D model into layers (0.01mm thick or less in most cases).
- o Each layer is then traced onto the build plate by the printer, once the pattern is completed, the build plate is lowered and the next layer is added on top of the previous one.
- o 3D Printing eliminates such waste since the material is placed in the location that it is needed only, the rest will be left out as empty space.

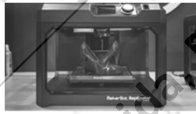


Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INTRODUCTION TO 3D PRINTING

Advantages:

- o Layer by layer production allows for much greater flexibility and creativity in the design process
- o significantly speeds up the design and prototyping process
- o Print on Demand.
- o Strong and Lightweight Parts.
- o Fast Design and Production.
- o Minimising Waste.



Limitations:

- o The limitations of 3D printing in general include expensive hardware and expensive materials. .
- o It also requires a CAD designer to create what the customer has in mind, and can be expensive if the part is very intricate. .
- o Limited Materials.
- o Restricted Build Size
- o Reduction in Manufacturing Jobs



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

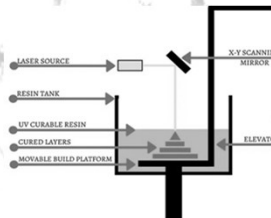
INTRODUCTION TO STEREO LITHOGRAPHY

Stereolithography is a 3D Printing process which uses a computer-controlled moving laser beam, pre-programmed using CAM/CAD software.

Process

- o The SL machine begins the 3D printing process by drawing the layers of the support structures, followed by the part itself, with an ultraviolet laser aimed onto the surface of a liquid thermoset resin.
- o After a layer is imaged on the resin surface, the build platform shifts down and a recoating bar moves across the platform to apply the next layer of resin.
- o The process is repeated layer by layer until the build is complete.
- o It belongs to the resin 3D printing category.

<https://www.youtube.com/watch?v=CmU1ImG8n3M>
<https://www.youtube.com/watch?v=faGyF81LadA>
<https://www.youtube.com/watch?v=NM5c5t5kw1>
<https://www.youtube.com/watch?v=jcCHKDx9qhd>
<https://www.youtube.com/watch?v=yW4EMCVadHE>



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

DISTINCTION BETWEEN AM AND CNC

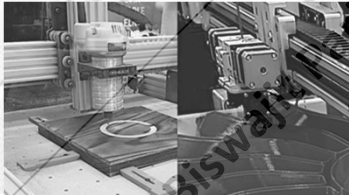
- **Size of parts:** With CNC milling, you can make broad range of sizes — from tiny, delicate parts to refrigerators. In 3D printing, on the other hand, the parts you make cannot be any larger than the printing bed.
- **Material availability:** In addition to accommodating many materials, CNC machines are also easy to adapt to use new materials. A 3D printer, on the other hand, can only work with one material.
- **Speed:** When it comes to mass-producing a product, CNC machining is faster because it involves an assembly line of machines producing each part. A single 3D printer makes the entire product from start to finish, which makes it less suitable for large-scale production.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

DISTINCTION BETWEEN AM AND CNC

- **Production:** CNC machining is more precise, providing accuracy to the nearest micrometer. That is because CNC machines have a higher tolerance for heat. 3D printing is still far from achieving this level of precision.
- **Repeatability:** CNC machines can consistently produce a product the same way each time.
- **Quality:** Because of its higher heat tolerance, CNC machines produce products with a more polished look. Parts made by 3D printers, however, tend to bend and warp, and layer lines can be visible, especially around curves.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

DISTINCTION BETWEEN AM AND CNC

- **Complexity of component:** 3D printing, because of its additive method of manufacturing, is often better than CNC for parts with complex geometries. It can only make components out of a single material.
- **Customization:** 3D printers are better CAN at creating more customized, unique products. Artists will often use them to make a piece of art, and medical industries like dentistry take advantage of this technology to create a unique item that suits a particular patient .
- **Turnaround time:** CNC is much faster than 3D printing, especially in larger-scale production.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

DISTINCTION BETWEEN AM AND CNC

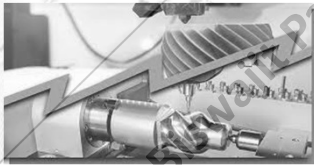
- **Accuracy:** For CNC, you can increase the speed of production by sacrificing accuracy — which is good to take advantage of where time is short and you do not need a high level of precision, such as when testing prototypes. 3D printers, on the other hand, cannot increase their speed of production. The only way to do so is to buy a faster printer.
- **Flexibility:** Although generally slower at producing a component, 3D printers are flexible and can quickly switch between jobs. So if you are making a small amount of several different items, 3D printing may be the better option than CNC.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

DISTINCTION BETWEEN AM AND CNC

- **Cost:** The CNC vs. 3D printing cost often depends on the number of items you want. If you would like to make a large quantity of something, CNC is the better option because the per-unit cost decreases. For 3D printing, the per-unit cost is the same no matter how many you make, so it is usually more economical for small quantities.
- **Product volume:** CNC fits with mass production, it takes a 3D printer to make just one.
- **Material of component:** CNC can work with a wider range of materials, including high-density metals, wood, wax and plastic. Because it can work with heavy metals, 3D printers work with fewer types of materials, such as specific plastics and resins, and these materials are usually not strong enough to serve as parts for engines or other machinery.



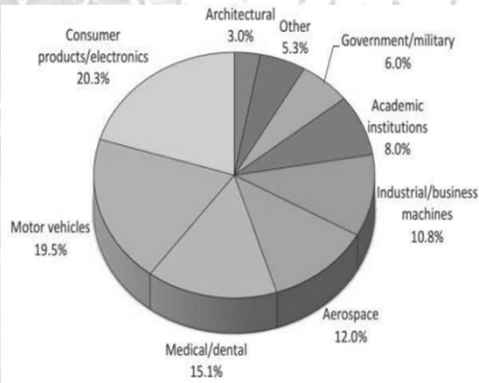
Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MATERIAL USED IN ADDITIVE MANUFACTURING

- **Polymers** are the most widely used material in AM. Most notably, nylon is the most widely used polymer because it melts and bonds better than other polymers.
- **Metal** products can be formed in a “direct” way – by melting metal particles together or an “indirect” way – by bonding the metal with post-processing. There are many ways and AM methods to form metals through the indirect or direct way.
- **Ceramics** are used in AM processing because of their chemical structures and resistance to high temperatures. Unfortunately, these materials can be brittle making them difficult to manufacture especially if complex geometries are involved. Examples of ceramics include alumina, silica and zirconia. Ceramics can be produced through indirect or direct process.
- **Composites** are, as their name suggests, materials that are combinations of two or more materials, either naturally (in nature) or engineered. Composites can be mixed uniformly or no uniformly to make different compounds.
- **Functionally graded materials** can be created through AM processing. Guo & Leu (2013) show that, “One example is a pulley that contains more carbide near the hub and rim to make it harder and more wear resistant and less carbide in other areas to increase compliance.”

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

APPLICATIONS OF AM TECHNOLOGIES



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

APPLICATIONS OF AM TECHNOLOGIES

o **Consumer Products:** Within the consumer market there is a large array of products being manufactured by various AM technologies including toys, games, home furnishings, fashion items, sports equipment etc. Artists, jewellers and fashion designers are using AM in a range of ways including to produce one off bespoke pieces.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

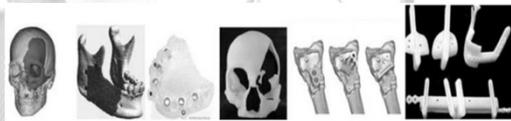
APPLICATIONS OF AM TECHNOLOGIES

o **Medical and Bioengineering:** AM techniques have been applied within the medical and dental arena for the creation of assistive, surgical and prosthetic devices, surgical implants, and scaffolds for tissue engineering.

o For instance, AM allows complex parts to be created specifically for the patient direct from a 3D CAD model generated from a patient's CT or MRI scan.

o Accurate patient specific implants produced using the 3D scan data can reduce the removal of healthy bone, eliminate the need for bone grafting, promote effective planning of implantation/surgery and shorten the time of anesthesia.

o There is also the possibility that the customisation enabled by AM will result in increased implant-life eliminating the need for further surgery.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

APPLICATIONS OF AM TECHNOLOGIES

- **Aerospace:** AM is an attractive alternative manufacturing route for the aerospace industry, due primarily to its high material use efficiency and ability to process aerospace grade titanium and nickel alloys.
- AM is seen as an enabling technology for light-weighting or topology optimisation, because of its capability to create complex structures.
- This can have the additional benefits of improving performance and reducing waste.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

APPLICATIONS OF AM TECHNOLOGIES

- **Architecture:** In the field of architecture, AM is used to produce scaled replica models of buildings and constructions.
- A continued challenge in this field of application however exists in scaling down features such as window frames and guard railings.
- When scaling down a construction to a size that can be produced using AM, any such features virtually disappear and need to be reconstructed on the scaled CAD model – which is a time consuming exercise.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

FLEXIBLE MANUFACTURING SYSTEM

- Flexibility can have different interpretations; but it generally refers to the system's responsiveness to changing demand patterns, so that the mix of part styles in the system and the production volume that can be adjusted rapidly to meet changing requirements.
- So FMS is the production with machine systems capable of making a different product without retooling or similar changeover.

The basic elements of FMS are

- a) Works station
- b) automated material handling and automated storage and retrieval systems
- c) control systems.

- Because of major capital investment; efficient machine utilization is essential.
- Consequently, proper scheduling and process planning are crucial, that are complex in nature.
- Because of the flexibility in FMS, no setup time is wasted in switching between manufacturing operations; the system is capable of different operations in different orders and on different machines.

○ https://www.youtube.com/watch?v=qWBZJf_Bkx0

○ <https://www.youtube.com/watch?v=PDSmRPhcTAM>

○ <https://www.youtube.com/watch?v=...>

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

Chapter-03: Additive Manufacturing Process

FLEXIBLE MANUFACTURING SYSTEM

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

Chapter-03: Additive Manufacturing Process

CONCURRENT ENGINEERING

- Concurrent engineering, also known as simultaneous engineering, is a method of designing and developing products, in which the different stages run simultaneously, rather than consecutively.
- It decreases product development time and also the time to market, leading to improved productivity and reduced costs.
- Concurrent Engineering is a long term business strategy, with long term benefits to business.
- Though initial implementation can be challenging, the competitive advantage means it is beneficial in the long term.
- It removes the need to have multiple design reworks, by creating an environment for designing a product right the first time round.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

Digitized by Dr. Biswajit Parida, Faculty of Mechanical Engg. Dept. Govt. Polytechnic Kendrapara

Chapter-03: Additive Manufacturing Process

CONCURRENT ENGINEERING

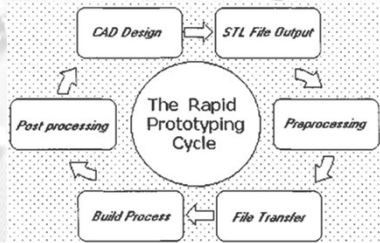
- In concurrent engineering (CE) product is developed by a team involving engineers from both the design section and the production shop.
- The advantages of concurrent engineering are based on the economic leverage of addressing all aspects of design of a product as early as possible.
- It is also true that the importance of early modification is very significant and the ability of the early change to influence the product cost is much larger as indicated.
- The duration of prototype development is an important factor and it is found that more than 25% of the total product development time goes in fabricating the prototype.

Concurrent engineering
Tech Design

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

RAPID PROTOTYPING

- o To reduce the development time and adopt concurrent engineering in its true spirit, quick and inexpensive fabrication of prototype parts is essential and 'rapid prototyping (RP)' technology has made that possible.
- o By rapid prototyping processes a solid object with prescribed shape, dimension and finish can be directly produced from the CAD based geometric model data stored in a computer without human interventions.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

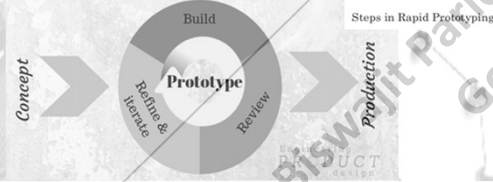
RAPID PROTOTYPING

Rapid prototyping can be of two types.

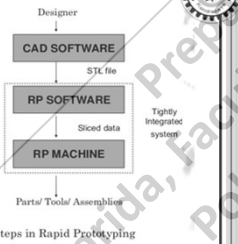
- o The part obtained by RP technology can form the prototype directly, without requiring any further processing.
- o Else the parts obtained by RP technology can be used to make moulds for casting the prototype components.

<https://www.youtube.com/watch?v=0hNnKTacVI>
https://www.youtube.com/watch?v=3KcKc-FY_OI

Rapid Prototyping



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

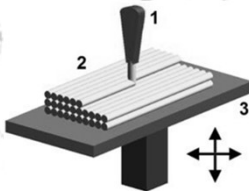


INTRODUCTION TO FDM – FUSED DEPOSITION MODELING

Is an additive manufacturing technology commonly used for modeling, prototyping, and production applications.

Process

- o FDM works on an "additive" principle by laying down material in layers.
- o A plastic filament or metal wire is unwound from a coil and supplies material to an extrusion nozzle which can turn the flow on and off.
- o The nozzle is heated to melt the material and can be moved in both horizontal and vertical directions by a numerically controlled mechanism, directly controlled by a computer-aided manufacturing (CAM) software package.
- o The model or part is produced by extruding small beads of thermoplastic material to form layers as the material hardens immediately after extrusion from the nozzle.
- o Stepper motors or servo motors are typically employed to move the extrusion head.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

Chapter-03: Additive Manufacturing Process
INTRODUCTION TO FDM – FUSED DEPOSITION MODELING

Advantages:

- o Cheaper since uses plastic, more expensive models use a different (water soluble) material to remove supports completely.
- o Even cheap 3D printers have enough resolution for many applications.

Limitations:

- o Supports leave marks that require removing and sanding.
- o Warping, limited testing allowed due to Thermo plastic material

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

Chapter-03: Additive Manufacturing Process
INTRODUCTION TO SLS - SELECTIVE LASER SINTERING

Is an additive manufacturing technique that uses a high power laser (for example, a carbon dioxide laser) to fuse small particles of plastic, metal (direct metal laser sintering), ceramic, or glass powders into a mass that has a desired three-dimensional shape.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

Chapter-03: Additive Manufacturing Process
INTRODUCTION TO SLS - SELECTIVE LASER SINTERING

- o The laser selectively fuses powdered material by scanning cross-sections generated from a 3-D digital description of the part (for example from a CAD file or scan data) on the surface of a powder bed.
- o After each cross-section is scanned, the powder bed is lowered by one layer thickness, a new layer of material is applied on top, and the process is repeated until the part is completed.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INTRODUCTION TO SLS - SELECTIVE LASER SINTERING

Advantages:

- o Speed is the most obvious because no special tooling is required.
- o allows for more rigorous testing of prototypes.
- o Since SLS can use most alloys, prototypes can now be functional hardware made out of the same material as production components.
- o It is possible to design internal features and passages that could not be cast or otherwise machined.
- o Complex geometries and assemblies with multiple components can be simplified to fewer parts with a more cost effective assembly.
- o SLS does not require special tooling like castings, so it is convenient for short production runs.

<https://www.youtube.com/watch?v=9E2MfBAV1dA>
<https://www.youtube.com/watch?v=kLlAksyBI>
<https://www.youtube.com/watch?v=Mj6oaMVWrs>

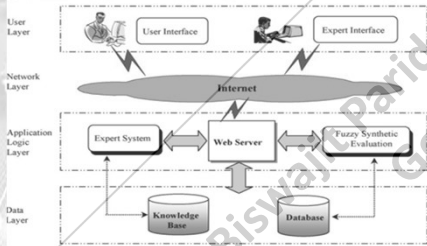
Limitations:

- o The aspects of size, feature details and surface finish should be considered prior to the use of the technology.
- o Surfaces usually have to be polished to achieve mirror or extremely smooth finishes.
- o For production tooling, material density of a finished part or insert should be addressed prior to use.
- o In this process metallic support structure removal and post processing of the part generated is a time consuming.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

WEB-BASED RAPID PROTOTYPING

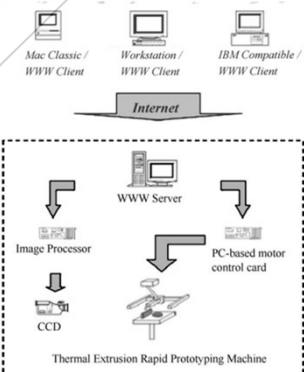
- o Rapid prototyping and manufacturing (RP&M) technique has shown a high potential to reduce the cycle and cost of product development, and has been considered as one of crucial enabling tools in digital manufacturing to effectively aid rapid product development.
- o Manufacturing industry is evolving toward digitalization, network and globalization. The Internet, incorporating computers and multimedia, has provided tremendous potential for remote integration and collaboration in business and manufacturing applications.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

WEB-BASED RAPID PROTOTYPING

- o RP&M technique using the Internet can further enhance the design and manufacturing productivity, speed, and economy, as well as share the RP machines.
- o Web-based RP&M systems have been developed and employed to implement remote service and manufacturing for rapid prototyping, enhance the availability of RP&M facilities and improve the capability of rapid product development for a large number of small and medium sized enterprises.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

Chapter-08: Additive Manufacturing Process

TOOLS USED IN CAPSTAN AND TURRET LATHE

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

THANK YOU

By
Dr. Biswajit Parida, Lecturer,
Mechanical Engg. Department,
Govt. Polytechnic Kendrapara

CHAPTER-04: SPECIAL PURPOSE MACHINES (SPM)

By
Dr. Biswajit Parida, Lecturer,
Mechanical Engg. Department,
Govt. Polytechnic Kendrapara

INTRODUCTION

- o Special purpose machinery, as the name suggests, is constructed for some very particular purpose.
- o These machines are not built in masse as is the case with most types of machinery and are custom made.
- o SPM is designed specifically for exact requirement of component to be processed or machined.
- o It is used to manufacture special type of products.
- o Generally used in mass production environment.
- o SPM tools are designed to perform special machining operations, usually for production purposes. Examples include gear-cutting and gear-grinding machines, broaching machines, lapping and honing machines, and boring machines.
- o A SPM (Special Purpose Machine) is a machine tool designed and manufactured to suit a specific requirement and perform a of operations. limited range

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

INTRODUCTION

- o SPM is built such that unwanted movements and operations are eliminated so that machine is confined to perform machining on single variety components.
- o As SPM is self-contained machine having inbuilt units like a gear box, a bed, hydraulic drives pneumatic systems of combination of all at a time.
- o SPM is a machine which is component or work piece oriented.

Automated production techniques are widely used in manufacturing industries for dealing with issues such as

- o high cost of labour,
- o shortage of skilled people,
- o low interest of labour to work in production firms,
- o safety,
- o high cost of raw materials,
- o improved quality,

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

WHY DO PEOPLE ORDER SPECIAL PURPOSE MACHINES AS AGAINST MASS PRODUCED MACHINES...?

Special purpose machines are in demand because they do the job they are created for more efficiently when compared against mass produced machines available in the market.

This efficiency can be measured in two ways. In different words, people order special purpose machines for two reasons.

1. The first is to save money

- o leads to a considerably less amount of investment in the long term.
- o lower power consumption.
- o less wastage material.

2. The second reason is the aspect of time

- o Which is a major commodity when it comes to commercial industries.
- o In fact, indirectly speaking, even the saving of time due to the use of special purpose machines can be taken as a way of saving money.
- o Therefore, an engineer job in the special purpose machinery industry would require an engineer to optimize a process as much as is logically possible with the help of the machine.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

SPECIFIC CONSIDERATIONS PERTAINING TO SPECIAL PURPOSE MACHINES:

- o Special purpose machines are almost always designed and created fresh for one particular purpose which is defined or specified by the client in question.
- o It is very rare for special purpose machines to be alike in terms of size and capacity, even if they are similar with respect to their functionality.
- o These variants of the same design are known as 'modules'.

<https://www.youtube.com/watch?v=GGB0VyAORtk>

<https://www.youtube.com/watch?v=eAYXq288Pk>

<https://www.youtube.com/watch?v=JFKqz9MCr2M>

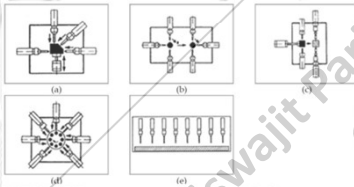
<https://www.youtube.com/watch?v=KYSsMU4bh8I>

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

DIFFERENT LAYOUTS OF SPM

Generally there are two layouts for SPMs;

- o *Single-station*
- o *Multi-station*.
- o In single station the workpiece is held in a fixed position where machining and sliding units are positioned around it such that they can process the part from different directions.
- o In the case of multiple machining units they may process the part simultaneously or in sequence depending on the geometry of the workpiece and machining features.



Different layouts for SPMs; (a) Single-station, (b) Special application, (c) Transfer machine, (d) rotary machine, and (e) In-line operation machine.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

PRINCIPLES OF SPM DESIGN

- o Designing of SPM is decided upon the principles of minimization of cost, improved productivity and better safety etc., which poses with high initial investment, higher maintenance cost etc.
- o Special Purpose Machine is higher degree mechanism in which human participation is replaced by an application of mechanical, electrical, electronics, hydraulic system.
- o Increase in productivity both qualitative and quantitative, Less human intervention, indirectly reduction in operator fatigue, Increase the profit of company. Special purpose machine is part of multi-tasking machine.
- o This is new approach to increase the productivity of organization.
- o If we compare between ordinary machine and special purpose machine in terms of time, costs, number of steps involved, etc.
- o The multi-tasking machine is preferred choice.
- o The most noteworthy aspect when using multi-spindle machines is the cycle time, due to parallel machining the total operating time is dramatically decreased. Special purpose machine (SPM) is combining the two machines which used for drilling and riveting operation separately. This machine concept provided most compact, economical and simple in operation by a single person.
- o The machine consist of single phase induction motor transmit power to drive mechanism by pulleys through V-belt and a hydraulic cylinder which drive the process unit.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

VARIOUS TYPES OF SPM

Types :

- o SPM for metal cutting.
- o Special purpose CNC machine.
- o SPM for vertical turning machine.
- o Rotary Indexing Drilling & Tapping SPM.
- o SPMs for multi and simultaneous operations such as Drilling, Milling, Boring etc.



Special purpose CNC machine

- o Machining Process
- o Component Handling & Holding System
- o Particular Fixture For Particular Component Holding
- o Component's Measuring.



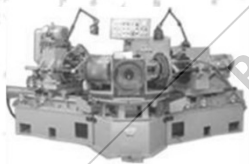
Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

VARIOUS TYPES OF SPM

Rotary Indexing Drilling & Tapping SPM

The Rotary Table has 3 stations -

- o Job loading / unloading
- o Drilling
- o Tapping



SPM For Vertical Turning Machine

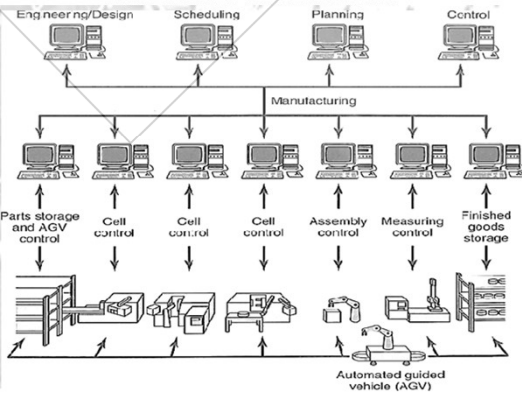
SPM for vertical turning machine are designed in three configurations to suit specific requirement-

- o VT- turning machines
- o VM- multi tasking turn-mill machines
- o VU- 5-axis universal turn-mill machines



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

AN INTEGRATED SYSTEM TO DESIGN MACHINE LAYOUTS FOR MODULAR SPECIAL PURPOSE MACHINES



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

SPECIAL PURPOSE MACHINES

Applications :

The modern manufacturing industry is concerned to automobile, food processing metal cutting sectors. All these sectors refer to high productivity and mass production. Productivity has now become everyday watchword. It is crucial to the well fair of the industrial firm as well as for the country. High productivity refer to doing the work in shortest possible time with least expenditure on inputs without sacrificing quality and with minimum rejection.

Following are the SPM's used in modern manufacturing, Modern SPM's,

- o Piston turning lathe.
- o Camshaft grinder.
- o Gear generating machine.
- o CNC vertical mould milling machine.
- o Super finishing machine.
- o Punching and marking machine for piston.
- o Carburetors cap machine SPM.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

THANK YOU



By
Dr. Biswajit Parida, Lecturer,
Mechanical Engg. Department,
Govt. Polytechnic Kendrapara

CHAPTER-05: MAINTENANCE OF MACHINE TOOLS



By
Dr. Biswajit Parida, Lecturer,
Mechanical Engg. Department,
Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Introduction:

- o "Prevention is better than cure". With reference to this proverb, the task performed to make the machine tools work perfectly is called 'Maintenance'.
- o This is achieved by ensuring that machine tools cutting tools and measuring instruments function properly without any fault.
- o Maintenance can be defined as a set of activities which are carried out to keep machine/device/equipment in good operating/working condition.

Purpose of Maintenance:

- o The primary objective of the maintenance department is to ensure the machine tools, instruments, tools and accessories in good working condition.
- o It is also necessary to ensure safety to both the machine tools and the operator.
- o The accuracy and efficiency of the machine tools and the instruments are also to be maintained properly.
- o By performing maintenance, we can avoid accidents inside the workshop and increase the production capacity

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

In short we can say maintenance is needed,

- o To avoid breakdown of machine.
- o Replace and repair of parts.
- o Lubrication in sliding/moving parts.
- o To maintain accuracy and productivity.
- o To ensure longer service life.
- o To reduce non productive time.
- o To maximum use of machine & improve efficiency.

Causes:

- o Insufficient Lubrication.
- o Overloading.
- o Misalignment.
- o Vibrations.
- o Improper handling.
- o Lack of preventive maintenance.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Causes:

Wear and tear

- o Due to continuous working of a machine tool and the nature of work performed on it, wear and tear is observed in the sliding parts of machine tools.
- o As a result of this, the accuracy of the products is affected.
- o In remedy, it is necessary to repair the said machine tools. The affected parts are to be replaced if necessary.

Backlash

- o Some slackness is observed in holding of parts, meshing gears or bolt and nut assembly. This slackness is known as backlash.
- o If the amount of backlash is more in the case of mating gears, they should be replaced.
- o The wear and tear on the gears should be observed once in a week time.

Lubrication

- o Rotating and sliding parts, which make contact with other parts, are subjected to wear due to friction.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

- Viscous oil called lubricant is applied to these parts to avoid direct contact between them. The process of reducing friction is called lubrication.
- Applying oil or grease to the axle shaft of the bullock cart and the cycle wheel, gearbox of automobiles, motor shafts of pumps, fans and sewing machine are some examples of lubrication.
- Friction occurs as the shafts are rotating and the sliding parts moving on each other. It generates heat and the parts get damaged.
- In order to keep the machine tools accurate and durable, it is necessary to apply lubricants between mating parts.
- It will reduce friction and wear is minimized.
- Lubrication is the nerve centre of machine tool. As it is blood circulation for the human body, lubrication is for the machine tools.

The machine parts which need to be lubricated

- Mechanisms of hydraulic systems
- Feed Box
- Guideways and sliding parts
- Speed changing mechanisms
- Rotating shafts
- Bearings
- Gear box

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Purpose of lubrication

- Smooth functioning of sliding movable parts
- To reduce friction and consequent wear
- To remove burrs and dust
- To reduce the heat generated due to friction
- To prevent rust formation on precise parts
- To provide cushioning effect to the load shocks
- For hydraulic circuits to transmit power.

Types of lubrication

The different types of lubrication are

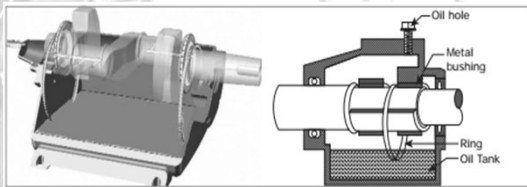
- Ring lubrication
- Wick Lubrication
- Splash Lubrication
- Grease Lubrication

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Ring Lubrication

- The method of lubrication involves a ring hanging from down the rotating shaft.
- The bottom portion of the ring is immersed in the oil container.
- When the shaft starts rotating, the ring also rotates.
- While the ring rotates, it carries a small amount of oil and the oil is spread into the bearing and the shaft.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Wick lubrication

- Wick lubrication is a method in which the wick along with a flexible thin piece of metal is used.
- A container having oil is placed above the bearing.
- The wick connects the container and the part to be lubricated.
- This lubrication enables the oil to flow from the container to the required place.



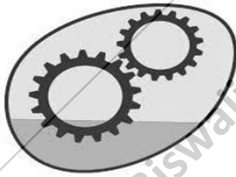
Wick Lubrication

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Splash lubrication

- The rotating part of the machine itself is made to be immersed in the oil container.
- When the part starts rotating, the oil is splashed and the moving parts are lubricated.
- Bearings are generally lubricated by this method.
- Little spoons are attached to the rotating parts to get more quantity of oil to the part to be lubricated.

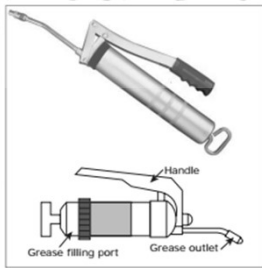


Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Grease lubrication

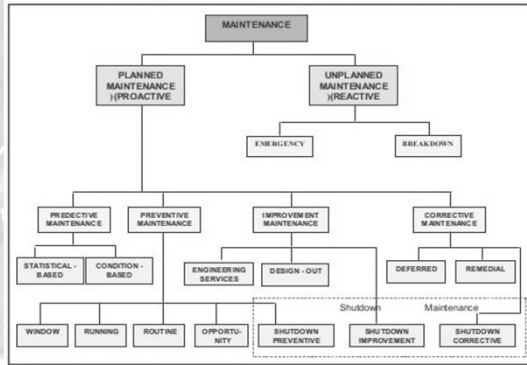
- Grease lubrication is done with the help of grease guns.
- Another way of doing it simply is so fill a container with grease and the container is connected to the parts to be lubricated by means of a small tube.
- When a screw is screwed into the container, a good amount of grease is taken to the required place.
- Lubrication oil and grease are manufactured under several trade names by the Indian oil companies.
- Suitable lubricants are used for specific purposes.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Types of Maintenance



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Types of Machine Tool Maintenance

There are different types of maintenance and they are

- Routine maintenance
 - a. Daily maintenance
 - b. Weekly maintenance
- Preventive maintenance
- Breakdown maintenance
- Capital repairs or Corrective maintenance.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Routine Maintenance

- Routine maintenance is done to avoid unnecessary breakdown of machine tools.
- It involves regular works like cleaning and lubricating, making minor adjustments and doing small repair works.
- It is important to chart out what are all to be done, daily, weekly and monthly.



Daily Maintenance

- Lubricating the movable parts with grease and oil as per requirements.
- To correct the machine tool to make it operate accurately.
- To look at whether the coolant apply and auto lubricating equipments are working properly.
- To remove the burrs cleanly.



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Weekly Maintenance

- The measuring instruments, gauges and hand tools are checked and corrected if necessary.
- The spare parts and integral parts of the machine tools should be cleaned.
- The entire workshop premises should be maintained cleanly.
- Grinding wheels of bench grinders and tool and cutter grinders should be dressed.
- The work rests of these machines should be adjusted properly.
- The protective devices in the machine tool are checked whether they are properly fixed. And they are corrected if necessary.
- The cables and electrical connections should be checked.
- The position and working of belt, chain etc., are checked and adjusted.
- Parts like gears, clutches and bearings are checked for their proper functioning.
- The accuracy of precision measuring instruments are checked and corrected. They are also checked for zero error.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Preventive Maintenance

- In order to avoid sudden breakdown of machine tools and maintenance programme is charted out.
 - This will ensure that there is no slip in the rate of production.
- In case of any major breakdown to the machine tool, two types of losses are incurred to the management.

1. Direct losses 2. Indirect losses

- Direct loss is the expenditure incurred for repairing the machine tools and getting them back in action.
- Indirect losses happen by the loss of income for the disturbed production.
- The management has to pay the labourers their wages.
- It will also be earning a bad name due to non-deliverance of the products to its customers.
- So, it is necessary to plan the preventive maintenance program to avoid such losses.
- Even if the machine tools are working in proper conditions, it is better to stop production once in a while to make the necessary repairs and adjustments.
- Certain parts should be replaced if necessary.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

MACHINE TOOL MAINTENANCE

Capital Repairs (or) Corrective Maintenance

- Even if the machine is functioning properly, it is necessary to halt the functioning of the machine to do some major repair once in a year.
- To do that, the machines parts are to be disassembled completely and worn out parts are replaced.
- Some parts of the machine may be in a condition that they need to be replaced soon.
- To correct all such difficulties, the machine is stopped from functioning to do all and every repairs to bring back the machine to accurate machining conditions.
- This called as capital repairs (or) corrective maintenance .

Breakdown Maintenance

- Even after enforcing routine maintenance and preventive maintenance, there are chances that some machine parts may fail due to some reason or other.
- In order to bring back the machine to its original working condition, some minor or major repairs are needed to be done.
- This type of maintenance is known as breakdown maintenance.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

PLANNED MAINTENANCE PROGRAMME

Planned Maintenance Programme

- The main objective of planned maintenance programme is to increase the production by keeping the machine tools always ready in good condition.
- It is done by keeping the machine tools to perform all the activities correctly with the required accuracy at desired speed with full safety protection.

The planned maintenance programme is to be prepared and executed as follows.

- When a new machine tool arrives to the machine shop or the existing machine tools are to be replaced, it is required to install the machine tools properly, level and align them correctly and connect them to the electrical terminals safely.
- If errors are found in the dimensional accuracy, the errors should be recorded and analysed whether the machine is in bad condition.
- It is necessary to plan and get ready the materials, spares and tools required for the maintenance in advance so that the maintenance work is carried out in time.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

PLANNED MAINTENANCE PROGRAMME

Planned Maintenance Programme

- The operators and supervisors should know the importance of the cutting speed, feed data of the machine tools.
- Emergency repair works should be done without any delay in the case of breakdown of any of the machine tools.
- The machine should be overhauled if the working efficiency of the machine tool goes below a particular level.
- If the machine tools become very old and not performing to the desired level, it has to be dismantled completely and worn out parts should be replaced to bring it to the normal working condition.
- The following details should be prepared and made as charts the layout plan of the shop, the size and specification of the machine tools and the parts to be lubricated. The manuals and the list of spare parts of all the machine tools are also to be kept ready.
- Annual budget for the maintenance work should be prepared atleast six month or once in year in advance.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

PLANNED MAINTENANCE PROGRAMME

Instruments needed for maintenance

- Steel rule
- Try-square
- Calipers
- Micrometer
- Vernier
- Gauges
- Vice
- Files
- Tap & Die



- Screw gauges
- Spanner set
- Hammers
- Screw drivers
- Wrenches
- Hacksaw Frame & Blades
- Lubricating devices
- Emery sheets
- Scraper



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

HOUSE KEEPING

- It is a practice or culture which arrange various facilities to create healthy & cheerful work environment.
- In simple manner 'Housekeeping' is the culture to put right things at right place at right time.
- Poor housekeeping increases the chances of breakdown, unsafe working condition & poor utilization of resources like man, machine & material.

Elements of House Keeping

- Maintain easy and efficient flow of production
- Adequate space is allotted for the storage.
- Arrangement like ventilation, lighting, air circulation and exhaust system.
- Clean & safe water supply, proper sewage disposal facility.
- Cleaning, sanitary facilities, lockers, changing room, hygienic food canteens, etc.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

HOUSE KEEPING

Necessity of House Keeping

- Make & maintain a clean, neat work area and surrounding.
- Make work area look pleasant, more satisfying and motivate for quality work.
- Minimize discomfort to the workers.
- Minimize injury and accidents.
- Increase the life of plant, building.
- Avoid fire and other hazards.

Advantages

- Safety working
- Increase life of building, machine, tools, etc.
- Increased moral of employee.
- Increased production.
- Better quality of product.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

HOUSE KEEPING

Advantages

- No time lost for locating or searching of tools.
- Inspection, maintenance, production is easy.
- Easy & fast material handling.

Disadvantages.

- Inadequate lighting, ventilation causes more fatigue to the operator.
- Quality of the product decreases.
- Oil spilled on shop floor may cause accidents.
- Poor cleaning causes unhygienic work area.
- Decreases moral of employee.
- Poor utilization of given space.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

TOTAL PRODUCTIVE MAINTENANCE (TPM)

What is TPM

- Total productive maintenance (TPM) originated in Japan in 1971 as a method for improved machine availability through better utilization of maintenance and production resources
- It can be considered as the medical science of machines.
- It is a maintenance program which involves a newly defined concept for maintaining plants and equipment.
- The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction.
- TPM brings maintenance into focus as a necessary and vitally important part of the business.
- It is no longer regarded as a non-profit activity.
- Down time for maintenance is scheduled as a part of the manufacturing day and, in some cases, as an integral part of the manufacturing process.
- The goal is to hold emergency and unscheduled maintenance to a minimum.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

TOTAL PRODUCTIVE MAINTENANCE (TPM)

Why TPM

TPM was introduced to achieve the following objectives. The important ones are listed below.

- Avoid wastage in a quickly changing economic environment.
- Producing goods without reducing product quality.
- Reduce cost.
- Produce a low batch quantity at the earliest possible time.
- Goods sent to the customers must be non defective.

TPM Targets:

- Obtain Minimum 90% OEE (Overall Equipment Effectiveness)
- Run the machines even during lunch. (Lunch is for operators and not for machines!)
- Operate in a manner, so that there are no customer complaints.
- Reduce the manufacturing cost by 30%.
- Achieve 100% success in delivering the goods as required by the customer.
- Maintain an accident free environment.
- Increase the suggestions from the workers/employees by 3 times. Develop Multi-skilled and flexible workers.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

TOTAL PRODUCTIVE MAINTENANCE (TPM)

Stages in TPM implementation

Step A - PREPARATORY STAGE:

- STEP 1 - Announcement by Management to all about TPM introduction in the organization:
- Proper understanding, commitment and active involvement of the top management in needed for this step. Senior management should have awareness programmes, after which announcement is made. Decision the implement TPM is published in the in house magazine, displayed on the notice boards and a letter informing the same is send to suppliers and customers.
- STEP 2 - Initial education and propaganda for TPM:
- Training is to be done based on the need, Some need intensive training and some just awareness training based on the knowledge of employees in maintenance
- STEP 3 - Setting up TPM and departmental committees:
- TPM includes improvement, autonomous maintenance, quality maintenance etc., as part of it. When committees are set up it should take care of all those needs.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

TOTAL PRODUCTIVE MAINTENANCE (TPM)

- o STEP 4 - Establishing the TPM working system and target:
- o Each area/work station is benchmarked and target is fixed up for achievement.
- o STEP 5 - A master plan for institutionalizing:

STEP B - INTRODUCTION STAGE

- o A small get-together, which includes our suppliers and customer's participation, is conducted.
- o Suppliers as they should know that we want quality supply from them. People from related companies and affiliated companies who can be our customers, sisters concerns etc. are also invited.
- o Some may learn from us and some can help us and customers will get the message from us that we care for quality output, cost and keeping to delivery schedules

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

TOTAL PRODUCTIVE MAINTENANCE (TPM)

STAGE C - IMPLEMENTATION

- o In this stage eight activities are carried which are called eight pillars in the development of TPM activity.
- o Of these four activities are for establishing the system for production efficiency, one for initial control system of new products and equipment, one for improving the efficiency of administration and are for control of safety, sanitation as working environment.

STAGE D - INSTITUTIONALISING STAGE

- o By now the TPM implementation activities would have reached maturity stage. Now is the time to apply for award.

Uniqueness of TPM

- o The major difference between TPM and other concepts is that the operators are also made to involve in the maintenance process. The concept of "I (Production operators) Operate, You (Maintenance department) fix" is not followed.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

TOTAL PRODUCTIVE MAINTENANCE (TPM)

Direct benefits of TPM

- o Increase in productivity and OEE (Overall Equipment Efficiency)
- o Reduction in customer complaints.
- o Reduction in the manufacturing cost by 30%.
- o Satisfying the customers needs by 100 % (Delivering the right quantity at the right time, in the required quality.)
- o Reduced accidents

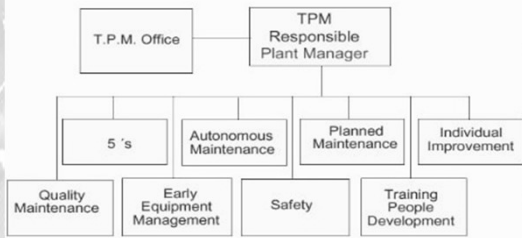
Indirect benefits of TPM:

- o Higher confidence level among the employees.
- o A clean, neat and attractive work place.
- o Favourable change in the attitude of the operators.
- o Achieve goals by working as team.
- o Horizontal deployment of a new concept in all areas of the organization.
- o Sharing knowledge and experience.
- o The workers get a feeling of owning the machine.

Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

TOTAL PRODUCTIVE MAINTENANCE (TPM)

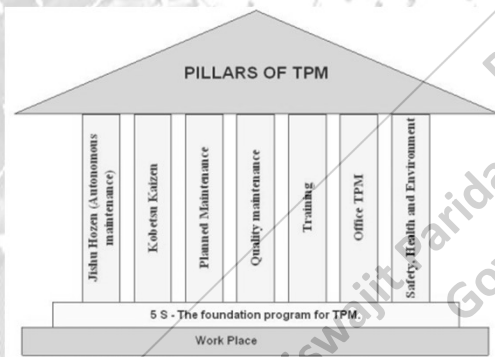
T.P.M. PLANT WIDE STRUCTURE



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

TOTAL PRODUCTIVE MAINTENANCE (TPM)

PILLARS OF TPM



Dr. Biswajit Parida, Lecturer, Mechanical Engg. Department, Govt. Polytechnic Kendrapara

THANK YOU



By
Dr. Biswajit Parida, Lecturer,
Mechanical Engg. Department,
Govt. Polytechnic Kendrapara
