Flexible Robotic End Effectors for Redeploying Robots

Before cobots and other fast-deployable robots, many automated manufacturing cells incorporated only fixed or dedicated tooling rather than solutions that are easily updated. An advantage of fixed automation is that it allows for reliable and high throughput but also tends to be custom engineered towards a specific process. Changes in the workpiece or production process often mean redesigning large sections of the fixed automation system or even starting completely over from scratch. With the onset of robots, flexible automation solutions are being considered in anticipation of unknown future demands. End-of-arm-tooling (EOAT) on robots can be updated to accommodate changes and the robots themselves can be reprogrammed to complete new tasks.

Cobots and other fast deployable robots have made automation even more flexible. These intuitive robots can be programmed in minutes and re-tasked for new operations across the factory floor, resulting in increased productivity. With the wider use of cobots, new types of EOATs should also be considered. End effectors that are flexible in design and can be redeployed in minutes without additional engineering time are ideal for supporting updated manufacturing demands. These flexible gripping systems should be re-deployable together with the robot even multiple times and reconfigured to accommodate new challenges. EOAT changes such as differing quantity, type, and orientation of gripping tools should come as naturally as reprogramming robots.

Traditional robot EOATs are often designed and built only as complete custom solutions and depending upon the complexity of the tasks, customization is often necessary. For simpler tasks, standardized flexible tools can be a significant costs savings to the user of the robot with respect to both the initial purchased components and design time. When creating an EOAT there are many criteria that need to be considered: the part weight, material, dimensions, plus the end effector's overall weight, material, finger length, custom mounting components, workpiece presentation, workpiece placement, grip position on the part, etc. Criteria such as part presentation, placement and grip position still need to be considered when implementing a collaborative gripper or other standard off-the-shelf tool. A good rule for the EOAT process is to consider the workpiece in every stage of its manufacturing process when it is handled by the robot. The fingers of the gripper are designed to pick in a specific location on the workpiece; then the finger design is evaluated at the placement point. The fingers will need to be evaluated every time the part is picked back up if there were any dimensional or orientation changes to the workpiece. A specific example of this is a workpiece that is being machined and having material removed between picks.

The next design phase of an end effector is to look at how the robot will move with this tool and if it needs an offset or angle bracket to make it easier to move in the operating space. All the components that are being chosen for the end effector need to be configured onto the robot anticipating that everything was done correctly the first time. Occasionally, during the assembly and initial setup of the robot in the cell it is found that there is an interference issue or that something needs to be redesigned

completely. This can be costly for tasks that have limited life spans or for operations, like machine shops, that change regularly. In instances like these, a more flexible solution up front might be a better fit. Modular gripping systems can be redeployed quickly and modified easily for a variety of tasks. SCHUNK's Flex Grip Tools is a good example of a modular gripping system, and uses dovetail rails, clamps and connectors for easy adjustments and reconfigurations of EOATs.

When a robot needs to be redeployed quickly sometimes there is not enough time to properly evaluate the operation in the same way as the original EOAT. Flexible EOATs can be assembled directly on the end-of-arm often without need for any need for prior CAD modeling. Through trial and error, problems like mechanical interferences or limited robot reach can be easily solved by physically changing or adjusting the tool to fit in the available space. For example, in a CNC lathe loading project, a workpiece being handled from its end rather than from its side could affect the overall space available to the robot to maneuver inside the machine. Sometimes the machine does not have room to accommodate a robot with the gripping tool mounted centrally to its wrist when loading the workpiece into the lathe chuck. Instead, the EOAT may need to be offset from the robot wrist in order to reach inside the machine. Traditionally a custom-designed adapter would need to be created, but with flexible solutions, extensions can be assembled effortlessly for increasing the robot's reach using standard components. Flexible gripping solutions should also have a flexible finger design so that a standard solution can accommodate as many different parts as possible. Having fingers that can be repositioned on the base jaws of a mechanical gripper is an excellent way to increase the flexibility of a standard end effector. This allows the grip position to be adjusted on the base jaw and allow for a wider range of dimensionally different parts.

Flexibility in manufacturing and automation is all about being able to modify an existing solution to work for a new task. Solutions that allow you to swap out different sizes or styles of grippers easily offer great value for factories that have parts that range widely in weight and dimension. Being able to add multiple grippers to a tool without having to design or machine adapter plates can also be important when choosing the best solution for flexible automation. A multi end-of-arm-tool can help increase production by having an unfinished part in one gripper and picking a finished part with the other and loading immediately after, saving precious seconds over the course of operation. Sometimes more grippers are needed or various orientations such as back to back, offset, or other configurations to avoid robot singularity. Being able to adjust angles of adapter plates on the fly is an advantage when unforeseen interference issues arise. Anything that makes the end effector flexible in design and easily modified can only add to the ease of use of the redeployable robot.