How a robotic arm can improve your packaging operation

Travis Wallace and Michael Johnson Taylor Products div. Magnum Systems

In an effort to reduce worker injuries and trim labor costs, many companies are moving away from manual bag filling, palletizing, and depalletizing. Some companies are automating these functions. Others are using a newer option — the robotic arm. This article will provide basic information about the robotic arm and how it can improve a packaging operation.

The bulk solids packaging industry has embraced the 21st century with open arms — open robotic arms, that is. That's quite a step for an industry that's as diverse technologically as the products it encompasses. While some companies still rely on manual labor for repetitious or strenuous tasks, others have taken advantage of robotic technology to increase productivity, improve packaging accuracy, and reduce waste while decreasing operator injuries.

Robotic arm basics

If you think of *Star Wars*'s R2-D2 or another movie invention when you think of robots, forget it. Robots used in dry bulk solids packaging look nothing like those humanoid critters imagined by moviemakers. In fact, the most common robot used in packaging dry bulk materials is the robotic arm. The robotic arm resembles a human arm in that it's jointed, has an immense range of movement, and has a "hand" of sorts. In dry bulk materials packaging operations, it's used primarily to place empty bags on fill spouts and to palletize and depalletize filled bags.

The robotic arm's main components are the arm itself, which may have several segments; the joints (called *axes*), which are located between segments; the "hand" (called the *end effector* or *end-of-arm tooling*); and software that tells the arm what to do. The robotic arm is mounted on a base that can be installed on the floor, ceiling, or wall or in a metal framework — whatever best suits your plant layout. The arm also has a power source, most commonly an electric motor, and it has wiring and various electrical and electronic components that allow it to perform its functions, direct it, and enable operators to interact with it. The robotic arm is integrated with other equipment, such as pallet dispensers, bag fillers, and conveyors, via drives and controllers.

More about axes. Most commonly, the robotic arm used in dry bulk material packaging has four or six axes. The axes allow an arm, arm segment, or end effector to rotate and move in various planes and at various angles. More axes allow more complex motions.

More about the end effector. The end effector is the robotic arm's hand. The end effector can be any of various tools designed to perform a particular function. In dry bulk material packaging, the end effector is usually a claw that can grip or a suction device. Claw end effectors are often equipped with a sensor that can tell the robot when it's gripping too tightly or too loosely.

Programming and operating the robotic arm. Once the robotic arm is installed in your plant, programming it is generally easy. Software supplied by the manufacturer prescribes the arm's general movements. Then, using a PC or a wireless device called a *teach pendant* or *i-pendant,* an operator walks the robot through the specific motions needed to do its job in your application. This "teaches" the robot, which then can perform the actions without any operator interaction.

Once programmed, a robotic arm can perform the same actions over and over with unrivaled accuracy for years on end without ever breaking down. In fact, reliability, flexibility, and ease of use are the primary benefits of using a robotic arm.

Robotic arm advantages and disadvantages

Reliability. The most obvious advantages of a robotic arm over manual labor are that a robotic arm doesn't get sick, take vacations, get tired, or participate in work stoppages. But the robotic arm's reliability doesn't stop with these day-to-day benefits: One leading robotics manufacturer claims an average of 70,000 working hours before failure in its robotic arms. (The actual rate depends on the way the arm is used and the peripheral equipment, such as bag fillers and conveyors, involved in completing the function.)

This rate outstrips mechanical systems, which are hampered by wear items such as chains, belts, ball joints, and other components that have a limited life and must be repaired or replaced periodically. Even if the basic equipment lasts many years, it's likely to experience planned or unplanned downtime for maintenance and repair.

This six-axes robot takes an empty bag from a bag dispenser, places the bag on the bag-filling spout, and removes the filled bag to a conveyor. It can do this thousands of times a day every day for several years without breaking down.

Higher-end robotic arms typically don't use these wear items. These robotic arms rely on servo motors and directly coupled drives that are totally enclosed with no external gears and no chains between parts. Additionally, a higher-end robot's wiring is sometimes placed inside the arm, which not only protects the wiring from damage but allows the arm more freedom of movement with no chance of binding. However, keep in mind that lower-end robots and a robotic arm's peripheral equipment might use wear items. This means that if you're considering installing a robotic arm, you need to consider the motor's drive mechanism and the way the robot's joints are connected, as well as the peripheral equipment. The more mechanical components in these parts, the further from the 70,000-hour mean you get.

Flexibility. Another advantage of the robotic arm is flexibility. It generally has a small footprint and mounting flexibility, so it can easily be installed in most plants. The exception may be a plant with an extremely dusty or harsh environment. But even here, accommodations can be made. Severe-duty sleeves, special wiring, or a special arm provide the protection the arm needs. These items do add to the robot's cost.

Most robotic arms are designed to avoid obstacles that mechanical systems can't. These include stationary objects such as pillars and other plant equipment. But in addition, many robots have sensors that prevent them from colliding with equipment that erroneously moves into their working space.

Robotic arms also provide operational flexibility. Where mechanical and automated bag fillers and palletizers, for example, are limited to a single bag pickup and drop-off location, the robotic arm can serve several customized pickup and drop-off points. For instance, a robotic arm palletizer can pick up bags at several locations — say at the end of several bag-filling lines — and place them on pallets located at one or more spots. The robotic arm can also handle bags and other objects of various sizes and shapes in the same operation. The robotic arm's only limiting factor is the reach of its arm (its *work envelope*).

Adding to the robotic arm's flexibility is the growing number of equipment designs and software programs that are making robotics practical in a growing number of applications. For example, where robotic arms in packaging were initially used mostly for moving a filled bag to a pallet, during the past 3 to 5 years an increasing number of companies has put them to work in bag-filling and depalletizing operations as well.

Ease of use. Many people who've never used a robotic arm fear that learning to use one and training operators will be too complicated. Seeing a four- or six-axes robotic arm at work, with its wide range of motion and its speed and accuracy, can be intimidating. But the reality is that if you can operate a PLC, you can operate a robot. Most robotic equipment suppliers, both manufacturers and integrators (companies that don't manufacture robots but integrate them into a system they design and supply), provide intuitive interfaces that step the operator through the initial startup, system changes, and troubleshooting.

Cost. What may appear to be the biggest disadvantage of the robotic arm may not be a disadvantage at all. It's undeniable that robotic arms have a high initial capital investment. But the arm's many advantages may very well lead to a short return on investment. Payback will vary depending on your application and the type of system you're replacing. If you're replacing a manual system, it's important to look at more than just hourly pay rates. Insurance, paid time off, training, consistency over the shift, and reduced injuries must be factored into the equation. If you're replacing a mechanical system, you must consider growth potential, product waste, downtime for maintenance, and rework. In most cases, you can look at an average of 18 to 24 months payback for a robotic arm, and in some cases, payback is only 6 to 7 months.

Working with a robotic arm supplier

If you're considering a robotic arm, the first thing to do is determine your needs.

- What will your application require as far as payload capacity (the weight the arm has to carry while performing its tasks)?

- What size work envelope do you need (the linear and vertical area your robotic arm will need to cover)?

- How many types of movement will your robot need to do?

The answer to this last question will determine the number of axes the robot needs. Fewer axes will be needed for a simple application in which the arm only needs to pick up an item from one location and put it down at another. But if you're going to have multiple pickup and drop-off points, or if you want the arm to place empty bags on a bag-filling spout and remove full ones, your robotic arm will need additional flexibility, which means more axes.

Don't expect one arm to do too much. In most cases you're better off buying separate robots designed to do specific jobs rather than slowing down your process and straining the robot to save on up-front costs. For example, if you wanted to use one robotic arm for both bag-filling and palletizing, the robot would be oversized for the bag-filling function but undersized (and therefore slower) for the palletizing.

Finding a robotic arm supplier. Once you've determined your basic needs, it's time to find a robotic arm and a supplier for it. The key to a successful robotic arm adoption is to think long-term and do your homework. The payback is only valid if the application works effectively and has the flexibility to serve your future needs. Therefore, it's important to work with a supplier that can help you evaluate your needs.

You can look for the arm first and then find a supplier, or find a supplier first and work with the equipment that supplier provides. When you look for a robotic arm, consider who the manufacturer is and what reputation this company has for service, reliability, and training. When you look for a supplier, you might work directly with a manufacturer, but more likely you'll work with an integrator. In either case, you want to work with an experienced supplier, and preferably one that has experience with applications similar to yours. Most robotic arm manufacturers offer certification to integrators. The certification proves that the integrator has received training in setting up, operating, and servicing the manufacturer's robots.

Next, examine your robotic arm choices. Consider how flexible a specific arm is for future packaging line or product expansion. Work with your supplier to determine whether a pre-engineered work cell (the arm and its end effector) will suffice or whether you'll need a customized work cell.

Finally, make sure that the service responsibilities for the arm, end of arm tooling, peripherals, and software are clearly specified. The last thing you need is finger pointing if there's a problem. **PBE**

For further reading

Find more information on dry bulk solids packaging in articles listed under "Bagging and Packaging" in *Powder and Bulk Engineering*'s comprehensive article index at www.powderbulk.com and in the December 2005 issue.

Travis Wallace *is robotics product manager and Michael Johnson is director of marketing at Taylor Products div. Magnum Systems, 1250 Seminary Street, Kansas City, KS 66103; 800-748-7000, fax 913-362-7863 (mjohnson@magnumsystems.com). Wallace has more than 7 years experience in the dry bulk solids industry and Johnson has more than 5.*