

aPPLIED PHYSICS major Assignment

3D PRINTING TECHNOLOGY



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# START

Asslamulaikum friends. Welcome to our presentation.

First of all let me introduce myself I am Taimoor ul islam and my id is 14031. And our team members for this presentation are Dawood and Muhammad Sher Ali.

What if I say you that there is a machine that can make anything for you that you envisioned at your desktop on your single click? Will you believe me? Yes, now it is possible with the magic of 3D printer.

Let discuss about this magical box. Here in this presentation, we will reveal the simple working mechanism of 3d printer. Its importance and applications.

Hope you all will enjoy this discussion. Let’s begin.

# HOW WE MAKE THINGS?

To understand 3d printing technology, first of all we have to understand how we make things in normal ways.

We manufacture things generally in four ways.

## **Subtractive Manufacturing Process**

The first one is subtractive manufacturing process. Now what is subtractive manufacturing process? Probably, you have seen woodcutter cutting pieces of wood from the larger wooden block. In this example wood maker is using subtractive manufacturing process as he is subtracting pieces from a larger block of wood.

## **Forming**

The second one is forming. Forming is forcing material from different directions to adapt the particular design. As gamla makers do to make round gamlas.

## **Molding**

The third one is molding. In molding a mold is prepared in which a molten material is poured. After cooling or drying the material than adopt the size of the mold. Bricks are also made by molding process.

## **Additive Manufacturing Process**

Finally the fourth one with which we are concerned is additive manufacturing. In additive manufacturing things are made by piling up layers of materials upon each other. 3d Printer use additive manufacturing process to print almost everything.

Hope you all got that.

# WHAT ARE 3D PRINTERS?

Now let’s move ahead towards our topic 3d printers.

What does a 3d printer do? 3d printers print a digital 3d file to a physical 3d object by using additive manufacturing process by adding layers of material upon each other according to design in that 3d file.

In more easy words as we know 2d printers print 2d image or text file on a paper which is 2d printing. 3d printer do the same thing but in 3 dimension, printing a 3d model or 3d file into a 3d object.

But the difference is that in 2d printers we use ink as raw material while in 3d printers we use a plastic, rubber, metal or any other material from which we want to make something as a raw material.

Here you see pictures of a 3d printer. These printers comes in variety of size and shapes according to specific needs.

# HOW TO PREPARE 3D FILES

### **Preparing Models**

As 3d printer can’t know what is in your mind that you want to print so. The solution is to prepare a 3d model in soft form which is a digital file.

If you know 3d modeling you can make you own 3d models in any 3d modeling software like auto cade, blender, 3D maya, Autodesk. If you don’t know 3d modelling than don’t worry.

Tons of 3d models are available free of cost at different website. You can go there and download any of the model to 3d print.

If you need highly customized models than hire a 3d artist at fiver or workup. If you don’t have money than you can learn some basic 3d modelling on any software and that build a model.

If you need exact copy of an object, here you can do one more thing you can scan the object by the help of 3d scanners rather than modeling and thus can create a 3d file of that scan.

After you model it than it is the time slice it into pieces. Yes it is not finished now you have to use another software called slicer which will convert 3d file to stl format from any other format depending on the modeling software. The reason behind 3d printer only accept stl format 3d file is that stl 3d file contain information that in how much 2d layers your 3d model is divided and also density etc information. You have to do all that settings in slicer.

Once you have prepared your file you have to connect your computer to the 3d printer and click on print button in slicer just like we do with traditional 2d printers.

# HOW IT WORKS

## **Printing Process**

Now 3D printer finally take over. Let’s understand how printer use 3d file to create a real object.

Now before we move ahead mechanism of printing let’s take a look what’s inside in a 3d printer.

### **Components**

Controller Board

Controller board sends out commands to all other parts of 3d printer including the motors. It also sets the right temperature for the plastic filaments to melt, so that they take the shape of the object that needs to be printed. Moreover, it sends gcodes from the slicer software to the parts responsible for the printing process.

Filament

It is the raw material required for printing three-dimensional objects. Filaments come in many colors and materials, so you can choose one according to your needs. They are made of materials that easily melt and take the shape of the object that needs to be printed.

Frame

The frame of a 3D printer houses all of the electrical and mechanical components. It holds the components in place, and provides space for objects to be printed.

Stepper Motors

Stepper motors have the characteristic of working in steps, rather than working continuously like an ordinary DC motor, which gives them their special name. These motors inside a 3D printer help in building an object in multiple small steps. The printer head, printer bed, rods and screws move with the help of stepper motors.

Belts

The second motion component of a 3D printer is the set of belts present inside it. The stepper motor connects to drive gears via belts which fit over the gears and allow them to move smoothly with the motor.

Threaded rods

Threaded roads allow the 3D printer head to move up and down, in the z-direction. Belts allow movement in the x and y axes, while threaded rods cater the z-axis

Power Supply Unit (PSU)

The power supply unit, as the name suggests, supplies power to all the other components present inside a 3D printer.

Print Bed

The print bed is the place where the final 3D object is formed. The filament material is deposited here, just like ink is placed on a piece of paper in the traditional 2D printers.

Print Head

The print head is the part through which filament enters, melts and then takes the shape of the object that needs to be printed. It consists of two parts, the cold end and the hot end. The cold end is present at the top of the print head, and it is cold, as the name suggests. The filament enters through this end and goes down towards the hot end. A motor is attached with the print head, which allows the filament to travel from the cold end to the hot end.

At the hot end is a nozzle, through which the filament flows out. Before the nozzle is a heating chamber, which melts the solid filament into a liquid form. The liquid filament is then pushed out of the nozzle, according to the commands of the controller board.

*Motion Components*

*The motion components of a 3D printer include all such parts that move inside it, in the x, y and z directions, and contribute towards the printing process. The print bed and print head move on the instructions of the controller board, to create a 3D printed object. Let’s see which parts come under the umbrella of motion components and how do they work.*

### **Mechanism**

A 3D printer essentially works by extruding molten plastic through a tiny nozzle that it moves around precisely under computer control. It prints one layer, waits for it to dry, and then prints the next layer on top.

# WHAT ARE ITS PROS AND CONS?

## **What are the Pros of 3D Printing?**

### **1. Flexible Design**

3D printing allows for the design and print of more complex designs than traditional manufacturing processes. More traditional processes have design restrictions which no longer apply with the use of 3D printing.

### **2. Rapid Prototyping**

3D printing can manufacture parts within hours, which speeds up the [prototyping](https://www.twi-global.com/technical-knowledge/faqs/faq-manufacturing-what-is-rapid-prototyping) process. This allows for each stage to complete faster. When compared to machining prototypes, 3D printing is inexpensive and quicker at creating parts as the part can be finished in hours, allowing for each design modification to be completed at a much more efficient rate.

### **3. Print on Demand**

Print on demand is another advantage as it doesn’t need a lot of space to stock inventory, unlike traditional manufacturing processes. This saves space and costs as there is no need to print in bulk unless required.

The 3D design files are all stored in a virtual library as they are printed using a 3D model as either a CAD or STL file, this means they can be located and printed when needed. Edits to designs can be made at very low costs by editing individual files without wastage of out of date inventory and investing in tools.

### **4. Strong and Lightweight Parts**

The main 3D printing material used is plastic, although some metals can also be used for 3D printing. However, plastics offer advantages as they are lighter than their metal equivalents. This is particularly important in industries such as automotive and aerospace where light-weighting is an issue and can deliver greater fuel efficiency.

### **5. Fast Design and Production**

Depending on a part’s design and complexity, 3D printing can print objects within hours, which is much faster than molded or machined parts. It is not only the manufacture of the part that can offer time savings through 3D printing but also the design process can be very quick by creating STL or CAD files ready to be printed.

### **6. Minimizing Waste**

The production of parts only requires the materials needed for the part itself, with little or no wastage as compared to alternative methods which are cut from large chunks of non-recyclable materials. Not only does the process save on resources but it also reduces the cost of the materials being used.

### **7. Cost Effective**

As a single step manufacturing process, 3D printing saves time and therefore costs associated with using different machines for manufacture. 3D printers can also be set up and left to get on with the job, meaning that there is no need for operators to be present the entire time. As mentioned above, this manufacturing process can also reduce costs on materials as it only uses the amount of material required for the part itself, with little or no wastage. While 3D printing equipment can be expensive to buy, you can even avoid this cost by outsourcing your project to a 3D printing service company.

### **8. Ease of Access**

3D printers are becoming more and more accessible with more local service providers offering outsourcing services for manufacturing work. This saves time and doesn’t require expensive transport costs compared to more traditional manufacturing processes produced abroad in countries such as China.

### **9. Environmentally Friendly**

As this technology reduces the amount of material wastage used this process is inherently environmentally friendly. However, the environmental benefits are extended when you consider factors such as improved fuel efficiency from using lightweight 3D printed parts.

## **What are the Cons of 3D Printing?**

Like with almost any other process there are also **drawbacks of 3D printing technology**which should be considered before opting to use this process.

### **1. Limited Materials**

While 3D Printing can create items in a selection of plastics and metals the available selection of raw materials is not exhaustive. This is due to the fact that not all metals or plastics can be temperature controlled enough to allow 3D printing. In addition, many of these printable materials cannot be recycled and very few are food safe.

### **2. Restricted Build Size**

3D printers currently have small print chambers which restrict the size of parts that can be printed. Anything bigger will need to be printed in separate parts and joined together after production. This can increase costs and time for larger parts due to the printer needing to print more parts before manual labor is used to join the parts together.

### **3. Post Processing**

Although large parts require post-processing, as mentioned above, most 3D printed parts need some form of cleaning up to remove support material from the build and to smooth the surface to achieve the required finish. Post processing methods used include water jetting, sanding, a chemical soak and rinse, air or heat drying, assembly and others. The amount of post processing required depends on factors including the size of the part being produced, the intended application and the type of 3D printing technology used for production. So, while 3D printing allows for the fast production of parts, the speed of manufacture can be slowed by post processing.

### **4. Large Volumes**

3D printing is a static cost unlike more conventional techniques like injection molding, where large volumes may be more cost effective to produce. While the initial investment for 3D printing may be lower than other manufacturing methods, once scaled up to produce large volumes for mass production, the cost per unit does not reduce as it would with injection molding.

### **5. Part Structure**

With 3D printing parts are produced layer-by-layer. Although these layers adhere together it also means that they can delaminate under certain stresses or orientations.

### **6. Reduction in Manufacturing Jobs**

Another of the disadvantages of 3D technology is the potential reduction in human labor, since most of the production is automated and done by printers. However, many third world countries rely on low skill jobs to keep their economies running, and this technology could put these manufacturing jobs at risk by cutting out the need for production abroad.

### **7. Design Inaccuracies**

Another potential problem with 3D printing is directly related to the type of machine or process used, with some printers having lower tolerances, meaning that final parts may differ from the original design. This can be fixed in post processing, but it must be considered that this will further increase the time and cost of production.

### **8. Copyright Issues**

As 3D printing is becoming more popular and accessible there is a greater possibility for people to create fake and counterfeit products and it will almost be impossible to tell the difference. This has evident issues around copyright as well as for quality control.

# WHERE WE USE IT?

## **1. Construction**

Construction is one of the significant applications of 3D printing. Concrete 3D printing has been explored since the 1990s as researchers sought a faster and cheaper way to construct structures.

Today, large-scale 3D printers designed to print concrete are used to pour foundations and erect site walls. They are also capable of printing modular concrete sections for onsite assembly. These solutions allow for higher accuracy, more complexity, faster construction, and improved functional integration while lowering labor costs and minimizing waste.

In 2016, the first pedestrian bridge (12 meters long, 1.75 meters wide) was 3D printed in Spain using micro-reinforced concrete. A year later, the first fully 3D-printed residence was built in Russia. 600 wall elements were 3D-printed and assembled, after which, the roof and interiors were created for a total area of nearly 300 sq meters.

3D printing is also helpful in producing architectural-scale models. It is even being explored as a solution for constructing extraterrestrial habitats on the Moon or Mars, should the need ever arise.

## **2. Prototyping and manufacturing**

In the case of traditional injection-molded prototyping, it can take weeks to produce a single mold that would cost up to hundreds of thousands of dollars. The original purpose of 3D printing was faster and more efficient prototyping.

3D printing technology minimizes lead times in manufacturing, enabling prototyping to be completed within a few hours and at a small percentage of traditional costs. This makes it especially ideal for projects where users must upgrade the design with every iteration.

3D printing is also suitable for manufacturing products that do not need to be mass-produced or are usually customized. SLS and DMLS are used in the rapid manufacturing of final products, not just prototypes.

## **3. Healthcare**

In healthcare, 3D printing creates prototypes for new product development in the medical and dental fields. In dentistry, 3D printing is also helpful in creating patterns for casting metal dental crowns and manufacturing tools for creating dental aligners.

The solution is also helpful for directly manufacturing knee and hip implants and other stock items and creating patient-specific items such as personalized prosthetics, hearing aids, and orthotic insoles. The possibility of 3D-printed surgical guides for particular operations and 3D-printed bone, skin, tissue, organs, and pharmaceuticals is being explored.

## **4. Aerospace**

In aerospace, 3D printing is used for prototyping and product development. The solution is also critically helpful in aircraft development, as it helps researchers keep up with the strenuous requirements of R&D without compromising on the high industry standards. Certain non-critical or older aircraft components are 3D-printed for the flight!

## **5. Automotive**

Automotive enterprises, especially those specializing in racing automobiles, such as those used in F1, leverage 3D printing for prototyping and manufacturing specific components. Organizations in this space are also exploring the possibility of using 3D printing to fulfill aftermarket demand by producing spare parts as customers require rather than stocking them up.

## **6. Education**

It helps students take a more active approach to learning with its hands-on, interactive visualization-based learning experience. Students can play with 3D models that help them dive deeper into each topic and make recalling the concepts considerably easier.

# 3D PRINTING VERSUS TRADITIONAL MANUFACTURING METHODS

## **3D Printing Methods**

There are different 3D printing processes:

* Selective Laser Sintering (SLS),
* Binder Jetting,
* Stereolithography (SLA)
* Poly-Jet
* Fused Deposition Modelling/Fused Filament Fabrication (FDM/FFF), etc.

## **Traditional Manufacturing Methods**

There are four main families of standard manufacturing processes

* Injection molding
* Machining
* Forming
* Joining.

Similar to 3D printing, each manufacturing process has advantages and limitations.

## **Quantity: how large is the production run?**

Traditional manufacturing processes like forming and injection molding are more suitable for large scale manufacture, whereas 3D printing may be more economical for small volumes.

## **Lead time: how soon do you need your parts?**

The traditional manufacturing technologies require molds to be manufactured and factories to be ramped up to speed. As a result, it can take upwards of 15-60 days (and sometimes more) to have the first part in hand. For 3D printing, the part can be printed on demand and shipped without any ramp-up or tooling, resulting in a lead time as short as 2 or 3 days.

## **Shape/Complexity: what is your item shape?**

For high complexity parts, fully assembled components or parts that need to be customized, using a Professional 3D printer is the best choice. Indeed, the price of such items would be very high and sometimes they would just be not feasible using traditional manufacturing technologies such as molding, machining or forming.

## **Material selection: what material do you need?**

Traditional manufacturing options like injection molding and forming can offer a high material selection. When it comes to 3D printing, material selection is much sparser. FDM is limited to extricable thermoplastics, SLS requires thermoplastic powder that is machine-specific, and SLA and Poly-jet applications are limited to photo-curable acrylate and epoxy-based resins.

As the 3D printing technology matures, a greater variety of materials with varying characteristics are being introduced.

# GROWTH OF 3D PRINTING INDUSTRY

See slides and graphs.

# CAN WE MAKE MONEY WITH IT?

## **1. Jewelry**

The production of rings, bracelets, and earrings, among other jewelry pieces, is increasingly being done through the use of 3D printing by jewelry designers.

The market for 3D jewelry is anticipated to expand by $1.95 billion between the years 2020 and 2024, representing a compound yearly growth rate of 21%. (CAGR). The popularity can be ascribed to the ease with which extremely detailed patterns can be created as well as the greatly reduced amount of time needed for manufacture.

## **2. Home Decor Items**

The housewares industry is a natural fit for 3D printing because it appeals to those who have a strong interest in interior design.Additive printing makes it simple to construct a wide variety of objects, including vases, lamps, planters, picture frames, plates, drinkware, tablecloths, and cutlery.

Create an online storefront via which your designs may be viewed by customers, and then print their orders according to the specifications they provide.

At the same time, you can leverage existing traffic on websites such as Etsy, where customers are always looking for interesting and unique home decor that reflects their personal style and a desire for one-of-a-kind items.

## **3. Toys for kids**

Toys are some of the easiest things to make with 3D printing, and they are in high demand among people who are always eager to add to their collections of dolls, action figures, fidget spinners, toy cars and trucks, and bath toys.

The ability to customize and personalize game pieces, such as those used in chess or board games, is a trending application of 3D printing technology.

Toy printing may appear to be a simple path to commercial success; nevertheless, there are a number of issues, including intellectual property, that need to be taken into mind when selecting models to print.

## **4. Glass Frames – Made to Order**

Who doesn’t enjoy looking good in a trendy pair of eyeglasses or sunglasses?  
In the same way that no two people’s faces are exactly the same, the majority of people also do not have ears that are perfectly symmetrical.

You can remedy that by getting glasses that are 3D-printed just for you. This is an interesting specialized market to enter.

## **5. Promotional Products Printing**

Another industry that has a significant demand for 3D printing services is the creation of promotional materials. The vast majority of businesses desire customized, one-of-a-kind items to showcase their brand.

Outsourcing from the manufacturer is not an option because most factories have significant quantity demands for bespoke items, and the entire process of production and shipment would delay the whole project.

As a result, this option cannot be considered. Nevertheless, having access to a local 3D printing service would be of tremendous assistance in accelerating the overall process.

And since businesses are always seeking creative products to have their name on, 3D-printed promotional goods would be a really nice alternative for a home-based startup company if you are thinking about starting a home-based business.

## **6. Smartphone Protective Cases**

People’s personalities and aesthetic preferences can be easily and popularly reflected in their choice of a customized smartphone case. Because of this, many of them change their appearance frequently, which results in recurring sales of personalized phone cases.

## **7. Spare parts**

It’s possible to make a lot of money by specializing in the 3D printing of spare parts. Manufacturers are frequently put in the position of having to deal with the difficulties that the production of replacement parts offer in terms of both cost and inventory.

Many simply do not have the storage space necessary to house all of the components that are required for the assembly of their products, let alone the financial resources necessary to manufacture and stock them.

When you add on top of that the delays that can occur when obtaining components from overseas and the influence that this has on customer relationships, it’s easy to see how businesses might get into difficulties when they need to make repairs or replacements.

A digital database of parts that can be printed as needed is one approach that can be implemented by manufacturing companies.

As a locally owned and operated company that specializes in spare parts, you have the potential to become the go-to source for local service providers and tradespeople when they need a replacement part or a special fitting.

## **8. Medical Implants**

Numerous medical implants, such as bones, heart valves, and teeth, could be produced by your company. You might produce a wide range of them or concentrate on a particular medical area and necessity.

Keep in mind that 3D-printed medical implants are frequently subject to laws. Therefore, you must carefully examine whether a license is required or whether you must use particular materials and printers for a given kind.

## **9. ART work**

Personal art design using 3D printing can be a rewarding and sometimes profitable business. While it will take time to establish your brand, you can express your creativity by selling your products at local markets or online.