3D-Printing: Which way should it go?

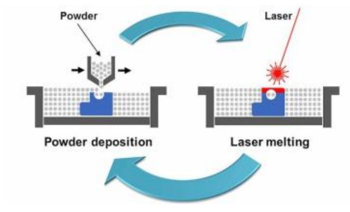
A few decades ago, 3d printing was quite easily comprehensible, its three major technologies quickly distinguishable:

1.: Chuck Hull polymerized resin by laser on a top down machine –invented SLA and founded 3D Systems in 1986. Today resin is polymerized by a Laser, by a thumbnail-sized chip containing

1-2mio switching mirrors, or by displays like your mobile or TV.

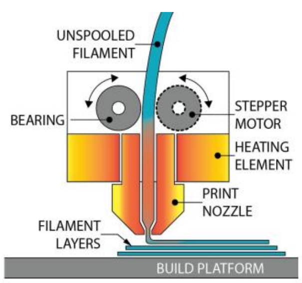
2.: At about the same time Carl Deckard lasered plastic powder -invented SLS and founded DTM, later bought by Chuck Hull´s 3D Systems.

Arguably the **most promising technology**? To be discussed in this essay in the later section.



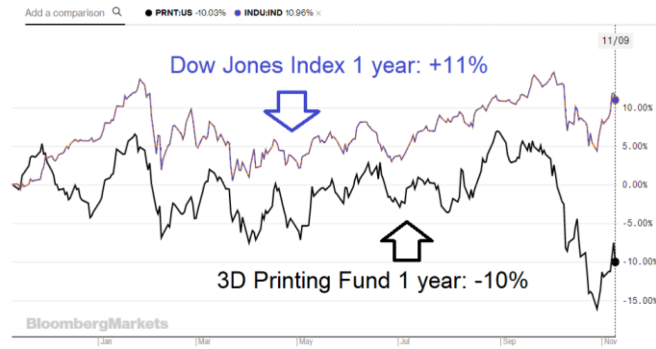
3.: Scott Crump melted a plastic filament extruded by a heated nozzle that laid one beam on top of the other like a Canadian blockhouse –invented FDM and founded Stratasys in 1989; no big evolution can be found here, today´s precision allows for 20 micron layers on good machines, and material diversity grew, like bronze, wood, various plastics, etc.

What followed was Polyjetting, where resin is pressed out of a printhead like the one in your ink jet printer at home, and binder jetting, where a liquid is jetted onto a powder layer on the print bed so that the neighboring spheres are "glued" together. And barely adopted outsiders like printing and cutting copy-paper, gluing page onto page.



However, even taking into consideration that annoying post processing has been conveyed to neighboring machines – now we are talking systems, space for machine parks, and cost- the 3D printing hype came to an end, as reflected by the stock market´s 3d printing index PRNT, which is so recent (you guess why?) that I have to show you its heavy weight´s former chart development in a second graphic in order to let you

esteem the gravity of hurricane that burned previous 3DP-ETFs to ashes:

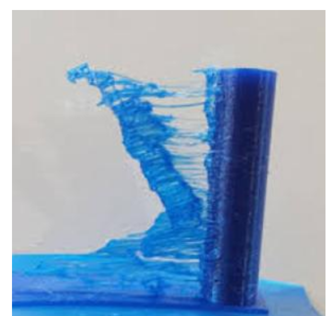


The technologies are quite easy to differentiate by use: FDM= consumer market, the rest is for the industry, as the other processes are dangerous (high laser power, carcinogenic resins, nano-particles in powder, needing mask-protection, evacuation systems, inert gas chambers, etc).

However it is fair to say that even FDM printers ship to the industry in order to support show cases by providing prototypes. Remember how hard it was to understand the 2D drawing showing three sides and a lot of cross sections? Now the architect can show the palace to the sheik in 1: 1000 scale –well 1:100 would be sufficient for my house, and it still fits my wife´s palm.

All three major patents expired long ago, yet today we have to learn over 20 new technology-names –mainly because of ego trips and the need to avoid costly patent wars,

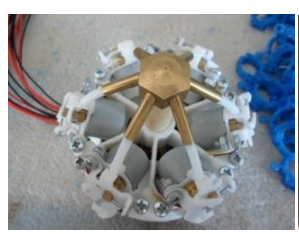
so every "inventor" slightly modifying a melting (FDM/SLS) or polymerizing (SLA/Jetting) process finds another abbreviation for his "paradigm shifting" methodology, enabling him to found a company and trying to enter the hall of fame.



Yet: 3D printing at home gets boring after a while, you cannot make all sizes in full color at a reasonable price, the stuff cracks –if the print succeeds at all…

Worse: The industry is unhappy, having hoped that the transition from prototype to mass production was just a decade to go; 20 years later it is still waiting. Which printer can replace cheaply ABS-granulate injection-molding machines producing by the millions, especially when the powder is at least ten times the granulate´s price? Post processing is another nightmare, besides dim surface finish, part accuracy, strength, porosity, repeatability, etc.

We can quickly exclude FDM from the mass producer´s wish list, as the quality, especially in Z, will usually be too bad to ever receive functional parts. The FDM process is well understood and might need color, so we built a 6 filament printhead prototype with load control and 2µm filament movement detection.



You may have heard of the many breakthrough technology providers like electron-beaming Arcam, Fusion Jetting HP, powder-reusing Aerosint SLS (yes, plastic powder 10-100 times more expensive than the injection molded granulate regularly cannot be reused and has to be wasted!), and we see the advantages of these tech-modifications, but mass production? No way! Arcam´s technology serves the military, aeronautical and medical industry, it´s for the Formula 1 race car, not for your Toyota. It prints the rocket, not the sprocket, to give you a picture.

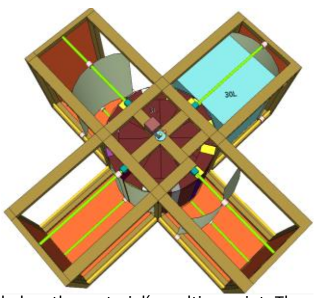
So instead of bothering you with detailed tech-discussions of “sideways” technologies – those that remain but wont give new hope, possibly leading to no-where- I chose to analyze in a moment those methods that have a chance to tempt serving as alternatives, eventually even as replacements, for the mass production systems like injection molding.

Still let me quickly give you an overview of the technologies that I don’t think will change the world: All resin-based inventions can only emulate functional materials. Those products being “born” in a vat of homogenous resin can be used for Adidas shoe soles and show multiple functional properties at the same time and SLA printers make precise individualized objects for good prototypes. This is where injection moulding machines cannot work, like expensive stuff “wrought” for humans. LOM/SDL done paper-works should be replaced by colored FDM objects. Here Geniusthingks offers a filament printhead, giving millions of colors or material mixes.

Polyjetters using resin are precise, colorful and of better quality than SLA. Here we still have a speed problem, so at geniusprinters, we invented a vertical drum with printheads installed at the inside, jetting to the outside. Unidirectional rotations are much faster, and this principle applies to many of our inventions as we will see in further discussions. An automatic 24/7 industrial MJP 4-table printer version is shown here.

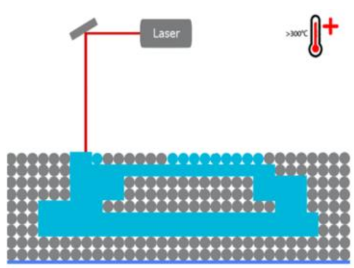
All that needs to be discussed is: **<u>Fusing Powder</u>**. Binding/SLS/SLM/DMLS/EBM: Metal or plastic? Sintering or melting? What “adhesion” quality?

You already learned that EBM makes that NASA stuff, an electron beam melts powder on a preheated layer, the part´s surface is rougher compared to SLM machined parts, and the support-points are harder to remove, but the part´s strength is usually better. Hot isostatic pressing helps to come even closer to wrought parts quality. No cheap stuff, but the best we have got so far for “freestyle” designs.



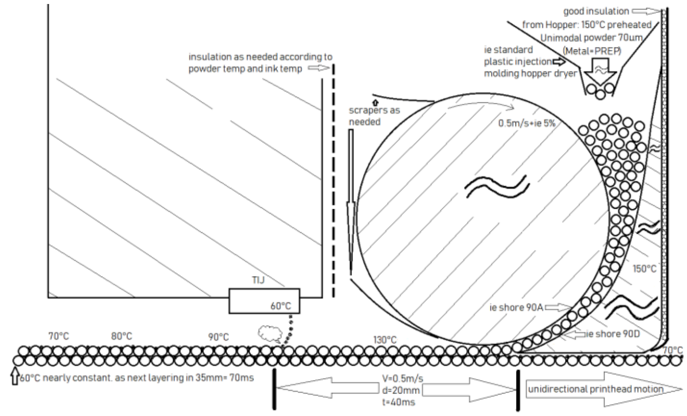
The SLS/DMLS process in contrast doesn’t melt the powder but just sinters it by staying below the material´s melting point. The part´s strength is worse, internal porosity of 30% cannot match molten part´s strength. Why is that?

Well, look at this picture, what is wrong here? The circle can neither transform into a rectangle of the same layer height, nor could the sphere turn into that cube! Powder printing works best with stacked spheres. 1-Pi/(3x root2) gives you the minimal empty volume, ca. 26%, so 30% is no modest estimate.



In order to revolutionize the 3D printing world by replacing injection molding machines, the task would be to: produce a (drum) printer that is at least 200 times faster than HP´s current Jet Fusion system (another powder sintering process) AND to eliminate the empty-volume-weak-part-problematic AND to overturn the poor surface finish restrictions, AND to work for ceramic, metal and plastics.

That´s exactly what we did at geniusprinters! We are looking for an investor enabling us to exploit our patents, building the world´s first powder-based 3D printer that can print a layer of 1/4m² within 100 milliseconds.



We call this technology Hyperfusion. It is faster than HP s and Desktop Metal´s inventions.

We are keen to bring to live all of our patents, like gel-printing robots allowing for objects of unmatched volumes of 10-100m³ (ie refugee-shelters), and house printing robots, etc.

Markus Ulrich is the founder and CEO of **geniusthingks**, the holding of geniusprinters. His think-tank offers unconventional solutions for tough nuts to crack. Markus studied mechanical engineering, founded and led an IT-database company for 13 years and built machines for all his life.