Lasers, Cobots and Karakuri: Toyota Manufacturing Innovation Takes On Many Forms

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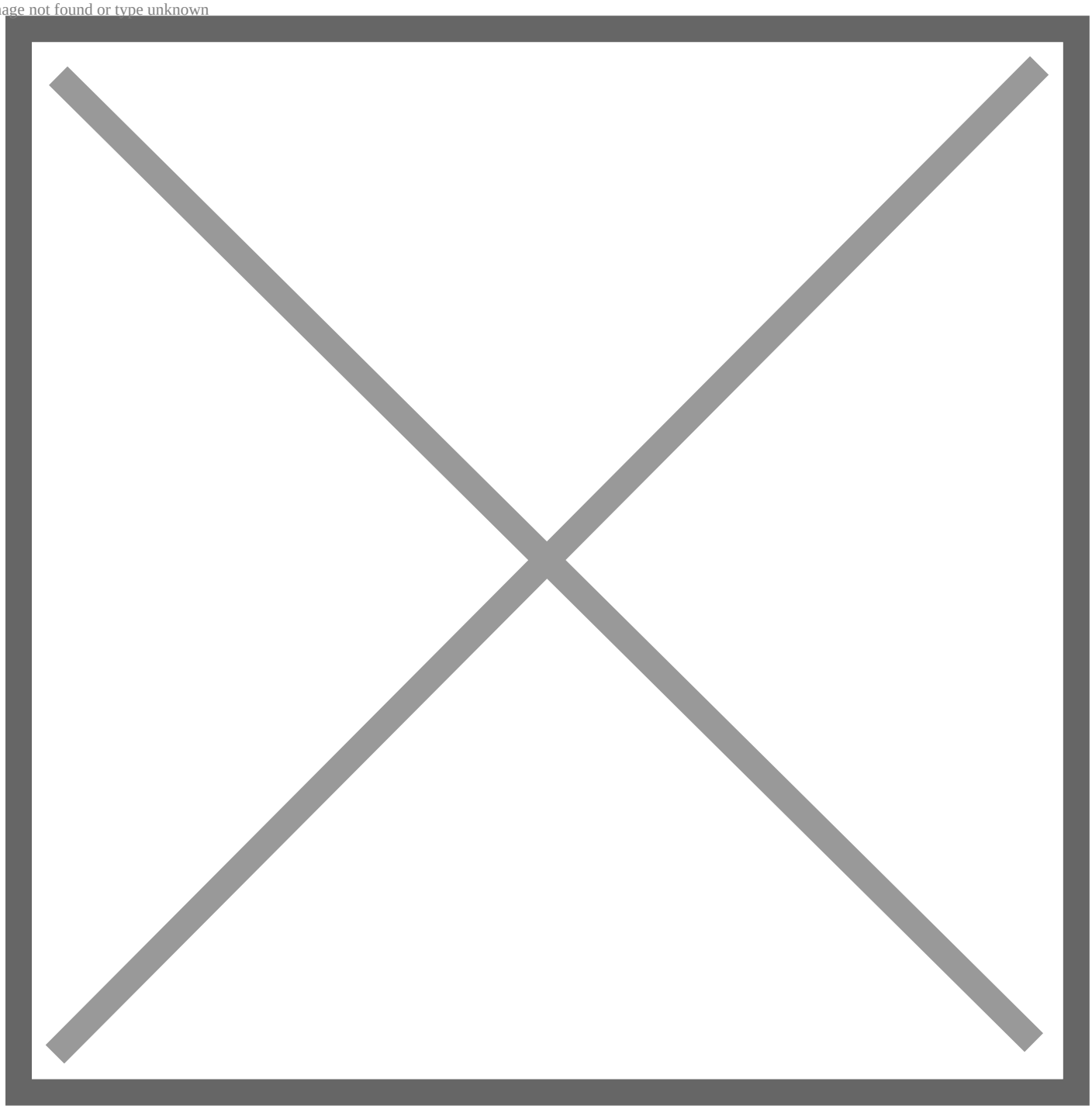
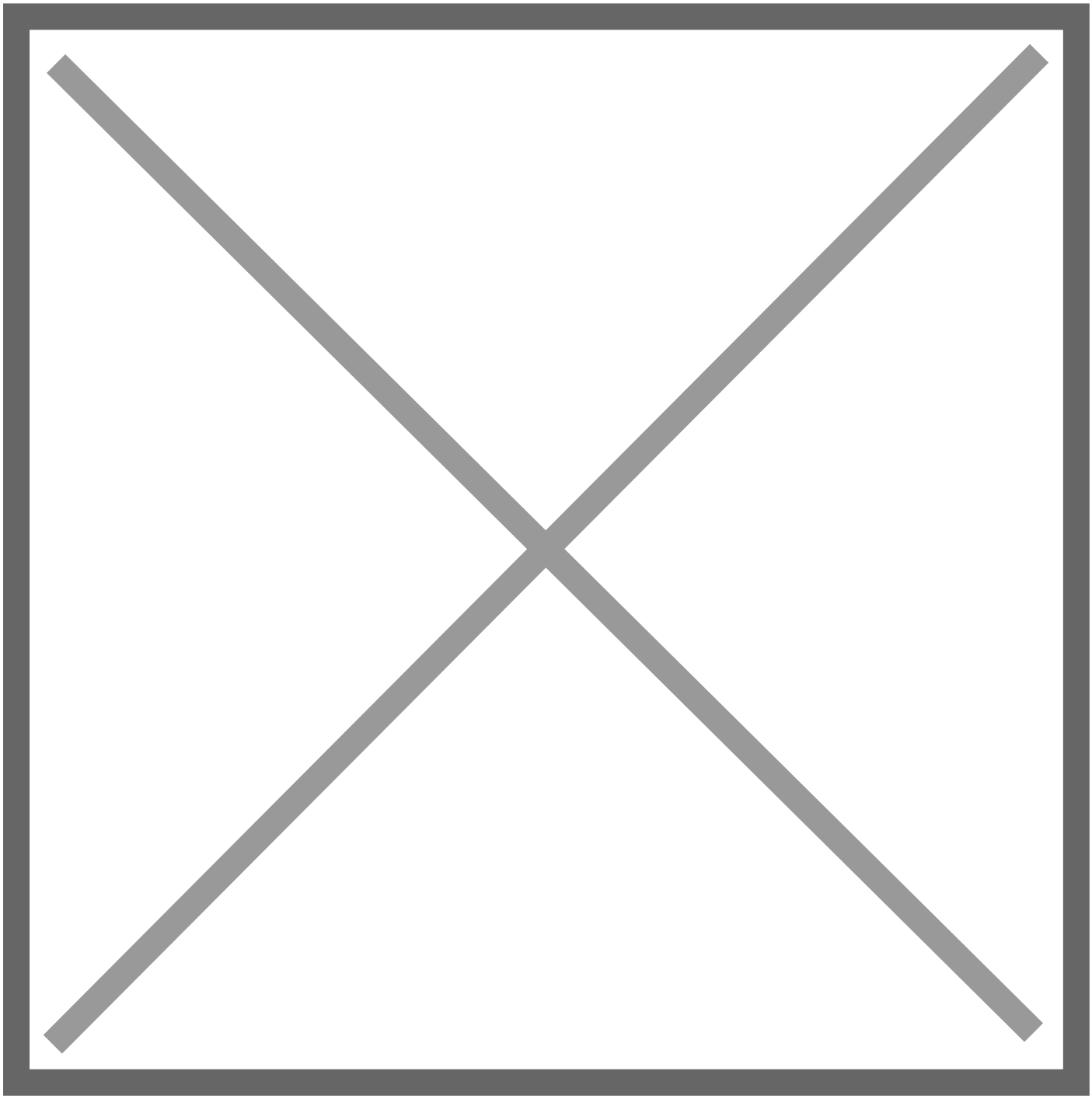


Toyota is an automotive manufacturing marvel.

Building on the firm foundation of the Toyota Production System, team members at the organization’s North American plants continuously search for and introduce new technologies that enhance the efficiency, safety, flexibility and quality of the processes that produce components and assemble the vehicles that are the lifeblood of the business.

What follows are brief summaries of three such innovations that are making a difference since being introduced in recent years.



Let It Roll – A TABC team member prepares a coil of steel to be fed into the plant's new laser blanking apparatus.

Making What's Old New Again

TABC in Long Beach, California, has been churning out steel and aluminum components since 1972. That makes it Toyota's oldest manufacturing facility in North America. And the way that it processes large spools of sheet metal hasn't changed much over those more than 50 years.

Until 2024, that is. That's when TABC introduced coil-fed laser blanking technology to prepare sheet metal so that it can be formed into Tacoma components, such as tailgates, hoods, roofs and doors.

The traditional method of accomplishing this blanking task relies on mechanical die sets transported by overhead bridge cranes that cut the metal — a bit like the way a baker presses a cookie cutter into flattened dough to make cookies.

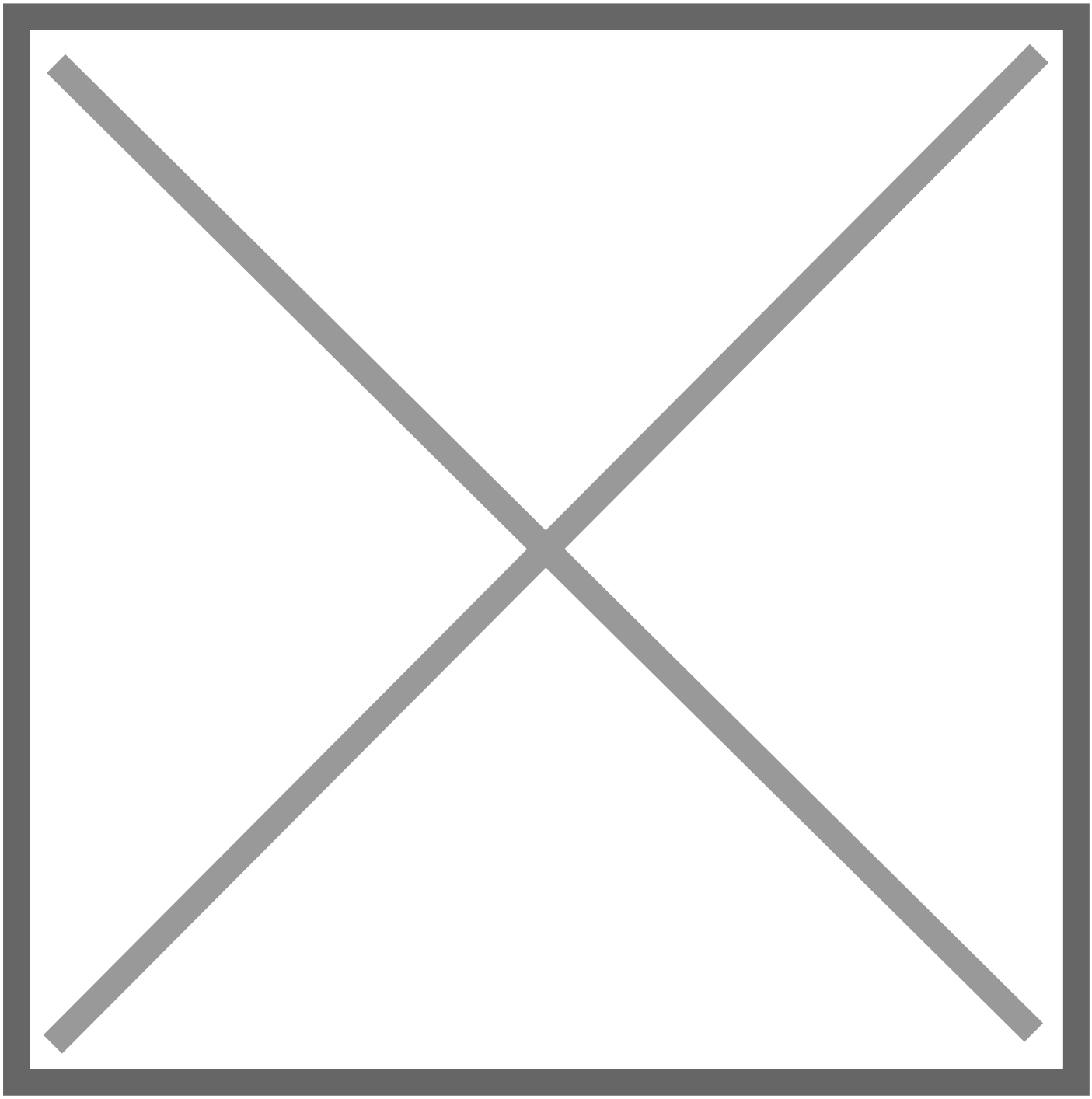
The upside? It's tried and true. It works. The downside? The die sets are huge (as large as 12- by 16-feet), heavy (up to 40 metric tons), expensive to produce and take up a lot of valuable space on the assembly line floor when not in use.

Laser blanking technology delivers benefits on all those fronts. Instead of a die set, the system employs a pair of lasers controlled and coordinated by a computer program to cut the sheet metal precisely and efficiently, minimizing scrap metal. And if designers decide to change the components, TABC can simply change the computer program — rather than create costly new die sets.

"The fact is, with the changeover to the current generation Tacoma, we were up against capacity constraints with our mechanical press lines," said Manufacturing Senior Manager Eric Chapman. "To keep up, we had to bring in blanks from third-party suppliers. With this new technology, we are once again completely self-reliant."

Chapman is quick to credit Toyota Motor North America's Production Engineering team for their instrumental role in bringing laser blanking technology to TABC, and to Toyota as whole.

"This is a global first for Toyota," Chapman said. "We have some of the oldest manufacturing equipment across Toyota at TABC. But now we also have some of the newest. We might not be as big as some of the other facilities. But we have the same heart and determination to produce components of the highest quality. New technology like this helps make that possible."



Special Handling – This Toyota Missouri cobot handles a hot and fragile sand core used in the manufacturing cylinder heads. Previously, team members took on this repetitive and taxing work.

Technology and Team Members Working in Harmony

Robotics have been a staple on the assembly line floor at Toyota manufacturing plants for some time. But collaborative robots, or more simply known as cobots, are a relatively new technology.

In 2021, Toyota Missouri introduced them into their process of manufacturing cylinder heads — specifically to assist team members with handling and transporting the sand cores that form the heads' internal passages. These cores are delicate and very hot. Moving them from one station to the next is highly repetitive and physically taxing, requiring each team member to walk nearly five miles per day. By shifting this burden to the cobots, the team members have been freed to take on other work that better leverages their skills and experience.

Since introducing five cobots in that first year, Toyota Missouri has since deployed a fleet of 117 across more than 20 lines. That sounds simple, but it was anything but.

"It was a non-stop process of learnings," said Engineering Manager Ryan Buenemann. "That first year alone we introduced more than 50 kaizens to make it easier for the team members who interact with the cobots day in and day out. By making that investment upfront, we were able to show our team members that the technology would make their jobs easier. That led to a total tide shift. Initially, there was some resistance. But now? If you were to ask team members if we could take away their cobots, they would not be happy."

Buenemann said the key to making it all work was a commitment to standardization. Each installation of new cobots led to a flurry of improvements that would be applied to the cobots that came before. That includes transitioning from the plant's original cobot manufacturer to a new one midway through the process.

"In the end, it was about reducing hard work and reducing process waste," Buenemann said. "We don't want our team members handling sand cores. The cobots have completely eliminated that."

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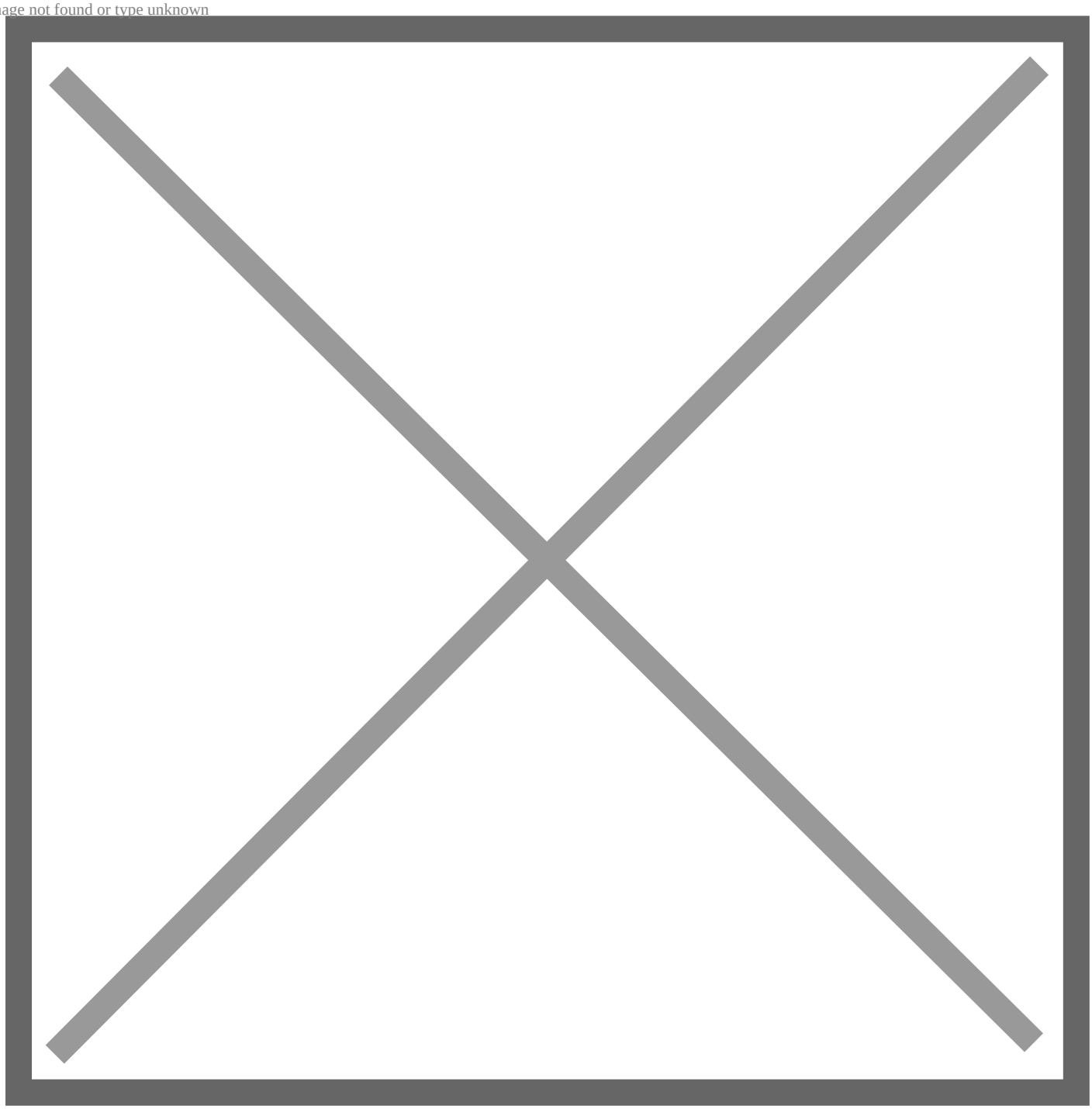


Goodbye Dolly – Before AMRs (on the left), team members at Toyota Texas delivered large trays lineside with the aid of a dolly. After (on the right), AMRs shouldered this burden.

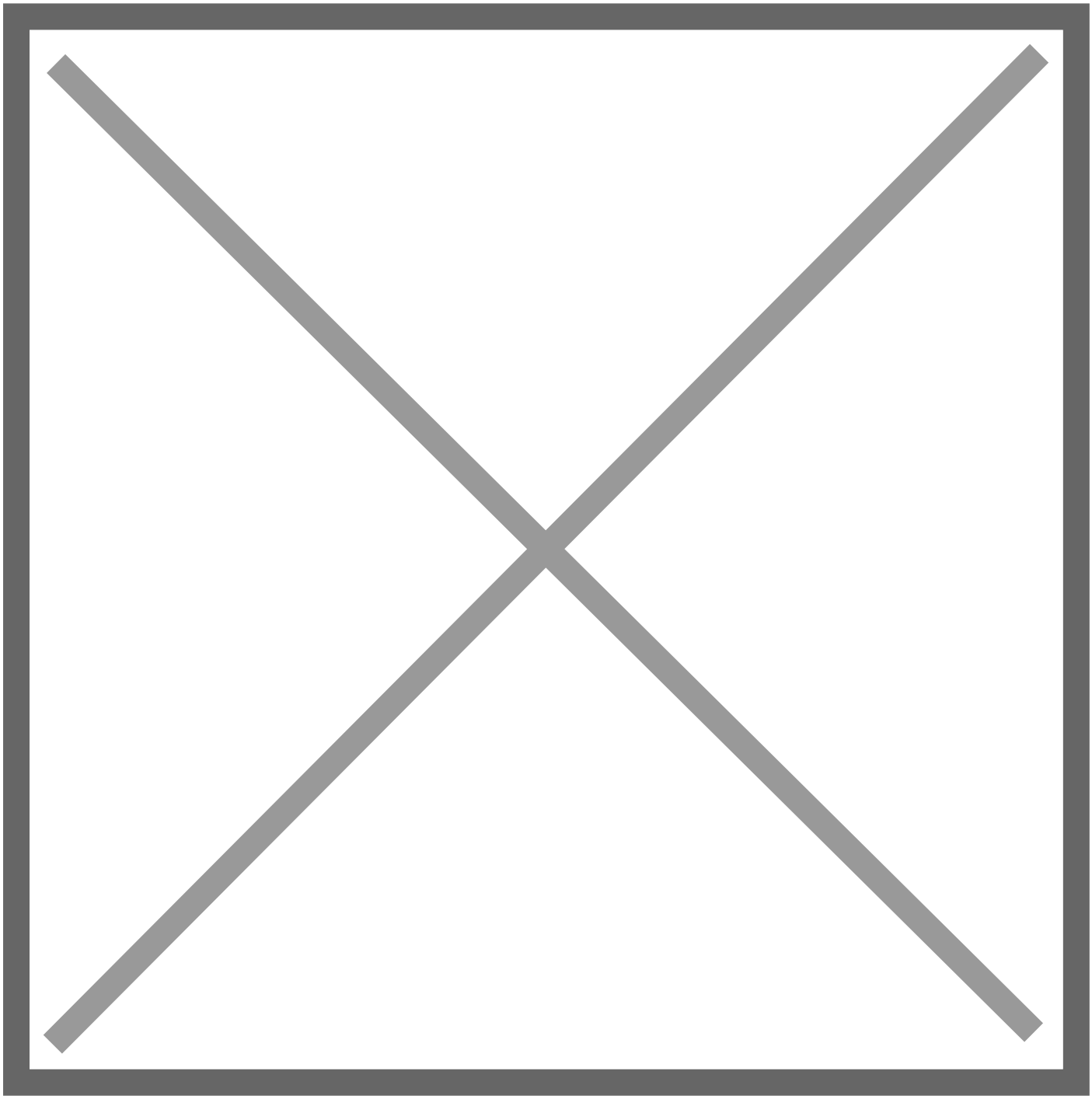
Toyota Texas has realized similar benefits since it introduced an initial wave of six autonomous mobile robots (AMRs) in 2021 to help automate simple, repetitive tasks across various areas of production. Today the San Antonio plant employs more than 120 of these units, with more to come.

For example, in the assembly shop the AMRs deliver more than 500 distinct parts directly to the line, streamlining operations and boosting human efficiency. Each relies on Wi-Fi connectivity and a preloaded digital map to navigate defined delivery routes and designated drop-off points. The AMRs' paths are set by team members who work alongside them and are responsible for monitoring, guiding and maintaining their daily operations to achieve a high level of safety and quality.

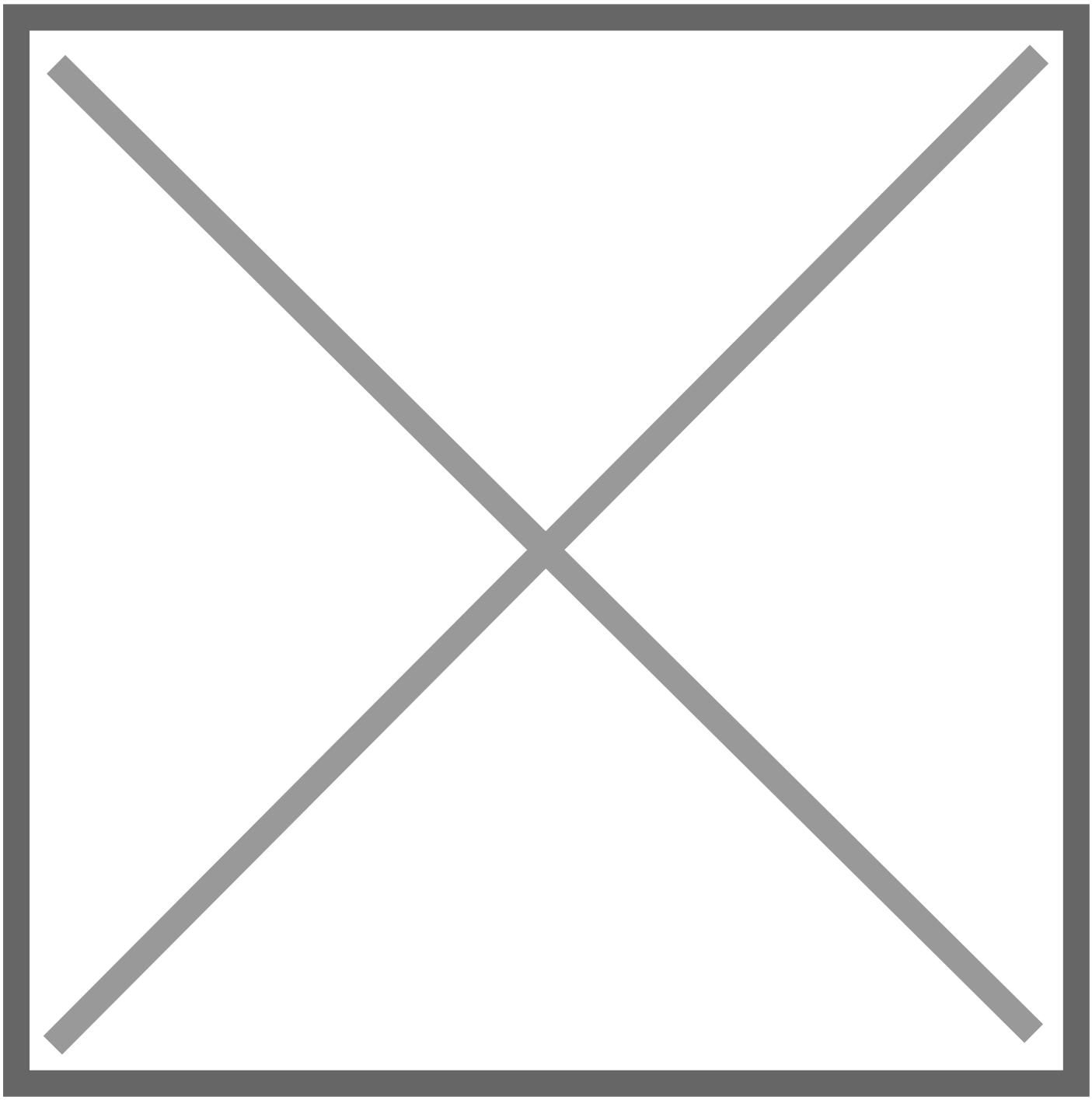
"At Toyota Texas, digital transformation begins with a focus on our team members," said Brian Dougherty, senior manager of Internal Logistics Projects. "'Respect for People' isn't just a value. It's our strategy for introducing technology in a way that works for everyone and with the customer in mind."

As the machines take on more and more of the repetitive physical tasks, it is important to note that the technology is empowering team members, not replacing them. Team members can transition to new challenges, such as data analysis, code scripting, robotics and digital applications.

It's this commitment to continuous improvement that helps ensure Toyota's people and plants will remain at the forefront of the manufacturing industry well into the future.



Up and Over – Here's a karakuri installation at Toyota Mississippi. Above, bins containing kits of components are transported up one tower, across the bridge and down the other tower using gravity. Below, you can see the full bins on the left. Empty bins are placed on the rollers on the right and then trundle down to go back over the bridge to the other side where they are refilled.



Harnessing Gravity

Lasers and cobots are decidedly high tech. But sometimes even seemingly simple innovations can have just as much of an impact.

Examples can be found at virtually all of Toyota's 14 North American manufacturing facilities, which have embraced the unassuming genius of karakuri automation. This refers to a practice that uses simple, low-cost mechanical devices driven by leveraging principles such as gravity, springs and levers rather than external power sources. These clever contraptions are often used to safely move components across busy conveyance aisles or

enhance accuracy while team members perform more advanced tasks.

“The core principle of karakuri is to harness natural forces, and what force is more fundamental than gravity?” said Kevin Willoughby, senior manager of Manufacturing Development at Toyota Mississippi. “Every gear-turn and lever-pivot is a testament to Toyota’s ability to take a simple concept and build upon it with complexity and accuracy, all without using a single electrical current.”

If you know where to look, examples of karakuri innovation can be found deeply embedded within the plants’ operations, such as a system of rollers and ball bearings triggered by a falling weight or titled platform that sets off a chain reaction. These devices perform menial tasks while reducing repetition, poor ergonomics or even boredom.

“This is just another way Toyota uses kaizen to think creatively and strategically about our process and how we can always work to improve,” said Kevin Mills, general manager for Toyota Indiana. “Karakuri teaches us that the simplest things can have the greatest impact.?It’s a reliable, fundamental process that helps improve the team members ergonomics. It also saves the team member process time that can help keep our costs down which we can then pass on to our customers, all while helping to provide safety and quality in every vehicle.”

Who knew such a simple principle could have so much gravity?