## *UNIT IV - Digital Manufacturing : 3D Printing & Drones*

## # 3D Printing

3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file.

The creation of a 3D printed object is achieved using additive processe in which an object is created by laying down successive layers of material until the object is created.

3D printing is the opposite of subtractive manufacturing which is cutting out / hollowing out a piece of metal or plastic with for instance a milling machine.

3D printing enables you to produce complex shapes using less material than traditional manufacturing methods.

**3D Printing Limitations:**

- × Surface texture is generally too rough.
- × Materials generally have low strengths.
- × Material prices are too high.
- × Parts are generally not so dense.
- × Color is only possible with Mcor and Zcorp and these do not provide for functional parts.
- × The software tool-chain is too complex.
- × It is difficult to make 3D model.
- × Manufacturing complex parts or organic parts needs a lot of 3D modeling training.
- × 3D scanners are not good enough and create holes in final files.
- × Printers are not large enough.
- × Printers are not fast enough.
- × Build quality and up-time on desktop systems is terrible.
- × Machines are too expensive.
- × Very little R&D is done in 3D printing.
- × There is too much manual labor in manufacturing with 3D printing, 30% of costs.

**3D Printing Advantages:**

- ✓ It Is Affordable.
- ✓ Rapid Prototyping.
- ✓ Strong and Lightweight Parts.
- ✓ 3D Printing Technology Is Environmentally Friendly.
- ✓ Easy to Access.
- ✓ Fast Design and Production.
- ✓ Reduced Waste.
- ✓ Print on Demand.
- ✓ Flexible Design.

## # The History of 3D Printing

**1.** The earliest record of 3D printing through the additive process was the Japanese inventor **Hideo Kodama in 1981**. He created a product that used ultraviolet lights to harden polymers and create solid objects. This is a stepping stone to stereolithography (**SLA**).

**2. Charles Hull** invented stereolithography, a process similar to 3D printing that uses technology to create smaller versions of objects so they can be tested before spending time and money on creating the actual product. The object is printed layer by layer, rinsed with a solvent, and hardened with an ultraviolet light. The process uses computer-aided designs (**CAD**) to create the 3D models.

**3.** Selective Laser Sintering (**SLS**) is another, more advanced, form of 3D printing. It uses additive manufacturing and a powder polymer—typically nylon—to create objects. SLS uses a laser to fuse the powder together, layer by layer, into more complex shapes than SLA is capable of creating.

**4.** Fused Deposition Modeling (**FDM**), developed **by Scott Crump**, is the most common form of 3D printing today. It is known as the "**desktop 3D printers**" because it is the most commonly used form of the technology. To form an object, the printer heats a cable of thermoplastic into liquid form and extrudes it layer by layer.

Overall 3D printing has changed and improved over the past thirty years. SLA, SLS, and FDM show the history of 3D printing, and thus how it became a vital tool for manufacturing. It allows you to make virtually anything simply by creating a computer file.

## # Principles of 3D Printing

**1. Reduction Of Costs Associated With 3D Printing**

In traditional manufacturing, the more complicated an object's shape is, the more it costs to make. To produce an object of equal complexity, 3D printing can remove the overhead costs associated with retraining human machinists or retooling factory machines.

**2. No Assembly Is Required**

By making objects in layers, a 3D printer could print a door with its attached interlocking hinges at the same time, with no assembly required. Supply chains will be shortened, while saving money on labor and transportation costs at the same time.

**3. Ability To Print On-Demand**

A 3D printer can print on-demand when an object is required. The capacity for on-the-spot manufacturing reduces the need for companies to stockpile physical inventory. New types of business services become possible as 3D printers enable businesses to make specialty or customized objects on-demand in response to customers' orders. This could also minimize the costs of long-distance shipping since the object required can be printed as long as a 3D printer is present.

**4. Portable Manufacturing**

Since 3D printers are generally lighter in weight and smaller in scale compared to traditional machines, users can freely move them around anywhere to print 3D objects.

**5. Recise Physical Replication**

A digital music file can be copied endlessly without losing its audio quality. In the future, 3D printing will extend this digital precision to the world of physical objects. Scanning technology and 3D printing will work together to introduce high-resolution shape shifting between the physical and digital worlds. We will scan, edit, and duplicate physical objects to create exact replicas or even improve upon the originals.

**6. Variety is free**

A single 3D printer can make many shapes. Like a human artisan, a 3D printer can fabricate a different shape each time. Traditional manufacturing machines are much less versatile and can only make things in a limited spectrum of shapes. 3D printing removes the over- head costs associated with re-training human machinists or re-tooling factory machines. A single 3D printer needs only a different digital blueprint and a fresh batch of raw material.

**7. Less waste by-product**

3D printers that work in metal create less waste by-product than do traditional metal manufacturing techniques. Machining metal is highly wasteful as an estimated 90 percent of the original metal gets ground off and ends up on the factory floor. 3D printing is more wasteless for metal manufacturing. As printing materials improve, "Net shape" manufacturing could be a greener way to make things.

## # Use Cases/Applications of 3D Printing

**1. Replacement Parts:** Many times for older or rare equipment replacement parts are simply not available. Some things can never be fully repaired unless you have the replacement part it needs. When you own a 3D printer, you can use the machine to produce suitable replacement parts for any number of things.

**2. Jewelry:** Nowadays jewelry designers now prefer to 3D model and print their designs over traditional handcrafted methods.
Jewelry 3D printers create pieces from resin or wax, based on the 3D model of the jeweler's design. Digital models can be easily edited, which makes prototyping jewelry with 3D printing incredibly cheap and convenient.

**3. Shoes:** Until today, most shoes were made exclusively in factories, molded with expensive tooling and then stitched together with various materials. Now it's possible to use a 3D printer to produce comfortable, stylish & custom designed shoes.

**4. Miniature Models:** Using 3D printing software and machinery, you can print out miniature models (a small copy of larger things) and specialty replicas to add to your miniature model collection. From buildings to power lines a 3D Printer can virtually recreate a whole cityscape in miniatur.

**5. Functional Organs:** Yes, it is possibile to make 3D printed organs. These aren't just models mind you, scientists are looking into the possibilities of using 3D printing software to actually produce functional replacement organs.

**6. Model making:** Model making is another niche practice to which the 3D workflow is ideally suited. Where realistic reproductions were once inordinately expensive or impossible to model, the quality of detailing and finish possible through 3D printing methods has made the production of realistic, detailed miniatures and scale models more affordable & easier.

**7. Forensics:** 3D printing has as much potential utility in reconstruction as it does in production. The work of a forensic artist is often made difficult by incomplete evidence. 3D printers can use in legal investigations and can augment the abilities of forensic artists to reconstruct accurate models of persons of interest or victims.

**8. Glasses and Eyewear:** According to face shapes, customized eyewears can be made by 3D Printing. Which will lower in cost and at greater convenience to the customer. These Eyewears are lighter, more comfortable, made with minimal waste.

**9. Recreating History**
**10. Housing and Construction**
**11. Musical Instruments**
**12. Movies and Visual Effects**
**13. Architecture**
**14. Dental Products**

## # Introduction to Drones:

1. **Drone** is the common name for an **unmanned aerial vehicles (UAVs)**. UAVs are vehicles that do not carry humans inside of them. They can be controlled by either a human or by a computer.
2. UAVs were originally used in the military to carry out tasks that were either too difficult or too dangerous for humans to perform. Some other military applications include drone surveillanceand drone attacks.
3. Nowadays UAVs have become more and more popular. Some recreational drone activities include photography, product deland racing. UAVs have also been used to smuggle drugs and other types of contraband. Many companies are now pushing for drone delivery services.

### # Types of Drones:

They are of three types:

**1. Single Rotor Helicopters**

Single rotor helicopters look exactly like tiny helicopters and can be gas or electric powered. The single blade and ability to run on gas helps its stability and fly for longer distances. These UAVs are usually used to transport heavier objects, including LIDAR systems, that can be used to survey land, research storms and map erosion caused by global warming.

**2. Multi-Rotor Drones**

Multi-rotor drones are usually some of the smallest and lightest drones on the market. They have limited distance, speed and height, but make the perfect flying vehicle for enthusiasts and aerial photographers. These drones can usually spend 20-30 minutes in the air carrying a lightweight payload, such as a camera.

3. **Fixed Wing Drones**

Fixed wing drones look like normal airplanes, where the wings provide the lift instead of rotors- making them very efficient. These drones usually use fuel instead of electricity, allowing them to glide in the air for more than 16 hours. Since these drones are usually much larger, and because of their design, they need to take off and land on runways just as airplanes do. Fixed wing UAVs are used by the military to carry out strikes, by scientists to carry large amounts of equipment and even by nonprofits to deliver food and other goods to areas that are hard to reach.

| Pros (Advanatges) | Cons |
|---|---|
| Safe Environment | Privacy Issue |
| Cost Saving Technology | Spying |
| Quality Of Aerial Imaging | Easily Hacked |
| Flexibility For Quick Inspections | Weather Dependent |
| Easy Controllable | Knowledge And Skill |
| Minimizes Obvious Danger and Health Risks | Software issues or Malfunction |
| Reach Hazardous Area | Not good for Wild animals |
| Secure | Data Transfer speed is slow |

### # Technology, features and components

Drones contain a large number of technological components, including:

- ✓ **Electronic Speed Controllers (ESC),** an electronic circuit that controls a motor's speed and direction.
- ✓ Flight controller
- ✓ GPS module
- ✓ Battery
- ✓ Antenna
- ✓ Receiver
- ✓ Cameras
- ✓ **Sensors**, including ultrasonic sensors and collision avoidance sensors.
- ✓ Accelerometer, which measures speed.
- ✓ Altimeter, which measures altitude.

## # Multirotor Assembly Course:

- ✓ The multirotor drone engineering course will help you to enhance your technical knowledge and skills which will help you to get jobs in the **drone** industry.
- ✓ You will learn to assemble Multirotor Drones and get trained from expert instructors. It gives in-depth knowledge about working of a **Multirotor drone**. Get hands-on experience of assembly and troubleshooting.
- ✓ Get Certified by Ex - **UAV Military Instructors**. Learn to fly UAVs (Drones) with India's only drone training institute, i.e., **(IID) Indian Institute of Drones,** which is registered with Government.
- ✓ They provides the nation's highest quality drone training with a simple yet comprehensive model for enterprise clients, government agencies, public safety departments, and individuals.

## # Drone Regulations in India:

- ✓ Foreigners are currently not allowed to fly drones in India. For commercial purposes, they need to lease the drone to an Indian entity.
- ✓ All drones except those in the Nano category must be registered and obtain Unique Identification Number **(UIN)**.
- ✓ A separate permission is required for commercial drone operations (except for those in the Nano category flown below 50 feet and those in the Micro category flown below 200 feet).
- ✓ Drone pilots must maintain a direct visual line of sight at all times while flying.
- ✓ Drones cannot be flown more than 400 feet vertically.
- ✓ Drones cannot be flown in areas specified as "No Fly Zones", which include areas near airports, international borders, Vijay Chowk in Delhi, State Secretariat Complex in State Capitals, strategic locations, and military installations.
- ✓ Permission to fly in controlled airspace can be obtained by filing a flight plan and obtaining a unique Air Defense Clearance (ADC)/Flight Information Center (FIC) number.
- ✓ You can't fly in or capture footage of other people's property.
- ✓ Don't drink and drone.

### # Drone Categories in India

Registration is required for all but not for Nano category.

1. **Nano:** Less than or equal to **250 grams.**
2. **Micro:** From **250 grams to 2kg.**
3. **Small:** From **2kg to 25kg.**
4. **Medium:** From **25kg to 150kg.**
5. **Large:** Greater than **150kg.**

### # Required Drone Equipment in India

India has specific requirements regarding the types of features a drone must have to be flown in India (excluding those in the Nano category). These mandatory requirements include:

- ✓ GPS
- ✓ Return-to-home (RTH)
- ✓ Anti-collision light
- ✓ ID plate
- ✓ A flight controller with flight data logging capability
- ✓ RF ID and SIM/No Permission No Takeoff (NPNT)

## # Procedures for becoming a drone Pilot in India

According to the rules and regulations introduced by the **DCGA**, an ideal drone pilot must satisfy the following requirements:

- ✓ Must be at least **18 years old.**
- ✓ Should have **passed 10th** Standard.
- ✓ Should be **trained at** a DGCA recognised and approved flying training organisation **(FTO)**. Example - **(IID) Indian Institute of Drones.**

Also, drone pilots need to understand the basics of flying. They must be able to assess the weather, wind speed, and other mechanics.

There is one Institute in India i.e., **(IID) Indian Institute of Drones .** Which conduct course for Drone Pilot Training, which offers a total of four courses (1, 3, 5 and 7-day courses) in 6 cities across India and 2 more abroad.
The time duration for **multirotor** drone pilot course is **seven days** and the **fixed wing drone** pilot course is **ten days**.