

Case Study: Robotic Tube Bending Increases Throughput & Eliminates Safety Risks

Application: Machine Tending
 Robot Model: R series general purpose robots

OVERVIEW

Robotic machine tending can offer a wide range of benefits, whether it is ergonomic relief, increased throughput, or a more streamlined and efficient process overall. For Kawasaki Motors Manufacturing Corp., USA (KMM), automation helped them in all of these areas.

Five years ago, KMM installed their first tube bending cell using Kawasaki R series robots, called Bender Bot 1, to bend pipes to construct all-terrain vehicle (ATVs) and four-wheeler frames. Since the implementation of Bender Bot 1, they've installed another tube bending cell, aptly named Bender Bot 2, and they're hoping to install a third Bender Bot cell in the near future.



Inside KMM's Bender Bot 1 cell, which uses one RS050N robot to load and unload a tube bending machine.



KMM's Bender Bot 2 cell uses two Kawasaki RS020N robots to load and unload smaller pipes with the goal of increasing throughput.

“A lot of times when you automate a process you'll say, 'If it works for 85% of what I want to do, that is great.' And here, that was unacceptable.”

-Scott Gordon, Chief Engineer,
 Kawasaki Motors Manufacturing Corp., USA

CHALLENGES

- Eliminate safety risks posed by heavy pipe loading
- Increase throughput for the bending of smaller pipes
- Streamline the post-bending process
- Design a reliable process for weld seam alignment
- Create an easy-to-program system for product changes

An Ergonomic Challenge

Before installing Bender Bot 1, the company's manufacturing process required an operator to continuously pick up 10 ft-long pipes weighing up to 20 lbs over the course of an 8 hour shift, while ensuring the weld seam was loaded perfectly. This precise, repetitive motion involving such cumbersome objects posed an obvious risk of injury for the operators.

Speed Up Production

As production goals increased, KMM needed a solution that would allow them to speed up the process of bending their smaller, lighter tubes without additional labor or compromising their product quality.

Accuracy is Crucial

Many of the roughly 65 tube configurations require the bending of round tubes. If the round tube isn't placed in the bending machine at a near-perfect angle, the weld seam could stretch or shrink, which distorts the shape of the tube and creates waste through rejection. KMM needed to use robots they could count on. "Kawasaki robots are known in the industry for their reliability," Gordon said. Kawasaki RS020N and RS050N robots have a repeatability of ± 0.04 mm and ± 0.06 mm respectively which, when paired with the Laser Seam Finder, results in the consistency KMM needed for a quality end product.



The Laser Seam Finder uses a Cognex camera to locate a notch in the front of the round pipes, which signifies the pipe's weld seam is in the proper position.

SOLUTION

After seeing the potential for operator injury, Chief Engineer Scott Gordon designed Bender Bot 1 to eliminate this risk. The cell uses one Kawasaki RS050N robot to unload the pipes from the Laser Seam Finder, which sets the tubes in the ideal weld seam position for the robot to pick up. The robot then picks the heavy pipes one at a time and loads them into the tube bending machine. Once the pipe has been bent, the robot unloads them onto a custom rack.

With the positive effects of Bender Bot 1, KMM decided to install another tube bending cell to handle the smaller, lighter pipes, but with a different goal. This cell would be focused on increasing throughput, so it uses two Kawasaki robots – one to unload pipes from the Loader/Seam Finder and load them into the tube bending machine, and another to load the finished pipes onto the custom pipe cart.

Both cells use a proprietary Loader/Seam Finder, which was also designed by Gordon. Here's how it works: A tiny notch is cut in the round pipes. The Laser Seam Finder rotates the pipe in front of a Cognex camera until it notices the notch. This machine can get within 1.5° of the notch – a point that is critical in this process, especially when the pipes have special features such as rivet holes or shaped ends. For pipe with straight cut ends, a color sensor is used to detect the weld seam. If the weld seam is even 5° off for these specialty pipes, it could cause the pipe's features to shift and make for a defective product down the line. This machine, paired with the reliability of Kawasaki robots, allowed KMM to eliminate human error and drastically decrease the amount of scrap they were producing while seeing consistent product quality.

RESULTS

- Operators' heavy pipe lifting stress is reduced to one lift per pipe as opposed to two
- Loader/Seam Finder load height is lowered to waist level, which is an ergonomic improvement
- Robotic cells increased production
- Time freed by Bender Bots 1 & 2 allowed operators to take on additional work
- Loader/Seam Finder has up to 1.5° accuracy for weld seam finding

After implementing Bender Bots 1 and 2, KMM saw an increase in production in two ways. Bender Bot 1 allowed for non-stop production during an 8 hour shift – before automation, the operator would have to stop production repeatedly to inspect pipe, manage pipe carts, or go to break, lunch and shift change.

The Bender Bot cells also gave KMM the versatility they were looking for. All components of the Bender Bot – the Loader/Seam Finder, Kawasaki robots, tube bending machines and pipe carts – are all connected by Ethernet. The Tube Bender is the master, which makes it easy for the operator – they call up one program, and all of the machine components receive that program number, adjust and cross check automatically. This gives the operators more time, so they're able to run specialty pipes through a die press prior to loading into the Loader/Seam Finder. Before automation was needed, this process was done by different operators in another area of the building. This role consolidation was an unexpected benefit that KMM didn't take into consideration when they implemented Bender Bots 1 and 2, but resulted in a big impact on their overall efficiency.

CURRENT STATE

KMM bends 700 pipes/hour using Kawasaki robots. Currently, 33% of KMM's pipe bending processes are automated, but they'd like that number to increase. They're looking to add a Bender Bot 3 in the next year. Over the past 5 years, KMM has met their ROI for both cells, and has seen improvements across the board – some they weren't even expecting.

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