Feature article

Developments in robot applications for food manufacturing

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Abstract
Purpose – The purpose of this paper to provide an overview of the current state of play for robot applications in the food industry.
Design/methodology/approach – This paper is based on experience and knowledge gained by working in the automation with specific contact with the food sector and automation suppliers who are working in that sector.
Findings – The food sector has enormous potential for the application of robots and many of the technical challenges are solved. The major problems lie in the lack of the necessary engineers to both conceive and implement automated solutions.
Originality/value – This paper provides an overview of the current situation including the benefits in favour of automation together an assessment of the challenges to be solved.

Keywords Food industry, Food manufacturing equipment, Robotics

Paper type Research paper

The food and drink sector is the largest within the European Union and food manufacturing facilities exist in all countries in the world. For example, in the UK, the food and drink sector includes 7,000 companies employing 440,000 people. It is recognised as a major growth market for robot utilisation by all of the robot suppliers and has the potential to have the same impact on the robot industry as the automotive sector had in the earlier years of robot development.

As we all know robots are now used extensively throughout the automotive industry. However, in the early days, about 30 years ago, there were many challenges to solve to make even the simplest applications work. The automotive companies employed engineers working on application development in conjunction with the robot suppliers. I was one such engineer, working for BL Cars, as it was then called, at the Cowley factory in Oxford.

The initial challenges came from the robots themselves as well as a lack of application knowledge. The robots were expensive, difficult to apply and limited in functionality. Processes had not been robotised and therefore associated equipment, such as tools and grippers, were being developed to suit the applications and on many occasions engineers were implementing solutions which were new and unproven. Even applications, such as spot welding, which are now common place were new and a number of years of development and iterations in both robot and process equipment design and functionality were required before the robot systems achieved the levels of reliability and performance required.

The food industry is, in many ways, in a similar position to the automotive industry back in the 1970s. There are however, some major differences, both positive and negative, which are impacting the uptake of robot systems into food manufacturing companies.

Robot development

The knowledge and experience gained by the robot suppliers over the last 30 years, has led to the development of robots that are easy to use, provide extensive functionality and very high levels of reliability. This improved product and improved performance is also provided at a much lower price, with robots costing less than half they were, even 20 years ago. This means the basic building block, the robot, provides a level of performance at a very competitive cost and is therefore of interest to the food industry.

The suppliers have also recognised that different applications require specific capabilities. There are no longer general purpose robots but machines designed for specific applications such as picking and palletising. Robots for palletising are well proven and provide performance which cannot be matched by either dedicated layer palletisers or by manual means. Robot palletising systems are almost a catalogue product with standard solutions (Figure 1) and predesigned grippers, conveyors and software systems available to make system implementation quick and low risk.

More recently robots, such as the ABB FlexPicker (Figure 2) have been developed to provide very fast pick and place performance. These machines can operate at rates of up to 200 picks per minute providing a competitive solution to manual operation. Although, it is often product issues that limit the speed. There are now similar machines available from a wide range of suppliers.

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Figure 1 Standard palletising solution

Figure 2 ABB FlexPicker

Hygiene and cleanliness are obviously important for the food industry and current robots are designed to meet this requirement. Both the FlexPicker and other robots, such as the Fanuc M-430iA (Figure 3), are designed to withstand a complete wash-down for use within the high-care areas of the food factory.

Associated equipment

In addition to the robots themselves supporting technologies, such as software and vision, have been developed to provide both the functionality required and also ease of implementation and use. Vision systems are integrated within the robot controller to provide for picking of randomly oriented products, such as chocolates, from conveyors. The software

Figure 3 Fanuc M-430iA

also provides for conveyor tracking to allow the robots to work with the moving conveyors typically used within food. These are complex functions but the integration within the robot controller makes them largely transparent to the user. Operator interfaces have been developed to make systems easy to use and, where appropriate modify. Using palletising as an example, the operator is simply able to define box and pallet sizes and the software will provide options for the most efficient palletising patterns. Once the pattern is selected the robot programme will be developed automatically by the software.

All this functionality is a major step forward from the early days in the automotive industry when engineers had to develop every programme via the robot teach pendant, defining every step in the programme. Not only did this require many man hours of input but also required expert programmers, even for relatively simple changes. Therefore, the machines provide the functionality and performance and are also relatively easy to apply and use.

One of the major application issues relates to the type of products being handled which are often delicate or of variable size and shape. Developments in gripper technology are available to solve these problems. As an example, RTS flexible systems have recently installed a robot system to pack poppodoms (Figure 4) immediately after frying, and we all know how delicate they are! Festo have recently developed an entirely new gripper concept, the "Fingripper" (Figure 5) which adapts its form to the object being picked, providing reliable gripping for fragile or soft objects. Even delicate fruit, such as peaches, can be gripped without bruising. The production method used to produce the Fingripper, laser sintering, is now being used to produce highly effective, lightweight grippers for all types of applications.

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Figure 4 Poppodom handling

Figure 5 Fingripper

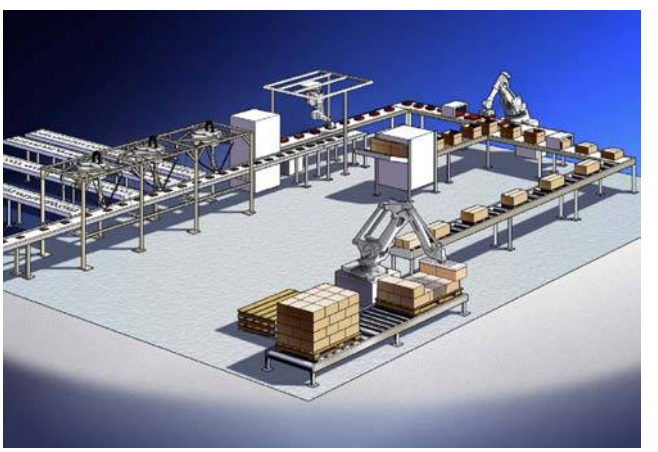
Barriers to system implementation

Most of the technical challenges to implementing robotics in the food industry can now be solved and there are many applications for which solutions not only exist, but are proven in production (Figure 6). These range from palletising through to secondary packing, primary packing and even food preparation, such as lettuce processing (Figure 7).

However, most food manufacturing companies, particularly the smaller businesses, have very limited engineering resources and one of the most significant challenges to the industry is the identification of opportunities for robotics and automation and the specification of applications. Companies do not have the luxury of engineering teams able to develop and test new applications in the way the automotive industry did 30 years ago. Engineers in food manufacturing are usually focused on the day-to-day operations. They lack the time to develop new ideas, knowledge or skills and have limited experience of robots and robot applications.

This lack of time and knowledge is proving to be more of a barrier to the introduction of robots to the food industry than the technology. There are many proven solutions which are highly effective and can easily be applied to many more businesses but the uptake of these is hindered by companies lacking the resources or awareness to approach the relevant suppliers.

Figure 6 Typical applications



Those companies that do make the first step and contact automation system suppliers are often highly reliant on the knowledge and expertise of those suppliers. However, the initial selection of supplier can often be "hit and miss", dependant on word of mouth rather than any detailed research and often the better qualified suppliers for a particular application may not be involved in the project.

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Figure 7 Lettuce processing

This lack of direction from the customer can lead to problems later in the project. Few customers prepare a detailed specification prior to involving the automation suppliers. They provide a basic description and are then reliant on the supplier interpreting the requirements correctly and also investigating and identifying all the other issues which may affect the automation solution. This can cause difficulties when a supplier is new to the factory and does not fully understand the actual operation and can lead to items being omitted from the specification which may have a significant impact on the performance later.

It is also often the case that the customer will not understand the importance of some of the items within the specification, in particular, the tolerances specified by the supplier. Automation can and will provide highly reliable performance but it does not have the same adaptability as humans and there must be some control of all the factors that can affect that performance. This may include tolerances on sizes, positions, other characteristics of the inputs and also environmental factors, such as room temperature.

In the UK, the centre for food robotics and automation (CenFRA) has been created to provide support to address these issues and assist food manufacturing companies to improve their competitiveness by introducing automation. The Doncaster based centre is supported financially by Yorkshire forward, the local regional development agency, and is therefore fully independent of any robotics supplier and can supply impartial support from the commencement of a project all the way through to project implementation.

Once engaged, CenFRA will provide a factory audit to identify those areas where automation could be beneficial. This is supported by factory simulation software to model the operations and test alternatives to ensure the optimum solution is identified. Assistance can then be provided to develop the all important specification and ensure that the scope and detail of the project are fully understood and the most appropriate supplier is selected.

Many companies suggest that their lack of long-term contracts with their customers is a barrier to investment but those companies which do invest and improve their competitiveness will be those who gain business in the future. To be successful, food and drink businesses need to investigate the application of automation and at least determine if they would benefit.

There is increasing recognition within the food sector that competitiveness needs to be, and can be enhanced by the application of automation. In 2009, CenFRA undertook a project for a large UK food manufacturer. The operations within this group are typical of many food businesses and an analysis of the results of the study identified the main applications which could be automated (Figure 8). This study demonstrated that the technology exists, to provide solutions for the applications, the major challenges being expertise and financial.

Benefits of automation

In addition to the need to improve competitiveness, the increasing interest in automation is partly a recognition that robots are now just as applicable to the food sector as the automotive industry and partly that the cost of automation solutions is often lower than the perception within the sector. In many cases very short payback constraints are applied to capital projects and it can be difficult to achieve these if only labour costs are considered, particularly on single shift operations, however there are often other benefits which are not taken into account.

The automation performs exactly as required which often reduces waste and increases yield from the input materials. Automation performs reliably over many hours and does not suffer from lapses in concentration or tiredness again providing reliable output. Vision used for inspection removes the risk of humans missing rejects. Automation used for tedious or arduous operations reduces the risk of injuries and insurance claims. Companies often do not consider that the automation system will still be performing reliably after ten years and therefore significantly enhances the business, beyond the initial payback period.

It is often a combination of factors that provide the real benefit to the business. Fosters Bakery, based in Barnsley, UK has automated an oven loading application (Figure 9). The shelves in the reel oven move continuously through a vertical loop making it impossible for an operator to unload a full tray of baked product and reload the same shelf with a new tray. Therefore, the oven would operate at reduced capacity as shelves would rotate without product. The robot is able to unload and reload trays within the available second cycle time and the oven now operates at full capacity. Not only has the robot allowed fosters to increase production

Figure 8 Automation opportunities

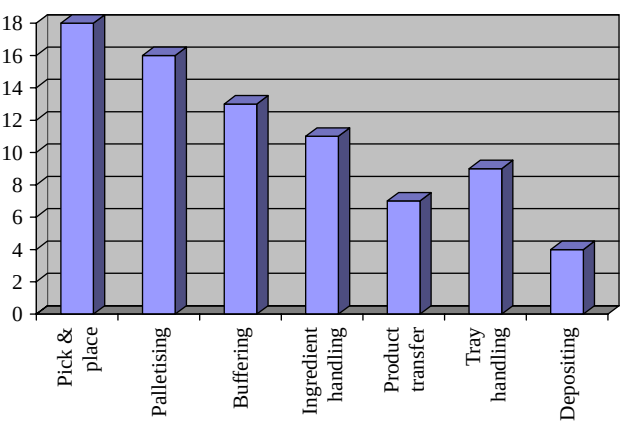

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Figure 9 Fosters bakery oven loading application

capacity by 80 percent but has also provided an energy saving of 50 percent.

An automated packing system based on FlexPicker robots (Figure 10) has been installed at Honeytop Speciality Foods by RG Luma, a UK systems integrator. Honeytop are Europe's leading volume manufacturer of speciality flatbreads and were looking to improve the productivity of their pancake line. The robots are helping to ensure all pancakes are picked and stacked quickly and precisely improving both productivity and hygiene as well as improving worker health and safety. In addition, the built-in versatility has dramatically reduced the changeover time between products.

Figure 10 Pancake packing at Honeytop speciality foods

Conclusion

The food sector has enormous potential for the application of robots and will benefit from the improvements that can be gained from automated production. The technological challenges, in many cases, are already solved but there are issues to be addressed particularly in the availability of skills and expertise to implement automated solutions. We have seen how the application of robotics has provided a fundamental change to the productivity and quality of product within the automotive sector and we can expect robots to have a similar effect on the food industry. "Untouched by human hand" could well become a significant marketing differentiator for food products in the future and those companies who can claim this will be those who gain increased business and growth in the future.

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