DENSO

Robotics

Small Assembly Robots:

Comparing the Cost of Ownership of Different Brands

A Guide for Manufacturers, Machine Builders and System Integrators

Never before has such a wide choice of robots been available.

This is truly a boom time for small assembly robots. More and more companies are discovering the benefits of using such robots in their manufacturing, packaging and other industrial processes.

In addition, the number of different robots being offered in the marketplace continues to grow at an unprecedented rate. Never before has such a wide choice of competing products been available.

Yet the large variety of robots now being offered also presents prospective buyers with a challenge: How to evaluate and compare the cost of ownership of the numerous different brands, to be certain of making an informed investment decision?

To answer that challenge, this white paper examines the many factors — some obvious and some not so obvious — that determine cost of robot ownership, and gives buyers useful information to help guide them through the evaluation process.

Small Assembly Robots Defined

Small assembly robots are a class of robot arms consisting of four-axis (SCARA) and six-axis articulated robots.

Small assembly robots can carry out many more tasks than just assembly.

Despite their name, small assembly robots can carry out a much greater variety of tasks than just assembly. These include all the various functions involved in manufacturing, packaging and other industrial processes, such as:

Assembly	Nut driving
Dispensing	Package forming
Encapsulating and potting	Parts finishing
Grinding	Pick and place
Insertion	Polishing
Inspection	Press fitting
Labeling	Product insertion
Loading and unloading	Screw driving
Laser welding	Soldering
Machine tending	Spot-welding
Machining	Surface finishing
Material handling	Test handling
Material removal	Ultrasonic welding

For the purposes of this paper, small assembly robots are considered to be those with payload capacities up to 20 kg (44 pounds) and reaches up to 1,300 mm (51 inches).

Larger robot arms have different types of motors, arm and joint construction, and maintenance requirements, and therefore different cost-of-ownership considerations.

Initial Hardware and Software Costs

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As with any type of equipment, comparing apples-to-apples costs among robot brands means understanding which items are included in the initial quote and which are add-ons.

Robot and controller: Some manufacturers sell the robot arm and controller as a set, while others do not include the controller in the basic price.

There may also be an additional charge for the motor and encoder cable, power cable and electrical connectors.

Controller features: With some manufacturers, the controller comes with all features activated.

Others have software and firmware licenses, with additional post-sale charges required to activate individual features such as palletizing, singularity avoidance and collision detect.

Additional charges may also be required to extend the I/O (input/output) configuration, or obtain updates and license renewals.

Teach pendant: One piece of hardware that is not strictly necessary, but which most robot users purchase, is a teach pendant, a convenient handheld control box used for programming a robot. Teach pendants are not usually included in the price of the basic robot set.

Integrating end-of-arm tooling and a vision system with the robot can add considerably to the overall cost.

End-of-arm tooling and vision system: All robots require some kind of end-of-arm tooling (end-effector). Depending on the application, a vision system may also be needed. Both of these are usually priced separately from the robot.

In addition to the hardware cost of the end-of-arm tooling and vision system, it is important to determine how easy it will be to integrate them with the robot, as this can add considerably to the overall cost.

Electrical wiring and air piping: In order to run their end-of-arm tooling, robot arms require "dressing" with electrical wiring and air piping that delivers electricity and air to the tooling.

Some robots are designed with the wiring and piping installed internally, so there is no additional charge for these items; otherwise they may cost extra.

Mounting-configuration firmware: If the robot is to be mounted in a horizontal or inverted position, it may need special firmware, often at an extra cost.

Software: Some manufacturers offer programming-software packages with a low base price, but have expensive upgrade options for individual features such as 3-D simulation, remote monitoring, arm compliance, palletizing and dispensing. Other manufacturers include these features as standard.

Training: Most manufacturers offer free training. The cost to the customer, however — in both non-productive employee time and travel expenses — can vary considerably, depending on the length of the training and the distance of the training center from the customer's facility.

Long-Term Costs

Long-term costs account for most of a robot's total cost of ownership.

Long-term costs account for most of the total cost of ownership of a robot. It is therefore crucial to understand each of these costs and ask questions about them early in the buying process:

Maintenance: Robots can differ greatly in their maintenance requirements.

In addition to the cost of the maintenance itself, production downtime due to overly frequent, time-consuming maintenance procedures can significantly increase the cost of ownership.

Telephone support: Some manufacturers require a service contract before providing telephone support, while others will field routine telephone questions at no charge.

Reliability and longevity: Traditionally, many manufacturers have used mean time between failures (MTBF) as a basic measure of robot reliability and longevity.

Increasingly, however, the number of joint cycles between failures has begun to be recognized as a more meaningful figure.

Obsolescence: Some manufacturers come out with new robot and controller models every few years, and quickly stop supporting older ones. Having to replace a robot due to premature obsolescence can be a major factor in increased cost of ownership.

Other manufacturers offer support and upgrades for older robot models for up to 10 years after they are discontinued.

Speed and productivity: All other factors being equal, robot speed counts. A robot that completes more cycles per hour over a given working lifetime will usually have a lower cost of ownership than another robot that costs less initially but has lower performance levels.

Energy consumption: Lightweight, efficiently designed robot arms require less power, so their motors draw less electrical current. This can result in significant long-term cost savings.

Know what to look for when comparing and evaluating robots from different manufacturers.

8 Things to Look for When Choosing a Robot

When choosing a robot, here are eight important things to consider:

1. Experience and expertise of the manufacturer: Look for a manufacturer that has established itself as an industry leader and whose robots have stood the test of time.

Small, high-speed, high-inertia robots have their own unique design challenges. A manufacturer that specializes in such robots is likely to have expertise that others do not.

2. Type of manufacturer: Robot manufacturers fall into two basic categories: (1) those whose primary business is selling robots and (2) those whose primary business is producing and selling other types of products, which they manufacture with robots they design and build themselves.

Manufacturers in the second category depend on their robots to keep their products competitive in the marketplace.

As a result, they are likely to design robots that have the highest productivity levels, longest working lifetimes and lowest maintenance requirements.

3. High maximum allowable moment of inertia: Look for a robot with a high maximum allowable moment of inertia, the measure of how much force it can exert.

The higher the maximum allowable moment of inertia, the more easily the robot can lift and move a given size of payload, putting less strain on its motors and resulting in a longer working life.

4. Continuous-duty cycle time: When comparing robot cycle times, be sure to ask whether the figures given are for continuous duty or only shorter bursts of an hour or less. If the latter, the robot will have to operate at a slower speed in normal operation, reducing productivity.

5. Compact, efficient robot design: A compact robot design with a small footprint makes integration easier and saves valuable factory floor space.

In addition, designs with concealed air and electrical lines keep the lines from interfering with other equipment, as well as protecting them from wear and damage.

6. Robot controller features: Desirable features to look for in robot controllers include small size and weight; fast processing speed; modular expandability, to accommodate additional peripheral equipment without having to purchase a new controller; ease of integration with a vision system, PLC or other devices; and ease of servicing.

7. Affordable offline programming software: In general, most applications are not difficult to program. Be sure the offline programming software being offered does not include expensive, advanced features that are unnecessary for your needs.

8. Safety codes: To protect your employees and limit your company's liability, verify that the robot meets or exceeds all current safety codes.

About DENSO Robotics

As one of the world's largest automotive parts manufacturers, DENSO Corporation has been a pioneer and industry leader in robot design and manufacturing since the 1960s.

DENSO is also the world's largest user of small assembly robots, employing more than 17,000 robots in its own manufacturing facilities. Other companies use more than 77,000 additional DENSO robots worldwide.

DENSO Robotics offers a wide range of compact four-axis SCARA and five- and six-axis articulated robots for payloads up to 20 kg, with reaches from 350 to 1,300 mm and repeatability to within ±0.015 mm.

Available configurations include standard (IP40), dust- and mistproof (IP65), dust- and splashproof (IP67), cleanroom (ISO 3, 4 and 5) and aseptic (H_2O_2- and UV-light-resistant).

ANSI and CE compliance enables global deployment. UL-listed models are available for both the U.S. and Canada.

Easy-to-use programming software, controllers and teaching pendants are also offered. The company's offline programming software, which features 3-D simulation, also allows remote monitoring of robot operations.

DENSO robots are used in a broad variety of applications, such as assembly, dispensing, insertion, inspection, machining, machine tending, material handling, material removal, pick and place, test handling and ultrasonic welding.

Industries served include appliances, automotive, chemical, consumer products, disk drives, electronics, food and beverage,

general manufacturing, life sciences, machine tools, medical devices, packaging, pharmaceuticals, plastics and semiconductors.

For more information, visit the DENSO Robotics website at www.densorobotics.com.