BOYCE TECHNOLOGIES' ADDITIVE SOLUTIONS TO WIN BUSINESS

How NYC's Boyce Technologies integrated AM beyond prototyping into vacuum forming and end-use parts.

Boyce Technologies, prominent designer and manufacturer of products for public safety security and communications systems, is an expert on manufacturing technology. In their 150,000-square-foot state-of-the-art facility in New York City, the company uses a variety of technologies to deliver necessary products from emergency response systems to radio and wireless networks, along with intercom systems, security alarm systems, customer information display systems, and integrated software systems.

Among the 125 employees on the team are skilled designers, CAD drafters, CNC programmers, machinists, welders, engineers, assemblers, field technicians, project managers, software designers, salespeople, and administrative support. Together, the team has created a smooth process for innovating solutions in its chosen fields.

Boyce Technologies

bigrep

As a competitive company, Boyce grows with demands of the times. Not only is its facility expanding - to 250,000 square feet by 2020 - but so are its processes. Boyce Technologies has long been familiar with traditional manufacturing processes, offering expertise with multi-axis CNC machining, laser technologies for cutting, and welding, multi-axis industrial robots, and multi-axis water jet cutting. But these weren't enough for some of the company's more recent projects that required more iterations and complex geometries.

To find a solution, Boyce began investigating options in 3D printing.

Initially, company leadership did not see the value of bringing 3D printers into operations.

"I used to think the fastest way to do something was to do it out of a piece of metal, I didn't think I needed 3D printing and now I can't live without it," said Charles Boyce, President of Boyce Technologies.

To narrow down their search, the team laid out several necessary parameters.

Their chosen technology had to be:

- Fast
- Reliable
- Accessible
- Large format
- Versatile
- Open to future modification

Ajmal Aqtash, Boyce Technologies' Director of Advanced Robotics, worked on the search with his team. They had their work cut out for them proving to management – including Aqtash himself – that the investment was worthwhile.

To gain approval, they had to prove that a system could provide:

- Time savings
- Accessible pricing
- Low material costs
- Low maintenance
- Modifiable
- Many potential uses

The BigRep STUDIO ultimately met all of Boyce's needs, and they set about exploring ways they could use the system to its greatest effect.

> *"At the beginning we understood 3D printing as primarily a prototyping tool, that quickly shifted into production."*
>
> Ajmal Aqtash, Director of Advanced Robotics, Boyce Technologies

The planned integration for the new system was for about 90% prototyping usage and 10% production. **What ended up happening was exactly the opposite**, and the team has seen its usage shift to **90% production and 10% prototyping**.

Today, Boyce sees great use for its BigRep large-format 3D printers across a variety of applications including prototyping, manufacturing end-use parts, and creating vacuum forming molds.

PROTOTYPING : VERIZON DIGITAL KIOSK

Verizon approached Boyce with a “cartoon sketch” of a digital kiosk. The various experts across Boyce were all engaged in the interdisciplinary project. Since the 5G structure is designed for installation outdoors in dense urban areas its needs are complex, and it fell to Boyce to engineer it.

3D printing was integral to a few areas of the design including the exhaust and intake systems, cooling manifolds, and door hinge filler. Boyce built its own testing chambers to put the prototype structure through its paces, “pushing the 3D printed parts through a very extreme set of circumstances,” Aqtash said.

Among the many strenuous tests were a 3-4-hour rain test, 100+ degree heat chamber, -40-degree cooling chamber, an 8G shake test, and structural deformation – all to ensure the kiosks can stand up to outdoor environments.

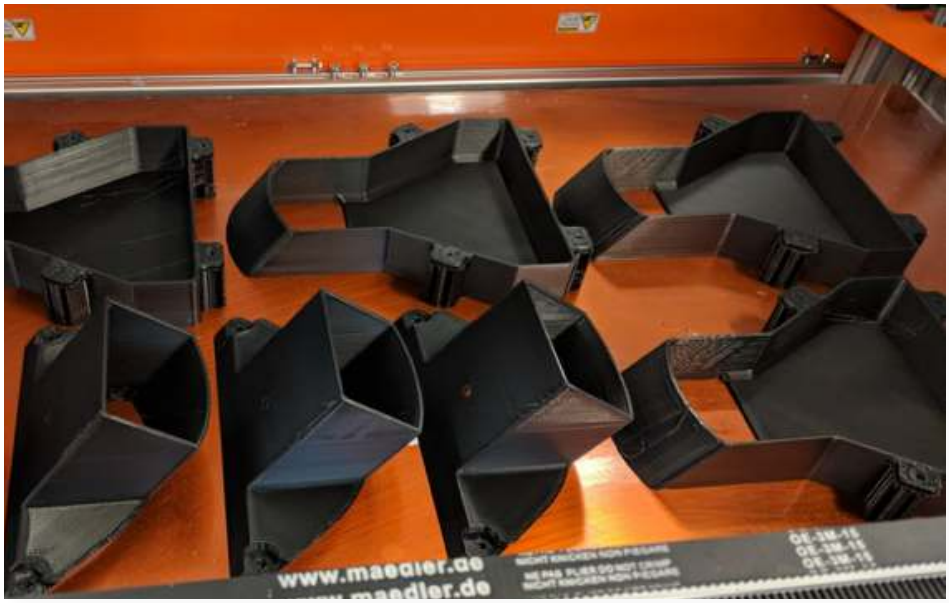
Through the testing and building at a rate of 10 kiosks per week, the team noticed some non-structural aluminum elements were deforming and needed to be replaced with a more suitable solution. For these and other parts 3D printing provided additional value for Boyce, who now needed to create a solution for parts involving complex organic shapes.

A form factor and fit test showed that 3D printing was perfectly suited to prototype a new part, ensuring perfect fits before investing into final materials. Costs in terms of time and personnel were cut significantly from the traditional workflows Boyce previously relied on.

The project was important for Boyce, and not just for the work with a major client like Verizon in a city like New York; they began to more deeply understand what 3D printing could offer.

"This was how we started," Aqtash reminisced "over time we realized that much of this was very useful, but also we began to realize, identify and ask questions about why we couldn't use these as end-use parts."

The team "saw a transformation occurring in real time as we were testing" as their understanding of their newest tool deepened.



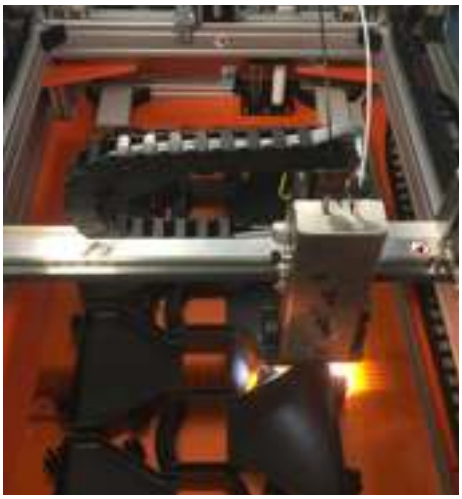
End-use parts

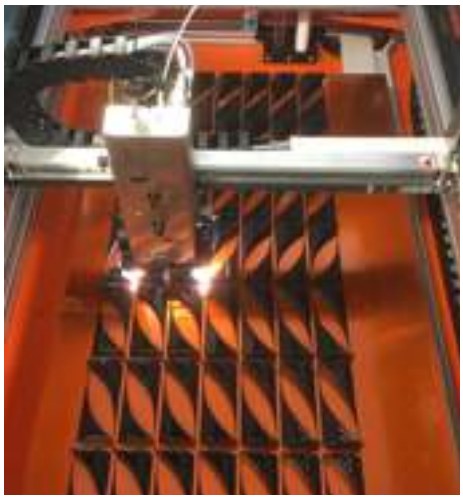
END-USE PARTS

Discovered “not by design, but after developing a more intimate relationship with the printer itself,” as Aqtash put it, the Boyce team began to understand that their in-house 3D printing capabilities could create end-use parts.

As the 3D printer ran after hours in “lights-out manufacturing,” the Boyce team found that they could come in to finished parts in the morning. This massively enhanced their capabilities and excited their engineers and designers, who “began to think about 3D printing differently, that it was something more than we had conceived,” Aqtash said.

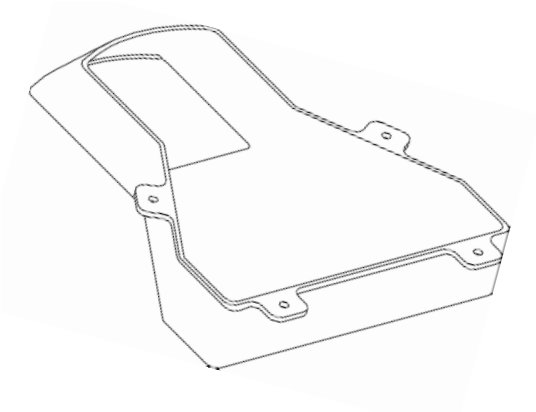
New workflows allowed the team to explore even more possibilities, such as mass customization with differences between parts in a two or three dozen part production run and pack multiple different parts onto the same print bed.





COOLING SYSTEM AIR-INTAKE DUCT

Designed by: Boyce Industries, Inc.
Dimensions: 127 x 223 x 77 mm
Nozzle: 0.6 mm
Layer Height: 0.3 mm
Plastic Weight: 1.8 Kg
Filament: Black Pro HT
Printing time: 2.5 hours (x1) - 34 hours (x16)

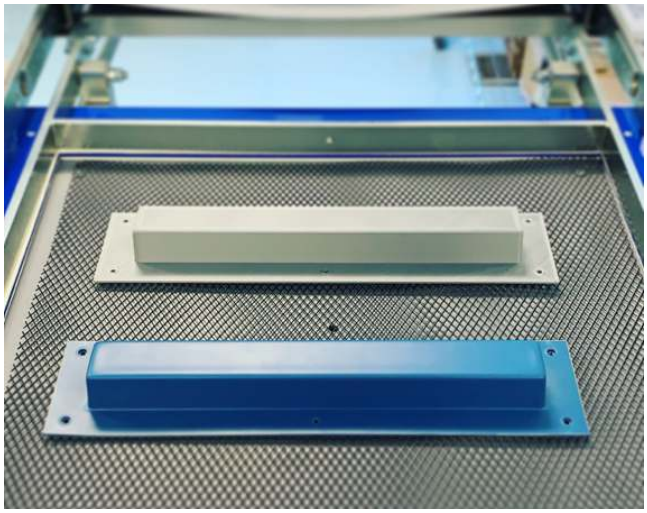


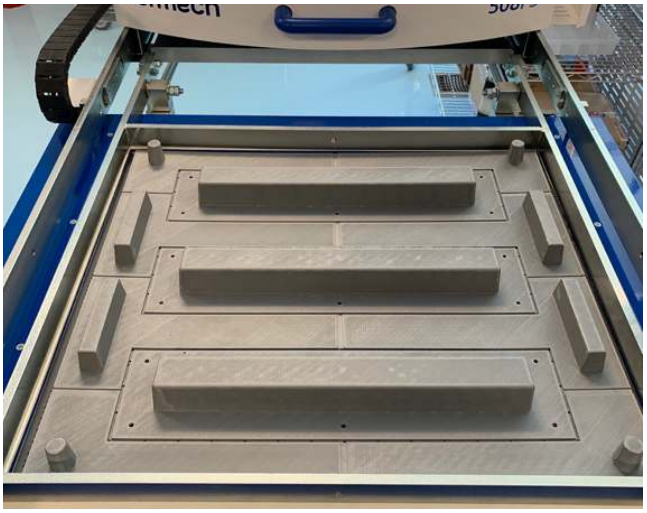
VACUUM FORMING PARTS

In vacuum forming, a layer of plastic is heated and conformed to a mold through heat and suction.
This is a common technique used at Boyce Technologies for applications like the shroud covering the 5G kiosk.

When the team began looking at a vacuum-formed 'totem' part made for the Metropolitan Transportation Authority (MTA) two decades before the Verizon project, they decided it needed an update and turned to newer technologies for a solution. Needing to get mechanical fastener locations identical but not wanting to suffer from the costs and timelines of machining a mold from aluminum, the team turned to 3D printing again.

Boyce 3D scanned the original part to generate a digital model and from there 3D printed a mold. A day of testing was followed by a second day of verification to ensure fit and finish. From there a stronger mold was 3D printed using carbon nylon material to generate a short run with thermoforming.

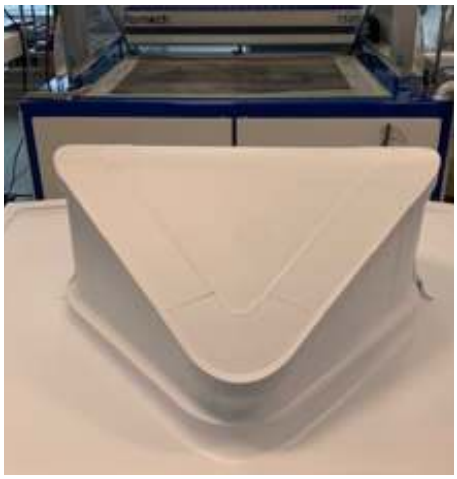


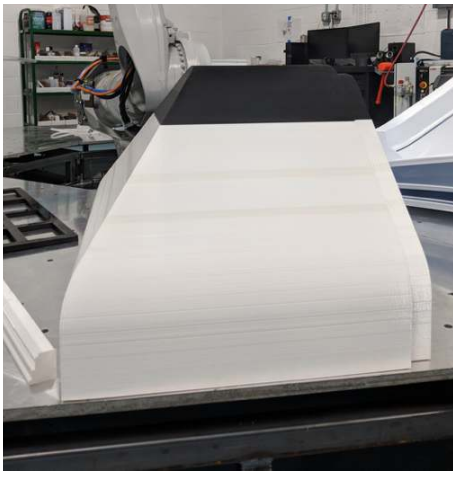


Developing a mold using 3D printing for accurate geometry to produce **consistent and precise parts** was an ideal solution. Doing so with traditional aluminum molds for a low-volume run would have required significantly more time and money. By 3D printing test molds in a **low-cost material** for verification and then creating final molds in a more robust material, **the entire process took only days**. The successful results allowed the Boyce team to produce a short run of replacement parts incredibly efficiently.

After successful results on the MTA project, Boyce looked to a bigger project in vacuum forming: creating a mold for the Verizon digital kiosk. A large collapsible mold, created for undercut processing required in thermoforming that makes the formed product removal easier, changed the strategy a bit. The team knew from the start that the final molds would be produced from aluminum but getting the precise, verified design merited in-depth prototyping. Before investing in the final mold, they verified all angles and appropriate collapsibility with 3D printed parts, creating a process that ensures perfect final part production.

"These are ways for us to quickly use an inexpensive, fast strategy to verify more complex, expensive processes," Aqtash said of the experience. "It's the value we often look at when people refer to 3D printing for prototyping."





Another large mold, about 30 inches cubed this time, is a shroud mold made in two pieces for the Verizon digital kiosk. With 3D printing, the Boyce team discovered, a large, dense part becomes extremely durable – ideal for thermoforming. The team saved time and money again making this large mold from 3D printed plastic filament ahead of creating the final with traditional methods from aluminum.

BENEFITS OF PRINTING

With more experience in 3D printing throughout a variety of in-house applications, the team at Boyce Technologies found across-the-board benefits to bringing the BigRep STUDIO into operations. This was exponentially increased when they invested in a BigRep PRO; a fully enclosed large-format printer with a one-cubic-meter build volume capable of printing engineering-grade materials with high repeatability.

"With the PRO, we are now much more competitive because we're able to produce large proofs of concepts faster than anyone else in the industry." said Aqtash upon the installation.

Examining material costs and comparing 3D printed filament to the traditional costs of working with aluminum proved illuminating for Boyce. The team examined different practical parameters and found that filament saved on :

ASSOCIATED MATERIAL COSTS	TIME TO PROGRAM/PREP	POST FINISHING
• Storing 60 – 80% less material • Waste Disposal	• 3-6 Hours for CNC Aluminum • 15-30 Mins for 3D Print Plastic Print	• 12 people working for Metals Parts • 2 people working for Plastics Parts

As Aqtash noted, moving fast is important to the strategy at Boyce. Being able to iterate more rapidly, create usable molds and tools, and produce end-use parts in shorter timelines with less costly material and labor has shown that 3D printing is here to stay.

Ultimately, Aqtash laid out the benefits of 3D printing as hinging on time-to-market reductions and increased business.

Beneath these two final takeaways are a great deal of supporting factors, as shown through projects such as the 'totems' for MTA transit, replacing multiple static subway maps at each station.
Due to contract changes that brought the project to Boyce relatively late in the overall development process, the team had less than two weeks to design, engineer, fabricate, and install the machines. Another team failed to deliver in 8-9 months, and MTA returned to Boyce to see what they could turn around in just two weeks.

The relatively complicated designs, required to operate in all kinds of environmental conditions with full connectivity, necessitated speed and accuracy in all its parts. Engineering new housing for an LED strip and light controller, as well as plastic parts housing a 4G cell for RF transparency, offered challenges with severely limited time that sent the Boyce team straight to 3D printing. Without time to generate tooling for injection molding and parts that aren't ideal for CNC machining **"we were able to fulfill a very complex, intense order in less than two weeks,"** Aqtash said as their use of 3D printing enhanced the quality of the project. Upon the MTA's unveiling, "the governor was extremely happy" – and so were other customers. Boyce Technologies reported more business coming their way following the success of this high-profile project.

Winning business and meeting tighter deadlines captures some of the most-touted aspects of 3D printing in a tangible way. Boyce's experience with their large-format 3D printers has shown the innovative ways these high-level goals can be met, even after just a single high-impact application like prototyping, and later expanded upon as the team becomes increasingly familiar with the technology. Boyce's success demonstrates how the proper integration of additive manufacturing not only provides solutions, but unlocks the potential for further efficiencies and advancements.

Hear from Boyce Technologies how BigRep Large-Format 3D Printers changed their business in our video use case. ▷

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REDEFINING **ADDITIVE**

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