

Through collaboration, Unlimited Tomorrow makes high-tech prosthetics more accessible



Medical device startup develops and manufactures its TrueLimb® robotic prosthetic device by leveraging HP's MJF 3D printing technology and working with partners including ABCorp and Singularity Group

Unlimited Tomorrow recently partnered with ABCorp, a 3D printing service bureau, choosing them to additively manufacture components for the TrueLimb® robotic prosthetic. ABCorp operates a fleet of HP Jet Fusion 5210 3D printers and utilizes them to provide Unlimited Tomorrow with more consistent parts, faster and less expensively—enabling them to scale and ultimately fulfill their global mission of augmenting the human body with better technology.

Background

In 2017, it was estimated that 57.7 million people were living with limb amputation due to traumatic causes worldwide. That's up significantly from 2005, when the World Health Organization (WHO) reported that globally, 30 million people were in need of prosthetic and orthotic devices. WHO's research predicts the number could grow significantly higher by 2050, in large part due to diabetes and other repercussions of vascular disease.

Limb loss can either result from a birth defect or happen later in life. In the U.S., it's estimated that each year, between 1,500 and 4,500 children are born with a congenital limb deficiency and nearly 60% of those involve an upper limb. There is less data on the number of people who require an amputation, but research suggests that a large portion of the injuries are accidental and happen to children under five years old.

Traditional prosthetic devices are heavy, uncomfortable, visually unappealing, and hard to use. For children who need these devices, the problems are compounded. As they grow, their prostheses need frequent resizing and adjustment. It can be frustrating, and oftentimes patients simply stop wearing them.

Unlimited Tomorrow

“I was 14 when I invented my first robotic hand,” said Unlimited Tomorrow CEO Easton LaChappelle. “Shortly after, I was invited to compete in my state’s science fair. It was there that I randomly met a 7-year-old girl with a limb difference. In some ways, she became the catalyst for my life’s work. When I saw the prosthetic she was wearing and talked with her parents about the cost, I knew we had an opportunity to change the outcome for a lot of people.”



LaChappelle with Ukrainian TrueLimb® recipient

Easton LaChappelle is a 26-year-old robotics wizard and the founder of Unlimited Tomorrow, a New York-based medical device company that manufactures cutting-edge prosthetics. When 14-years-old, LaChappelle became interested in robotics and not long after, built what became known as RoboArm. He founded Unlimited Tomorrow with the goal of developing a prosthetic that was lighter, more functional, easier to manage, more appealing to wear, and perhaps most importantly, less expensive.

Since its founding, Unlimited Tomorrow has been creative in finding ways to achieve its mission. For example, they used crowdfunding to secure investments and provide prosthetics for children through an IndieGogo campaign, they called 100 Tomorrows.

Additionally, the company has taken an innovative approach to product development and manufacturing. Through partnerships with HP, Siemens, and ARROW Electronics, Unlimited Tomorrow gained access to several emerging technologies, including robotics, machine learning, the Internet of Things (IoT), and perhaps most importantly, 3D printing.

Today, Mr. LaChappelle and the team at Unlimited Tomorrow are leveraging these capabilities to build state-of-the-art prostheses that are more attractive and perform more effectively, at a tenth of the cost of other devices.

Market research and product development

Before going to market, Unlimited Tomorrow spent a significant amount of time researching the market and comparing their solution with other commercially available prosthetics.

“We were fortunate to start with a clean slate,” said LaChappelle. “We weren’t trying to reinvent ourselves while still clinging to old, out-of-date business processes. As a startup, you have to be nimble and flexible. To succeed, you need better efficiency with both the external user experience and internally with manufacturing and operations.”

Issues with traditional manufacturing methods

The traditional process for making prosthetics hasn’t changed much over the last 100 years. First, a socket is made to fit an individual’s body. It enables a patient to wear and control the prosthesis. Properly fitting the socket can take many iterations. Once the socket is fitted, patients can choose a cosmetic attachment, which often appears unnatural, or they can use a functional attachment to help them grip and hold objects. Oftentimes, these are primitive hooks or clamps that are controlled by the patient’s body movements.

Powered devices are also available; however, they tend to be ugly, heavy, and have limited battery life. They are also very expensive, typically costing \$80,000 or more. Many factors contribute to the cost, including the labor and time it takes to build and fit a prosthesis, in addition to limitations with technology and traditional manufacturing methods.

Health insurance is also a barrier. Many people who want a powered device find that their insurance will only cover a basic hook option.

With children, the problems are magnified. They outgrow devices quickly, and as a result, they must endure the expensive and painful fitting process repeatedly. Also, they can only lift and carry so much weight, so powered devices are less of an option. Finally, and perhaps most importantly, unappealing traditional prosthetics can be stigmatizing. So even after going through all the pain and time involved with fitting a device, many kids simply won't wear them. Among all users of passive prosthetics, it's estimated that rejection rates can exceed 60%. With kids, the numbers can be even higher.

Research and development

"To really understand the problems people with limb differences have, you need to see them in action," said LaChappelle. "We wanted to know if our product could meet a wide range of needs, from those of a world-class athlete to a small child. So we went to the Amputee Long Drive Championship and many other events for real-world feedback. Much of what we learned was incorporated into TrueLimb®."

Unlimited Tomorrow went out and spoke to people with limb differences and those who wear prostheses to better understand their needs. The people they interviewed told them they wanted a device that was functional, lighter weight and "cool" to wear, while also being less expensive.

With a treasure trove of real-world data and their prior experience working with robotics and 3D printing, Unlimited Tomorrow knew they could build a better device. But they also wanted to improve how prosthetics are ordered and fitted.

3D scanning has been a game-changer for the healthcare industry, but it has mostly been used in a clinical setting. With more recent advancements in cameras and other technology, smart devices were becoming more capable. The team wanted to know if patients could be scanned, or even scan themselves, remotely with a tablet or phone.

"We were very interested to learn if non-technical people could navigate the 3D scanning process," said LaChappelle. "Web technology has gotten to the point where we could design a pretty elegant user experience, but our big question was around scanning. Could customers actually manage that remotely? Turns out, the answer was a resounding YES."

To test their theory that users could provide the scans themselves, Unlimited Tomorrow developed 3D scanning kits that were shipped to prospective customers and developed a software workflow that was easy to use, secure, and HIPPA-compliant. The results quickly proved it could be done—users were able to scan and send their data directly to Unlimited Tomorrow.

Once Unlimited Tomorrow knew that remote 3D scanning was feasible, they worked to refine their order workflow. They wanted to offer a flexible solution that would support customers with and without insurance.

Serving consumers and clinicians

“My goal is for the industry to never have to deny someone a prosthetic limb,” says LaChappelle. “A lot of our customers have insurance and trust their prosthetist. We fully support that and want their patients to have access to our capabilities. We also know there are a lot of people with limb differences who don’t have insurance or faced problems with it in the past. We developed our remote fitting process address this unserved and underserved market.”



New patient shows off dexterity with TrueLimb®

A remote fitting process drastically increases access for people who can’t or don’t want to utilize insurance. But going direct doesn’t mean that they receive inferior treatment. Unlimited Tomorrow’s in-house clinical team oversees the entire process, working directly with the patient and refining the socket for a perfect fit.

Orders coming from healthcare providers follow a similar workflow, except in those cases, a prosthetist examines the patient and sends 3D scans to Unlimited Tomorrow. Check sockets are shipped to the clinician, who oversees the fitting. Modifications are communicated and once a final socket is approved, Unlimited Tomorrow delivers the entire unit directly to the clinic.

Unlimited Tomorrow is unique in the prosthetics industry because it is both a manufacturer and a central fabrication facility. Having the ability to 3D print sockets and also manufacture and assemble customized robotic prosthetics not only enables them to tightly and securely control the order process, but it also enables a state-of-the-art device with many innovative features.

Product features

“Most people are conscious of their appearance and the perceptions others have about them,” said LaChappelle. “It can be magnified for those who require prosthetic devices. Generic prostheses don’t help. We wanted to create a device that people, and especially kids, would wear with pride. Certainly, we could improve the technology, but the real question was whether we could develop a product that would inspire confidence.”

Based on their research, the team at Unlimited Tomorrow designed TrueLimb® with several groundbreaking features:

- **Functionality** - TrueLimb® is significantly lighter than other powered devices and offers multi-day battery life. It further excels by allowing more natural movement and positioning, individual finger control, and multi-grip functionality, including six individual grips, giving users the control they need to perform daily tasks.
- **Durability** - With daily use, prosthetic devices are subjected to ordinary wear, but they also get spilt on, bumped, dinged, and dropped. Unlimited Tomorrow has engineered TrueLimb® to be incredibly durable and they also conduct extensive testing to ensure external and internal components continue to meet the rigors of everyday life.
- **Customization** - TrueLimb® was designed to be functional, realistic and “cool.” There are no preset sizes, each device is made to be a mirror image of the person’s arm, down to the finger length and width. While the design freedom and cost efficiencies of 3D printing enable that level of customization, Unlimited Tomorrow also offers a wide array of colors - including 144 skin tones - in addition to themed devices in gold, silver, black, and white, among other options.
- **Upgradeability** - For an individual with a prosthetic device, the choice of prosthesis is an important, lasting decision. With pediatric patients, the need is again amplified. Children can begin using prosthetics at an early age, and as they develop, they quickly outgrow them and must go through the time-consuming process of forming and fitting new sockets. With Unlimited Tomorrow, patients can simply send in a new scan and receive upgraded components, including the electronics, 3D printed socket, and other customized pieces.

- Economics - Cost is a significant barrier for most patients who require prosthetic devices. Health insurance companies typically won't provide coverage, so patients must pay out of pocket. Unlimited Tomorrow shatters the cost barrier, selling its state-of-the-art solution, including remote 3D scanning, test sockets, a final breathable, personalized socket, and a personalized TrueLimb® prosthetic, for a fraction of the cost of other devices.

Benefits of 3D printing

Before they collaborated with HP and ABCorp, Unlimited Tomorrow had marginal success with additive manufacturing. They experimented with fused deposition modeling (FDM) but found it wasn't efficient enough and didn't provide the attributes with their high-tech product demands. They needed a cost-effective way to make strong and durable parts that are highly customizable.

"HP's research and development team has been instrumental in our success with additive manufacturing," said LaChappelle. "We experimented with HP's technology and uncovered several important insights. We found that the quality, speed, and economics of HP's solution were ideal, but if we really wanted to scale, we needed a partner who could manage production while we focus on building the business."

With HP's Multi Jet Fusion 3D printing solution, Unlimited Tomorrow had the capabilities it needed to build a next-generation prosthetic that was more functional, durable, and realistic.

Weight reduction

Unlimited Tomorrow made light weighting a priority, and this is evident with TrueLimb®; the entire device weighs 1.5 pounds. Some of the weight savings come from the advanced electronics and batteries used in the device, but HP's 3D printing technology also plays a vital role by allowing Unlimited Tomorrow to develop customized plastic sockets that are much lighter and more comfortable than multi-material, handmade versions.

"Socket design is really crucial," said LaChappelle. "If it's not stable and comfortable, many users simply abandon the device. We took a new approach, developing a breathable, lightweight socket."

Beyond the socket, HP's technology and Design for Additive Manufacturing (DfAM) principles also help the team optimize other parts, further contributing to TrueLimb®'s weight advantage.

Material strength

Much of the weight savings can be attributed to HP's Multi Jet Fusion 3D printing process and its unique HP 3D High Reusability (HR) PA 12 material. Together, they empower Unlimited Tomorrow to develop high-quality plastic parts with superior strength and durability, helping reduce the need for metals and other heavy materials.

The combined machine/material solution also brings other benefits. Because parts are manufactured additively, layer by layer, engineers can completely rethink their designs by using strong lattice-type structures instead of solid surfaces. Designers can also use DfAM to build multifunctional parts, sometimes eliminating the complexity and assembly associated with traditional components.

Sustainability

3D printing also provides significant sustainability advantages for Unlimited Tomorrow and its customers. For one, there is little scrap material left over compared with subtractive manufacturing methods such as machining and milling. With HP's solution, the material is recycled during the printing process, practically eliminating waste. On-demand manufacturing also plays a role by reducing obsolescence and reducing part inventories.

Efficiency

With HP's 3D printing, Unlimited Tomorrow is able to deliver a superior product in less time and with less stress and discomfort for its patients. It's estimated that globally, there are over 57 million people who could benefit from a prosthesis, yet less than 5% have access to modern prosthetic devices. Unlimited Tomorrow is poised to capture a significant share of the market but must be able to grow to meet the demand. Digital manufacturing is very scalable.

Collaboration with ABCorp

In March of 2022, American Banknote Corporation (ABCorp) announced a strategic partnership to produce TrueLimb® Prosthetic Limbs for Unlimited Tomorrow. With its design and production capacity, ABCorp is ideally suited to cost-effectively 3D print end-use parts with unparalleled speed and productivity. Their highly secure, FDA-registered facility with HiTrust certification and HIPAA compliance also ensures the security and privacy of Unlimited Tomorrow's intellectual property and patient information.

"ABCorp has a history dating back more than 225 years of providing essential, critical goods and services to world-class organizations in more than 120 countries worldwide," said William Brown, ABCorp Chairman and CEO in a press release. "Many of our relationships date back decades, if not centuries, and we do not enter into strategic partnerships impulsively. We are pleased to announce our new association with Unlimited Tomorrow for the latest generation of prosthetic limbs."

About ABCorp

American Banknote Corporation is a unique manufacturing services company headquartered in Boston, Massachusetts. The company's main expertise is in fraud prevention and they are frequently called upon to design secure, error-free manufacturing processes. Their products and services are used by many organizations, including those in the commercial, FinTech, government & not-for-profit, healthcare, and transit sectors.

ABCorp's roots in printing trace back to 1795 when the newly established First Bank of the United States called upon them to create a counterfeit-resistant currency for a young nation. Since then the focus has shifted and today the company's core revenue derives from the design, manufacture, and personalization of gift cards, credit cards, and other financial instruments.

ABCorp is also aggressively implementing new digital manufacturing technologies. For decades, their primary 2D printing technology was lithography. Over the past few years, they have transitioned to electronic printing and have acquired several of HP's digital presses. With these new capabilities, they've expanded beyond printing on plastic and now offer personalized, digitally printed products that facilitate omnichannel marketing efforts.

Beyond ink and paper, the company has also transitioned into 3D printing. ABCorp opened its Additive Manufacturing Center inside its 125,000 square foot secure, state-of-the-art facility in Boston, Massachusetts. The facility acts as a service provider and collaborates with customers to produce highly detailed prototypes and end-use parts. The center is home to a fleet of HP's Multi Jet Fusion 3D printers and serves clients in the aerospace, defense, automotive, consumer products, medical, and robotics industries.

Partnership pays off

“Our mission is to use all available technology and resources to make the highest-quality, lowest-cost prosthetic arms in the world,” said LaChappelle. “After visiting ABCorp’s facilities, our team was lit up! Their technology was state-of-the-art, the focus on security was evident and the organization and attention to detail was impressive.”

With their device validated and a go-to-market strategy in place, Unlimited Tomorrow began selling TrueLimb®. In addition to the remote fitting process, they were excited to see demand from doctors at clinics and the Veterans Administration. In those cases, insurance would pay some or all of the cost.

With their new partnership in place, Unlimited Tomorrow began sending sockets and devices to ABCorp for production. The part quality was excellent and they received them in about half the time it would take to produce them internally. The cost was also much lower.

“3D printing is really good for bridge production and HP’s technology is perfect for robotic prosthetics,” says Neil Glazebrook, VP of 3D Solutions at ABCorp. “But for us, this is more than just a revenue opportunity. ABCorp has a strong culture and giving back to the community is very important to us. When we heard about TrueLimb®, we were excited to roll up our sleeves and help Easton and his team achieve their vision of making advanced prosthetics available and affordable.”

Casualties in Ukraine

In February 2022, Russia invaded Ukraine. Since the war started, the office of the UN High Commissioner for Human Rights (OHCHR) estimates that nearly 6,000 civilians have been killed and almost 9,000, including hundreds of children, have been injured. Military casualties have also been high, with some sources claiming hundreds of thousands have been killed and over 100,000 injured.

With so much suffering, Unlimited Tomorrow knew they had to act. But getting there was another problem entirely. First patients would need local access to 3D scanning and then Unlimited Tomorrow would have to find a way to get customized TrueLimb® devices to the point of care.

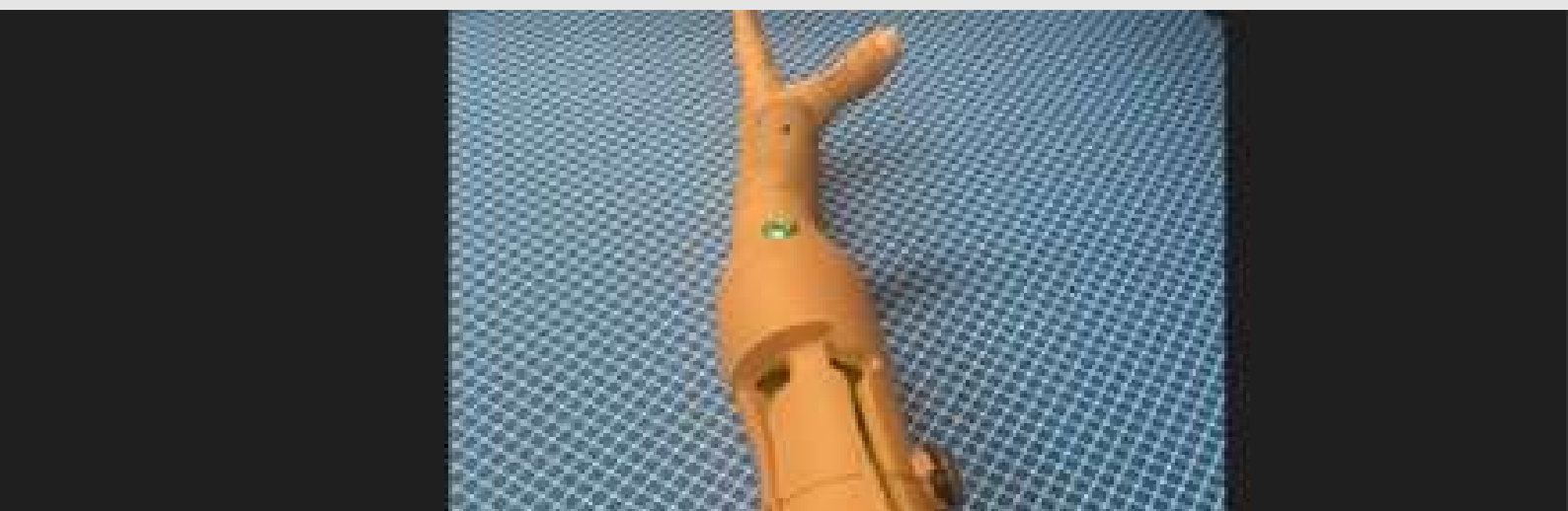
To meet the need, Unlimited Tomorrow began working with Singularity Group. The organization is dedicated to making applied innovation available and investable across sectors and industries. With their global footprint and contact base, The Singularity Group confirmed that they could help get Unlimited Tomorrow’s devices to war-torn Ukraine.





First 3D Scanner arrives in Lviv, Ukraine in July, 2022

Today there are two 3D scanners in place and Unlimited Tomorrow is actively filling orders to Ukraine. Just like any other order, once a 3D scan is taken, it is sent to ABCorp for production. The components are shipped to a neighboring country and hand-delivered to the patient or clinic.



The first TrueLimb® device sent to Ukraine, August, 2022

Bringing technology to the patient

To further expand access to its capabilities, Unlimited Tomorrow is experimenting with different imaging technologies. With recent advancements in technology, smartphones are becoming better at capturing 3D scans. Unlimited Tomorrow is researching this approach and hopes to migrate to an app any person can use to scan and order a TrueLimb® prosthetic.

The company is also looking for ways to bring manufacturing technology closer to its consumers. Ideally, they would like to pack a shipping container with all the machines and materials they'd need to produce hundreds of TrueLimb® devices onsite. With a distribute-then-print business model, Unlimited tomorrow could further reduce the time associated with order fulfillment, and handle fitment issues much more quickly.

In the shorter term, however, they are focused on optimizing and improving their current workflow. ABCorp is building additional capacity at its plant in Tennessee and plans to ship devices from that location. Not only will this allow Unlimited Tomorrow to serve the U.S. market more quickly and less expensively, but it will also enable new features and finishing options.

To learn more about Unlimited Tomorrow and its mission to make high-quality, low-cost bionic prosthetic arms easily accessible to everyone, please visit <https://www.unlimitedtomorrow.com/>

To learn more about how HP's MJF 3D printing is helping revolutionize technology, including medical devices and robotics, please visit <https://www.hp.com/us-en/printers/3d-printers/industries/healthcare.html>

