Robotics 101: 6-Axis vs. SCARA vs. Delta vs. Collaborative

The Basics of 6-Axis, SCARA, Delta and Collaborative Robots
Not everyone knows the basics of how to match the right robot for a given application so here are some of the basic considerations you should take into account as you evaluate the myriad of options available to you.

First off, if you can identify these application requirements you can then use them to help narrow down the possible options:

Load – Or the weight of the objects you need to pick up or manipulate with the robot. Remember to take into account the weight of the "end of arm tooling" you will need (end of arm tooling is industry jargon for the gripper, brackets, sensors, hoses or cables that you mount on the end of the robot arm). Also note that most robot manufacturers call out the max load capacity of their robots in their part numbers (MH5 denotes a 5 Kg max load capacity) but the rated load at which the robot is designed to work at full speed is anywhere from 1/2 to 1/3 of its max.

Work Area – This is the three dimensional space that you need the robot to be able to reach. How restrictive is it?

Cycle Time – This the amount of the time it takes for the robot to complete an out-and-back move. Although robot manufacturers are fond of publishing this spec, it really doesn't help us much since it is an idealized situation that they define very vaguely. It is always best to find your worst case move requirements and have your provider simulate the move.

Repeatability – This is the amount of physical variance a robot will have in its ability to position to a programmed point in its work area. This is normally given in "plus or minus X" thousandths of an inch or mm.
Planes of Operation – There are certain robot types that lend themselves to certain applications based on their configurations. A key differentiation is whether or not the robot is just operating in the horizontal plane with a relatively small vertical travel or whether the robot will have a large vertical travel requirement and/or need to 'reach' into a vertical plan such as through an opening in the side of a machine.

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Now that we have the basics of what to look for in your application, here are the different styles of robots and what they have to offer.

6-Axis Robots
Sometimes called an articulated arm, this is the configuration that most people think of when you talk about an industrial robot. The number of axes corresponds to the number of 'joints' – or points – along the arm where it can bend or twist. These robots are very versatile and are used in applications ranging from welding (think of all the car commercials you see with robot arms flailing and sparks flying) to machine tending, where the robot arm reaches into a machine to grab a finished part, takes it out, and places it into the next part of the process. Some 6-Axis robots can be mounted in various orientations including wall mounted and ceiling mounted. Load capacities for industrial 6-Axis arms have the largest range, anywhere from small 3 kg units to monster 1000 kg systems.

- **Strengths**: Very flexible and can mimic the motion of a human arm. Very good at reaching in and around objects.
- **Weaknesses**: Can be more compliant and a little slower than other configurations due to the nature of the design.
- **Number of Axes**: Six, usually, but there is a new "snake" variant robot that adds a 7th axis that gives the system an even better ability to reach in and around obstacles.
- **Typical Load Capacities**: 3-600 kg



SCARA Robots
If you have ever seen a high speed robot assembling small components, like a watch or cell phone, chances are it was a SCARA. The SCARA or Selective Compliant Assembly Robot Arm is your high speed work horse, but they aren't limited to assembly or pick-and-place applications! They can be very useful in applications such as dispensing, where you need to precisely

follow a path at constant speeds while dispensing things like adhesives or gasket materials. If the SCARA is based mounted, the available work area will look a little like a curled up Cheeto with its two ends touching and a hole in the middle. Due to the configuration and orientation of the joints, the SCARA is well suited for providing downward thrust. These robots are used quite frequently to load and unload from square target areas. The largest square target area that the robot can service is referred to as it's max 'pallet' size.

- **Strengths**: High Speed and very rigid with very good repeatability.
- **Weakness**: Available work area can be limited and not suited for manipulating objects in a vertical plane.
- **Number of Axes**: Three or Four – the fourth is determined if you need a wrist or twist axis about the Z-Axis (vertical).
- **Typical Load Capacities**: 1-20 kg

Delta Robots

Also referred to as "Spider Robots", Delta Robots are one of the latest entrants into the main stream industrial robot world and they remind me of something out of a Matrix movie. Deltas are best suited for super high speed pick-and-place applications with relatively light loads. The classic application for a Delta solution would be high speed sorting station with conveyor tracking. Imagine two conveyors running side by side, one of them with a continuous flow of red and green parts while the other conveyor has boxes that it are indexed forward incrementally at a set rate. There is a vision system that feeds position, orientation, and color data to the robot as the parts pass underneath the camera. Based on the data transmitted from the vision system and rate at which the conveyor is moving, the Delta Robot picks the green parts from the moving conveyor and puts them in one box while picking the red parts and putting them in another box.

- **Strengths**: Very High Speed.
- **Weakness**: Available work area can be limited in the vertical plane at the extents of its reach and it's not suited for manipulating objects in a vertical plane. Due to the duty cycle requirements, there can be significant mechanical maintenance required.

- **Number of Axes**: Three or Four – the fourth is determined if you need a wrist or twist axis.
- **Typical Load Capacities**: 1-3 kg

Collaborative Robots (Cage Free)
Collaborative Robot (cobot) classification isn't something that specifically has to do with the configuration of the robot like the other categories do. This differentiation has to do with whether or not humans can safely interact with an industrial robot in a production situation without extra safety equipment. To date, the dominating type of robot being used for industrial collaborative robots is the 6-Axis. In terms of making industrial robots more productive and affordable to use, this technology could bring about significant changes. For more information, please see the in-depth article Is a Collaborative Robot Right For You?

No matter what your industrial application is, Cross robotics specialists can help you determine the right robot and accessories to automate it. Contact us today