The future in 3d printing: A comprehensive review of three-dimensional printing in orthodontics.

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Abstract:
As the world enters a new era of manufacturing revolution with 3-D printing, all wonder what effects it will have on the dental industry. Three-dimensional printing has quickly become one of the hottest areas of technology in orthodontics, thanks to its wide range of clinical applications. Three dimensional printing also known as additive manufacturing, is a technology whereby sequential layers of material are deposited on top of one another to eventually form an object. With new-generation printers rendering accurate, affordable, and instant prototypes, 3-D printing has proven to be economical and easy to use in an orthodontic practice.

Index Terms/Keywords:
3-D printing, three-dimensional printing, orthodontics, dentistry

I. Introduction

Orthodontics, in particular, has quickly incorporated advanced technologies in dentistry as and when available. One of the most cutting-edge technologies in the manufacturing sector is three-dimensional printing. Making dental casts was one of the very first applications for three-dimensional printers in orthodontics. The intraoral scanner allowed dentists to take dental impressions without the discomfort that patients experienced with traditional impressions.

3D printing, also referred to as additive manufacturing, is a technique in which successive layers of material are put on top of one another to gradually come to form an item. It is the antithesis of subtractive manufacturing, which involves carving away a block of material to create the product.

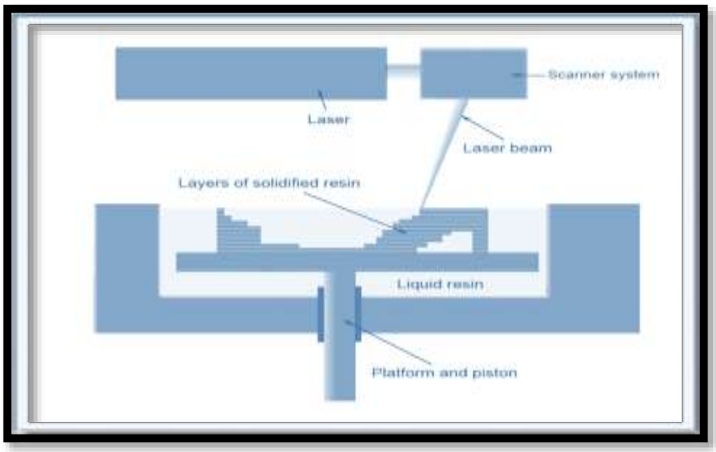
By using UV light to cure tabletop coatings in 1984, Chuck Hull developed the concept of 3D printing. Hull founded a corporation in 1986 to market the first rapid prototyping device, which he named stereolithography (SLA).[1,2-4] Fused deposition modelling (FDM), created by Scott Crump in 1988, went on sale in 1990.[5] In 1998, Polyjet Photopolymer (PPP) printing was established.[6] Several firms currently provide dozens of 3D printers that use various SLA, FDM, and PolyJet technologies.

II. Three-Dimensional Printing Technologies

1. Stereo lithography (SLA)

Stereo lithography is an additive manufacturing process using a build tray of liquid UV-curable photopolymer resin and a UV laser to build parts layer by layer at a time. An SLA printer's build tray is submerged in a liquid resin that can be cured by a powerful ultraviolet laser light (Fig. 1)

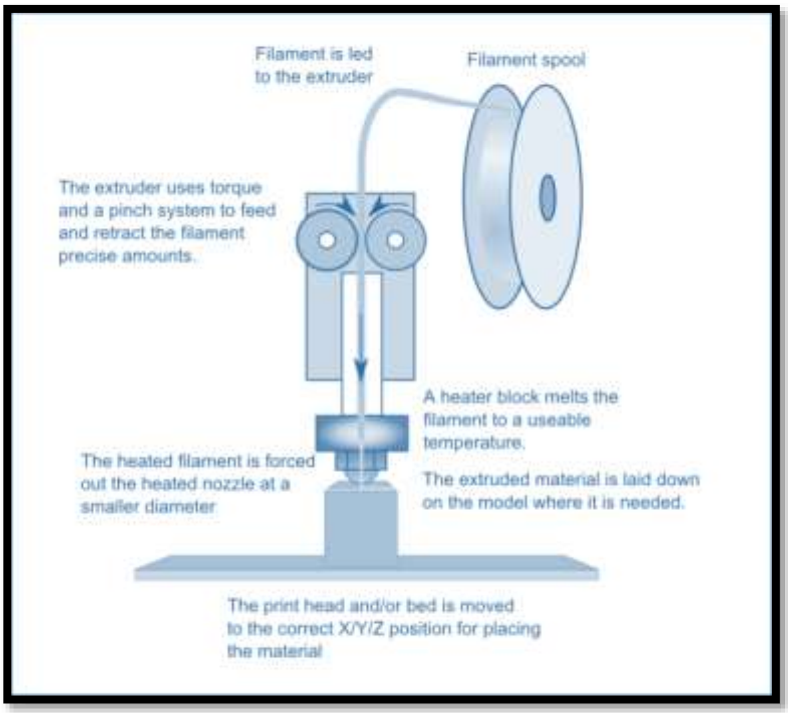
Each layer is created by the laser drawing a cross-section of the item. The tray falls by a distance equal to the layer thickness after the layer has dried, allowing uncured resin to cover the prior layer. Hundreds of instances of this process are carried out as the printed object acquires shape. As a result of the laser's limited ability to cure a large area at once, SLA printers are typically slower than others.



(Fig.1)

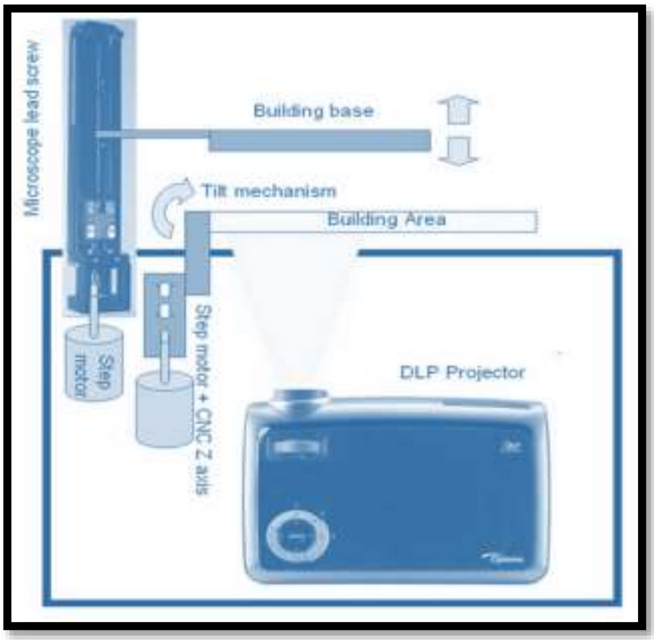
2. Fused Deposition Modelling (FDM)
A resin heated just past its melting point is extruded by an FDM printer and deposited layer by layer. Extruded hot material rapidly hardens following extrusion, minimising errors. (Fig.2)

The most popular materials are acrylonitrile butadiene styrene and polylactic acid (ABS). They frequently arrive on spools that can be easily replaced as needed.



(Fig.2)

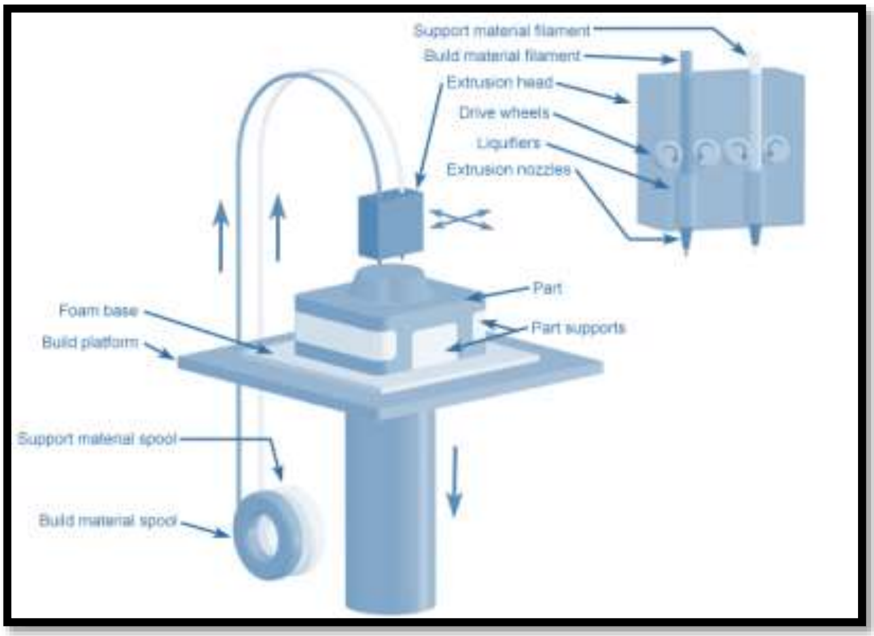
3. Digital Light Processing (DLP)
The only difference between DLP and SLA is the light source. In contrast to the SLA laser, which needs to draw the complete layer in order to cure it, a projector may cure an entire layer at once. This leads to noticeably quicker print times, comparable to the distinction between stamping and sketching an object. (Fig.3)
There are no visible steps since a DLP printer constructs a model using voxels rather than layers, making the final quality the greatest available for 3D printing.



(Fig.3)

4. PolyJet Photopolymerization(PPP)

PPP printers use the same fundamental technology as a typical inkjet office printer, but they print in three dimensions. Many nozzles spray liquid resin, which is then instantly exposed to UV radiation to cure it (Fig. 4). In order to allow additional layers, the build platform adjusts vertically. Although this method does create stratification lines on the model, the surface quality of PPP models is frequently very good because the build layers can be as thin as 16 microns.



(Fig. 4).

III. Conclusion:

The various 3D printing technologies can have an impact on the precision of three-dimensional printed models. The PPP is the technology that is the most accurate overall, according to this evaluation. Although 3D printing hasn't yet spread throughout orthodontic offices, we anticipate it to take a similar route as intraoral digital scanners. Models created using intraoral scanning, computer aided designing and automated 3D printing have a greater amount of details than a conventional model would. 3D printers can be also used to make auxiliaries such as retraction hooks, lingual retainers and attachments for aligners thus the orthodontist can accomplish a fully digital workflow by adding a 3D printer.

IV. References

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