

A Discussion of the Future of 3D Polymer Printing

A SMARTECH PUBLISHING INTERVIEW

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An interview with Scott Dunham, Vice President of Research at SmarTech Publishing.

He is interviewed by Lawrence Gasman, SmarTech Publishing's President and founder

Lawrence: Polymers have been the mainstay of the additive manufacturing world since the very beginnings of 3D printing. Although metals printing has grabbed much of the limelight in past few years, SmarTech believes that "plastics" represent a substantial opportunity going forward. We publish an annual market analysis report and ten-year forecast that identifies the current and future market opportunities in 3D-printed polymers. We are speaking here with Scott Dunham, Vice President of Research and the author of the study, "[Opportunities In Polymer and Plastic 3D Printing-2017](#)" to discuss what SmarTech is seeing in the 3D-printed polymer business.

I should also mention that we have a report and forecast on the related market area of 3D printed [composites](#). And both the polymer and composites reports are available now.

Scott, I'm going to kick off with a general question. Are you seeing any significant opportunities for polymers, and how do you see market size, and evolution in the near future?

Scott: The perception out there in the market, is that polymer-based 3D printing for manufacturing has fallen behind the curve a bit, compared to the metal segment. As an industry analyst, I would say that I agree with your sentiment. Things have changed and metals are a little bit more in the limelight.

Of course, what this means is that there's a lot of significant opportunities out there for companies to come in, and solve some of the problems that we're seeing, and bring improved solutions. I'm optimistic that will happen. Some of those challenges will be solved, given the interests in additive manufacturing, across the board; it just seems to be at such an all-time high.

As far as specific opportunities for polymer 3D printing, there's no doubt in my mind that the short-term areas are going to be ones that already seem familiar. Medical and dental applications currently, just are no-brainers at this point. That's probably, where you'll see a good deal of the focus going right now. The whole serial manufacturing issues around

3D printing with polymers and metals, can get sorted out over the next 18 months or so.

If you combine the opportunities for polymer print materials and the printers themselves, for medical and dental opportunities together, our models are showing more than \$560 million of total revenue opportunity there for printers and print materials on the polymer side, by the end of 2018. That's before you even start considering things like services related software; secondary opportunities that might be driven by medical applications, but, ultimately, fulfilled by printers and materials in service bureaus. That's a pretty significant opportunity, coming in just the next few years.

If you extend those same projections, to say, 2026, within nine, or ten years, that same opportunity, medical and dental applications for polymers, looks at between \$2.5 billion, to maybe \$3 billion by our SmarTech market model estimates.

Of course, when it comes down to it, polymer print materials in medical and dental applications are pretty specialized. The materials themselves, tend to be fairly specialized. It's a lot of photo polymers for modeling, or photo polymers with certain types of bio additives.

For mainstream manufacturing polymers, with materials that we're more familiar with in traditional manufacturing that are widely available, I think the big opportunity for 3D-printed polymers could end up being in automotive. The disconnect there today, from a manufacturing standpoint, is that a lot of the auto industry's use of polymers, is in things like polyethylene, polypropylene, ABS, etc.

The 3D printing processes that are showing the best promise for higher volume productivity, like say, polymer powder bed fusion techniques, are limited to very specific semi-crystalline polymers, that have a wide thermal processing window. Obviously, the market there is centered a lot around nylon and polyamide. Materials for those print processes, need, as I was saying, a wide thermal processing window. They need good absorption of a CO2 laser energy source. There's a ton of factors that go into making a good powder-based polymer for powder bed fusion.

The auto industry isn't necessarily ready to change its production in polymer material choices overnight; just to suit 3D printing. There have been some examples though, for production of automotive parts in some high luxury model vehicles that are very promising. So, there are printed parts in those cars today. The most likely scenario for automotive and production in 3D printing is probably a staged

integration, that starts with spare parts manufacturing, using additives, as a primary source, because the requirements there for those types of parts can be a little bit more flexible. While the benefits of using additive are maybe, even more suitable for spare parts.

Lawrence: Let me jump in here, and ask you a little bit about how the 3D polymer market is breaking out? I'm old enough to remember when the 3D polymers meant low-end filaments. At the same time, as you've been mentioning, a lot of polymers are now being used in 3D printing in very serious applications. You mentioned automotive, to some extent. But, also, aerospace.

Is there still a profitable market for low-end filament in similar products? When I was at the Consumer Electronics Show earlier this year, it seemed to be mainly very small companies turning out very simple products, and with the main diversification being in terms of color. But, is there something more to the filament market, and where do you see it, if there is?

Scott: Well, the biggest market that we're talking about, out there for printable polymers, is going to be in photo polymers. That's still being driven, in a large way, by prototyping applications. Everybody talks about parts manufacturing, and for good reason. But, obviously, prototyping is not going anywhere. It's not like, all the sudden, all the world's 3D printers will suddenly, magically, be converted to production tools. The world's manufacturers still have to design and iterate before they get to that production stage. The best tool for that prototyping job right now is 3D printing using polymers.

But, when you talk about filaments, this is a gray area, because there's pre-comp now, with polymer 3D print technologies, with material extrusion using filament materials. Well, you can also get into systems that are using pre-compounded materials, like filaments, versus materials that are compounded during the printing itself. So, there's pros and cons to each approach.

What makes printing and material extrusion exciting for manufacturing applications in the future is use of high-throughput pellet-based systems for near net shapes. That type of approach to 3D printing with polymers, using say, injection molding pellets that are compounded as the machine is printing, provides an opportunity that other processes can't really touch for really big parts that are printed relatively quickly. Yes, they might need some finishing steps after that, but that's a pretty valuable opportunity that processes like photo polymerization or powder bed fusion can't necessarily provide.

Addressing your point regarding low-end filament printing, there's definitely a market for this in the future. For example, just in the last six months, there has emerged a viable market for extrusion printers in this category. This lower-end category has just emerged in dentistry. Filament-based printing in dentistry just wasn't viable before the cost for printers and materials fell 60%, or more. We'll definitely see more of that.

Lawrence: Moving on, and talking maybe a little bit less about the materials. One of the things I think is very interesting, is how the supply chain for 3D printed polymers will breakout. When you're talking about metals, at some level, it's obvious, because they're already firms that do steel, or titanium, or platinum, or whatever. With polymers, it's a little bit more complicated, because traditionally, the big polymer firms have worked in a very large range of areas. How do you see the supply chain working out for polymer 3D, now, that we've moved beyond the core filament range? Is something new happening there and, is it of significance?

Scott: Yeah. That's a good question. This is going to be a valuable question for stakeholders out there. For the analysis and services that SmarTech offers, including our new 3D polymer service, this is going to be one of the biggest questions.

What I really think this goes back to, ultimately, is something I've been talking about for a couple years. I affectionately refer to the concept as the "golden rule" of 3D printing, which states that there is no one print process to serve all applications. I've yet to see that idea disproven. I'll go on record saying today, that it probably never will be. With that in mind, I think it's most sensible to segment the market by process. Especially on the polymer side. Nonetheless, you still hear it today, even the largest of manufacturers out there, referring to 3D printing like it is a single process. The extrusion printer "revolution" probably had a lot to do with this, because thousand dollar printers started putting 3D printing on a lot of executives' radars.

If you're serious about printing for anything beyond modeling or prototyping, you have to know the intricacies of the processes that are out there themselves, their strengths and weaknesses, what potential they have for certain materials, certain polymers, and on, and on. Even for stuff like prototyping and modeling, this is becoming more important, because companies are starting to compete on those applications alone.

Printer companies coming out with lower cost printers, lowering the total cost of ownership, they're going to start competing, just in the modeling, and prototyping space, on that basis.

I put together an infographic of sorts for a client that meant to demonstrate the vast amount of polymer print process variation that we see out there today. Offshoots of extrusion, offshoots of powder bed fusion, offshoots of photo polymerization, those have bonded now. This graphic that I created, ended up looking like I was trying to map out the veins in the human body, with little offshoots for specialized processes everywhere. It all goes back to that parent process or print concept. So, it's really important to understand and to segment the market looking at it from that perspective, because really the process dictates all sorts of things, such as the material potential, and the capabilities of different processing characteristics. On the printer side, there's tons of specialization. For materials, maybe not so much.

Lawrence: Okay. One of the things that SmarTech is going to be doing in Q3, and especially, Q4, is launching a range of new data services. Basically, we're providing forecasts of the next 10 years on a number of different areas, including software, and metals, and printing machines themselves. Also, we're doing one on polymers, which will be available in the very near future, if anybody has any interests in those things we'd love to hear from you.

I think in a way, it's much harder to do services like that now. You could sort of hand wave at some of the categories that are now becoming more important. In particular, breakouts by manufacturing. How are you seeing the main manufacturing trends in polymers right now? Scott, this really ties into what you said before, about there being many kinds of 3D printing. How are you seeing it breakout, specifically in the polymer space?

Scott: If you're an end-user of 3D printing out there, of course, you're going to be looking at your options for printing with the part properties and materials that can get you where you need to go. That's going to be your first mindset, starting with the end in mind. Then, figuring out which print process or material combinations can get you to that point.

If a 3D printing solution doesn't exist to get you where you need to go, you're basically faced with two options. You can develop your own print process, or you can augment the design, or the requirements of the parts that you're intending to print, or wanting to print, so that it can be achieved with something that is available today.

There's not a lot of that latter option being explored just yet, in my opinion, because major industries, like auto, aerospace, medical, are relatively inflexible in that regard. Where that's different, is maybe,

consumer products. I would expect the attitude towards printing to change a lot in that area in the near future.

If we're looking at major trends brought by polymer printing process families, I think the biggest potential disrupter of what's going on out there today is probably in photo polymerization technologies using various methods for high-speed printing.

The reason this is such a big deal, or potentially, a big deal, is because over time it's becoming more and more likely we'll see the first printing process emerge that leaves behind some of the historical compromises between part performance, production capacity, and esthetic quality of the parts being printed. That's not to say there aren't challenges with high-speed photopolymerization techniques, because there definitely are.

They're not going to entirely replace traditional photo polymerization systems that are out there today, because it won't make sense for some of those areas where these traditional printers are already entrenched. With that said, high-speed photo polymerization, in my opinion, is probably the best positioned print process long-term, with the potential to compete with injection molding for small polymer parts. That's a big deal, competing with injection molding.

I would expect, say, Carbon or 3D Systems, to lead the charge along that avenue. Maybe Carbon, more so, because its business model is pretty much designed around achieving that goal, and competing with injection molding, and using polymer 3D printing for manufacturing.

VisionTech probably, has the most expertise actually in this area, going back historically. But, it's a little hesitant, it seems, to attack it full on. Probably, because that company is really entrenched using the traditional photo polymerization approach, and that's working just fine for some of the markets that it's in. If you're looking at trends for 3D printed polymers, and what is most potentially disruptive, and how it's playing out, I would definitely keep a close eye on what's going on there.

Lawrence: Next question, is really, in some ways, the same question, how are you seeing analysis change from the perspective of end-users, and where suppliers are? Personally, I have a long background, about 15 years, in the advanced materials industry. As a whole, it's the same players in 3DP. Probably been around for many decades, suppliers, plus a few start-ups.

One thing that's really interested me in the future, is how Chinese suppliers of materials, and polymers, in particular, of course, are going

to play into this. Chinese technologies, as a whole, have reached a point where it's certainly going to be treated seriously by major markets across the world, in terms of quality. Also, Chinese industrial policy is very much aiming at high value-added products. Are you seeing that in the polymer space, and how do you think it's likely to play out?

Scott:

We're definitely seeing that. Chinese suppliers, both of polymer materials and of polymer printers, are going to play a big role in the market. For a little context, according to the SmarTech models, by 2020, we're expecting just shy of around billion dollars total, polymer print hardware, and material sales in the Asia Pacific region, with a sizable portion of that demand, obviously, coming from China. Off the top of my head, I'm not sure the exact percentage there for China, but it's definitely going to be the biggest in that region. A lot of that one-billion-dollar opportunity in that region, is going to be fulfilled by print and material companies' native to China.

I would keep my eye on Farsoon in China, as well as XYZ Printing. Farsoon, already claims to be the only provider in the world that makes both laser sintering machines, and actually manufactures powders for use with its printers and other laser sintering printers. As far as I know, that's still true. Although, they aren't having much impact, on the materials, or hardware side outside of Asia Pacific, just yet.

That's going to change, I think. Farsoon, specifically, has already been pretty active in Europe. Especially, Germany and the U.K. More recently, we've seen they've officially entered the U.S. market, with a corporate presence, since the intellectual property control around sintering is fading.

The reason I bring up XYZ Printing, is because its done a pretty impressive job of doing something similar in the desktop market to what Farsoon is doing in the professional and production printer market. XYZ Printing's not making materials, I don't believe. But, it has been able to rapidly establish a strong worldwide presence in desktop extrusion, and photo polymerization, once the IP there started loosening up. It is providing a wide range of solutions that were much less costly than alternatives.

You talked about lower costs, and maybe there's a perception of lower quality there. That still could be true in some ways. I always hear some interesting reports on the use of machines or materials coming out of that region. However, they're definitely selling a lot of these things and a lot of these materials. They're definitely doing some things right.

Really, when you get down to it, cost is a big issue out there right now. There is plenty of demand and interest in additive manufacturing right now. It's huge. If that were all translating directly to the bottom line, the market for polymer printing would have been growing extensively over the last 18 months or so. Instead, it's been growing modestly. A lot of the reason, is getting down to just cost control.

With companies coming out of Asia that are able to produce both printers and materials, maybe a little bit more cost effectively, for various reasons, I think that's going to play a big role in translating some of that interest we see out there into actual investment, and actual production using 3D printers.

Lawrence: Well, I mentioned earlier that I went to the Consumer Electronics Show at the beginning of the year. Of course, a lot of the 3D printing companies there, well actually all of them in polymers, but basically, low-end filament type machines are going into the educational market really, rather than consumers.

Also, I led our analyst team down to the RAPID show earlier this year. We talked to a lot of companies there, printer firms, end-users. Had a lot of people go by our booth. What did you see there, Scott, in terms of new developments on the polymer side, both on the machines, and on the materials side? Was there anything really new? Any new kinds of polymers out there, new kinds of machines that you think are going to make a commercial impact in the future?

Scott: Well, actually, what springs to mind, wasn't technically there on the show floor at RAPID, because it was still under wraps. But it's since been publicly announced.

Lawrence: Right. I guess, actually, the question is also, what didn't you see there? I think that might be almost as important.

Scott: Yes. What wasn't technically, there, but was very close to release, and has now been officially announced and I think is going to be huge, is coming out of Formlabs. It recently, announced what it is calling the "Fuse 1", a laser sintering printer, right at the \$10K price point. That's going to be huge, mark my words.

Low cost sintering has been a reality for about a year. Maybe, a little bit longer, with some other companies. Mostly in Europe really, and some kit-based printers, which may or may not be relevant for the professional market. Formlabs, is going to come in here and fill a role I think, in that market that nobody has yet. As a U.S. manufacturer of a system in the \$10K range for laser sintering, with a strong brand already

established. That machine, along with some other interesting things going on that were on display at Rapid in the laser sintering segment, is why we actually see the hardware revenues for powder bed fusion, and the polymer market going to about 50% of total hardware revenues by 2026.

I talked about high-speed photo polymerization being one of the most important things. That's definitely true. Maybe, a little bit more so, from a production, end-user standpoint. If we're talking just purely about what might come out and really give a big change and big opportunity on the hardware side for polymer 3D printing, I think low-cost sintering, is just going to be massive.

On the materials side, I did not see at the tradeshows things on the polymer side that were super interesting. But, there's ongoing research and development again, on the sintering side. Really, I think on the sintering side, that's one of the big opportunities, as far as where we need to see some innovation and some new materials coming up in the near future. Sintering is one of the best processes as far as potential throughput, cost for parts, and in robustness and mechanical performance of parts printed that way.

It's one of the best processes in that regard. However, it's also, one of the hardest to qualify new materials, because of the powder form factor, and the use of a laser, and studying all the different characteristics that affect their fusion, and their mechanical performance, everything like that.

I'm excited about R&D going on with things like ABS, actually for laser sintering. That's been experimented with for a very long time and nobody's ever really nailed it, I guess. The impetus to get it right hasn't really been as strong in the past. Materials like ABS, polyethylene, polypropylene, maybe even polybutylenes for sintering, when we get to that point, and it's ongoing right now, that's where it's really going to be interesting.

Lawrence: Well, we're probably, running out of time. We promised just 30 minutes, to listen to us. That was all very interesting. Your last comment, reminded me a little of what I remember from many years ago, when the laser printers, the graphics printers began to takeoff, they hit \$10 grand. Then, suddenly, anybody who really needed them could afford a very high-quality laser printer, they weren't toys anymore, and they were affordable. Maybe, we're hitting that with polymer 3D printing these days, based on what you said.

Meanwhile, I want to thank everybody who registered for this and who is on the call. As I say, we have a report in the polymer space. We'll be having more coming out. We will be having a polymer service, as well as several other services. For those of you who want to know about those services and also, about our ongoing work in other areas of 3D printing, I think we're the only industry analyst firm that's completely dedicated to covering the market opportunities in 3D printing and manufacturing.

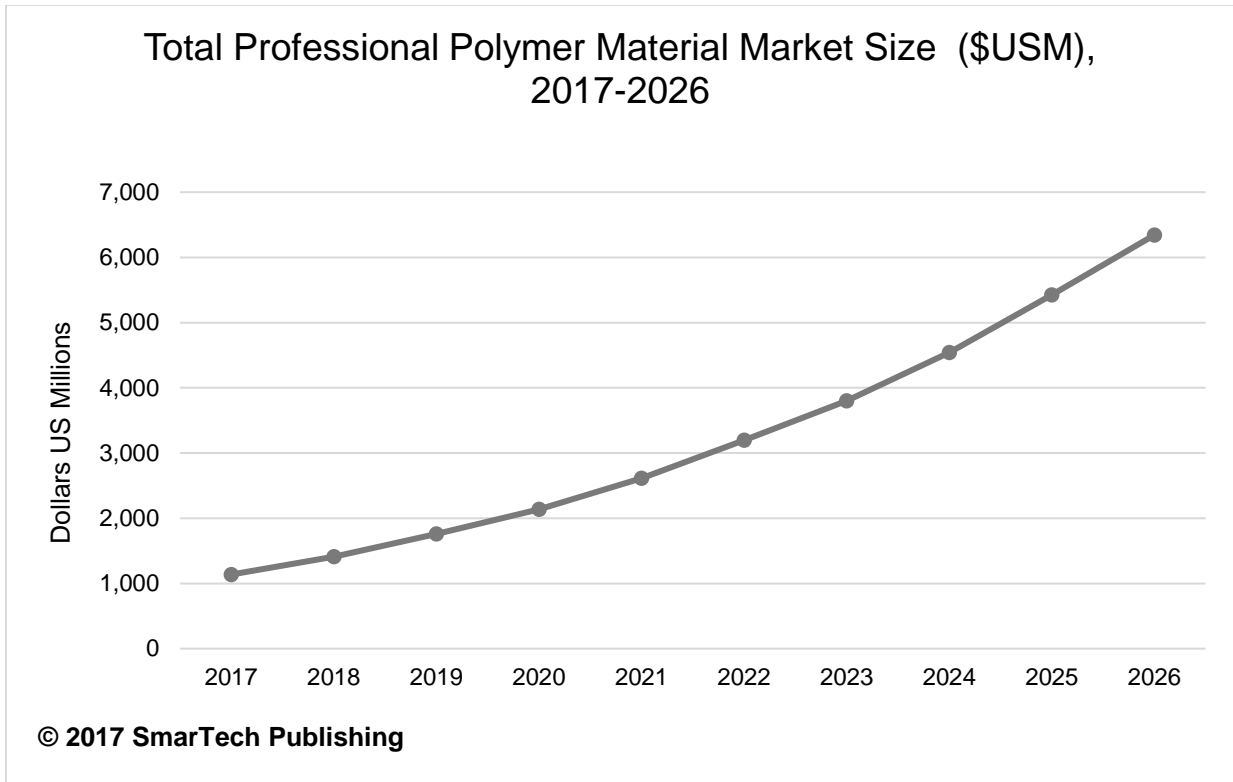
For those of you who want to know, we've got plenty of telephone numbers and emails on our website. If, you want to get in contact with more information, I suggest you go to Rob@SmarTechPublishing.com.

About the Report

Opportunities In Polymer and Plastic 3D Printing — 2017

Over the last two years, the polymer 3D printing industry has been in a state of tumultuousness marked by dozens of new competitors entering the market, partnerships for development of materials, and development of new print technologies. All of these and more have combined to create a whirlwind market that, in spite of so much activity and investment, has struggled to maintain its growth pace from 2012 through 2014 as customers have backed off purchasing in the traditional segments while adopting a 'wait and see' strategy. The demand for additive manufacturing in general has perhaps never been higher, but challenges associated with such rapid evolution in polymer and plastic 3D printing have suppressed growth in the face of historic interest in 3D printing at a professional level.

As the global chemical and polymer suppliers of the manufacturing world move into position to exert more influence over the increasingly integrated 3D printing industry, market change appears imminent. Meanwhile, the commercialization of disruptive new print technologies such as those from Carbon, HP, Rize, and more all ensure 2017 will be a pivotal year.



[Opportunities in Polymer and Plastic 3D Printing - 2017](#) is the third generation of the world’s most comprehensive analysis of polymer 3D printing technology. In this new edition, market analysis is segmented by print technology market—as each major polymer print process settles into its own roles and established applications, our analysis has deepened to the specifics of each driving print technology and associated materials.

Utilizing purpose-built proprietary 3D printing market models, **SmarTech Publishing** is able to present detailed market forecast data on thermoplastic filaments, powders, photopolymers, composites, and more utilized in popular print technologies of material extrusion (FDM, FFF), polymer powder bed fusion (SLS, Multi Jet Fusion), photopolymerization (SLA, DLP, CLIP), binder jetting, and more.

All available materials for primary polymer print technologies are analyzed and forecasted, including market revenues as well as material shipments, by industry and geography, over the next decade. Therefore, **SmarTech Publishing** believes that [Opportunities in Polymer and Plastic 3D Printing - 2017](#) will provide exceptional value to business development professionals and internal market strategy teams for the global chemical and polymer industries, as well as polymer 3D printer manufacturers, print service providers, and developers of polymer 3D printing manufacturing solutions.

About Scott Dunham

Scott Dunham is Vice President of Research at SmarTech Markets Publishing, bringing with him years of research experience in the areas of advanced manufacturing and 3D printing. Scott holds a Bachelor's degree in marketing and research from the University of Kentucky's Gatton School of Business & Economics, and has been a featured speaker at 3D printing industry events around the world.

About Lawrence Gasman

Lawrence Gasman is the founder of SmarTech Publishing and is acknowledged worldwide as an expert on technology forecasting. He has previously founded two other industry analyst firms and has also carried out a wide range of technology assessments in areas ranging from optical networking to advanced materials to augmented reality.