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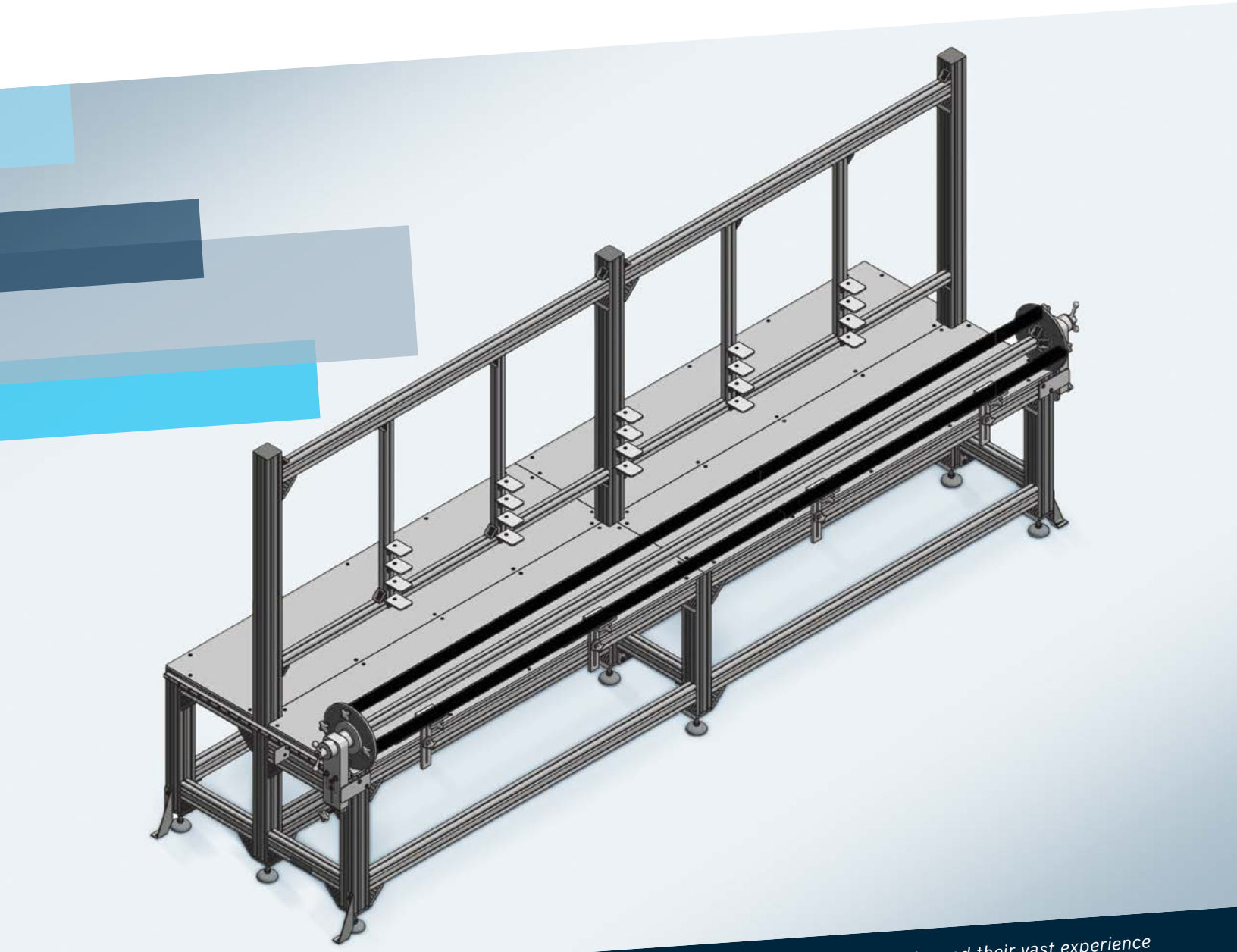


Knowledgeable distributor partners *can assist with the design and manufacture of complex projects, and their vast experience allows them to offer practical, cost-effective solutions.*

CASE STUDY

Spirit AeroSystems MGE Framing

Spirit AeroSystems MGE Framing

Challenge:

Develop fixtures that would improve ergonomics and reduce physical strain on operators in addition to reducing scrap and rework.

Solution:

Use Rexroth aluminum framing and ball rail systems to create fixtures that each operator can adjust to their own ergonomic preferences.

Results:

- **Ergonomic issues were eliminated with fully adjustable fixtures.**
- **Rework was reduced by 80 percent in the wedge area.**
- **Productivity was improved by 50 percent in the cove angle area.**

Overview

Few industries require the combination of labor-intensive manufacturing and precision that the aerospace industry requires. Airplane wings, for example, require hundreds, and sometimes thousands, of holes to be drilled in complex, fragile surfaces with high accuracy. This unique set of requirements poses two challenges for manufacturers: 1) to develop a method of securing parts during the drilling operation that doesn't cause damage, and 2) to provide an ergonomic work environment, customizable to each worker, that allows them to drill thousands of holes per day without injury.

At Spirit AeroSystems (Tulsa, OK - www.spiritaero.com), a manufacturer of complex structures for the commercial aerospace industry, these challenges were especially pronounced on the drilling stations for the "wedge" and "cove angle" components of the Boeing 787 aircraft wing. But with input from the operators who work at these stations, and by using Bosch Rexroth aluminum structural framing, Spirit AeroSystems was able to develop an ergonomic work station that helped to significantly improve quality, reduce worker injuries, and improve throughput.

> **"In the automotive industry, probably 90% of drilling is automated, with only about 10% of drilling operations being done manually. In the aerospace industry, the situation is almost the exact opposite."**
>
> - **Brian Lewis**
> CI Specialist, Spirit AeroSystems

Rexroth aluminum framing and ball rail guides allow the wedge to be positioned at any height and angle to make the drilling position ergonomic for each individual operator.

Wedge Fixture

The wedge structure is a composite piece of the leading edge of the airplane wing, and there are ten variations of the part. Each wedge requires around 300 holes to be manually drilled, and the typical production rate is six wedges per day, for a total of 1500 to 2000 holes per day – no small task for any operator.

The original workstation layout used a standard, flat table to hold the wedge during drilling. But the wedge is a contoured part, making it extremely challenging for the operator to drill hundreds of holes in their precise locations. The part tended to rock back-and-forth on its curved edge, so the operator often had to hold the part with one hand while drilling with the other hand. The lack of control from one-handed drilling, coupled with the odd position of the part, often led to “drill starts” – a condition when the hole is started in the wrong spot, resulting in marks on the part and in some cases, an out-of-spec, elongated hole.

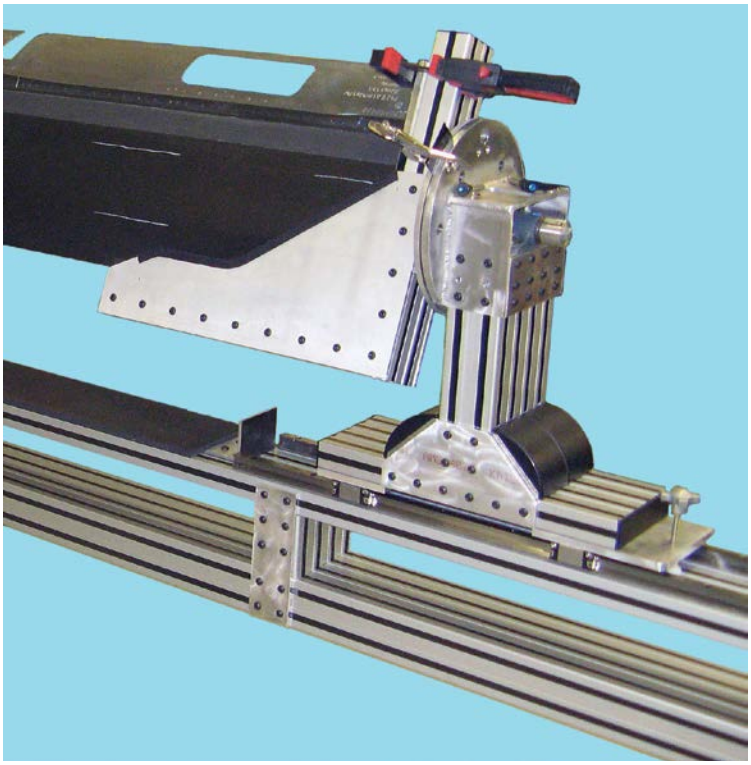
In addition, drilling hundreds of holes per day – even without the challenge of working with a curved surface on a flat table – requires thoughtful workspace design to ensure good ergonomics for the operator. In many cases of poor ergonomics, there is no one better suited to design a solution than the operator themselves. And that’s exactly what happened at Spirit AeroSystems.

James Wright, one of the operators on the wedge line, was plagued by the effects of poor ergonomics at the workstation. So he developed an idea for a rotating fixture – inspired by a rotisserie – that would allow the part to be positioned at any angle and height, depending on the current operator’s preferences. What was, quite literally, a napkin sketch was taken to Brian Lewis, Continuous Improvement Specialist at Spirit AeroSystems, who took on the task of making this concept a reality.

Having worked with Bosch Rexroth aluminum framing in the past to build tables, workbenches, and holding fixtures for other areas of the factory, Brian immediately saw its potential for the wedge fixturing system and enlisted the help of Matt Sheets, design engineer at Spirit AeroSystems, and Jay Rogers of Pacific Integrated Handling, (Tacoma, WA - www.pacificintegrated.com), to help with the design.

The value of a knowledgeable distributor partner

Pacific Integrated Handling (PIH) is a distributor with over 20 years of experience applying Bosch Rexroth aluminum framing to solutions that range from workstations to specialized assembly tooling and fixtures. In addition to the simplicity and versatility of Rexroth aluminum framing, PIH also relies on the MTpro software to provide models of all the profiles, connectors, and accessories, making it fast and simple to export them to Catia for detailed design layouts.



The custom wedge fixture features Rexroth's MGE aluminum framing and ball rail products.

Based on Wright's initial sketch, the wedge fixture was designed with aluminum framing for the fixture's structural support, along with a counterbalance system to make rotation of the wedge – an incredibly heavy part – easy on the operators. The fixture is infinitely adjustable in height, and the ability to rotate the wedge allows each operator to set the wedge at a drilling angle suitable to them. And to accommodate the variations in wedge designs, one end of the wedges is supported by Bosch Rexroth's size 25 ball rail, allowing the width of the fixture to be adjusted to the exact length of the particular wedge being worked on.

A workstation design that once required five people to complete five units per day, now has three people completing six to seven units per day – a huge improvement in productivity. And the company has been able to reallocate resources from the wedge area to other operating stations where additional production resources are needed. To date since the fixture was put in use, rework in this area has been reduced by 80 percent.

Possibly the most important outcome of this new fixture is the improved ergonomics. With the previous workstation design, operators experienced back problems from bending over or leaning in to drill holes, and soreness in the upper body was a common complaint. As Wright says, "The improvement in ergonomics was immediate. This fixture, and the ability to adjust it to my specific needs, has really made a difference in my physical well-being."

With the wedge fixture in place and proving a success in terms of improved quality, higher throughput, and a better working experience for the operators, other areas of Spirit AeroSystem's facility are looking at it as a model for how they can make improvements in their areas. As Wright described it,

"Other areas are looking to replace their old, 'dinosaur' tooling and fixtures – typically made of steel – with lighter, more cost-effective, and more ergonomic designs made from Bosch Rexroth aluminum framing."

Cove Angle Carousel Fixture

A cove angle is also a part of the 787 wing – a structural member used in the front slats to help produce lift. Like the wedge, there are ten variations to the cove angle, but each variation requires drilling 168 holes. On the cove angle, these holes must be drilled twice – once for a pilot and then a second time to achieve the specified hole size.

In the original workstation design for the cove angle, the operator drilled one part at a time, with the part on a typical, flat work bench. This led to a significant amount of lost productivity, since no real work was occurring every time the operator had to offload one part and load the next. Rework and scrap rates in this area were very high due to damage from drill starts and holes that were out-of-round.

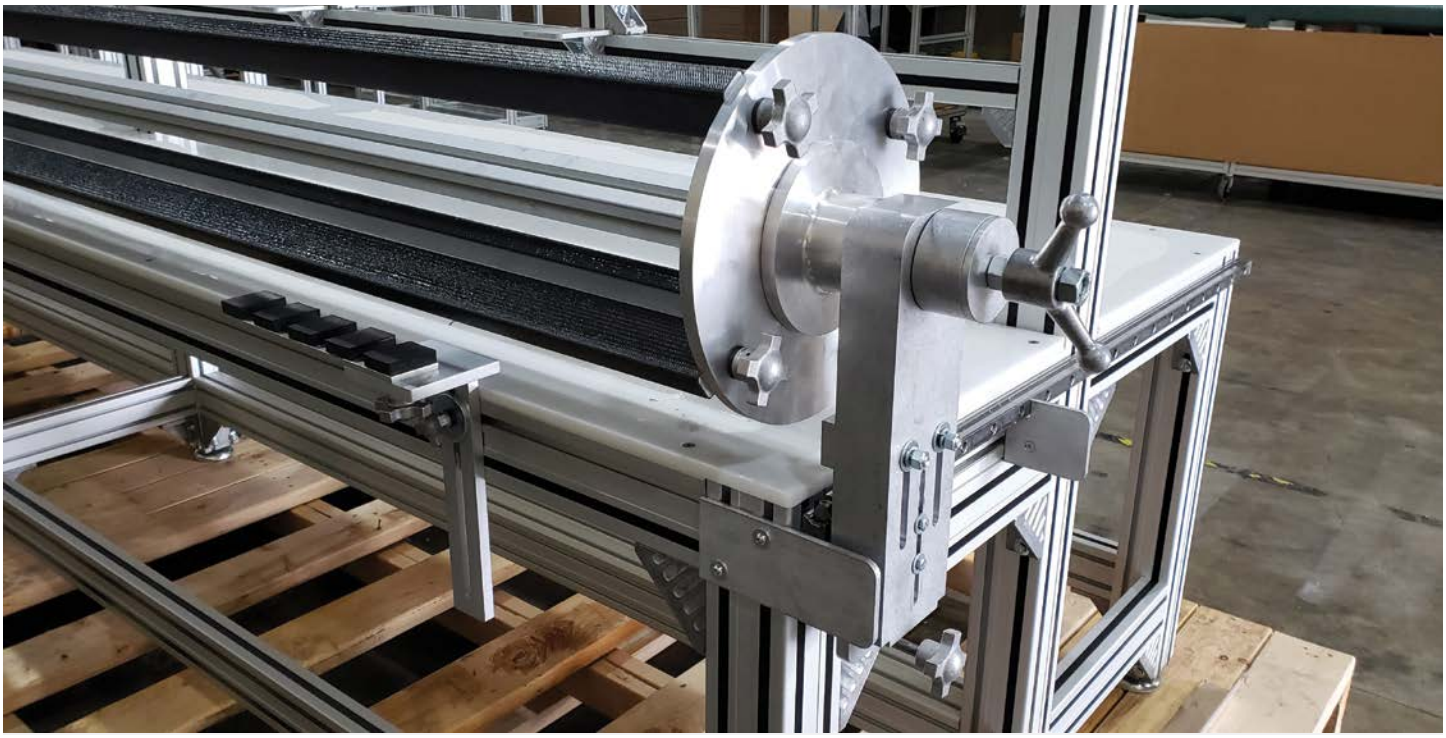
The inspiration for a solution to these issues – a rotating carousel fixture – came from a fixture that Sprit AeroSystems had implemented on a smaller scale in the Boeing 737 program, where the part was essentially the same, but made from aluminum rather than composite.

Cove angles are approximately 12 ft. long and 2 in. wide, making them ideal for loading onto a carousel. The final design involves a carousel fixture, supported by Bosch Rexroth aluminum framing, that holds five parts at a time. Not only does the carousel rotate and lock into place while operator drills each part, it can also be moved in-and-out, to be closer to or farther away from the operator to meet their ergonomic preference.

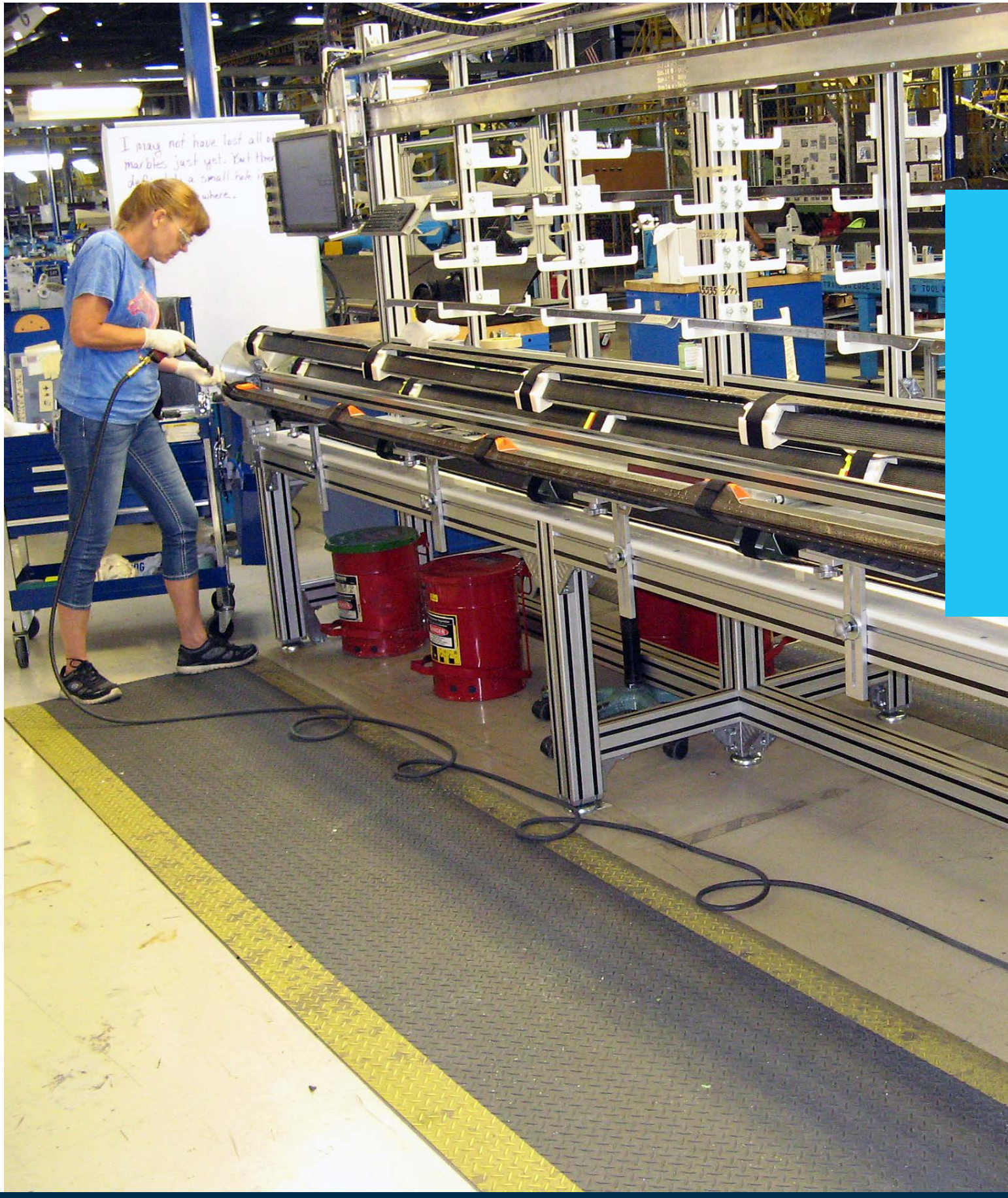
A monitor mounted to the structural framing displays the work instruction and layout of each part. With feedback from a linear encoder, the monitor can be moved down the fixture along the length of the part. As the monitor moves, the displayed drawing corresponds to its position along the part, providing instructions to the operator that are specific to that exact spot on the part. When the operator finishes one part, they rotate the carousel and work back along the length of the fixture on the next part.

Although it was inspired by a solution from the 737 program, the cove angle carousel fixture was especially challenging to design and manufacture, due to its larger scale. One particular difficulty was making a fixture that could rotate while maintaining enough stiffness to support the pressure from drilling.

The complexity of this project led Spirit AeroSystems to completely outsource the design and manufacturing to Pacific Integrated Handling. The team at PIH worked with designers and operators at Spirit AeroSystems to provide a turnkey solution that met the operators' requirements for ergonomics and simplicity, while meeting Spirit's cost and timeframe goals.



A carousel-style fixture not only improved productivity, it also reduced floor space and improved part flow.

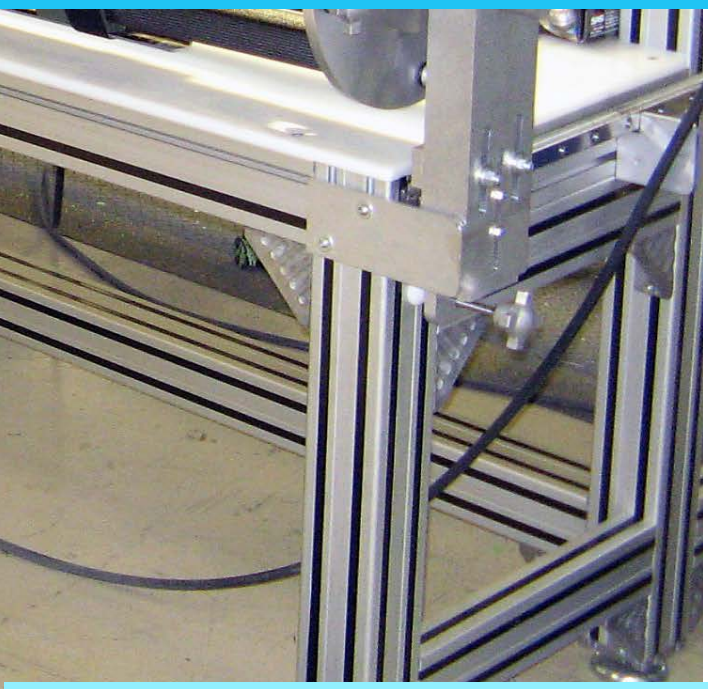


The rotating carousel holds five cove angles, so operators can work on multiple parts before stopping to load and unload.

With the implementation of the carousel fixture, productivity in the cove angle area has increased by 50 percent, and, like the wedge area, ergonomics were vastly improved. The ability of the cove angle fixture to handle five parts at a time also reduced floor space and improved part flow through the line.

State of the Aviation Industry

Aviation orders are at a level not seen since the 1980's. Airplane manufacturers currently have backorders for approximately 14,000 planes, but current production rates are a fraction of that, at around 1,500 airplanes per year. Spirit AeroSystems, located in Tulsa, OK, is expanding its manufacturing facility and expects to hire 300 to 400 people in 2019. To find and retain workers – a critical step toward meeting these incredible industry demands – Spirit recognizes that the combination of good ergonomics for operators and reduced downtime, rework, and scrap, will be critically important.



Both the wedge and cove angle fixtures resulted in greatly improved ergonomics for the operators on these stations. And when ergonomic issues are eliminated, productivity and quality are, in turn, improved. Case in point: The return on investment (ROI) for these projects was well within the three year timeframe set by management, based on increased throughput and reduced quality costs. Not only did these projects exceed the company's ROI target, workers compensation issues also decreased. As a bonus, upper management at Spirit AeroSystems was impressed with the amount of input and level of engagement the operators demonstrated in the design and realization of these two fixturing projects.

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