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Automation**



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Servo-controlled Needle Bender Boosts Precision and Flexibility

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Invio helps a maker of wearable drug delivery devices scale up hypodermic needle production with a flexible, programmable, vision-guided system

Company overview

This large MedTech company has won awards for its wearable, tubeless insulin management system. It uses Bluetooth technology to provide automated insulin delivery for up to 72 hours through a waterproof pump, removing the need for multiple daily injections or fingersticks. The company currently offers its flagship product in 25 countries.

[summary]

Challenges

- Scale up production of hypodermic needles for popular wearable drug delivery device
- Bend hypodermic needles into unusual and complex shapes with pinpoint accuracy
- Form one or more bends in hypodermic needles without occluding the inside diameter
- Overcome material hardness variations without time-consuming machine setups

Solution

- Automated, programmable needle-bending machine that requires little to no tooling change
- Automatic calibration, defect alerts, and real-time measurement feedback for fast adjustments
- Compact, modular solution that maximizes cleanroom space and minimizes maintenance
- Built using Rockwell Automation [Programmable Controllers](#), [Servo Drives and Motors](#), [Push Buttons & Signalling Devices](#), [Safety Relays](#), [Power Supplies](#), [Switches and Sensors](#), [Circuit & Load Protection](#), [Variable Frequency Drives](#), and [HMI](#)

Results

- One needle produced every nine seconds, significantly increasing daily lot production
- Accurate needle bends to $\pm 0.005''$, significantly reducing the number of defects
- A system that automatically adjusts for material bounce back, giving seamless lot changes
- Almost 54 ft² of expensive cleanroom space saved compared to the alternative solution
- Better utilization of the technical team and greatly improved operational efficiency
- Ability to scale up production to meet new sales targets and changing business goals

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INTRODUCTION

The complex manufacturing needs of wearable drug delivery devices

Wearable drug delivery devices have transformed the lives of countless patients around the world, freeing them from the burden of daily injections and helping them comply with strict dosing schedules. Designed to be worn on the body, these small platforms incorporate smart features like closed-loop systems and sensors for continuous monitoring and feedback. Unsurprisingly, manufacturing precision is critical, particularly when it comes to producing hypodermic needles.

"Most cannulas are pretty simple to produce—they're straight needles that are glued into plastic parts. But wearable drug devices often require bent needles, and each device requires a needle of a totally different shape," explained Eric Peterson, Executive VP of Concepts & Solutions at [Invio Automation](#), a producer of comprehensive automation solutions and a gold-level member of the [Rockwell Automation® PartnerNetwork™](#) program.

Moreover, the angle of the bend in each needle must be accurate. Slight variations in simple syringe needles do not generally affect performance. That's not the case with wearable drug devices. Their needles, which share a tiny space with objects like pivoting levers, gear wheels, and fluid reservoirs, must be inserted under the skin at the correct depth to achieve the proper flow rate and avoid occlusion. It's an added complexity that medical device manufacturers have to address.

So, when a long-standing customer asked Peterson's opinion about a piece of equipment it wanted to purchase to mass-produce bent hypodermic needles, he expressed concern. "The equipment was large and expensive and required a separate station for every bend. They wouldn't know they had a good product until they got to the last bend."

This lack of ability to monitor quality at each stage of production posed a significant risk to the production process. Peterson decided to help the customer identify a more viable solution to achieve its goals of reducing production cost per unit and delivering consistent quality and performance. He found inspiration in an unusual place.

CHALLENGE

Scaling up the bending and assembly of hypodermic needles

The customer that approached Invio is an award-winning medical device company that develops and manufactures wearable insulin management systems for people with diabetes. Its flagship product attaches to the body and delivers continuous insulin based on the wearer's personal settings. Inserting the tiny soft cannula under the skin is incredibly easy and virtually pain-free. Press a button and the stainless-steel needle is in and out in 1/200 of a second.

However, the needle inside the wearable device has a complicated shape involving at least 14 bends. It also requires an accuracy of $\pm 0.005''$ on the first and last bend, while the total tolerance of the needle stock is $\pm 0.015''$. Manufacturing these needles is extremely challenging.

"The technicians were doing all these adjustments to the bends on hard tooling," said Peterson. "They were moving between different pieces of equipment and spending a lot of time tweaking the bending module every time they changed needle lots. Just a one-degree difference in material 'bounce back' required recalibrating all of the bending stations with all the adjustments that go with it."

Crunch time came when the manufacturer decided to scale up production. Jonathan Poole, VP of Automation Technology and Standards at Invio Automation, explained: "Manual and semi-automated needle bending techniques don't allow the scaling up of mass production because they can't precisely form one or more bends in a repeatable and efficient manner. In fact, it's virtually impossible."

To achieve its strategic goals, the customer needed a flexible bending and assembly machine that could automatically modify hypodermic needles into various shapes regardless of their material hardness.

SOLUTION

A flexible, programmable machine that forms multiple bends

The idea to automate the bending process using a programmable system came to Peterson from an unexpected place. "I was at home watching 'How It's Made'," he said. "I saw a company using a bending machine to make baskets from industrial wire. It was a light bulb moment. Long story short, we presented the idea and a prototype to the customer, who was amazed and placed an order there and then."

That prototype eventually became Invio's patented [Needle-Bending and Assembly Machine](#), a unique solution in the market. The apparatus is programmable, allowing it to form one or more bends in a hypodermic needle in various directions and at multiple angles. This flexibility is a crucial advantage, as it allows operators to form different, user-selectable bends via a diagnostic interface and with little or no tooling changes. The flexibility greatly enhances the efficiency and adaptability of the manufacturing process.

"Our customer was excited about the flexibility and programmability of this machine," said Peterson. "Different needle lots have different hardness properties, so our machine uses an inspection camera to measure all the critical dimensions. It then uses the vision feedback to adjust the bending parameters in the bending modules automatically. This keeps the needle shape centered on the dimension targets. What's more, it doesn't take up much space. The cell is only 3x6 feet."

Automatic calibration that achieves consistent needle quality

The vision-guided process and precision part handling aspects of this machine are innovative because the bends on both ends of the needle have to be highly accurate for the wearable device to function. A camera mounted in the bending module finds the ends of each needle, and a servo-driven slide positions the needles exactly where the bends are required.

While the tolerance required is ± 0.005 ", the machine is capable of forming bends at a tolerance of ± 0.002 ", fully compensating for large needle stock tolerance with every single needle. This level of precision delivers consistent quality and performance, saving time and effort for operators and giving quality control peace of mind.

"The operators don't even realize the machine is calibrating itself every time they put in a new lot of material," continued Peterson. "The process is essentially invisible. Now they can produce a needle every nine seconds. They rattle through it. And when the company wants to scale up production, all it needs to do is add more modules."

Control for the machine is built on Rockwell Automation [CompactLogix® Programmable Controllers](#). The machine is powered by [Kinetix® Servo Drives & Motors](#) as well as [PowerFlex® 525 AC Drives](#).

[Switched Mode Power Supplies, Fuse Holders, Disconnect & Contactors](#) and [Stratix® Switches](#) ensure smooth power flow, and [Photoelectric Sensors](#) are used to detect the motion of the product as it moves through the machine. Operators interact with the machine using [PanelView™ Graphic Terminals](#) and Allen-Bradley® [Push Buttons & Signaling Devices](#).

"We knew from the outset we'd get everything we'd need from Rockwell Automation," said Poole, "thanks to the investment we already put into the partnership. All we had to do was build on top of their platform to create our custom code and configure our controls."

RESULTS

Improved production efficiency and cleanroom space utilization

Once Invio had installed the bending and associated assembly machine in the customer's cleanroom, the operators were given a manual and some hands-on training. Within a matter of hours, they were independently using the machine. "That's a real benefit to manufacturers," said Poole. "They don't need to use their skilled technicians to make adjustments because the machine makes all the adjustments itself. They just need operators."

Since the installation, the medical device company has seen some impressive results. It avoided the need to buy an overly expensive machine with a ton of support equipment like boxes, belts, dies, lubrication and trays. Instead, it has a compact, modular conveyor system that takes up roughly three times less cleanroom space and requires far less maintenance.

It also has the flexibility that it needs to handle lot variation and scale up production with the ± 0.005 " precision its wearable devices demand. The production team can now keep pace with ever-increasing sales targets and changing business goals.

Helping medical device manufacturers make good decisions

Invio's expertise in vision-guided processing, precision part handling, and controls engineering, plus its partnership with Rockwell Automation, enabled the design of a unique machine that is perfect for manufacturers of drug delivery systems looking to scale up production, reduce operational costs and increase business resilience.

"We've saved many customers from going down a really bad path by understanding their challenges and helping them make good decisions," said Peterson. "Thanks to our wealth of experience in automation, we're not afraid to offer alternative solutions if we think there's a better way of doing something."

Learn more about [Invio Automation](#).

[Web tags: Programmable Controllers, Push Buttons & Signaling Devices, Safety Products, Sensors & Switches, Motion Control, Human Machine Interface (HMI), Drives, Life Sciences, Optimize Production]

Pull-out quotes

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