PEER REVIEWED

Robotics for Pharmaceutical Manufacturing

Three Considerations for Robot Deployment in Pharma Production

Pharmaceutical manufacturing's roots can be traced back to the 15th century, where skilled practitioners worked tirelessly to create medicines in local apothecaries. Back then, processes were manual, requiring hours of labour to develop just one bottle of medicine. Unsurprisingly, today's manufacturing practices are fast-paced in comparison. As pharmaceutical manufacturers invest in automation to increase production, Nigel Smith, managing director of TM Robotics, explains three factors manufacturers need to consider before deploying robots in their facilities.

These factors include: defining the correct application for robotics, ensuring simple programming and appropriate vision and when required, choosing robots that are specifically designed for use in cleanroom environments.

According to the *Executive Summary World Robotics 2018*, a report published by the International Federation of Robotics (IFR), robot sales in the pharmaceutical industry are on the rise, having increased by 26 per cent since 2016. There are several advantages of robotics in pharmaceutical manufacturing, including increased production levels and assistance in meeting certain regulatory requirements of the sector.

As the worldwide supply of robots continues to increase, the industry is likely to see an even wider adoption of automation during the next decade – particularly as pharmaceutical manufacturers operate in such a financially competitive landscape.

Despite the lucrative nature of pharmaceutical manufacturing, a complete automation overhaul is not a feasible option for most manufacturers. Instead, many are incorporating automation and robotics into production by making small, incremental investments. To do this effectively, manufacturers must first decide which is the best process in their facility to automate, whether that be picking, placing or packaging applications.

1. Defining the Application

The benefits of automation include improving efficiency, saving workers from repetitive tasks, reducing overheads and increasing repeatability and reproducibility on the production line. In fact, pharmaceutical manufacturers have long used different types of automation in their facilities, for example conveying systems and bowl feeders to sort and transport medicines around the plant. But, where do robots fit into proceedings?

An increase in the use of robots for these applications is particularly significant in dispensing, sorting, kit assembly and light machine-tending. However, one of the most common applications for robots in pharmaceutical manufacturing is for product packaging, particularly end of line packaging.

In fact, according to a study by PMMI Business Intelligence, 61 per cent of pharmaceutical manufacturers already use robots in their packaging processes. Of the 39 per cent that are not currently using robotics, a third stated that they were planning to do so in the future.

The key factors required for robotics used for packaging are the payload, flexibility and all importantly, the speed of the robot itself. Speed is particularly pertinent in a pharmaceutical manufacturing facility where, for instance, a broken ampoule or spilt syrup can mean a breach of the aseptic environment – which could lead to costly down time and significant losses.

Interestingly, pharmaceutical manufacturing facilities often require much higher levels of speed, precision and cycle times than other robotic operations. For example, automotive production generally aims for cycle times greater than four seconds. In pharmaceutical applications, required cycle times are often fewer than four seconds.

Payload, which is often a specification associated with heavy industry applications, is also an essential consideration for pharmaceutical manufacturers. While very few laboratory applications require significant payloads, in pharmaceutical packaging applications, robots can often be required to lift heavy items.

New versions of industrial robots are now being developed for the pharmaceutical market to fulfil this need. For instance, vertically

articulated six-axis robots can be designed in several sizes and payloads, to suit different manufacturers' requirements.

While six-axis robots such as these are advantageous for large packaging applications, they are not the only type of robot used in pharmaceutical manufacturing. Depending on the application, pharmaceutical manufacturers could also choose a Cartesian or SCARA model to automate part of their facility. This can be particularly beneficial for speeding up the manufacturing process itself, by automating one section of a production line.

Unfortunately, one of the common objections of investing in robotics is related to the potential challenges of installing and programming the robot. For robots to be deployed directly onto the production line, this can be even more daunting, as a mistake in programming could cause detrimental downtime costs.

To alleviate this, another vital consideration for manufacturers is to select a robot model that offers simplified programming.

2. Simplifying Programming

Pharmaceutical manufacturers often have the unique challenge of using a single manufacturing line for multiple products. For instance, a contract pharmaceutical manufacturer may need to produce one particular medicine for a few months, before moving onto an entirely different formulation for another set period of time. For this reason, robots for pharmaceutical manufacturing must be designed with flexibility in mind.

Ease of programming is a key thing to consider, particularly for contract pharmaceutical manufacturers like these. Facilitating the changeover between one batch and another should be as simple as possible, as robots will often need to be re-programmed in order to enable this change.

Industrial robots often get a bad rap when it comes to programming. This is hardly surprising, considering there are currently over 1500 different programming languages in the world. For new automation users, including many of those in the pharmaceutical industry, this can be incredibly daunting.

According to the results of TM Robotics' *Global Robotics Report*, 79 per cent of robot distributors stated that simple programming was one of the five most important things customers were looking for in control technology when choosing a robot. While this is not exclusive to pharmaceutical applications, the increasing demand for batch and customised production will make this even more prevalent in the sector.

BASIC and Pascal are the basis of several industrial robot languages and tend to be the first any budding robot programmer begins to learn. BASIC, standing for Beginners All-purpose Symbolic Instruction Code, is relatively simple, but can also be considered outdated for today's demanding robotic applications.

When choosi manufacturers are advised to ask robot suppliers about the complexity of the software – there are several programming languages that are similar to BASIC, but with more advanced features. Not only will simple software assist in production, but also lessen the costs of training for new staff.

For the pharmaceutical industry, this ease-of-use can provide greater flexibility in production, allowing

manufacturers to produce multiple products on one production line – without complicated programming.

Interestingly, the same report stated that 55 per cent of distributors believed integrated vision is another priority for end users when choosing a robot. Similar to simplified programming, integrated vision systems can add flexibility to a robot's performance. Advanced versions of these systems can also lessen the programming requirements for an operator, by reducing the need to manually input data that the camera can capture instead.

Robot vision can also play a pivotal role in quality assurance and inspection for pharmaceuticals. The industry depends on automated process control and quality assurance systems to ensure that batch production is carried out repeatably, reliably, and accurately. Critical to this level of control is incoming material inspection and proofreading of labels.

According to the Food and Drug Administration (FDA) guidelines, each package produced in a pharmaceutical manufacturing plant must carry the exact label that was originally approved by the manufacturer. This process is still commonly completed by human proofreaders, but this leaves room for error. As an alternative, using a vision-equipped robot for this process can eliminate the chance of mistakes.

There are several potential processes for robots in pharmaceutical manufacturing, related to mechanical and vision-based tasks. However, some applications require robots that have been specifically designed for use in those environments. Cleanrooms are one example of this.

3. Automating for Cleanrooms

Maintaining a controlled cleanroom environment, with strict restrictions on the number of airborne particles in the area, is vital for some types of pharmaceutical manufacturing. When investing in automation, pharmaceutical manufacturers must first consider whether the robot needs to meet cleanroom standards and, if so, choose one that is certified to operate in these areas.

A non-cleanroom robot might emit a relatively low number of particles – at least when compared to a human working in a cleanroom environment. However, considering a gripper opens and closes 10,000 times over its lifetime, the potential for particle emittance problems over the working life of a robot can add up.

Like any mechanism, robots can shed particles from belts, gasses from hoses and dust particles from the movement of the end effectors. It is this particle disbursement that can be the critical issue for cleanroom robotics.

This includes dust, vapours and moisture contaminants. Keeping these particles in check is essential for minimising damage to vulnerable products and this relies on the right processes and equipment to maintain the necessary level of control.

The cleanliness level of a cleanroom varies, with ISO Class 1 ranked as the cleanest, through to ISO class 9, which is the lowest level by cleanroom standards. Typically, cleanrooms ISO Class 7 or cleaner have a separate changing atrium for gowning, away from the main working area.

This reduces contaminants from entering the clean area via movement of workers. Yet the time it takes for workers to put on and take off the protective suits costs businesses time and money, which is a huge incentive for implementing automation as an alternative.

Robotics can be beneficial to several cleanroom environments, such as electronics manufacturing. However, pharmaceutical manufacturing is a prime example of how automation can reduce the risk of contamination, which could have disastrous consequences.

For instance, a single particle finding its way into a pharmaceutical recipe can damage the potency of the batch. Not only can this impact the product itself, causing high costs for re-manufacturing, but could also cause the manufacturer to fall foul of regulatory requirements. To ensure compliance, pharmaceutical manufacturers should ensure that the robot they use meets the specific cleanroom standards.

Choosing the correct robot for a cleanroom application depends on the classification of the robot, compared with the strictness of the cleanroom environment. Robots are certified as appropriate for different industries and cleanroom levels according to the number of particles they generate when in motion. In the case of pharmaceutical manufacturing, customers should ensure the robot is certified for use in biotechnology, pharmaceutical and medical industries.

Pharmaceutical production has become increasingly sophisticated in recent years, and today's manufacturing practices could not be further from the experimental apothecaries of the fifteenth century. As with all industries, growing demand for products creates a need to increase productivity – and automation has quickly become the ideal way to boost production in pharmaceutical manufacturing.

Before investing in robotics, however, manufacturers should consider the best application for these machines, their programming requirements and how the robots will perform in specific environments, like cleanrooms.

Nigel Smith

Nigel Smith, managing director of TM Robotics, directs the overall growth and development of TM Robotics throughout Europe, the Middle East, Africa, India, Russia, North and South America. Smith founded TM Robotics after holding a number of positions at Toshiba International, which is headquartered in Japan. During his time at Toshiba, he was responsible for the sales, marketing and support of the company's PLC and Industrial Robot product range throughout all of EMEA.