Robots provide new twists, bends, and rolls for automated medical manufacturing.

Leslie Gordon
Senior Editor

Robotic automation has long helped aerospace, automotive, and electronics OEMs cut manufacturing costs. But one estimate says only about 5% of the medical-manufacturing industry currently uses the technology. Phil Baratti, manager of applications engineering at Epson Robots, Carson, Calif., says this is largely because medical designers are accustomed to working on functional requirements. Few use design-for-automated-assembly principles. But recent advancements in robotics, as well as lower costs, now let even small and midsized firms use robots to assemble, inspect, transfer, and package such parts as stents, shunts, and catheters.

For example, current robotic systems conform to medical requirements such as CFR Part 11 for tracking and validating software. Also, today’s robots can perform the precise movements needed for small, thin, and complex parts. In addition, controllers are PC based and no longer require programming with complex ladder diagrams.

Robotic systems also let designers accurately simulate and prove-out robotic lines before packing parts or connecting wires in the real world. This lowers costs, reduces risks, and shortens lead times. Simulations let engineers determine in advance factors such as cycle time, how many robots are needed, and whether a line will fit in a certain space.

Companies can purchase robots directly from the manufacturers or work with firms called integrators. These help select and install the correct robots as well as design, test, and verify...
programs to run them. Some integrators also provide packaging equipment and components in the robot’s end-of-arm tooling (EOAT).

FROM CARTESIAN TO 3D VISION

The simplest robots are gantries or Cartesian systems, according to application engineer Mark Handelsman at Fanuc Robotics America Inc., Rochester Hills, Mich. “Gantries have rectangular work envelopes and their EOAT moves in linear X, Y, and Z directions,” he says. “Sometimes they also move along an additional guide rail. Articulated robots, on the other hand, move their jointed arm in a spherical work envelope. The arm can reach above, below, behind, and in front of parts. Robots usually have four to six axes or joints, and sometimes up to 12.” Of course, robots are directed by a program, but they can also be guided by a camera.

Handelsman says a simple example of a robot comes from a packaging line in which the robot takes a product from a known location, puts it in a box, and sends the box to packaging equipment. “Integrators such as ESS Technologies Inc. in Blacksburg, Va., specialize in packaging medical devices,” he says. “To build such robots for packaging, engineers at the company first import a 3D IGES model of the medical product into our RoboGuide software, along with conveyor, feeder, and packaging-equipment drawings from suppliers.”

The next step mathematically defines frames that tell the robot where it is with respect to the part and the packaging equipment. Programming the robot is then a simple matter of using a teaching pendant to show the robot where to move.

“The software includes a digital version of the pendant. Using the pendant tells the simulated robot to move one way or another.

Not just an end effector

“End effector” is the generic name for end-of-arm-tooling (EOAT) robots use to move or assemble parts, says Dan Peretz, director of automation product management, De-Sta-Co Inc., Madison Heights, Mich. “We are standardizing effector components we supply to most robot manufacturers. We don’t supply tooling that actually touches parts because most manufacturers prefer their own designs. That’s because part dimensions might change several different times while designing the robot and before the machine is even shipped. Each change affects how tooling, such as fingers, will grab the part.”

Peretz’s firm also supplies off-the-shelf and customized grippers. Basic grippers use pneumatics to drive them, pushing and pulling a wedge to open and close the grippers’ jaws. A robot manufacturer would design the fingers separately. Linear slides let robots grab different sized parts with more dexterity. Rotaries turn a gripper from 0 to 180°. Toolchangers let one arm use several end effectors. And compliance devices help align parts during assembly.
Pressing Record saves the locations," says Handelsman. "Robots can be programmed in different ways. Users can, for instance, key in just X and Y locations, which is easiest for most. Designers would program the arm to go, say, up 100 mm and over 50 mm, and the software takes care of the arm’s movement. Each robotic joint can be programmed to move a certain number of degrees. Another option lets users specify pitch, or how far the end of the part moves up or down. Operators also program yaw, or how far the part moves sideways. Even roll, is programmable." Such precise movements might be useful, for instance, to ensure a syringe tip...
doesn’t get caught while putting it in a tray.

“Our robots have vision to locate parts that shift in trays, scatter on conveyors, or are randomly piled on top of each other,” says Handelsman. “Users just need to load the optional vision software and hook up a camera to the robot’s CPU. The camera acts as the robot’s eyes, directing the robot by recognizing part patterns.”

Machine vision can be 2D, with one camera, for locating parts placed randomly in a plane, such as on a conveyor. Some Fanuc robots use a camera with a laser to put a red “X” of light on top of the product. The camera finds the cross, calculates how much it is distorted depending on part orientation, and then tells the robot where the part is. This is useful when parts are loosely stacked or randomly located in bins or boxes.

“In one application, we designed equipment that assembles and packages a medical device, places it in a blister card, loads multiple cards into a carton and, finally, into a case and onto a pallet,” says Sales and Marketing Director Walter Langosch at ESS Technologies Inc. “The process involves seven robots, including several LR-Mate six-axis robots and 16 other pieces of equipment.”

In this assemblage, robots pick parts from a feeder, and assemble them with other components. End-of-arm tooling, which ESS Technologies designed and built, includes a forced sensor technology that tells the robot when the product is properly grasped. Another robot picks up items as they travel from one station to the next and passes them in front of a camera for inspection. Yet another robot uses vision guidance to pick up the bottom of a small, oblong plastic housing, assemble components in it, check their location, and then add the other half of the housing.

“Robots such as these can help even small companies compete in a global economy,” says Langosch. “For instance, one customer ships products to China. Product integrity is so critical that a whole shipment would be returned if just one insert out of 100,000 was missing. Robotics and vision inspection let the customer check every insert, eliminating possible returns.”

THREE LINES OF CODE

Robot manufacturer Epson also makes several kinds of gantries, articulated arms, and Scara (selectively compliant assembly robotic arm) robots. Scaras target high-speed assembly and are especially good for applications requiring some flexibility, such as inserting a round pin in a hole without binding. All the robots have built-in vision and can handle inspection too, according to Regional Manager Jay Hallberg. “It typically takes only about an hour to set up a robot and camera, calibrate them, teach the part, and write a simple program that tells the robot to find the part, pick it up, and place it,” he says. “Once a vision-controlled robot is set up, operators need know only three lines of code to run it, V-Run, V-Get, and V-Set.”

Document-process control, a frequent requirement for medical devices, is simplified because
robots capture part dimensions in real time and archive them in the PC-based controller, says Hallberg. The controller’s open architecture lets users add third-party hardware, such as data-collection boards, or software, such as LabView, to interpret data.

One recent application used cameras to find and pick up 0.004-in.-diameter stent wires. “Several cameras are necessary because the ends of the wires are often bent. The cameras locate the tips of the wires in space, letting robots know exactly where to pick them up,” says Hallberg. “The manufacturer originally used 22 people for this process. With robotics, the company uses only three individuals.”

An inverted Epson Pro Six PS5 robot with built-in vision and flexible feeding picks dental parts for packaging.