# Architectural Analysis and Functional Evaluation of 3D Printer

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***Abstract*-- Industrial adoption of 3D Printing has been expanding bit by bit from prototyping to assembling of low volume altered parts. The requirement for tweaked dental implants like tooth crowns and bridges, improved hearing aids, and orthopedic new devices has made the life sciences companies upgrade to innovation of latest technologies in 3D Printing. On-demand for low volume spare parts of old car models makes 3D printing exceptionally valuable in the car industry. It is conceivable to 3D print in a wide scope of materials that include thermoplastics, pure metals, metal combinations and pottery. At this moment, 3D printing acts as feasible end-use fabricating innovations at initial stages. Yet in the coming few years, and in blend with engineering science and nanotechnology, it can possibly fundamentally change many industrial design, production and global logistics processes. The printing is done layer by layer i.e. Additive manufacturing utilizing plastic, metal, nylon over a hundred different materials. 3D printing has been observed to be helpful in areas, for example, fabrication, industrial design, jewelry, footwear, design, building architecture, car, aviation, dental and medical businesses, geographic data systems, and numerous others. 3D printing usages are consistently expanding and it is demonstrating itself as a remarkable innovation to modern world. In this paper we try to investigate how it functions, present and future utilizations of 3D printing.**

***Keywords- 3D printing, Design technology, Additive layer manufacture, 3D objects***

## I. INTRODUCTION

3D printing is an advancement of printing innovations, competent to create or recreate freestanding refined structures in a single piece. 3D Printing or Additive Layer Manufacture (ALM) processes is just opposite to subtractive manufacturing processes. The 3D printing procedure occurring inside the machine comprises of two phases, (1) The direct transfer from software data to printed outputs, (2) positioning the print head in each of the three headings in space so as to print layer by layer the entire object [1]. Generally, first the plan is made by a CAD system, and after that the areas are printed by breaking the model in to 2D slices that prints layer by layer until the article is finished. The second phase of the assembling procedure can likewise be again divided into two essential advances "coating and fusing", all through these means, the material is laid over a surface and by the activity of a source of energy, and the layers are made. The energy sources and the raw materials differ contingent upon the used technology [2].

Domestic use of 3D printers has been on the ascent with the normal cost running from a couple of several dollars going up. Notwithstanding, one noteworthy disadvantage is that it requires high knowledgeable technician to print 3D objects [3]. In fact, it requires a capable individual to make both the digital file and the final printing process. Commercial use of 3D printers has been on the increase too in sectors, for example, the automotive business and air space designing. Spare parts, for instance, are being made in the car and air space industry prompting improved economies of scale.

## II. HISTORY OF 3D PRINTING TECHNOLOGY

3D printing is modern highly essential innovation, the introduction of 3D printing was in 1984 on account of Chuck Hull who invented a procedure known as stereo lithography [4], in which layers are included by curing photopolymers with UV lasers, from that point onward, 1990 layer by layer innovation utilized each layer has 0.1mm profundity, in 1999 the main use in medicine, in 2000 the main and initial parts of human, for example, ears, fingers was done, 2005 3D printing innovation ended up open source, in 2006 the first SLS (specific laser sintering) machine become variable, in 2008 the first self-replication printer which made the printer ready to print most of its own parts likewise at that year 3D innovation created to complete an exceptionally hard shapes and craftsmen for architects, in 2009 Atom by atom printing were done which takes into consideration Bio3D printing, in 2011 the first 3D printer Robotic Aircraft at that year the world's first 3D-printed Car and it turned out to be commercially accessible at the following year, at that year the primary gold and silver adornments were done using 3D printer.

While the expense of 3D printers has fallen rapidly and the precision of 3D printing has improved, Architects at the University of Southampton have flown the world's first 3D-printed unmanned flying machine, and KOR Ecologic prototype Urbee, a vehicle with a 3D-printed body that is worked to get 200 mpg on the freeway. Beyond ornaments and flying machine, 3D printing is presently being utilized to produce reasonable housing for the developing world, and visionaries have started to utilize the innovation to print everything from robotic arms, bone substitutions, and even particles of few atoms thick.

## III. ADDITIVE MANUFACTURING PROCESS CHAIN

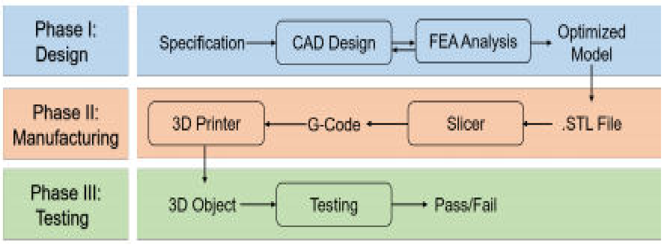


**Figure 1:** Outline of additive manufacturing process chain.

Figure 1 demonstrates an actual ALM process chain that incorporates computer aided design, finite element analysis, and computer-controlled ALM trailed by testing and assembly. The following paragraphs expand on these significant strides, with an eye towards the vulnerabilities present in each phase that could affect the final ALM product.

**Design**: This stage incorporates computer-aided design (CAD) and finite element analysis (FEA). A CAD group models the product dependent on the dimensions, properties and functionalities. The CAD programming produces the 3D model of the item on which FEA is performed. The flexible properties of the material must be known in advance so as to lead the simulations. One avenue opened by ALM is an adaptive design process where real-world usage information and FEA analysis are consolidated to consistently and semi-self-sufficiently improve the usefulness and dependability of the item [5].

**Manufacturing**: This stage incorporates cutting the 3D model and printing the item, and it is the place the ALM procedure starts to veer from traditional manufacturing. The final design of the object is changed over to *.STL format, which the slicer software at that point converts over into a target machine specific tool path code. G-code is one standard format of such tool path code, however various restrictive organizations are utilized by progressively advanced ALM equipment. G-code (as associated with material extrusion machines) encodes the movement of the printer head along x, y, and z headings, the measure of material to expel, and the movement speed of the head. Amid this progression, the G-code is stacked into the printer and the object is produced. The slicing step (in material extrusion, SLA, and so forth.) additionally includes figuring out where to utilize support material and (in all techniques) how to position numerous models inside the print volume.

**Testing**: For quality control or approval, a prototype printed part might be exposed to mechanical and physical testing, which can be destructive or non-destructive (NDT). Contingent upon the uniqueness and required dependability of the parts a randomly chosen sample or then again the majority of the produced parts might be investigated by NDT. Non-damaging testing strategies include X-ray computed tomography (X-beam CT) and ultrasonic imaging, and change significantly regarding goals and time investment. Destructive testing in the approval stage can incorporate any of the essential materials testing methods or analyses intended to evaluate consistence with different government or industry guidelines in basic AM components this progression isn't vastly different than in customary manufacturing, however expanded part multifaceted nature may confound such testing.

## IV. CURRENT 3D PRINTING TECHNOLOGIES

All 3D printers don't utilize the equivalent technology. There are different intends to print the layers to frame the final product. A few strategies melt the material or basically soften it to make the layers while others utilizes powerful UV laser beams to fix photo-reactive responsive pitch and "print" the object.

Some of the 3D printing technologies that are most broadly utilized these days [6] are given below:

1) Stereo lithography (SLA)
2) Fused deposition modelling (FDM)
3) Selective Laser Sintering (SLS)
4) Laminated object manufacturing (LOM)
5) Digital Light Processing (DLP)
6) Electron Beam Melting (EBM)

7) Selective Deposition Lamination (SDL)
8) Inkjet: Material Jetting
9) Inkjet: Binder Jetting

**1) Stereo lithography (SLA)**

Stereo lithography (SL) is generally considered as the first and foremost 3D printing procedure. It was additionally the first to be popularized. SL is a laser-based procedure that works with photopolymer resins that respond with the laser and cure to form a strong in an exceptionally exact manner. It is an intricate procedure but simply put the photopolymer resin is held in a vat with a versatile platform inside. A laser beam is directed in the X-Y axes over the outside of the resin as indicated by the 3D information provided to the machine (the .still document), whereby the resin solidifies unequivocally where the laser hits the surface. When the layer is finished, the platform within the vat drops somewhere near a portion (in the Z axis) and the consequent layer is followed out by the laser. This proceeds until the whole object is finished and the platform can be raised out of the vat for expulsion.
In view of the idea of the SL procedure, it needs support structures for certain parts, explicitly those with overhangs or undercuts. These structures should be manually evacuated. As far as other post handling steps, numerous objects 3D printed utilizing SL should be cleaned and restored. Curing includes exposing the part to extreme light in a stove like machine to completely solidify the resin. Stereo lithography is commonly acknowledged as being a standout amongst the most exact 3D printing procedures with phenomenal surface completion. Anyway limiting factors include the post processing steps required and the steadiness of the materials after some time, which can turn out to be progressively weak.

**2) Fused deposition modelling (FDM)**

3D printing using the extrusion of thermoplastic material is effectively the most well-known and recognizable 3DP procedure. The most prominent name for the procedure is FDM. Anyway this is a trade name, enrolled by Stratasys, the organization that initially created it. Stratasys' FDM technology has been around since the early 1990's and today is a modern evaluation 3D printing procedure. Be that as it may, the expansion of entry level 3D printers that have risen since 2009 to a great extent use a similar procedure, for the most part alluded to as Free form Fabrication (FFF), yet in a progressively fundamental structure because of licenses still held by Stratasys. The earliest Rep Rap machines and every resulting development utilize extrusion methodology. Be that as it may, following Stratasys' patent encroachment documenting against Afinia there is a question mark over how the entry level end of the market will grow now, with the majority of the machines conceivably in Stratasys' firing line for patent infringements. The procedure works by dissolving plastic fiber that is stored, by means of a heated extruder, a layer at any given moment, onto a build platform according to the 3D information provided to the printer. Each layer solidifies as it is kept and bonds to the previous layer.

Stratasys has built up a scope of exclusive modern evaluation materials for its FDM procedure that are reasonable for some production applications. At the entry level end of the market, materials are progressively restricted, yet the range is developing. The most well-known materials for entry level FFF 3D printers are ABS and PLA. The FDM/FFF forms need support structures for any applications with overhanging geometries. For FDM, this involves a second, water-dissolvable material, which permits support structures to be moderately effectively washed away, when the print is complete. On the other hand, breakaway support materials are likewise possible, which can be evacuated by physically snapping them off the part. Support structures, or deficiency in that department, have by and large been a limitation of the entry level FFF 3D printers. Nonetheless, as the frameworks have developed and improved to incorporate double extrusion heads, it has turned out to be less of an issue [7]. Regarding models produced, the FDM procedure from Stratasys is an exact and reliable procedure that is generally office/studio friendly, albeit broad post processing can be required. At the entry level, as would be normal, the FFF procedure delivers considerably less precise models, be that as it may, things are continually improving. The procedure can be moderate for some part geometries and layer-to-layer adhesion can be an issue, resulting in parts that are not watertight. Once more, post-preparing utilizing Acetone can resolve these issues.

**3) Laser Sintering / Laser Melting**

Laser sintering and laser melting are compatible terms that allude to a laser based 3D printing procedure that works with powdered materials. The laser is followed over a powder bed of firmly compacted powdered material, as indicated by the 3D information bolstered to the machine, in the X-Y axes. As the laser interfaces with the surface of the powdered material it sinters, or fuses, the particles to one another framing a solid. As each layer is finished the powder bed drops gradually and a roller smoothens the powder over the outside of the bed preceding the following go of the laser for the consequent layer to be framed and fuses with the previous layer.

The build chamber is totally fixed as it is important to keep up an exact temperature amid the procedure explicit to the softening purpose of the powdered material of choice. When completed, the whole powder bed is expelled from the machine and the abundance powder can be evacuated to leave the 'printed' parts. One of the key focal points of this procedure is that the powder bed fills in as an in-process support structure for overhangs and undercuts, and in this way unpredictable shapes that couldn't be fabricated in some other manner are conceivable with this procedure. Be that as it may, on the drawback, on account of the high temperatures required for laser sintering, cooling times can be considerable. Moreover, porosity has been an authentic issue with this procedure and keeping in mind that there have been huge enhancements towards completely dense parts, a few applications still require infiltration with another material to improve mechanical characteristics. Laser sintering can process plastic and metal materials, albeit metal sintering requires a lot higher powered laser and higher in-process temperatures. Parts delivered with this procedure are a lot stronger than with SL or DLP, albeit by and large the surface completion and precision isn't as great [8].

**4) Laminated Object Manufacturing (LOM)**

LOM and computer aided manufacturing of laminated engineering materials (CAM-LEM) are two firmly related SFF preparing strategies. Both techniques build a part by the lamination of sheet feedstock, which is cut by a laser along contours defined by the CAD file-generated tool path. SL or LOM is a system that utilizes metallic sheets as feed stocks. It utilizes a localized energy source, generally ultrasonic or laser, to bind a stack of precisely cut metal sheets to shape a 3D object.

**5) Digital Light Processing (DLP)**

DLP is a similar procedure to stereo lithography in that it is a 3D printing procedure that works with photopolymers. The real contrast is the light source. DLP utilizes a progressively regular light source, for example, a circular segment light with a liquid crystal display panel, which is applied to the whole surface of the vat of photopolymer resin in a single pass, for the most part making it quicker than SL Likewise like SL, DLP delivers very exact parts with excellent resolution, however its likenesses additionally incorporate similar necessities for help structures and post-curing. Nonetheless, one preferred position of DLP over SL is that lone a shallow vat of resin is required to facilitate the procedure, which for the most part results in less waste and lower running expenses.

**6) Electron Beam Melting (EBM)**

The EBM 3D printing procedure is an exclusive procedure created by Swedish organization Arcam. This metal printing technique is fundamentally the same as the Direct Metal Laser Sintering (DMLS) process as far as the development of parts from metal powder. The key distinction is the warmth source, which, as the name recommends is an electron beam, as opposed to a laser, which requires that the system is done under vacuum conditions. EBM has the ability of making completely thick parts in an assortment of metal combinations and therefore the method has been especially effective for a scope of generation applications in the restorative business, especially for implants. Be that as it may, other hi-tech sectors, for example, aviation and automotive have additionally looked to EBM innovation for manufacturing satisfaction.

**7) Selective Deposition Lamination (SDL)**

SDL is an exclusive 3D printing procedure created and produced by MCOR Technologies. There is a compulsion to contrast this procedure and the LOM process created by Helisys in the 1990's because of similarities in layering and shaping paper to frame the final part. Be that as it may, that is the place any likeness closes. The SDL 3D printing procedure fabricates parts layer by layer utilizing standard copier paper. Each new layer is fixed to the past layer utilizing an adhesive, which is connected specifically as indicated by the 3D information provided to the machine. This implies a much higher thickness of adhesive is stored in the

region that will end up being the part, and a much lower thickness of cement is connected in the encompassing area that will serve in as the support, guaranteeing moderately simple "weeding," or support removal [9].
After a new sheet of paper is fed into the 3D printer from the paper feed system and set over the specifically connected adhesive on the previous layer, the build plate is moved to a warmth plate and pressure is applied. This pressure guarantees a positive bond between the two sheets of paper. The build plate at that point comes back to the build height where a flexible Tungsten carbide blade cuts one sheet of paper at any given moment, following the object outline to make the edges of the part. When this cutting sequence is over, the 3D printer deposits the next layer of adhesive and going on until the part is completely over. SDL is one of the very few 3D printing processes involved which can 20 produce full color 3D printed parts, using a CYMK shading palette.

**8) Inkjet: Material jetting:**

3D printing procedure whereby the real build materials (in fluid or liquid state) are specifically streamed through different jet heads (with others at the same time jetting support materials). Be that as it may, the materials will in general be fluid photopolymers, which are cured with a pass of UV light as each layer is deposited. The nature of this product allows for the simultaneous deposition of a range of materials, which implies that a solitary part can be created from numerous materials with various attributes and properties. Material jetting is an exact 3D printing strategy, creating precise parts with an extremely smooth completion.

**9) Binder Jetting**

Where the material being jetted is a binder, and is specifically showered into a powder bed of the part material to fuse it a layer at a time to make/print the required part. Similar to the case with other powder bed frameworks, when a layer is finished, the powder bed drops gradually and a roller or blade smoothens the powder over the surface of the bed, preceding the following go of the jet heads, with the binder for the subsequent layer to be shaped and melded with the past layer. Besides, a range of various materials can be utilized, including earthenware production and sustenance [10]. A further unmistakable bit of leeway of the procedure is the capacity to effortlessly include a full color palette which can be added to the binder. The parts resulting directly from the machine, however, are not as strong as with the sintering process and require post-processing to ensure durability. As shown in Figure 1, the first step to 3D print an object is to make a model of the object using CAD software. The model describes the geometrical properties of the object. The CAD file is then changed over to STL document format. This document format characterizes the external closed surfaces of the initial CAD model. The STL document additionally incorporates the information for each single layer and can make calculations for the layers. The STL document is sent to the 3D printer and the printer is setup before build process, where settings incorporate build parameters, similar to energy source, layer thickness, and so forth. The part is then printed by an automated procedure with no supervision. When printing is done, the printed part is expelled and sent for post handling. After that, the object is ready for application.

The most common techniques are FDM, SLA and SLS. The following chart [11] explains the differences between them:

| | **Fused deposition modelling (FDM)** | **Stereo lithography (SLA)** | **Selective Laser Sintering (SLS)** |
|---|---|---|---|
| Material | Thermoplastic material | Photo-curable material | Powder |
| Hardening Method | Room Temperature (25 degree C) | Ultraviolet Rays | Laser |
| Manufacturing Cost | Cheap | Middle | Expensive |
| Manufacturing Time | Fast | Middle | Slow |
| Accuracy | Low | Middle | High |

**Table 1:** Difference between FDM, SLA and SLS printing techniques.

## V. 3D PRINTING MATERIAL GROUPS

Like 3D printing technologies, 3D printing materials can also be isolated into categories. The larger part of 3D printing materials can be isolated into 2 groups; polymers and metals.

**Polymers:**

Polymers in 3D printing generally come in three diverse forms: filament, resin and powder. Polymers in 3D printing are by and large partitioned into two categories: thermoplastics and thermosets. They contrast basically in their thermal behavior.

**Thermoplastics:**

Thermoplastics [12] can be softened and solidified over and over once more while generally holding their properties. Both conventional injection molding, as well as the FFF printing forms, make utilize of thermoplastics by warming up strong thermoplastic to a flexible state and injecting or extruding it into a die or onto a build platform where it then solidifies. Common thermoplastic items incorporate plastic bottles, LEGO bricks and nourishment packaging.

**Thermosets**

Unlike thermoplastics, thermosets don't soften. Thermosets [13] ordinarily start as a viscous liquid and are cured to gotten to be strong. Curing can happen by means of warm, light presentation or by blending with a catalyst. Once strong, thermosets cannot be dissolved and instead will lose basic integrity when subjected to high temperatures. The SLA/DLP and Fabric Streaming forms utilize photopolymer thermosets that solidify when uncovered to a laser or UV light. Common thermoset items incorporate two-part epoxies, bowling balls and high temperature components, just like the handles on a stove top.

**Others:**

A few 3D printing advances make utilize of ceramics [14] (regularly a polymer filled with ceramic powder) or composites (chopped carbon-filled fibers or metal-nylon powder). Polymers filled with ceramic powder have progressed wear resistance, making them perfect materials for tooling applications. SLA printing, for illustration, offers a ceramic powder filled resin utilized for the generation of high detail infusion molds. Carbon, aluminum, graphite and glass are all included to SLS powder expanding strength- to-weight execution, wear resistance and static resistance. FFF has numerous intriguing fibers accessible, like wood- or metal-filled PLA, coming about in an interesting portion appearance.

## VI. 3D Printing vs. CNC Milling: A Comparison

CNC Milling is the exact inverse of 3D printing and is generally called subtractive assembling technology. In this, a block of solid materials, for instance, metal or wood is taken and further objects are set up with the help of cutters or turning mills. These rotating mills on digitally fed codes from CAM programming and the cutters expel the superfluous bits of the block all as indicated by the codes.

They key difference between 3D printing and CNC machining is that 3D printing is a type of additive manufacturing [15], whilst CNC machining is subtractive as shown in figure 2. This implies CNC machining begins with a block of material (called a blank), and removes material to make the completed part. To do this, cutters and turning instruments are used to shape the piece. A few focal points of CNC machining incorporate incredible dimensional accuracy just as numerous compatible materials, including wood, metals and, plastics.

Let us take a few essential points of consideration and compare these innovations to find the best one

**Variety of Materials:**

Let us first take CNC processing. Here you could look over various materials to deal with, for example, metals (aluminum, metal, copper), metal compounds (bronze and steel and so forth.) wood (softwood and hardwood), froths, machining wax and thermoplastics and so on. As these materials fluctuate a lot in their features, you need various types of cutters for every one of them. In case of 3D printers, you have a wide scope of various equipment available. Some are personal while others are proficient 3D printers. And according to this, you could expect a wide range of printing materials available as well. For example, you could 3D print using ABS, Nylons, Thermoplastics, earthenware production, various types of valuable and non-valuable metals, composites, wood and paper and so forth. What's more, individuals today buy food 3D printers which could in like manner print consumable things, for example, chocolates and so on effortlessly. Not to forget, 3D printing likewise brought forth bio printing, where scientists had the option to print 3D human body parts, tissues, 3D scaffolds for bones and other life-sparing elements.

**Working Precision:**

CNC milling offers exceedingly accurate jobs. Some of them for example, the Nomad 883 and Pocket NC offer an immense accuracy of 0.001 inches and tolerance ranging to 0.005 inches. But here as well, in case the cutting gadgets are gloomy or harmed, plants are worn, or the CAM program passes on insufficient information, you might see more than many blunders that ruin the play.

Coming to 3D printing, expect extremely high exactness from a few of the most excellent 3D printers for case, Prusa 3D Printer, Zortrax M200 and CEL Robox and so forward. The precision in 3D printing seem moreover be influenced by the print technology utilized. However, not all 3D printers offer impeccable results and there are a wide number of reasons, for example, blocked nozzle and insufficient temperature and so on, where 3D printed outcomes could turn to be defective.

**Speed in Working:**

When looking at speed, you have to assess both the processes on various grounds. For example, CNC milling works quicker when chipping materials from a strong block of the object. In any case, the complex machining assignments might still take hours.

In 3D printing, the speed is for the most part slower than its comparative partner. Be that because it may, hope to induce the foremost intricate and complex 3D objects printed no sweat and with no issues.

**Vibrations and Noise:**

Regardless, CNC milling procedure could be a significant loud one. At the point when the cutting tools slam into the metals and woods, the noise could be incredibly ear-deafening. Likewise, a CNC mill would encounter substantial vibrations when working on these materials. Wholly against this, 3D printing includes insignificant noise and vibrations. You could utilize an individual 3D printer to print objects at home and this never turns to inform others with its sounds.

**Trash and Messiness:**

Pass on, 3D printing innovation is the undoubted champ in this. Expect no kind of waste and just negligible messiness when working with 3D printing materials. In any case, CNC processing includes cutting and expelling of materials from a block which not only incorporates a lot of waste material but on the other hand is somewhat messy. CNC mills need to be completely encased in a case or room.

**Cost**:

You don't generally need to purchase the best 3D printers continuously and reasonable desktop 3D printers could be acquired at a fair cost of American $500. For CNC mills, you need rather a major investment. The starter equipment could consume no under $2000 from your pocket.

**3D Printing vs CNC Milling: On the Bottom line**

Viewing all the above focuses, it could well be assumed that 3D printing innovation is an evaluation preferred and more financially savvy over the CNC milling technology. In spite of the fact that the latter offers enormous challenge to its partner in certain perspectives, considering the most up to date patterns of printing sustenance things and bio printing, 3D printing is the thing that picks up the edge.

3D printing can speed improvement and conveyance for tweaked things and bring extended adaptability through better stock organization and constant generation of items with variable interest. Other uses include manufacturing advantages for small batches, cost favorable circumstances dependent on efficiencies for specific applications and extraordinary adaptability in new markets. 3D printing also can improve quality through lighter parts, better efficiency, more safety and more design opportunity. In any case, low process dependability can contrarily affect quality; and low reproducibility can adversely affect item toughness. It's critical to think about necessities and needs to settle on the choice between 3D printing and traditional manufacturing. Like everything else, there are advantages and tradeoffs.

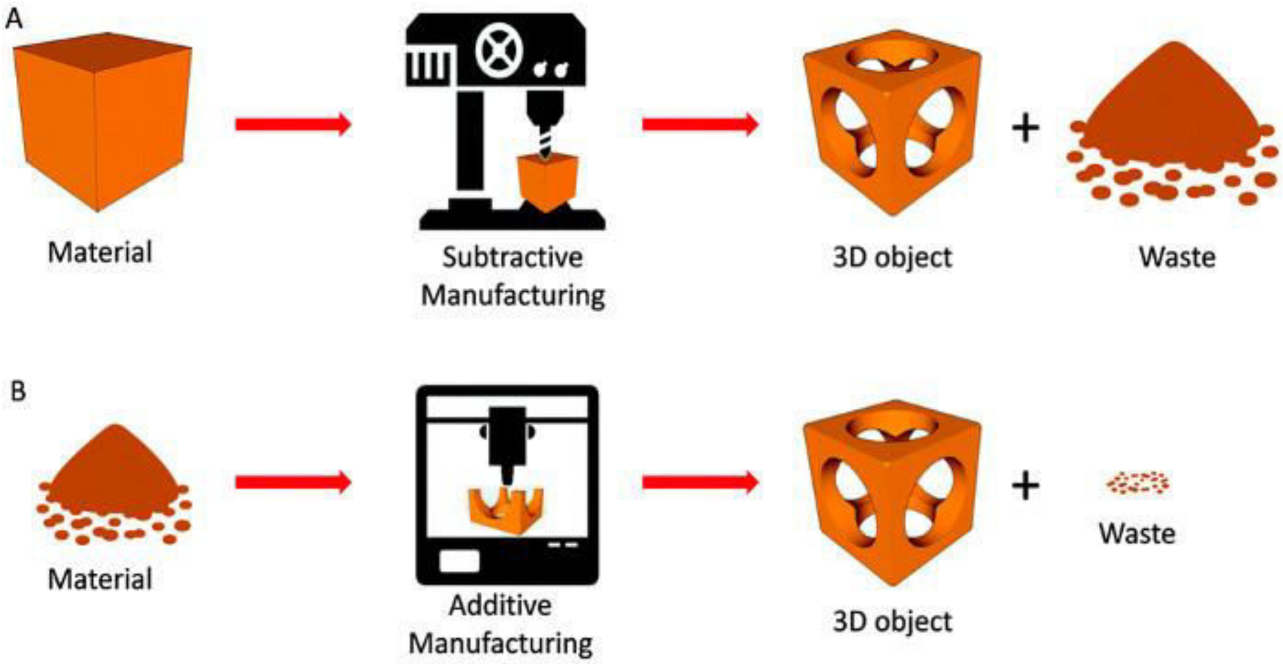


**Figure 2:** Subtractive vs Additive Manufacturing

| | Volume | Cost Per Unit | Time to market | Cost of Complexity |
|---|---|---|---|---|
| **3D Printing** | Small batch, Highly Customized | High variable costs, No fixed cost | Very fast (<=1 day) | No higher than simple parts |
| **Traditional** | Large batch, not Customized | Low variable costs, High fixed costs | Very slow to moderately slow | Much higher than simple parts |

**Table 2:** 3D printing vs Traditional Manufacturing

## VII. APPLICATIONS OF 3D PRINTING USING DIFFERENT TECHNOLOGIES IN DIFFERENT AREAS

**Aerospace**

NASA engineers drew on resourcefulness and advanced innovation. AREAS Aerospace NASA engineers drew on creativity and cutting edge development. Around 70 of the parts that make up the rover were built carefully, really from computer designs, within the warmed chamber of a production-grade Stratasys 3D Printer [16]. The strategy, called FDM Technology or additive manufacturing, makes complex shapes sufficiently strong for Martian terrain. For its 3D-printed parts, NASA utilizes ABS, PCABS and polycarbonate materials. FDM, licensed by Stratasys, is the main 3D-printing technique that bolsters production-grade thermoplastics, which are lightweight yet sturdy enough for tough end-use parts.

**Architecture industry**

Poly-Jet 3D printing innovation conveys fantastically smooth, definite compositional models in an assortment of materials, including rigid photopolymers arranged for painting. For models that must bear loads or take misuse, FDM Technology builds solid parts in production-grade thermoplastics.

**Automobile industry**

One of Ducati's key challenges is to lessen time-to-market for new products by reducing the design cycle. To help address this test, the entire plan process is approved utilizing FDM prototyping frameworks from Fortus. FDM (melded testimony demonstrating) empowers Ducati to manufacture both concept models and functional prototypes from ABS, polycarbonate and poly-phenyl sulfone [17].

**Consumer products**

*Consumer electronics:* Poly-Jet innovation can convey models with phenomenally thin walls - 0.6 mm or less ideal for little devices thickly packed with minute parts. Smooth completion and realistic hues make these models basically indistinct from the finished product.

*Sporting goods*: Prototypes often require a blend of unbending and flexible materials. Think about a helmet's hard shell and padded inside, or a couple of ski goggles with tinted focal points and elastic over molding. Just Poly-Jet innovation can create models with various materials and hues in a solitary, mechanized form, so it's optimal for sporting goods designers with an eye for aesthetics. FDM Technology works with production-grade thermoplastics to create parts with high effect quality and incredible strength. It's optimal for parts that need to withstand intense and repeated functional testing.

*Toys*: To catch the look and feel of your future items, just Poly-Jet can convey fine subtleties, smooth surfaces, fun loving surfaces, fluctuated materials and clear hues in a solitary, mechanized form process.

**Dental industry**

APEX Dental Milling Center (DMC) was one of the early adopters of CAD/CAM technology for conveying dental parts straight from CAD plan imagery. Instead of outsourcing production to CNC conventional milling strategies, the company at that point changed to in-house 3D printing. Having brought computerized dentistry into the core of its business, APEX DMC has found that in expansion to bringing down costs, it can give speedier delivery times whereas keeping up its high quality standards. For APEX DMC, any advantageous 3D printing solution needed to give at least one business points of interest, for example, better items, shorter preparing times or more exactness. The company found these focal points, and that's only the tip of the iceberg, with the Object 3D Printer. APEX DMC was impressed with the ease and speed of the Object Eden 260V 3D Printing System. The printed models created on the Objet Eden 260V delivered extraordinarily fine details and a remarkable surface finish– all important for guaranteeing the high precision required by the lab's group and its dental specialist clients.

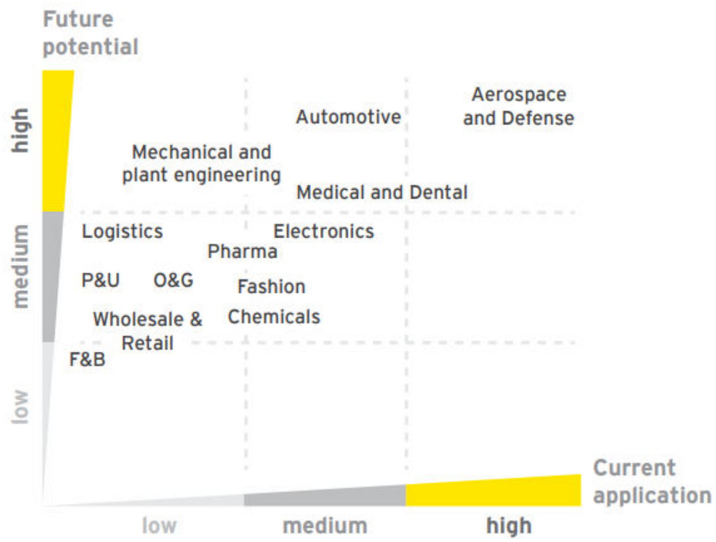


**Figure 4:** Current application and future potential of 3D printing by industry

**Food**

Numerous people shy away from the prospect of 3D-printed food, but there has been a lot of advancement in this zone. From crystalized sugar cake toppers and intellect boggling chocolate plans, to cracker-like yeast structures with seeds and spores that develop after a few time, to prepared to-heat pizzas and filled ravioli, printed sustenance has the culinary network talking. Early adopters are nursing homes in Germany, which serve a 3D-printed sustenance item called Smooth foods to older occupants who experience issues in chewing. The EU has put almost $3.3 million in this venture with the expectation of improving personal satisfaction for slight and old individuals living in care facilities. For people who have trouble to break down foods or swallowing, this method produces purees that offer tastier alternatives than traditional meals such as baby food.

## VIII. 3D PRINTING LIMITATIONS

In a part of businesses, 3D printing gives endless benefits. In any case, it isn't aiming to supplant traditional manufacturing. It is still a rising innovation with a few drawbacks that have to be be considered when selecting a product improvement strategy. Manufacturers and product designers subsequently got to see it as a handle to complement traditional manufacturing. With 3D printers, plastic blades, weapons and any other dangerous objects can be made. It makes simpler for terrorists and offenders bring a weapon without being identified. The greatest drawback of 3D printing is Counterfeiting. Anybody who gets a hold of a diagram will be able to fake items effectively. It'll gotten to be more common and following the source of the counterfeited things will be about impossible. Numerous copyright holders will have a difficult time ensuring their rights and businesses creating unique products will endure. Conventional manufacturing of products has an enormous extend of raw materials that can be utilized. Presently 3D printers can work up to roughly 100 distinctive raw materials and making items that uses more raw materials are still under improvement.

## IX. CONCLUSION

3D Printing innovation could change and re-shape the world. Advances in 3D printing innovation can basically change and improve the way we manufacture things and produce products around the globe. An object is scanned or designed with Computer Aided Design programming, at that point cut up thin dainty layers, which would then be able to be printed out to frame a strong three-dimensional item. As shown, 3D printing can have an application in dominant part of the classes of human needs as delineated by Maslow. One of the primary focal points of the industrialization revolution was that parts could be made about indistinguishably which implied they could be effectively supplanted without individual tailoring. 3D printing, then again, can enable quick, trustworthy, and repeatable methods for creating customized items which can at present be made cheaply because of automation of procedures and appropriation of manufacturing needs. Within the occasion that the last modern industrial revolution brought us huge scale manufacturing and the appearance of economies of scale - the computerized 3D printing revolution might bring mass assembling back a full circle- to a time of mass personalization, and a return to individual craftsmanship.

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