How Kawasaki Optimized Production with 3D Printed Tooling

Innovation begins with the tools that enable it.

In **Kawasaki Motors Corp.'s 2.1** million square-foot facility in Lincoln, Nebraska that employs over 2,400 plant workers, 75 engineers have been given a BigRep large-format 3D printer to find innovative solutions to their unique manufacturing challenges. By applying additive solutions to roadblocks in their advanced manufacturing of off-road vehicle, light railcar and aerospace products Kawasaki has realized some astounding cost and time savings.

The central production facility for the United States, Kawasaki's Lincoln plant works on a wide variety of intensive projects. From the recreational vehicles and other transportation solutions the company is usually known for, all the way to brand-new North American endeavors into aerospace, where cargo doors for the **Boeing 777X** are manufactured, Kawasaki is ambitiously pushing the limits of industry from their home in the Great Plains.

But such a large variety of engineering challenges requires a flexibility that often leads to serious dependence on outsourcing to acquire factory tooling and the other various equipment and parts needed for production. To overcome this challenge, Kawasaki turned to BigRep.

CHEMTRON INSPIRED BY INNOVATION Kawasaki bigrep

End Tooling in Automated Equipment

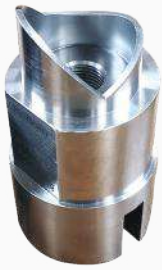
CNC Tube Bending

Since bringing in their BigRep 3D printer Kawasaki has found incredible savings in their facility, including an eight-to-ten times price difference compared to previous outsourcing expenses according to their engineering team.

An example of Kawasaki's newfound efficiencies has come from factory assembly pieces. While prototyping new vehicles the engineering team builds a frame from straight raw tubing, shaping it with a CNC tube bender to form the frame's design. CNC tube bending is a highly involved process that often requires significant tooling iterations to get right. Previously, Kawasaki had to outsource their bender's profile collets – parts that help to properly orient a tube throughout the bending process – but decided to integrate BigRep additive manufacturing into their workflow to bring the process in-house.

Before their BigRep 3D printer, Kawasaki's tooling was manufactured externally with heavy steel over long lead times and at high cost, making any of the necessary iterating a significant financial burden. The Lincoln team received quotes upwards of $500 US for outsourced collets that cost as little as $17 to produce much faster in-house using BigRep's PLA filament.

3D Printed Tube Bending Collect



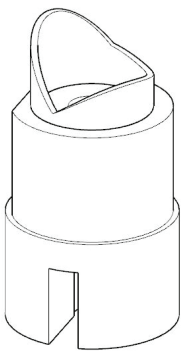
Outsourced Metal Tube Bending Collet

"They function for a good while," said Ross Makovicka, a production engineer at Kawasaki Lincoln, when asked about the reliability of 3D printed PLA tooling compared to previous steel clamps, adding that the sets of plastic tooling are used for roughly five months. "Once it wears to a certain point it meshes with the mating surface nicely, so it's kind of work treated on its own."

According to Makovicka, the parts experience 10-to-15 pounds of compressive force for about two seconds in 45 second intervals during normal production, and the affordable PLA material fares well under those conditions. In total, he predicts that Kawasaki has saved around 85% of expected outsourcing costs in their tube bending area by modernizing workflows with large-format additive manufacturing.

CNC Tube Bending Profile Collet

Dimensions	**54 x 54 x 95 (mm)**
Nozzle	**0.6 mm**
Layer Height	**0.3 mm**
Part Weight	**65 g**
Filament	**PRO HT**
Part Cost	**$ 17 (USD)**
Printing Time	**2 hours**



Kawasaki

5 Hour Aerospace Solution

Globally, Kawasaki has been supplying **Boeing** with aerospace parts for a long time, but only began manufacturing for aerospace in the US in 2017. The production of aerospace parts has extremely high qualification standards that make it a difficult business for manufacturers to enter, and continues to cause significant delays during production as new parts and tooling are required or need replacing. Kawasaki's new flash tooling-production capabilities with their BigRep 3D printer have paid off in these high-level aerospace projects. While manufacturing **Boeing 777X cargo** doors the team needed a new tool, but the stringent approval processes were set to cause a serious bottleneck in production. Instead, the aerospace team designed a mockup part as a placeholder to align tooling and continue with their work.

"They were having issues locating a part and came up with this design," Makovicka said. "I took a look at it and what they had designed seemed easily printable, so I told them it'd be good to go. Five hours later it was ready."

The manufacturing of Boing 777X cargo doors with Kawasaki's automated manufacturing systems.

A Kawasaki manual operator working with a Boing 777X cargo door.

Improving Factory Equipment

The Kawasaki Lincoln plant is notable for their exceptional automation, using state-of-the-art equipment like auto-riveters and robot cells in their aerospace facility among a variety of other tools in their three other departments to alleviate employee strain and workload.

“I asked the company for the 3D models and when they sent them I was able to modify their part to improve the fit for that clamping device, 3D print my part and swap them out the next day.”

Scott Gordon — *Chief Engineer, Kawasaki Motors Corp., U.S.A.*

When Kawasaki’s engineering team brought in laser engraving to etch vehicle identification numbers into recreational vehicle frames, they found the engraving unit was shipped with an imperfect part that could have caused some real problems for planned production.

“I noticed the clamping system on the engraving head didn’t really fit very well,” said Scott Gordon, Kawasaki’s Chief Engineer. “I asked the company for the 3D models and when they sent them I was able to modify their part to improve the fit for that clamping device, 3D print my part and swap them out the next day.”

The issue might have caused serious misalignments in the engravings but fixing it through their supplier risked lengthy communications and drawn-out delays that would prevent the facility from using their new investment, or even completely halt some production for an unpredictable amount of time.

In fact, Kawasaki has already avoided a number of production delays by applying additive solutions with their BigRep printer. When bushings are installed via a press in their assembly line, the installation can’t result in a perfectly centered bushing, so operators need to manually center after installation. Having a fixture to keep products oriented properly during the alignment is necessary, but it’s vital not to scratch brand-new consumer-bound products. To avoid this issue, tooling has to perfectly conform to the product’s curvature. Additive manufacturing was a natural choice.

“The fixture went through three different revisions until the perfect combination was found, saving countless hours of machine time, material costs, and lead times,” Makovicka said. “The 3D printed version works well in the production line, it meets all the desired criteria, so no other version needs to be created. The 3D printed one will stay in use.”

Kawasaki’s laser engraving system etches vehicle identifications numbers (VIN) onto vehicle frames with a 3D printed clamp (left).

BigRep's Industrial-Sized Materials

Kawasaki has found uses for a variety of **BigRep's industrial filaments**, mostly relying on the cost-effective PLA wherever appropriate. "It has been easy to work with and durable enough for fixtures and light use tooling," said Makovicka of the material that's available in large, **8 kg spools** suited to large-format applications like Kawasaki's and optimized for BigRep printers. The company also uses BigRep's PRO HT for applications where higher temperatures are required and TPU to create shock-absorbent qualities.

Logistics

With 75 engineers sharing the new additive manufacturing system in their facility, logistics have been incredibly important to ensure smooth organization and prioritization of projects. Though Makovicka is Kawasaki's dedicated 3D printer operator, the machines are open to anyone on the engineering team to use for various projects. Print requests are managed with a spreadsheet Gordon created on the company's internal server for any of the engineers to access. The team simply attaches their design files and specifies whether they'd like to operate the printer themselves. If they'd prefer not to, Makovicka takes care of it, sending parts over to the production facilities as soon as they're done.

Because of this organization Kawasaki has managed to print over 100 parts in just six months, creating operational savings that show a return on their investment in this short time. "We were estimating about 200 and 250 jobs a year," Gordon said. "It looks like we're going to hit that pretty easily."

Part of Kawasaki Lincoln's production line for MULE utility vehicles.

Conclusion

Kawasaki wasn't a stranger to 3D printing before diving into large format with their BigRep, and their wealth of experience with advanced manufacturing equipment helped to further inform their choice.

"R&D had their own printer, so they had some experience on what to expect - its capabilities, limitations," said Makovicka of the decision to buy a BigRep additive system. "We wanted something that was set up for industry, not just hobby."

Gordon said they had concerns over the reliability of some large-format printers while exploring their options, but were enticed by other companies' positive experiences with BigRep. After an approximate total of 850 hours operating their own BigRep printer daily and overnight or straight through weekends for longer projects, they're still happy with their decision.

Kawasaki says the benefits of their printer extend beyond its industrial applications. They're using it as an attractive showcase of the advanced manufacturing technologies available in their facility to attract new talent and to slow down turnover by keeping long-term staff engaged.

They've also found that having a large-format additive manufacturing system open to their greater engineering and research team has led to a variety of efficiencies and unplanned solutions. The ability to use plastic brackets and other tooling in their CNC tube bending process for an extended period provides massive savings for the facility and speeds prototyping processes along, unhindered by outsourcing delays or limits to iterations. Fast solutions to unexpected blockers, like lengthy approval processes for aerospace projects, provide a valuable route to remove bottlenecks from the production process and gain time on projects.

Having reduced tooling expenses by an astounding 85% and returned their investment in about six months, Kawasaki is only optimistic about the future of BigRep and large-format additive manufacturing in the company.

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