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EnvisionTEC's Expanding 3D Strategy

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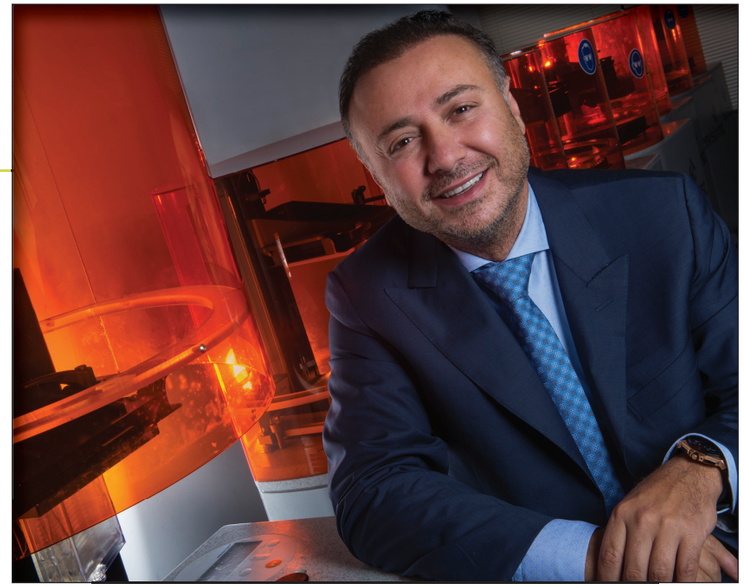


In 1996, EnvisionTEC CEO Al Siblani decided he would make his own printers. Today, his company is experiencing rapid growth.

Photo by Donna Terek

A MASTER OF INNOVATION, PRECISION AND DISRUPTION

Sarah A. Webster
Editor in Chief

A pioneer in precision 3D printing technologies helps to level the playing field on labor costs and begins growing an empire. He's in the running for Ernst & Young's US Entrepreneur of the Year.

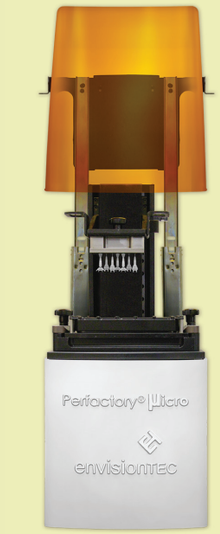
Al Siblani is building a modern manufacturing empire, one 3D printer at a time.

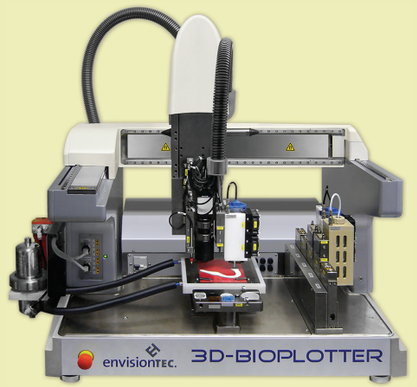
His company EnvisionTEC, founded in 2002, sells 3D printers that use unique patented methods of building objects, even complex pieces with fine detail, from digital design files. The company's seven families of printers, which create objects in plastics, fiber-reinforced composite polymers or biologic materials, have infiltrated, and seriously disrupted, a wide range of industries.

Six out of ten hearing aids, for example, are now made on Siblani's printers. Glidewell Dental Labs, one of the largest dental labs in the world, uses EnvisionTEC machines to print crowns, bridges and other dental prosthetics. The entertainment conglomerate Disney uses his printers in five locations around the world to build characters and props for movies. Ever used a Keurig K-cup? Those pods were prototyped on his printers. His machines are

A Growing Product Line

1. Perfactory Standard 3D Printer Family—launched in 2002—is low cost, easy maintenance and user friendly for rapid prototyping and rapid manufacturing.
2. Perfactory Mini 3D Printer Family—launched in 2002—offers the same features as the Standard family with a higher resolution and smaller build plate.
3. 3D-Bioplotter—launched in 2002—is a suitable rapid prototyping tool for processing a great variety of biomaterials within the process of computer aided tissue engineering from 3D CAD models and patient CT data to the physical 3D scaffold with a designed and defined outer form and an open inner structure.
4. The Perfactory Desktop 3D Printer Family—launched in 2007—is aimed at small to medium-sized companies looking to fulfill their 3D printing production requirements. With the ability to run unattended, 24 hour production, these printers can print a variety of materials for direct casting, hot rubber, and silicone molding.
5. Micro 3D Printer Family—launched in 2011—is the smallest professional-grade desktop 3D printer with the highest resolution.
6. Ultra 3SP 3D Printer Family—launched in 2013—uses ground-breaking 3S (Scan, Spin and Selectively Photocure) technology to quickly 3D print highly accurate parts from STL files regardless of the geometric complexity.
7. Large Frame 3D Printer Family—launched in 2014—EnvisionTEC's Xtreme 3SP and Xede 3SP large format 3D printers allow for production of exceptionally large 3D parts, built at fast build speeds without sacrificing surface quality and part accuracy.





also used to make consumer products, such as jewelry, toys and sporting equipment, car parts, prosthetic devices and more. Among his thousands of customers: GE, Procter & Gamble, Nike, Kraft and Cartier.

"I see new possibilities every time somebody walks in with a new idea," Siblani told *Manufacturing Engineering* during a recent interview. Among the ideas kicking around lately: custom eyeglasses, custom breast implants and custom in-ear monitors, the kind recording artists and TV anchors wear in their ears during performances.

EnvisionTEC printers have also become important tools in medical research, as scientists explore printing custom knee meniscuses and other medical devices embedded with biologic materials or pharmaceuticals. "Medical is going to be very interesting in the next few years," Siblani said.

Siblani's EnvisionTEC has grown so rapidly in recent years that it is now thought to be among the largest manufacturers of 3D printing technologies in the United States. While the privately held company doesn't share its revenues publicly, Siblani's competitors Stratasys (Minneapolis & Rehovot, Israel) and 3D Systems (Rock Hill, SC) saw amazing growth in 2014.

As a point of reference, 2014 revenues were up 54% at Stratasys and 27% at 3D Systems, as industrial customers figure out new ways to put 3D printers to practical use, not just in building prototypes, but full production parts and products, as well as jigs, fixtures and other tools that are often used in factories to make other things.

Demand for EnvisionTEC printers continues to grow so rapidly that the company this spring doubled production capacity at its two manufacturing facilities, in Gardena, CA, and Gladbeck, Germany. In June, Siblani was named the Ernst & Young Entrepreneur of the Year for 2015 in the technology category for Michigan and Ohio. He is now eligible for the consultancy's top Entrepreneur of the Year award, which will be announced on Nov. 14 in Palm Springs, CA.

EnvisionTEC printers are used to manufacture a wide range of products, and its printers offer smooth, accurate finishes.

Photo by Donna Terek

Made in Detroit

While EnvisionTEC GmbH was originally incorporated in Germany for technical reasons—a judge there required it in order for the company to acquire some assets—it is very much an American company.

Siblani, a 48-year-old from Metro Detroit, and a proud member of the large Lebanese community there, runs EnvisionTEC out of the company's corporate headquarters in Dearborn, in the former design center for Ford Motor Co.'s luxury Lincoln brand.

While Dearborn is Siblani's longtime home, there is some resonance to his company being based there. Henry Ford, whose namesake automotive company is also based in Dearborn, is famous for creating one of the most famous manufacturing technologies of all time: a moving assembly line for the auto sector.

Today, there are a wide range of manufacturing technologies used to produce manufactured goods, of course. In fact, many manufacturing insiders believe the industry is experiencing a renaissance in the technologies used to make things, with 3D printing enjoying a disproportionate share of the spotlight. The federal government is also creating a network of new public-private hubs—the National Network for Manufacturing Innovation—to grow these new technologies, which it believes are vital to restoring American competitiveness in manufacturing.

3D printing, a manufacturing technology first invented in the 1980s, is viewed as one of the more important of those new technologies, and it has been gaining fast in its third decade of development. Even 2D printing giant Hewlett Packard has said it plans to get into the game of industrial 3D printing.

But Siblani is one of the industry's pioneers, and he is not just an innovator—he is a practical innovator, focused on making 3D printers that solve the real industrial problems of global manufacturers. Having grown up around the automotive industry as an engineer, these are problems Siblani seems to understand deeply, and it's partly what give his printers an edge.

The EnvisionTEC Edge

Generally speaking, 3D printers work by building objects layer by layer, as a printer head moves back and forth, from a digital design file. This is why 3D printing is often referred to as "additive manufacturing" by industry insiders—in contrast to subtractive manufacturing, where material is removed from a bigger piece of material to create an object—but there are actually many very different AM technologies used to accomplish this.

In stereolithography, for example, a photo-reactive resin or polymer is cured by ultraviolet light from a very precise laser. In Fused Deposition Modeling, or FDM, a print head nozzle ejects molten material—say, a plastic filament or metal wire—in layers.

> "I see new possibilities every time somebody walks in with a new idea."

One of the shortcomings of many kinds of 3D printing is that final objects often reveal striations in the surface finish—you can literally see and feel the layers used to create the object. That may mean additional processing is necessary before the item is deemed complete or meets quality specifications.

But Siblani's approach is different. By building objects using volumetric pixels, or voxels, with a unique light projector-based approach to curing resin, his printers are able to build objects that don't show surface striations. Rather, his machines are able to produce beautiful curved objects with very deliberate surface finishes, accurate down to 15 microns in most cases.

Six out of ten hearing aids, such as these, are printed on EnvisionTEC printers.

Photo by Donna Terek

"Everyone builds in layers," Siblani explained. "We build in voxels, volumetric pixels. The biggest advantage is you have a much higher surface quality, which becomes very important when you're doing things like crowns. There's quite a number of advantages with our approach."

Today, EnvisionTEC holds 18 US and 91 foreign patents, many of which are framed in his lobby, to protect the company's printing methods.

EnvisionTEC printers are commonly used to manufacture dental prosthetics, and Siblani said his technology has helped this type of work remain in the US.

Photo by Donna Terek

His company is also aggressive in R&D, so that it can be first to capture patents in this intensely competitive technology area, which is also known for being fairly litigious.

EnvisionTEC has research being done at its headquarters in Dearborn, at its manufacturing facilities in California and Germany, as well as a facility in Kiev, Ukraine, that focuses particularly on software development.

Spend a little time with Siblani, and it's easy to see how a young engineering student eventually came to found and lead a fast-growing global 3D printing business. More than anything, Siblani is driven by ideas, and like many engineers, he is highly focused on how to make them a reality.

How it All Started

Like many young men who grew up in Metro Detroit, Siblani went to school to become an engineer.

He earned his bachelor's degree in engineering from Lawrence Technological University in 1990, followed by his Master's Degree in electrical and computer engineering in 1993 from Wayne State University.

That year, he was hired by Helisys of Torrance, CA, an early 3D printing company that used Laminated Object Manufacturing (LOM) technology, in which layers of adhesive coated materials, often paper, are glued together and then cut to shape with a knife or laser cutter.

A 26-year-old Siblani went to work at General Motors' design center in Warren as a Helisys employee, helping to build paper-to-wood prototypes with LOM technology.

Siblani and Helisys weren't the only 3D game in town. GM, like other automakers, was exploring other 3D technologies to build prototypes. Chuck Hull, regarded as the grandfather of 3D printing, was there, too, stationed in another room at GM with his SLA-1, which used stereolithography. So was Scott Crump, the inventor of FDM.

"It was interesting because they both had machines that had very small build areas," Siblani recalled, about 10 × 10" (254 × 254 mm).

But cars, and often car parts, are often bigger than that. The Helisys machine that Siblani offered had a build envelope of 20 × 30" (508 × 762 mm), and so GM asked him if he could print out a transmission case, which often took 15–18 weeks to build by hand.

"I said, 'Yeah, we can do that,'" Siblani recalled.

When they asked how long it would take, Siblani told them, "It's going to take about two-and-a-half to three days on the machine printing."

"They said, 'No way.'"

"And I vividly remember two things: It was my first experience seeing everybody that's anybody at General Motors looking at that thing that came out in three days versus 18 weeks … and the second thing I remember was it was my first experience getting a grievance filed against me by the union because I used a screwdriver."

Business at Helisys grew rapidly after that. "I went on to do the same thing at Ford, Lear, all the pattern shops that used to exist in Troy … just about every automotive manufacturer in Michigan," Siblani said.

Not long afterward, Siblani founded Sibco Inc., a company that provided 3D printing services and materials, many of which are uniquely prepared for the 3D printing process. In the early 1990s, Sibco was the only third-party provider of these services, and for Siblani, his work in this area amplified to him the shortcomings with the existing printers on the market. "If you provide materials as a third-party supplier, you have to optimize the parameters for the machines to deal with the different materials," Siblani explained. "You need a deep knowledge of the different technologies and that's where my background came in. I could take any machine and tear it down. I knew the exact strengths and weaknesses of every technology."

So in 1996, he decided he was going to make his own machines, and they would be better.

The First Printer

Several 3D printers in the market at that time already used light in some way to cure liquid resins to build objects, but Siblani wanted to use light from a projector, similar to those used in high-quality theater systems. And so he began tinkering, in the scientific way engineers do, with what would eventually become known as Digital Light Processing, or DLP projectors.

Two years later, he brought on Alexander "Sasha" Shkolnik, a former engineer from Helisys. Shkolnik is now the chief technology officer at EnvisionTEC.

By 2000, using funds from the Sibco business, Siblani and Shkolnik had created a printer, sitting on Sasha's carpeted living room floor—the world's first fully functional DLP printer.

Then, Siblani experienced an inventor's worst nightmare.

The whole time Siblani was working on his DLP printer, his Sibco service company had continued to grow, and Siblani had plans to visit a trade show, Euromold, that year to promote their services.

But as he walked around the show floor in Europe, he saw something that made his heart stop. "I see a booth and it says, 'A Breakthrough in Printing,' … and I'm like, 'Oh my God. Somebody is doing exactly what we are doing,' " Siblani recalled.

> "It eliminates the labor cost from the formula of manufacturing, and that's a very big deal."

So, he approached the booth of the German company and asked to see the printer. A man in the booth told him: "No, no, we're still just a concept. We're not all the way there yet."

And while Siblani was relieved that he already had a working printer, this company had something he didn't yet have: a US patent for the idea.

So, he proposed that they work together. They told him to get lost. But Siblani kept at it, working to develop his DLP 3D printing machine

Then, in 2002, he got a call. The German startup company couldn't get its technology to work and its investors were pulling the plug on the venture. The company had entered liquidation.

When launching his company, Siblani identified jewelry as a key market because of the need for precise details.

Photo by Donna Terek

Siblani hopped on a plane to Germany to try and get the patent in liquidation. "I sat in front of the judge and said, 'I just want the patent.' " Siblani recalled. "But the judge said, 'Oh no, you don't just get the patent. You also inherit the five employees and the company, and you have to employ them.'"

And so, EnvisionTEC GmbH was born.

The next year, EnvisionTEC showcased its technology at a jewelry show at the Hyatt in Dearborn, and quickly sold three Perfactory Mini printers. "From there, we've been in the black

and positive and growing," said Siblani.

And Shkolnik, like many members of the original EnvisionTEC team, have worked for the company ever since. "People tend to stay for a long time," Siblani said.

A Guy Walks into My Booth …

A key moment in the company's growth came a few years later, in 2005. A man walked into his booth at a trade show and asked Siblani if he could print a hearing-aid shell.

That buyer turned out to be Mike Jones, CEO of Phonak, a leading provider of hearing aids based in Switzerland, and the contact sparked a substantial amount of growth. Today, Phonak has more than 100 EnvisionTEC machines churning out hearing aid shells in more than 19 countries.

"Then, in 2008, a guy walks into my booth and says, 'Can you do teeth?'" Siblani said.

That guy ended up being Jim Glidewell, owner of Glidewell Dental Labs in Newport Beach, CA—one the single largest dental lab in the US. "It was truly amazing because he's a pioneer in the dental industry," Siblani said.

Today, Glidewell 3D prints all of its dental prosthetics and Siblani has grown accustomed to customers calling and asking if they can print their widgets and new ideas on his printers.

Siblani and his team have since expanded far beyond DLP technology, too. One of the challenges of using light sources to cure resin into objects is that the closer the resin is to the light source, the better resolution. And, the further away from the object, the worse the resolution of the final object. As innovators have tried to 3D print ever bigger objects, they've struggled to maintain resolutions and deliver a finely finished final object.

That has led Siblani's team to develop 3SP technology, which scans, spins and selectively photocures resins with lasers, resulting in larger 3D printed objects with high resolutions.

He was also an early player in printing biologic materials, with his 3D Bioplotter, which is, quite literally, being used by medical researchers to print organs, such as skin, heart valves, cells and implants.

EnvisionTEC printers are also used to make characters and props for movies. Disney is among EnvisionTEC's customers.

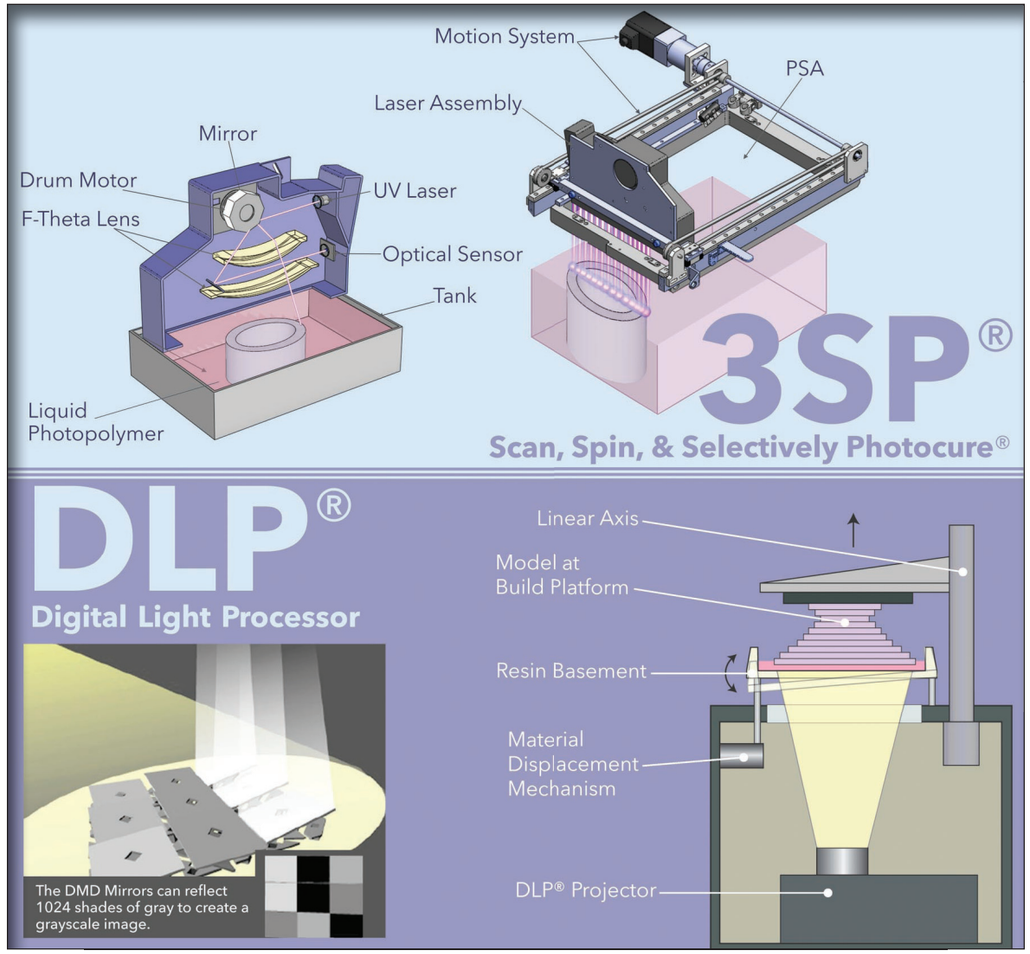
Photo by Donna Terek

Leveling the Playing Field

As Siblani's business has grown, and printer models have been added, Siblani hasn't been motivated much by money. "If I wanted to sell out, I would have done that a long time ago," he said, noting the high value of his growing list of patents.

As he bounds around his headquarters in Dearborn, showing off his technologies, it is clear that he is driven much more by new ideas and by how much this new manufacturing technology is disrupting the old business model of making things.

In his mind, 3D printing is one of the new technologies that is saving American manufacturing, and helping it grow anew.



Siblani explains how Michigan's dental labs had started going out of business in the years before 3D printing came along, because they needed to charge about $130 a crown to cover their labor costs.

Back then, it took one technician about 20 minutes to lay up a crown, so the skilled workers could produce just about three an hour. But China was offering crowns for $70, and many labs found they just couldn't compete at that price. But using a 3D printer, Siblani showed them they could churn out about 30 crowns an hour per printer, with very little skilled labor.

"3D printing plays a role not just in delivering a higher quality product, but also creating a level playing field when it comes to labor," Siblani said. "It eliminates the labor cost from the formula of manufacturing, and that's a very big deal."

Siblani is quite proud of the fact that EnvisionTEC printers have kept a lot of dental labs in Michigan, and other states, in business.

He recalled one customer, in particular, who told him that he was going to send about 100 dental bridges to China to be made. "I told the customer, 'We're going to do them in 24 hours, and if we do it, you're going to stop sending this work to China,' and he did.'"

And so, as much as EnvisionTEC has disrupted traditional ways of making things, his company has also disrupted foreign competitors.

In the mind of Al Siblani, a modern day booster of American manufacturing, that's just fine.