International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182, Print ISSN: 2349-5979, Impact Factor: RJIF 5.72
www.allsubjectjournal.com
Volume 3; Issue 11; November 2016; Page No. 185-189

3D printing business: Scope and development in various commercial sectors

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Abstract
The creation of a 3D printed object is achieved using additive processes. In an additive process an object is created by laying down successive layers of material until the object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object. There is a tremendous scope for 3d printing in India. Only challenge is to market and promoting a product is quite expensive because many people don't know about 3d printing and additive manufacturing technologies in India. Rest of the world is very far away and ahead from us in this technology.

Keywords: Bioprinting, Rapid Prototyping Food, Thermoplastics, Rapid Prototyping, Manipulating, Mitigate Risk, Sculpteo

1. Introduction

1.1 3D printing: An introduction

3D printing, also known as additive manufacturing (AM), refers to processes used to synthesize a three-dimensional object in which successive layers of material are formed under computer control to create an object. Objects can be of almost any shape or geometry and are produced from digital model data 3D model or another electronic data source such as an Additive Manufacturing File (AMF) file. Futurologist Jeremy Rifkin claimed that 3D printing or AM signals the beginning of a third industrial revolution, succeeding the production line assembly that dominated manufacturing starting in the late 19th century. The term 3D printing's origin sense is in reference to a process that deposits a binder material onto a powder bed with inkjet printer heads layer by layer. More recently, the term is being used in popular vernacular to encompass a wider variety of additive manufacturing techniques. United States and global Technical standards use the official term additive manufacturing for this broader sense.

Table 1: Various technologies of 3d printing

Type	Technologies	Materials
Extrusion	Fused deposition modeling (FDM) or Fused filament fabrication (FFF)	Thermoplastics, eutectic metals, edible materials, Rubbers, Modeling clay, Plasticine, Metal clay(including Precious Metal Clay)
	Robocasting or Direct Ink Writing (DIW)	Ceramic materials, Metal alloy, cermet, metal matrix composite, ceramic matrix composite
Light polymerized	Stereo lithography (SLA)	Photopolymer
	Digital Light Processing (DLP)	Photopolymer
Powder Bed	Powder bed and inkjet head 3D printing (3DP)	Almost any metal alloy, powdered polymers, Plaster
	Electron-beam melting (EBM)	Almost any metal alloy including Titanium alloys
	Selective laser melting (SLM)	Titanium alloys, Cobalt Chrome alloys, Stainless Steel, Aluminium
	Selective heat sintering (SHS)	Thermoplastic powder
	Selective laser sintering (SLS)	Thermoplastics, metal powders, ceramic powders
	Direct metal laser sintering (DMLS)	Almost any metal alloy
Laminated	Laminated object manufacturing (LOM)	Paper, metal foil, plastic film
Powder fed	Directed Energy Deposition	Almost any metal alloy
Wire	Electron beam freeform fabrication (EBF3)	Almost any metal alloy

1.2 Scope of 3d printing business

The growth of 3d printing business is growing rapidly in India. Because no one knows about 3d printing. There is a tremendous scope for 3d printing in India. Only challenge is to market and promoting a product is quite expensive because many people don't know about 3d printing and additive manufacturing technologies in India. Rest of the world is very far away and ahead from us in this technology. Some examples of various industries are as follows which used 3D Printing in their routine life and for the development of their profession.

1.3 Medical Industry

Medical 3D printing is an emerging area of technology that explores how 3D printing can be used to replace or support an existing biological structure. Medical practitioners have now begun using 3D printers to produce medical devices.

1.4 Importance of 3D printer in medical industry

- Doctors communicate more clearly with patients through tangible models.
- It's assisting doctors to plan a surgery, lowering operations time and increasing patient recovery.

- Medical device innovation through rapid prototyping.
- Low cost models arc great as teaching aids.
- It's possible to tailor parts any unique requirement.
- 90% of the raw material is used resulting in less waste.

1.5 Applications

1. Tissues with blood vessels

Researchers- at Harvard University are making great progress in bioprinting blood vessels, a crucial step towards printing tissues with a blood supply. The lab of Dr. Jennifer Lewis designed a custom-built 3D printer and a dissolving ink to create a swatch of tissue containing skin cells interwoven with structural material that can potentially function as blood vessels.

2. Low-Cost Prosthetic Parts

Creating traditional prosthetics is very time-consuming and destructive, in that any modifications to the prosthetics would destroy the original molds. Moreover, the cost, traditional prosthetics is a significant barrier to those without significant resources. Researchers at the University of Toronto, in collaboration with Autodesk Research and CBM Canada, used 3D printing to quickly produce cheap and easily customizable prosthetic sockets for patients in the developing world, particularly Uganda.

3. Drugs

In a talk Cronin describes a prototype 3D printer capable of assembling chemical compounds at the molecular level. Patients would go to an online drugstore with their digital prescription, buy the blueprint and the chemical ink needed, and then print the drug at home. In. the future Cronin suggests that we might sell not drugs but rather blueprints or apps. Progress is already being made in this direction as Louisiana Technical University researchers have printed biocompatible, biodegradable devices for delivering bone cancer medicines.

4. Medical Models

Printed models of cancerous tumors to aid discovery of new anti-cancer drugs and to better understand how tumors develop, grow, and spread. Creating patient specific models from CT and MRI scans expands from medical research into practical application with the ability to prepare doctors for surgeries, thus drastically reducing surgery times. Taking this one step further, there are numerous examples of using medical scan data to 3D print implants tailor-made to the patient.

5. Heart Valve

Jonathan Butcher, at Cornell University has printed a heart valve that will soon be tested in sheep. With a dual-syringe machine, he was able to print a combination of alginate, smooth muscle cells, and valve interstitial cells, to control the valve's stiffness.

6. Medical equipment

Already, 3D printing is occurring in poverty-stricken areas of the world. Due to the ability to manufacture items that may be difficult or expensive to obtain by traditional means, groups like iLab/Haiti have taken to 3D printing umbilical cord clamps for local hospitals in Haiti.

7. Cranium Replacement

A team of Dutch surgeons at the University Medical Center in Utrecht replaced the entire top portion of a 22 year old woman's skull with a customized printed implant made from plastic.

8. Organs

3D printed liver cells that able to function for more than 40 days. While at the moment, the product is used for testing new pharmaceuticals. Within a decade we will be able to print solid organs such as liver, heart, and kidney.

1.6 Food Industry

With the food industry, there are particularly 2 fields where rapid prototyping and 3d printing play a prominent role:

- Food & beverage packaging prototypes
- Food prototyping and producing.

1.7 Rapid Prototyping food arid beverage packaging

Although rapid prototyping different packaging for food and beverage before going into full scale production is not as common as in the automotive and aerospace industries, but, according to experts, companies are catching up very fast. It is shocking how fast and economically competitive it is to rapid prototype a food packaging compared to traditional means. Using higher quality commercial 3D printers, you can create prototypes that, once labeled, are hard to recognize from real packaging.

Different types of beverage packaging are made with rapid prototyping techniques. Since product packaging is one of the most important aspects of marketing a product, food and beverage companies increasingly recognize how vital 3D printing can be in today's competitive markets. Adjustments to 3D printed prototypes are very fast and easy, giving a company enough time to make the necessary alterations, without crossing deadlines. Considering the recent and future estimated drops in 3d printing prices, a promised 3d hardware revolution may be at hand, where the economic benefits of 3d printing for rapid prototyping techniques will be so much, that even low cost and fast prototyping jobs, like food and beverage packaging, will say goodbye to their traditional prototyping methods and embrace the future.

1.8 3D Printed Food

One of the more interesting and new areas of 3D printing is printed food. While we might not be very far from kitchen machines that rapidly produce our wildest, most delicious dreams with the push of a button, 3D printed food has a more strategic advantage that could help reduce global warming and humanity's growing dilemma of low natural resources.

1.9 Some Applications of 3D Printed Food

Here are a few interesting ways 3D printers can be used in near future

- **Modern Food Designs**

Some designs and structures are hard or even impossible to achieve with food. Modern prototyping techniques, especially 3D printing, allow us to create nearly any imaginable design with food. While 3D printed food is still not as much delicious as the handcraft of a chef, but its pleasures for the eye are so

much that one could already forget about the shortcomings in taste.

- **Food for the Elderly**

Until now, old people with chewing and swallowing problems had to eat the same puree, just in different flavors, again and again. This was also the case for people with Cerebral Palsy, stroke victims, and other disabilities that may impair swallowing. But with companies like Biozoon and cuisines like Smooth food, the play field has changed altogether.

- **Food Printing in Space**

Maybe you haven't been in space, but chances are that you have already read about freeze-dried foods. NASA is now actively looking for ways to 3D print food in space.

1.10 Architecture Industry

Poly Jet 3D printing technology produces astonishingly smooth, detailed architectural models in an array of materials, including rigid photopolymers ready for painting. For models that must bear loads or take abuse, FDM Technology builds strong parts in production-grade thermoplastics.

Poly jet 3D printing technology produces astonishingly smooth, detailed architectural models in an array of materials, including rigid photopolymers ready for painting. For models that must bear loads or take abuse, FDM Technology builds strong parts in production-grade thermoplastics. By printing more detailed models, will help your clients to better visualize the final projects, ultimately helping your firm to win more business. 3D printing is set to revolutionize the way architects explore designs and innovate. 3D printing for architects empower them easily creates complex, accurate and durable scale models quickly and cost- effectively. Magnificent 3D printed architectural scale models can help architects impress their clients create and seize more opportunities. All of this can be done iii house, in a matter of clicks.

1.11 Benefits of 3D Printing in Architecture

1. **Help Clients to Better Visualize the design:** By printing more detailed models, will help your clients to better visualize the final projects, ultimately helping your firm to win more business.
2. **Reduce in number of hours spent creating models:** With a 3D Printer can significantly reduce the time and expense in producing building models, often requiring highly delicate details. 3D printed models are also stronger than traditional models and won't buckle or break over time.
3. **Create a library of Reusable Designs:** Using 3D printing allows you to be more innovative with your model making. For instance when you have repetitive pieces, you can print one as a mold, cast it, and then use the cast to injections-mold the required duplicates.
4. **Promotion scale models:** Visualize your clients on your imagination. Promotional 3D printed models arc a key component on virtual tours to promote your real estate project. They allow your investors or future clients to project themselves on your programme.
5. Architects can test market potential, discuss ideas with potential buyers or raise capital from investors.
6. Easily recreate textures, finishes and colors to create a new dimension.
7. You can print complex shapes and geometries.
8. It creates less waste, using up to 90% of the raw material.
9. **Saves Time and Money:** One of the major benefits of 3D printing for architects is time-saving and cost-effectiveness. Unlike the traditional ways, 3D printed architectural scale models can be developed in matter of hours. Conventional methods require many days, many man-hours and skilled craftsmen, thus adding to the cost.
10. **Added Design Possibilities:** 3D printers allow architects to design freely without worrying about human-errors being introduced in the final output. 3d printed architectural scale models are immaculately accurate. This freedom empowers architects to push the boundaries of design while having the possibility of rendering multiple-copies faster than ever.
11. **Better Perspective:** No amount of drawings, blueprints, or digital 3D models can emulate the "real-life" perspective offered by 3D printed architectural scale models. Architects can identify, test and assess the scale-method for design flaws taking correctional measures before construction. These visually appealing scale models can also be leveraged in promotions and presentations to clients.

1.12 Automobile Industry

Since the early days, 3D printing in automotive manufacturing has witnessed unprecedented industry adoption. With the emerging economical and environmental concerns, there is a pressing need to rethink the way automobiles are designed and manufactured.

The automotive industry ought to adapt to this shift in paradigm quickly. This is where 3D printing in automotive design swiftly steps up. 3D printers not only help the aesthetic design of vehicles but it also has the prowess to deliver working prototype in record turnaround time. Leading global companies have recently begun to realize the commercial benefits of 3D printers in automotive manufacturing beyond prototyping. 3D printing has significantly transformed the way automobiles are designed, developed, and manufactured. 3D printers in automotive manufacturing and design can offer global automobile manufacturers the following benefits.

1.13 Benefits of 3D Printing in Automotive

1. 3D printing shrinks the development process from months to a matter of days.
2. You're able to test ideas quickly and discover what does and doesn't work. New iterations have no cost penalties.
3. It's easy to personalize and tweak parts to uniquely fit your needs at no extra cost and in just a matter of hours.
4. Engineers can discuss a design wit peers or rapidly test the market potential at a trade-show.
5. You can verify a design before investing in an expensive molding tool.
6. **Rapid Prototyping:** One of the major benefits of 3D printers in automotive design is the empowerment of rapid prototyping in the pre-manufacturing stage. Companies have the possibility of developing everything ranging from scale-models right down to individual component, faster than ever. Prototyping in-house allows businesses to control any Intellectual Property (IP) infringements and information leaks.

7. **Lower Turnaround Time:** Time saved in the prototyping stages drastically reduces turnaround time across all subsequent stages of manufacturing. This adds great business value in terms of lower costs and added agility.
8. **Low Consumption and Wastage:** 3D printing in automotive design drives lower consumption and wastage unlike the traditional approaches of vehicle design. Learning from this can be effectively leveraged in reducing consumption and wastage of materials in all subsequent manufacturing stages.
9. **Lower Costs:** Time and resources saved in the various stages of production reduces overall cost of production. Lowering costs at every level allows companies to transfer some of the cost-reduction benefits to the end-user.
10. **Added Flexibility:** 3D printers in automotive design empowers companies to try multiple options and iterations right in the development stages, leading to optimum and efficient automobile design. Manufacturers have the ability to make design changes on-the-fly helping them stay in-tune with market requirements and ahead of competition.

1.14 Fashion Industry

3D printing in the textile industry lets you unleash your imagination in order to quickly create new structures through innovative new materials.

1.15 Tailor-made with 3D printing

In the textile industry we are often forced as consumers to choose between different sizes which, depending on the brand, will not be perfectly adjusted to the dimensions of our body. With 3D printing you can create custom-made clothing. Various 3D modeling softwares allow you to create clothing that suits you depending on your body type. You will have to transcribe your measurements on 3D modeling software and then modelize what you have in mind. The frames will be tailor made so that you can print in rigid plastic or flexible plastic. One of these two materials associated with the conventional textile will allow you to create innovative clothing and perfectly suited to your body type.

1.16 Benefits of 3D printing in fashion:

1. It's easy to customize and tweak each design to fit your needs at no extra cost.
2. There's complete freedom to create any shape, even complex geometry.
3. You can recreate textures, finishes and colors that add a whole new dimension.
4. Designers can try an actual product and test its appeal.

1.17 Education

Education holds the key to unlocking the true potential of human ingenuity. Education should be multi-dimensional, giving equal importance to theoretical as well as a hands-on, practical approach. Integrating 3D printing in education exposes eager learners and future creators to stay adept with tomorrow's cutting-edge technology.

Numerous progressive schools, universities, and educational institutions across various disciplines have already integrated 3D printing technology into their classrooms and curriculums. 3D printing fuels limitless creativity and collaboration empowering pupils to envision, hold and test their ideas in real spaces. Here are some additional benefits of 3D printing in education.

1.18 Learning by manipulating

3D printing allows complex ideas to live in the real world From mathematics, to geography or history, one of education's key challenges is to allow everyone to grasp the most abstracts concepts. 3D printing is the solution to give them life and allow everyone to physically manipulate complex ideas. Visualizing data into space or creating physical educational material is a great addition to 3D images, texts and videos. Different 3D printing material, like plastic or resin, is very resistant over time, which allows you to transport and manipulate your material without risk. The multicolor material allows you to recreate textures from an historical object or to present data in 3D.

1.19 Technical, design or engineering curriculum

Bring the professional world to your students. 3D printing is a great tool for curriculum with a high level of professionalization. Using Sculpteo allow students to understand how they can easily go from a 3D file to a 3D model and a product. Our exclusive online tools allow everyone to analyze, review and optimize 3D files autonomously.

1.20 Benefits of 3D Printing in Education

1. **Practical Hands-On Approach:** 3D printing in academics helps transform students being passive consumers to active creators. Current system relies heavily on theoretical learning and very little on real-world deployment of knowledge. Having access to 3D printing technology at grass root level allows more students to adopt a practical hand-on approach.
2. **Engagement and Interactivity:** Educators have already witnessed the transformative effect introducing computers that have had in classrooms. 3D printing in education has the same transformative prowess. Introducing new technologies in the curriculum stimulates engagement and interactivity, even for the students who are coping with theoretical aspects of education.
3. **Promotes Problem Solving Skills:** 3D printing in education exposes students to a variety of learning experiences. Observations by leading educators have suggested that using 3D printers promotes development of problem solving skills and skills of persistence and prowess to overcome challenges.
4. **Sparks Creativity and Innovation:** Imparting new ideas and methodologies is easier done in the formative years of children. Empowered students in classrooms and education environments are equipped to solve tomorrow's challenges with creativity and innovation. Schools, universities and other educational institutions ought to introduce a curriculum based around 3D printing.
5. Three-dimensional visuals act as amazing learning aids to help explain difficult concepts to students at all levels
6. 3D printing inspires hands on learning and is a natural complement too.
7. It enhances problem solving as they have to correct flaws and reprint it to arrive as its final form

8. It introduces them to digital manufacturing and processes".
9. Three dimensional visuals act as amazing learning aids to help explain difficult concepts to students.

1.21 Entertainment Industry

In a business where every product is custom and unprecedented, 3D printing offers quick, agile fabrication. Effects studios, filmmakers and game designers use it in some of their most demanding projects.

Hollywood special effects studio Legacy Effects uses 3D printing to make blockbuster movies. And remember the farm family in Chipotle's award-winning 3D animation "Back to the Start"? They were 3D printed. Bono even swung from a 3D printed custom microphone during U2's world tour.

1.22 Make your movie heroes become real

Have you ever hankered for your favorite TV character to be real. Would you like to have a hero figurine to your image on your desktop? It's very easy with 3D printing! Check that you have the right to do it, upload your design on our website, set the size and get an instant quote on the price for 3D-printing. As studio, create a service of customized figurines for your fans and take advantage of 3D printing that allows each design to be slightly different without requiring a whole new process. Make a personalized marketing for each customer to reinforce their enthusiasm and passion.

1.23 Create perfect objects for using in a TV show

Many accessories are needed to shoot a TV program or a movie. Most of them are unique and need to be printed only once, that's why professionals of broadcasting often prefer 3D printing to manufacturing because it's easier, cheaper and faster. Printed object can be as simple as decorative brand logos for a TV show to promote a company or a product. From a simple logo, you can easily extrude a 3D object to create perfect badges or magnets.

1.24 Invent accessories to make your shooting easier

A lot of video and audio equipment is required on a shooting and that implies many peripheries and wires. Also technology is changing very rapidly and a brand new camera can quickly become obsolete and need adapters. For these reasons you'll love the 3D-printing solution that allows you to create dedicated boxes for your camera that will embed all peripheries. Reduce the risk of breaking them while carrying or during manipulations.

1.25 Merits of 3d printing

1. **Time-to-Market:** 3D printing allows ideas to develop faster than ever. Being able to 3D print a concept the same day it was designed shrinks a development process from what might have been months to a matter of days, helping companies stay one step ahead of the competition.
2. **Save Money:** Prototyping injection mold tools and production runs are expensive investments. The 3D printing process allows the creation of parts and/or tools through additive manufacturing at rates much lower than traditional machining.
3. **Mitigate Risk:** Being able to verify a design before investing in an expensive molding tool is worth its weight in 3D printed plastic, and then some. Printing a production-ready prototype builds confidence before making these large investments. It is far cheaper to 3D print a test prototype then to redesign or alter an existing mold.
4. **Clear Communication:** Describing the product you are going to deliver is often misinterpreted since it leaves construction up to the imagination. A conceptual picture of the product is better than the description since it is worth 1,000 words, but getting to hold the tangible product-to-be, in hand, clears all lines of communication. There is no ambiguity when holding the exact, or at least a very close, representation of the product.
5. **Get the Feel:** One thing you can't get from a picture or virtual prototype on the computer screen is the way something feels in your hand. If you want to ensure the ergonomics and fit of a product are just right, you must actually hold it, use it and test it.
6. **Build your Imagination:** In the modern boom of digital art and design, the possibilities are not only accelerating but limitless. One can now 3D print almost anything they imagine after drawing it up virtually. In a relatively short time, an idea, concept, dream or invention can go from a simple thought to a produced part that you can hold.
7. **Fail Fast, Fail Cheap:** Being able to test ideas quickly and discover what doesn't work accelerates discovery leading to an ideal solution. 3D printing allows a product developer to make breakthroughs at early stages that are relatively inexpensive leading to better products and less expensive dead-ends.

2. Conclusion

Thus, at the end we come to conclude that field like architecture, aerospace, defence, medical etc. No longer need to be dependent upon manufacturing industries. This task can be undertaken and fulfilled quickly by 3D printers. Gone are the days where patients had to wait for donors, as organs can be printed easily using patient's own cells. Also, a time is soon to reach where people would go to their printers instead of kitchens when they are hungry.

All thanks to 3D printing, the concerned industries would be progressing swiftly and bringing huge economy to the country. With passage of time, additive manufacturing is becoming more and more affordable. Thus, this is an economic solution to all our problems. Along with saving time and money, these are to produce almost anything at any time. By reducing the cost of labour, additive manufacturing would be taking taking us to the doorstep of being a developed country.

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