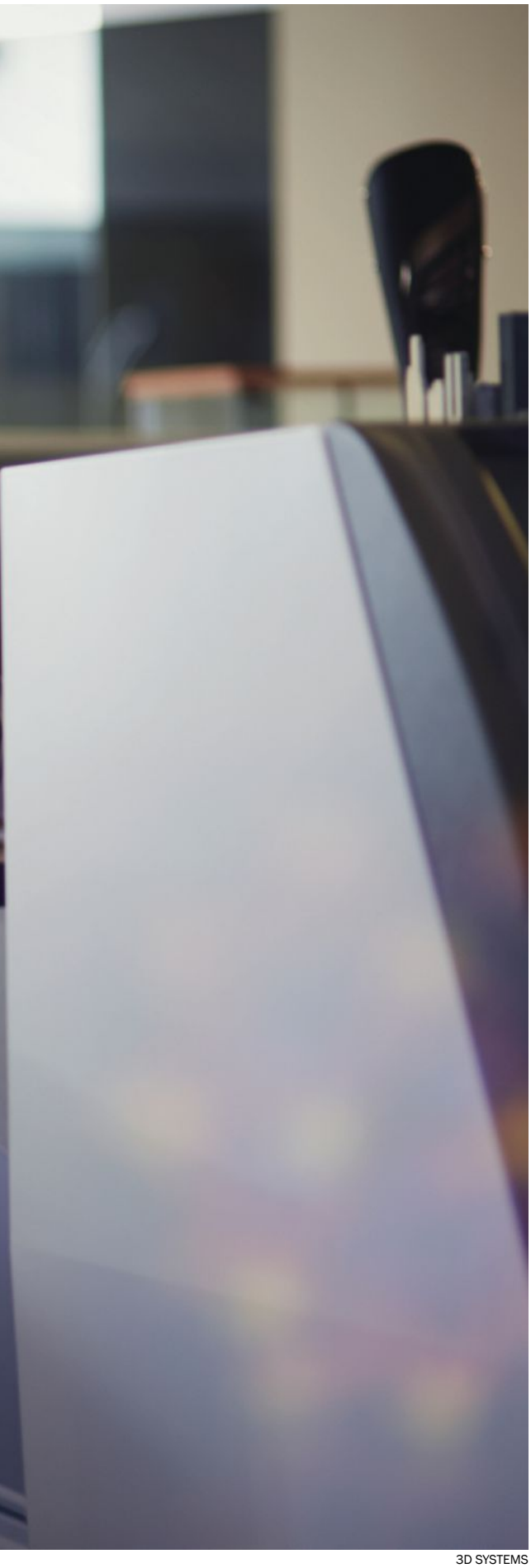

3D SYSTEMS

Q&A

NVTC sat down with Avi Reichental, president and CEO of 3D Systems, to discuss the profound impact 3D printing is already having today and the tremendous potential it holds for tomorrow.

By Sarah Jones

nvtc Can you talk a bit about 3D printing's evolution?

3D printing is an overnight success story 30 years in the making..

The first commercial 3D printing technology, stereolithography, was invented in 1983 in San Gabriel, California by Chuck Hull, 3D Systems' co-founder and CTO. Chuck was a design engineer and part-time inventor who, at the time, had been working for a company that specialized in liquid coatings that turned solid when hit with ultraviolet light. Chuck posited that by curing successive layers of material on top of each other, he could create a solid, 3D dimensional object. He tested his theory for months and then, one night in late March, he successfully 3D printed the first part in history: a small cup-like object (which he still has today). And that one print led to the creation of the first 3D printer, the SLA-1, and the birth of a multi-billion dollar industry.

Chuck instinctively realized that the ability to conjure physical parts on demand could substantially compress the entire design

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and prototyping cycle time for manufacturers. He recognized that his technology could enable designers and engineers to create and test physical models and evaluate their parts' fit, form, features and function quicker and more frequently. This, he believed, would be a boon for carmakers who were facing eroding competitiveness at the hands of cheaper, more nimble competitors.

Sure enough, automakers were quick to embrace 3D printing and use it to improve their time-to-market and accelerate their innovation cycles. Aerospace and healthcare companies were not far behind, using 3D printing to help control costs and minimize risks in product development. But for all of the benefits and competitive advantages that 3D printing generated for its early users, the fact remained that this technology was complex and expensive and, as such, was only available to deep-pocketed corporations.

That is no longer the case. 3D printing is becoming faster, cheaper and easier to use at an exponential pace. The same capabilities that cost $500,000 just a decade ago cost less than $50,000 today, for example. And the parallel advances in print processes and materials science — including direct metal printing, colorjet printing and selective laser sintering — have opened up countless new applications and expanded 3D printing's reach from the prototype shop to the factory floor.

In fact, costs of 3D printing have fallen so much that this technology is finally opening up to the consumer for home use. Last year, we introduced sub-$1,000, plug-and-play consumer 3D printers, which are supported by a vibrant ecosystem of design tools and creative communities that allow users to effortlessly create and share content.

All of this has made 3D printing much more accessible, powerful and fun than it has ever been before. And this is just the beginning.

nvtc What is your vision for the future of 3D Systems and 3D printing?

The problem of predicting the future of exponential technologies is that the pace of development of these technologies often outpaces our own imaginations. Every day we discover a new and impactful application for 3D printing, and every day these applications expand our horizons of what's possible. Culinary printing, direct metal printing, FDA-cleared medical printing and virtual surgical planning: all of these were unimaginable not too long ago. Now they are part of our industry vernacular.

At the same time, the convergence of 3D printing with adjacent exponential technologies — such as robotics, augmented reality, cloud computing, sensing and advanced control systems — is hastening progress in 3D printing faster than anyone could have dreamed.

As our industry and capabilities grow, we are guided as a company by the core belief that everyone should have the means and the skills to transform potential into real outcomes. From engine prototypes to flight-ready aerospace parts, from a surgical trial-run to medical implants, from a designer dress to intricate confections — our job is to let everyone make great things happen.

nvtc What is 3D printing's impact on manufacturing?

Manufacturers have been using 3D printing for decades to design and manufacture products. There is hardly a product available today that hasn't utilized this technology at some point during its development phase — from design to early prototypes to functional test parts to durable molds. The big shift that we're seeing today is that companies are increasingly relying on fab-grade 3D printing for just-in-time, end-use product manufacturing. Why?

First, a 3D printer requires no tooling or setup so there are no economies of scale to be achieved from mass production. Per-part costs are the same whether you are producing a batch of one or one million, and this gives companies the opportunity (and the incentive) to personalize each product to an individual customer's needs. We are at the dawn of the “mass customization” era, where products you buy — from clothing to consumer electronics to medical devices — will be tailored to your individual specifications. Align Technologies, for example, uses 3D printing to create millions of clear Invisalign aligners each year, each one made to measure for an individual patient.

Second, and perhaps most important, complexity is free in 3D printing. A 3D printer does not care if it makes the most rudimen-

tary geometry or the most complex. There is neither barrier nor penalty for complexity. Designers are therefore uninhibited by yesterday's manufacturing constraints and are free to produce whatever they can dream. That has powerful implications for sectors like aerospace, automotive and healthcare, where complex design is essential to unlocking better performance and durability.

Combining these two factors with the increasing speeds of 3D printing, I expect to see more and more manufacturers choosing 3D printing for just-in-time production runs. And because there are no economies of scale, this manufacturing can be placed as close to the end-user as possible, reducing logistics costs and carbon emissions substantially.

nvtc What is its influence on other industries?

We exist in a world where "need it now" collides with "fit for me," and that is generating a new expectation for how we create, construct and consume in every industry. 3D printing technology — which includes software, scanners and design tools — is the engine that is powering this change.

3D SYSTEMS

From architecture to consumer electronics to the culinary arts, from customized clothing and footwear to personalized healthcare, 3D printing blends with, enhances and augments existing techniques and allows us to transform our overwhelming human potential into improved outcomes. And we have only begun to scratch the surface of what's possible.

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nvtc How will consumers involve 3D printing in their everyday lives?

To me, the question is not whether or not you will have 3D printers in your home, but in what room will your 3D printer reside? Or in other words, in what way will 3D printing fit into your lifestyle.

Maybe your 3D printer will reside in the family room, producing decorative items and useful things for around the house. Maybe you will have it in your craft room or bedroom, where it can produce fashion accessories and even life-size shoes. Maybe it will be in a child's bedroom, where it can unleash creativity by allowing the endless design and creation of customizable toys and models. Maybe it will be in the garage or toolshed, producing spare parts for the house and car. Maybe it will be in the kitchen, enabling personalized, on-demand nutrition and delicious digital delectables. This is where I see it going and, in fact, it's not at all out of the question that we will

> “A world in which objects can be shared digitally and produced any time, anywhere. A world in which everything can be customized. It is that view of the world — so radically different from our current view — that will allow the next generation to harness the power and potential of 3D printing to do incredible things.”

have multiple printers in our homes — as well as in the classroom and at work.

nvtc What kind of skills will be needed in the workforce once 3D printing is widespread?

3D printing is already widespread in the engineering and manufacturing worlds and a growing number of positions within these fields require proficiency with 3D digital design and fabrication. Making digital literacy accessible to everyone is, therefore, our top priority within the field of education and we are partnering with educational institutions towards this goal.

The best way to think about 3D printing in education is not about teaching a skillset, it's about expanding students' minds to a world in which every idea can be realized. A world in which objects can be shared digitally and produced any time, anywhere. A world in which everything can be customized. It is that view of the

world—so radically different from our current view — that will allow the next generation to harness the power and potential of 3D printing to do incredible things.

nvtc What are some innovative projects you are excited about?

The applications for healthcare are certainly very exciting. Already, we are able to use CT/CBCT scan data from individual patients to create patient specific dental and anatomical models, custom surgical guides, implantable devices, exoskeletons, hearing aids, prosthetics, and braces for scoliosis and other applications. And that's just to name a few. Beyond that, we're also able to use the same patient specific data to provide surgeons with accurate planning models and virtual training and operating platforms for use in preparing some of the most complex surgeries performed today. By combining all of our technologies, we are building a seamless workflow for training, rehearsal and actual procedures — all designed to improve outcomes for patients and healthcare providers alike.

Another very exciting project is our continuous, high-speed printing platform. Architected as the first 3D printing flexible assembly line, this high-resolution color printer can output 4 billion drops of ink every minute, 50x faster than today's jetting products. But the real beauty of this continuous loop system is that it readily integrates with off-the-shelf automated secondary insertion and finishing operations based on customer's requirements, such as subtractive manufacturing stations (machining) or coatings. This new, endlessly-configurable platform opens up new frontiers in on-demand, customized production. It has the potential to create entirely new businesses opportunities and exciting new products within the automotive, footwear, toys and consumer electronics industries, just to name a few.

And, course the work our culinary team is doing to pioneer the future of food printing — in collaboration with traditional culinary experts such as the Culinary Institute of America — is simply astonishing.

nvtc Is there anything else you'd like to share with our membership in the technology sector here in Northern Virginia?

3D printing is one of the most impactful technologies since the steam engine and we have only just now begun to unlock its true power and potential. The choice facing companies in the here and now is whether to disrupt with it or be disrupted by it.

Sarah Jones is NVTC's Communications Manager.