Case Study: One-of-a-Kind Cell for Vision-Guided Aerospace Assembly

Application: Assembly, dispensing
Robot Model: Kawasaki R series general purpose robots

OVERVIEW

Unlike many of today's manufacturing sectors, aerospace tends to stray away from automation. Robotic arms are a rare sight in this industry due to low production volumes and the delicate nature of making such specialized parts.

This aerospace part supplier teamed up with Waterloo, Ontario-based integrator SYSTEMATIX to design a cell for installing nutplates, an irregular part with over 200 variations that holds the external skin of the aircraft to the frame. Although this complex application doesn't necessarily sound like an ideal candidate for automation, high performance Kawasaki robots and 3D vision products cut down cycle times, increased product consistency and decreased manpower for a boost in overall efficiency.

CHALLENGES

- Monotonous process led to low employee retention
- In-depth employee certification and training required
- Frequent inconsistent part quality

Tough & Tedious Application

There were multiple reasons why the nutplate installation process was chosen for automation. In order to meet strict quality requirements for parts, all employees had to undergo intensive training and certification for each part they produced, and document their work in real time. The monotonous nature of the nutplate installation process also created retention issues for the manufacturer.

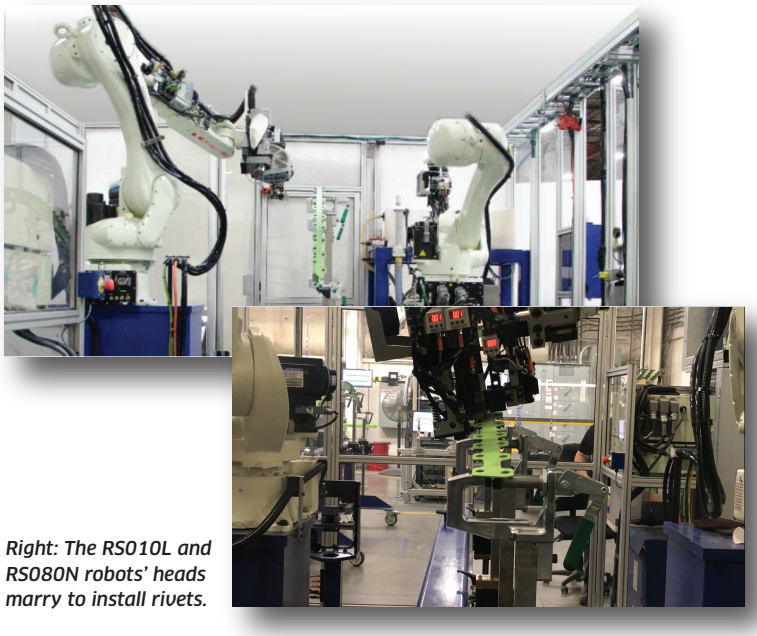
Quality Control

Because of the integral role the nutplate plays in the construction of the aircraft, the height of the nutplate rivets need to be exact. Prior to automation, human operators had to shave the rivets to the exact height needed, due to inconsistent rivet heights.

SOLUTION

- Three different Kawasaki R series robot models installed
- Matrox imaging software and LMI locators correctly identify 225 part types

The first robot, a Kawasaki RS080N, determines the part position by scanning three distinctive part features using 3D vision and adjusting accordingly. After the part is aligned, the RS080N robot's drill head end-of-arm tool (EOAT) grips the part, then drills and countersinks two rivet holes for the nutplate installation.



Right: The RS010L and RS080N robots' heads marry to install rivets.

The RS080N then releases the feature and rotates the arm to retrieve the correct rivets out of four possible lengths, and at one of two specific pitches, from the rivet slide tooling. While the RS080N is retrieving the rivets, the RS010L robot picks up a nutplate, and uses vision cameras to verify that it is the correct nutplate out of 28 possible types. From here, the robot places the rivet on the nutplate locating tool. Cameras perform a vision check before placing the nutplate on the tooling to ensure it is clear to receive a new nutplate.

The robot then places the nutplate on a turntable so the RS005N robot can apply sealant, which is a customer requirement to ensure corrosion resistance. The RS005N robot conducts two vision checks at this point in the process: one before the sealant application, and another one after application to ensure the sealant was properly applied.

From here, the turntable rotates so the RS010L can pick up the complete tooling package, which includes the nutplate and nutplate-locating tool. The RS010L robot scans three part features to ensure proper plane alignment for installation, and grips the part at the defined feature. While the RS010L robot holds the part in place, the RS080N robot enters the area and the two heads marry – the RS080N robot's rivet vacuum head places rivets inside the head of the RS010L robot, which installs the rivets into the part.

Once the rivets have been installed, the robot heads separate. The RS010L safely releases the part and rotates to drop off the dirty tooling, and the RS080N rotates the EOAT to the correct position for rivet crimping, which completes the 39-second process.

Integrator Support

Because robotics are used so infrequently in aerospace manufacturing, the supplier teamed up with an integrator, SYSTEMATIX. They helped design an adaptable, long-term solution that could meet cycle time requirements while identifying irregular part types in a multitude of configurations.

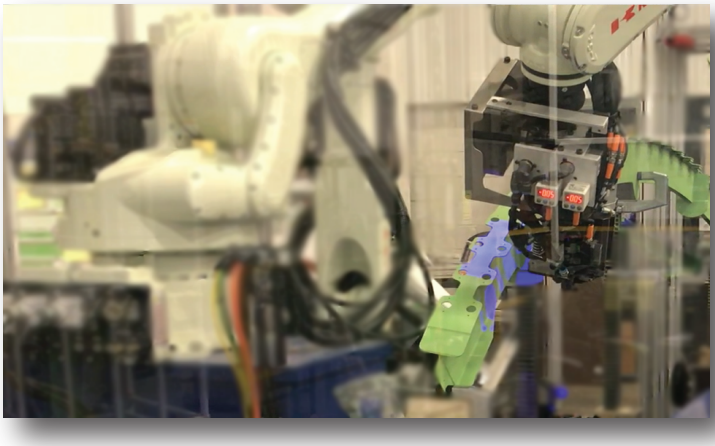
Vision, Precision & Speed

Throughout this complex process, you likely noticed a common theme: the importance of 3D vision. Matrox imaging software and LMI locators play a vital role in this application, which requires robots to correctly identify 225 part styles, 28 different possible nutplate configurations, all of which can be installed at two different pitches. The supplier chose Kawasaki robots because of the open architecture and ability to handle more advanced processes.

"I've touched almost every robotic arm out there... One reason I like Kawasaki is the ease of working with the programs, especially the AS Language," P.J. said. "It's one of the driving forces why we use Kawasaki."

One of many unique aspects of this application is how closely the robots work together. The heads of the RS080N and the RS010L robots have to connect without colliding – an action that wouldn't be possible without highly repeatable and reliable robots. Kawasaki's R series of general purpose robots fit this criteria, with repeatability ranging from ±0.02 mm to ±0.06 mm as payload increases (3 kg to 80 kg).

"The arms are very robust; they don't wander," project leader P.J. said. "The arms have to go to some very exact positioning, and we've not had a single issue with that. They're very precise."



3D vision was integral to the success of this application, helping robots identify 225 part styles and 28 nutplate configurations.

When developing this system, SYSTEMATIX leveraged Kawasaki's hardware and software safety option, Cubic-S, to ensure the robot heads didn't collide while installing the rivets. Using this software the integrator created zones for the robots to avoid, which prevented crashes with fencing or other equipment.

The high-speed capabilities of these robots also helped the supplier increase throughput. The lightweight arm along with high-output, high-revolution motors provide industry leading acceleration and high-speed operation. The acceleration rate automatically adjusts to suit the payload and robot posture to deliver optimum performance and the shortest cycle times.

> "Now we're increasing our production time with (the robot cell)... It's operating 24 hours a day now and we're relying on it to get the production numbers we need," P.J. said. "The reality is we're relying on the robotic cell – it's the main part of the process now."
>
> *- P.J., Project Leader, Automation Specialist*

RESULTS

- Cycle time reduced by 26 seconds (from 65 to 39)
- 97% consistency achieved
- Number of operators reduced from 3 to 1
- Cell creates fully completed part - no work-in-progress stations needed

Since installation, the supplier has experienced the benefits of automation firsthand. Drastically shortened cycle times, increased product consistency and reduced manpower helped them reach the cost reduction and increased production goals they had set from the beginning.

But when asked where they've seen the biggest improvement, P.J. cited consistency without hesitation. After being in production for just over one year, the cell has virtually eliminated part inconsistencies. They have achieved 97% consistency – a statistic that greatly affects their bottom line through both cost and time savings.

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