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# Automate **everything?**

**Robotics and Artificial Intelligence (AI)** are currently all the rage. Backtechnik discussed the **potential applications of these modern technologies** in the bakery with experts with practical experience.

*Stefan Schütter*

**Stefan Schütter:** We have organized this round table because AI and robots are currently being talked about everywhere, just as Industry 4.0 was the buzzword par excellence a few years ago. We would therefore like to clarify what artificial intelligence

and robots mean for the bakery. Which projects have already been implemented in practice and what might be conceivable in the future. Hence the first question. Many bakers often wait until something new comes along before they are ready to use this

technology themselves. So how willing do you think they are to introduce AI or robotics in the bakery?

**Harald Burgstaller:** At the König Group, we use AI in sales and marketing. In our experience, artificial intelligence is not actually being

used in baked goods production itself at the moment. In contrast, the topic of robotics is becoming increasingly dynamic in the bakery industry. We no longer have a project where robotics is not used. There are two reasons for this: Firstly, it is becoming increasingly difficult to find well-qualified employees. Secondly, the quality of the product can often be improved with a robot.

**Swen Fürer:** I can add that the food industry is a bit conservative. They first want to see a solution that works. Then you can convince the companies. However, we have already used AI, especially in quality control, with a deep learning approach. There are many new and exciting possibilities here. The data from the AI can be used to automate further processes with robots. For example, if a pastry is too dark and the AI recognizes this, the robot can sort it out. As far as robotics is concerned, I can confirm Mr. Burgstaller. A lot is being invested there.

**Christian Gugenberger:** Everyone is talking about AI, machine learning and digitalization. Yet there are still many companies - I'm thinking of SMEs and companies in hygiene-sensitive sectors - that have so far refrained from using robotics, even though they could benefit enormously from it. Robot manufacturers must make it easier for them to get started and, in particular, ensure simple integration and programming. This is why Stäubli has drastically simplified the programming and operation of its robots under the motto easy-to-use. Our robots can be easily programmed using graphical function blocks without any training. And the concept includes many other advantages that are well received by users.

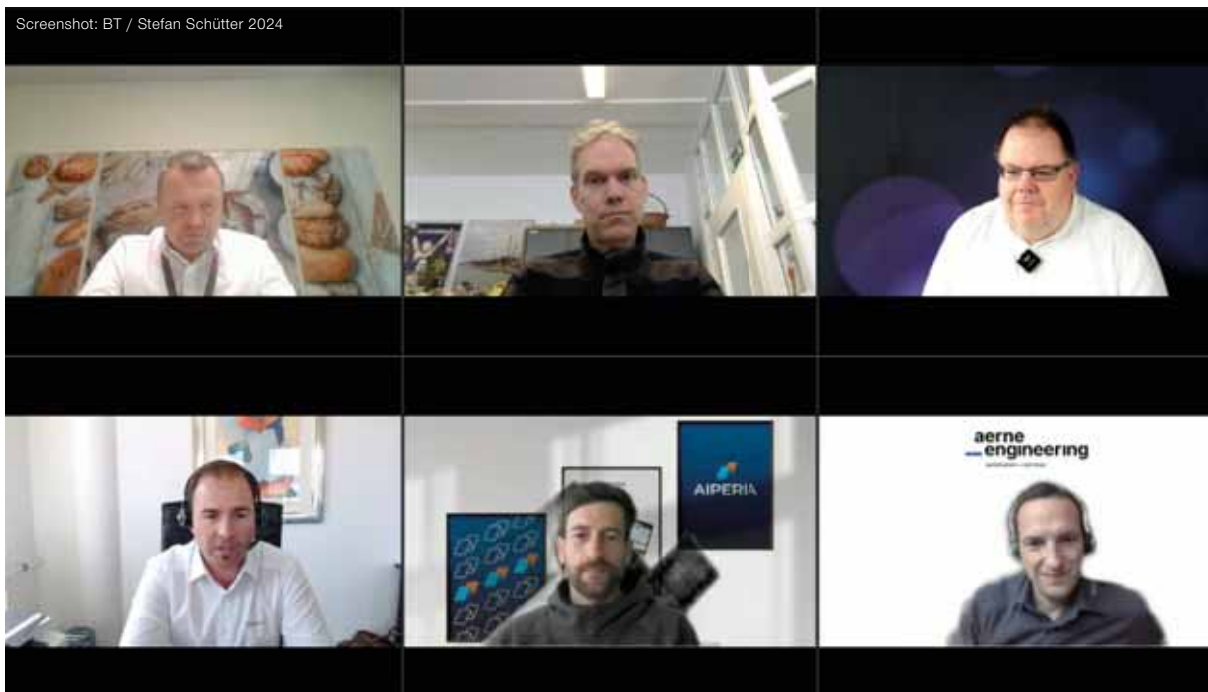
**Fabian Taigel:** Our perception as software developers is that there is a general interest in AI and therefore also in our product. But no baker buys a solution just because it says AI on it. Ultimately, it's always about solving a specific problem.

For example, if store deliveries are not going well, our AI-based forecast can help. I think it's similar with robots. Nobody puts a robot in the bakery just because it looks futuristic.

**Swen Fürer:** That's right, automation must always generate added value. But I also believe in AI, especially when it comes to vision technology. We already use deep learning very often for optical systems of this kind. This opens up new possibilities for automation. A lot will happen in the coming years.

**Fabian Taigel:** I don't come from the bakery industry, but I'm always totally impressed when I see how high the level of automation already is in some production facilities. In contrast, however, the planning processes are still comparatively little automated.

**Dirk Waclawek:** I also had to think about Aiperia recently when I was writing an article on store delivery. Could you imagine



The participants of the discussion (from left to right): Harald Burgstaller from König, Stefan Schütter and Dirk Waclawek from INGER, Christian Gugenberger from Stäubli, Fabian Taigel from Aiperia and Swen Fürer from Aerne Engineering.

controlling a bakery via your system, or is that a completely different level of complexity?

**Fabian Taigel:** There are a lot of work steps in a bakery, so it's a long way to controlling all the processes there with AI. I don't presume to make an assessment. However, store planning ultimately has to be implemented in the bakery. So the more sales data you know in advance, the easier it is to plan production precisely.

**Stefan Schütter:** Let's take a concrete look at how robots are used in bakeries today. We have already seen autonomous transport vehicles in reports at Lohners, for example, or a robot for packaging frozen dough pieces at Maurer. Robots have also become a more flexible alternative to the classic cup rounder or cutting unit, as shown by König at iba.

**Harald Burgstaller:** An example of our iScore cutting system on a large industrial line can be found in the USA. There, we cut a rustic garlic bread across the entire width of almost four meters. This requires the interaction of eight robots with the help of a 3D vision system. However, the wider the systems become, the more complicated the image processing becomes. We are currently seeing a lot of development in this area, because we practically no longer deliver a line without a cutting unit with robots. Incidentally, inquiries in this area are also increasingly coming from branch bakeries. Dough and pastry handling will also rely much more on robotics in the coming years, for example to remove pastries from trays.

**Swen FÜRER:** Yes, I think so too. In Switzerland, however, the limited floor space has to be taken into account. In comparison, German lines have much more space. In Switzerland, on the other hand, space requirements play an important role,



**1** Harald Burgstaller is Managing Director of König Industrial Solutions. **2** Christian Gugenberger is Sales Manager at Stäubli Robotics Switzerland. **3** Fabian Taigel is one of the Managing Directors of Aiperia. **4** Swen FÜRER is co-owner of Aerne Engineering AG.

but we have already been able to integrate a cutting application in a very small space, for example. The combination of automation and AI will also open up many new possibilities in the future. For example, it is too late if an employee only sees the finished product during the packaging process, which is often already automated today. It makes more sense to carry out a quality check with artificial intelligence beforehand and only pack goods that are in perfect condition. With new inspection technology, many more customers are prepared to automate packaging.

**Stefan Schütter:** Since you just mentioned quality inspection, Mr. FÜRER. A few years ago, there was

an intelligent in-store oven that was supposed to automatically recognize which baked goods were being inserted in which state, i.e. frozen, pre-cooked and so on. During baking, the oven was then supposed to monitor the browning and adjust the baking parameters if necessary. However, we never heard anything more about the oven later on. What is the current state of the art in optical or sensory product detection and quality testing?

**Swen FÜRER:** Development has made great progress in recent years. However, it is always important to carry out a so-called proof of concept with vision technology, i.e. to actually record different products live in the image and then evaluate the images.

## The participants

- **Harald Burgstaller** – König Industrial Solutions, Managing Director of the company, which deals exclusively with industrial solutions for large bakeries and medium-sized businesses. It supplies the complete range of processes, from kneading, dough preparation and robotics to proofing cabinets, oven technology and cooling spirals.
- **Christian Gugenberger** – Sales Manager Stäubli Robotics Switzerland and market specialist for food and AGV.
- **Sven Fürer** – Aerne Engineering AG, Head of Sales and one of the three owners. The company specializes in automation and testing systems with a focus on the food industry, where it has already completed a number of projects.
- **Fabian Taigel** – Aiperia. Taigel is one of the managing directors of the Würzburg-based company, which offers an AI-based planning solution for fresh products and baked goods in particular. In this context, he and his team are responsible for operations, i.e. setting up the solution and achieving the best possible results.
- **Dirk Waclawek** – INGER Verlagsgesellschaft, Editor-in-Chief of Backtechnik and Back Journal.
- **Stefan Schütter** – INGER Verlagsgesellschaft, specialist editor and Editor-in-Chief of Artisan Magazine.

land, the average ROI is usually in the range of two to six years, whereby the exact time span is strongly influenced by the chosen solution method. It should also be noted that the production volume of baked goods in Switzerland is relatively low compared to neighboring countries. There are only three to four large companies in this market that are driving forward automation processes on a significant scale.

**Sven Fürer:** I have to add that even the three big players in Switzerland have many different lines in operation, with even more different products running through them. A very high degree of flexibility is therefore required, which also makes automation complex there.

**Harald Burgstaller:** I would like to clarify once again that I was referring to our iScore cutting system in terms of ROI when it is in use 24 hours a day. We have also included an added value of 20 percent, which brings the aforementioned improvement in quality thanks to the precise and consistent cut by the robot. That brings us to around 1.5 years.

I think an oven project like this could be realized today.

**Stefan Schütter:** Of course, the question of how high the savings potential is is also interesting. Can you put a concrete figure on the savings potential of a robot in terms of working time or labor costs?

**Harald Burgstaller:** Yes, you can now do that very well. Of course, it depends on the country in which the installation is planned and what the labor costs are there. In the best case scenario, however, we are talking about a return on investment (ROI) of around 1.5 years for a robot. It replaces about two to three people.

**Sven Fürer:** In my view, several factors determine the ROI. Of

course, there is the amount of work that the robot replaces, whereby you don't want to rationalize the employee, but rather deploy them elsewhere. But you shouldn't forget the product quality. If the robot produces better quality than the operator, this is of course an additional added value. And if you factor in the elimination of quality inspections or the cost of a recall, then it is very difficult for us to calculate. If you have the right application, we can also imagine Mr. Burgstaller's 1.5 years. But the ROI is of course longer if you first have to develop something specifically for the customer.

**Christian Gugenberger:** A return on investment (ROI) of 1.5 years is considered outstanding. In Switzer-

**Dirk Waclawek:** Mr. Taigel, what do you say about the ROI of your system after you have analysed the data of a baker?

**Fabian Taigel:** I had to smile about the ROI because we sell our software as a subscription model. This means that our customers don't have this large investment upfront, but only pay for each integrated point of sale. So of course they can decide very quickly: How much more do I get out of what I spend here each month? However, the value of the AI forecasts can only really be estimated once the data has been integrated. In other words, when the system is actually running live. Nevertheless, we try to find out exactly what the quality of the data is like and where the problems lie

in the planning during the preliminary discussion. At the moment, it's usually the case that planning is too time-consuming, but the customer perhaps wants to continue to grow and doesn't have the necessary administrative staff to continue to manage store deliveries manually. In this case, automating planning makes a lot of sense because even a very well-trained person needs an average of ten minutes for each store every day. In a store operation with 100 to 200 locations, you can roughly imagine that several people do nothing else all day. However, if the models are properly trained, an AI only needs seconds to do this. That is a huge lever. This also applies to companies that already use a standard order, but which is very poor. The returns rates or availability of goods are correspondingly bad. Here, AI can help to keep the availability of goods constant and reduce returns by 30 to 40 percent. In addition, at least three percent more turnover is usually possible as pure added value. That's why our system often pays for itself from the very first month.

**Stefan Schütter:** It has already been mentioned that many of König's lines run 24 hours a day. To what extent does the possible operating time also play a role in the profitability of robots? Can you perhaps say that the company has to work at least two shifts, or is there a minimum operating time that should be achieved in any case?

**Harald Burgstaller:** According to our calculations, we have an ROI of 2.4 years in two-shift operation with two to three robots. Of course, this value decreases the more hours the robots are in use and the higher the alternative personnel deployment would be. However, we also believe that networking the systems will be

very important in the future. However, we are still a long way from this in the bakery industry because there are no established standards. I myself come from the semiconductor industry, where interfaces are clearly standardized. In the bakery industry, on the other hand, almost every manufacturer has its own interface and its own HMI. I think it would be really helpful if the HMIs were all standardized and also intuitive to use. After all, the problem is that we are getting fewer and fewer good staff. As suppliers, we must therefore do everything we can to make system operation and networking as simple as possible. Robotics alone can only be part of the solution in the future. For example, we also have to deal with weight accuracy, even before the dough pieces enter the proofing, because then I can still react. If the weight is not correct, I can, for example, automatically return a dough piece to dough preparation. This really helps to reduce waste so that the products coming out of the system are as 100 percent faultless as possible.

**“AI can help to keep the availability of goods constant and reduce returns by 30 to 40 percent.”**

**Dirk Waclawek:** I remember talking about an interface standard about 15 years ago. Why isn't there still one?

**Harald Burgstaller:** I think there should be an overarching organization, such as an association, that jointly drives the development of standards. Involving suppliers and also bakery customers. In other

industries, such as automotive or semiconductors, there are standards everywhere, including for machine parameters. In the bakery, standards would also make the entire automation process much easier, as well as the interaction with components from other manufacturers. After all, just like other machine manufacturers, we at König cannot supply everything.

**Stefan Schütter:** As you know, the Weihenstephan standards have been available from the Technical University of Munich for many years. As far as I know, they have only recently been updated and are also widely used in the beverage industry. Why isn't it the same in the bakery industry?

**Harald Burgstaller:** As I said, I am a friend of standards. In my opinion, there should be an overarching organization that also drives us suppliers to comply with these standards. But there is still a long way to go. We are a project partner of WS Bake Version 11 and, together with other companies, are taking an important step towards establishing uniform standards in the bakery industry with the Weihenstephan standards.

**Sven Fürer:** Interfaces are just as important. Up to now, signal transmitters and many other things have not been standardized. Instead, there are many different bus systems. The PLC manufacturers, such as Siemens, B+R and Beckhoff, have now joined forces to push for standardization, but there is still a lot to do. I very much hope that such a standard will emerge in the foreseeable future. The individual control panels need to be as intuitive as a smartphone, which even a small child can use today.

**Stefan Schütter:** In connection with the HMI, there is also the use of smart glasses. One vision

is that the glasses will make it much easier to operate systems and also to rectify problems or carry out minor repairs. What do you think of this?

**Sven Fürer:** I see data glasses being used more for standardized systems. However, we mostly deal with automation systems in batch sizes of one or, at best, in small series. The entire implementation effort is so great that the ROI is not given with the current technology.

**Dirk Waclawek:** We've already talked a lot about AI and robotics without defining what artificial intelligence actually is and what it can do. Perhaps Mr. Taigl is still actively involved in programming himself and can explain the difference to simple if-then program code?

**Fabian Taigel:** I hardly ever get around to programming myself. But I'm still so deeply involved that I know that our approach is fundamentally different from the human-defined if-then concept. We try to recognize patterns in the data, which is ultimately what machine learning and artificial intelligence are all about. The concept works particularly well for clearly defined problems. For example, what quantities make sense for the next day, or deciding whether a bread roll is nice or waste? These are simply defined problems. Adjusting various parameters during an ongoing baking process, on the other hand, is a much more complex problem. If you want to tackle this with AI, you would first have to bake many thousands of rolls in order to collect enough data. It may therefore make

more sense to try to model a physical model of this baking process and work with it.

**Dirk Waclawek:** So the baker who doesn't stick to the recipes is a problem for every AI, every robot and every automation system?

**Fabian Taigel:** Of course, reproducible processes are better. But in terms of networking, it would of course be great if we could automatically receive information about what the goods look like today for our models. There may still be a certain range of fluctuation and this could have an impact on customer demand. But when it comes to exchanging data between completely different systems, for example between a merchandise management program and our planning solution, we are still a long way from having

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standardized interfaces that can be used externally.

**Stefan Schütter:** You've already mentioned the issue of data volumes. Particularly with the currently popular language models and image generators, it is said that huge amounts of training data are needed for this, sometimes there is talk of half the Internet. How is it with you, Mr. Taigel? How many data sets does the baker have to provide for your software to be ready for use?

**Fabian Taigel:** The required data records are actually the main reason why we say that our system doesn't really make sense for a business with one, two or three branches. Even with a history of five years, there is simply not enough order data available. For companies with 30 stores or more, however, enough data is quickly collected to allow our models to be used sensibly. However, our data is mainly number-based and we do not have any image recognition problems or language models. Because numbers are naturally easier for computers to process, we are dealing with data volumes that are still relatively manageable for AI. We are talking about many thousands of observations, but not half the internet.

**Stefan Schütter:** I have a specific question for Mr. Gugenberger about robots. Our publishing house regularly awards innovation prizes, and a few years ago there was an application for a robot that was supposed to be able to independently assemble a burger from all the components. It didn't quite work in the practical demonstration. Would a robot be able to do that today?

**Christian Gugenberger:** The successful integration of robots in food processing depends heavily on the

respective requirements and circumstances. Although it is theoretically feasible, it is very challenging in practice. In practice, we process natural products that vary in size, shape and consistency. In a controlled environment with standardized ingredients - such as uniform rolls and meat with uniform dimensions - the use of robots is feasible. In day-to-day production, however, such uniformity is often not the case. Pieces of meat and rolls have natural differences that make automation difficult. Nonetheless, robots are already able to perform repetitive tasks efficiently, provided that the production parameters are precisely defined. Fully automated operation in food production under everyday conditions is currently a complex challenge. In the future, however, improved optical detection systems could recognize irregularities and automatically adjust the process. This would significantly increase the flexibility and autonomy of the production line.

**Swen FÜRER:** I can confirm that this is a complex task. All the necessary movements are no problem for the robot; the difficulty, as Mr. Gugenberger rightly said, is the gripping technology. Humans are very intuitive, they can feel what they are gripping. The robot needs appropriate sensor technology if it is to pick up a burger. Perhaps this is already possible with very expensive automation, but not yet economically viable. But I think a lot will develop in the near future, including with human robots.

**Harald Burgstaller:** This sensitivity is an issue where we often reach our limits, even with our automation. The human hand simply cannot currently be replaced by a robot, which still lacks the necessary sensitivity.

**Swen FÜRER:** In addition, a human being immediately recognises when what they are producing is faulty.

That happens automatically. I can imagine that a robot could acquire similar capabilities with the help of artificial intelligence. That would be the next big step.

**Stefan Schütter:** More possible applications could also help to increase the length of time a robot can be used. A human employee is multifunctional, so to speak. You can place it on the bread line for two hours, where it places the decorative slices, and then it can remove dough pieces or do something else on the bread roll line. Robots, on the other hand, have always been stationary and then only used for a specific task. Are there already approaches or even realised applications of multifunctional robots?

**Christian Gugenberger:** Continuous use of the robots is not essential for economic efficiency. Depending on the production volume, time-limited deployments such as individual shifts or half working days can also be sufficient for cost-effective operation. In addition, automated guided vehicles (AGV) from companies such as Stäubli enable flexible automation of production processes. These transport systems can be combined with various processing stations. An alternative are stationary robot cells, which enable the handling of different products through several feed lines.

**Swen FÜRER:** Incidentally, there are not only industrial robots for travelling from station to station, but also collaborative robots. These are limited in speed due to personal safety, but we have already had a few enquiries about them. The fact that they can be used multifunctionally makes a lot of sense logistically in theory, but we haven't yet realised a project in practice because it simply wasn't economical in the end.

**Harald Burgstaller:** I can confirm the difficulties. We have already thought about offering a mobile solution that can be used on several lines. However, the whole thing fails because of the safety technology. For example, we use a rotating cutting blade on the robot, so each line would have to have a corresponding safety enclosure in case the blade breaks. This effort doesn't really pay off. Perhaps ultrasonic or water jet cutting would be a solution for a mobile robot? But we generally don't see too many fields of application for this at the moment.

**Christian Gugenberger:** In Switzerland, a market study was carried out on mobile robot cells that can be equipped with either autonomous robots or collaborative robots, whereby the latter do not require a protective housing. The analysis shows that, as a rule, managing directors or company owners are the buyers of these technologies. These decision-makers often became aware of the robots at trade fairs, where the advantages of fenceless systems in particular were emphasised. This feature emphasises the mobility and flexibility of the solution and is usually very attractive. However, a closer look at the applicability in the individual bakery often reveals that the system is not the optimal solution. The reasons for this are manifold and can include deficiencies in the declaration of conformity, the use of sharp gripping tools or insufficient working speed. In such cases, the project is critically reassessed. It is often determined that a stationary robot solution is more suitable after all due to factors such as high throughput or the results of the safety analysis. The implementation in practice therefore sometimes differs considerably from the impression conveyed by a demonstration at the trade fair stand.

**Stefan Schütter:** Does it also happen that it turns out during a consultation that a robot can be used sensibly, but that the baked goods have to be adapted in some way? I'm thinking of an example from Coppenrath und Wiese. Many years ago, the company considered whether a robot could be used to place half a candied cherry on each dab of cream in a Black Forest gateau. The problem was that the robot could not recognise whether the cherry was on the round or the flat side. They then calculated everything and realised that it was more economical to have eight ladies continue to place half cherries than to buy a robot that automatically places whole cherries on the cake.

**Harald Burgstaller:** So far, we haven't had any enquiries where the baked goods have had to be adapted. Thanks to our 3D vision system, almost anything

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is now possible when it comes to cutting, for example, and also when it comes to sheet metal loading by robots.

**Fabian Taigel:** I have an example from data-based planning. The quality of the checkout is also important for data quality, especially for retailers who don't know the baked goods as well as a specialised salesperson. One of our customers, who supplies many discount shops, used our solution to recognise that the checkout quality was not good because two products were too similar. As a result, one pastry was changed to ensure better differentiation.

**Dirk Waclawek:** I have another question for Mr Taigel about detailed production control. If the batch size of a pastry is getting smaller and smaller across all shops, does your system then recommend that the pastry should be produced in stock over the cold instead of fresh every day? Is this a difficult or rather easy task for an AI?

**Fabian Taigel:** That depends on how often such a case occurs and whether the corresponding option is set in the decision model to be planned. If the system has only been trained to plan the delivery quantities correctly, it will not make such a suggestion on its own. This is actually also a management decision. After all, the refrigeration capacities and production processes have to make the changeover possible. I have already said that we are not yet ready to go that deep into production.

**Swen FÜRER:** The weather is certainly also an influencing factor, isn't it? After all, when the weather is nice, many people want to have a barbecue and the right pastries from the bakery to go with it. The AI would therefore need to know the weather data.

**Dirk Waclawek:** Without wanting to get ahead of myself. The weather is the easiest exercise, isn't it?

**Fabian Taigel:** Yes, the weather is almost a standard parameter. But the resulting production adjustment is not yet integrated into our decision-making models. We have an order quantity per shop and the total production quantity is transferred to the merchandise management system. Ultimately, the employees in production then have to check whether they can provide the quantities.

**Stefan Schütter:** To come back to the robots. What are the most common difficulties that arise when using them in practice? And what can perhaps be done in advance to prevent these problems from occurring in the first place?

**Christian GUGENBERGER:** Despite impressive advances in robot technology, robots still lack human-like senses such as smell and touch. However, it can be assumed that such abilities will be developed in the future and can be used in practice. In Switzerland, robot technology is used in a variety of ways, from cutting bread to refining cakes, for example. This ranges from applying icing to attaching decorations, such as chocolate letters that form 'Happy Birthday'. In these processes, however, the end product must have an artisanal character so that it does not appear too perfected and the consumer is given the impression that the product is handcrafted.

**Swen FÜRER:** The available space is also often a problem. Due to safety regulations, a robot cell simply needs more space than an employee. You have to take that into account.

**Harald BURGSTALLER:** From practical experience, I can say that sheet metal tolerances can also be a problem.

Sheet metal changes over time and often bends. This can lead to difficulties with the conveyor belts, but also with the robot, which cannot grip the sheets so well if they are not straight.

**Stefan Schütter:** Mr GUGENBERGER has just raised another interesting question. It was about the perfect appearance of the baked goods, which is sometimes not at all desirable. We asked the manufacturers about this some time ago. However, they all said that they had not yet had a customer who wanted an automation solution where the products did not all look the same so that they had a handcrafted appearance. Have there been any such enquiries in the meantime?

**Harald BURGSTALLER:** We often receive such requests and they are now very easy to realise. With our iScore system, for example, we can measure the products precisely using the 3D vision system and then make different cuts by programming to create a handcrafted look.

**Swen FÜRER:** That's right. Many customers want their baked goods to retain a handmade character and look slightly different.

**Christian GUGENBERGER:** An illustrative example from practice is the variety of white bread in Switzerland. Similar to the linguistic diversity with Italian, French and German, consumers also expect variation in white bread. In German-speaking Switzerland, bread typically has three cuts, whereas in French-speaking Switzerland, only two cuts are common. It is therefore necessary for manufacturers to organise their production process flexibly in order to be able to cater for these regional preferences within a single company.

**Swen FÜRER:** We once had an enquiry for a praline that was a

manufacturer's premium product. Therefore, there was a validation process to ensure that even experts could not distinguish whether the ball was handmade or machine-made. If the experts had been able to clearly distinguish between the two variants, the automation would not have been allowed to be realized.

**Dirk Waclawek:** Okay, we've already talked about customer expectations. What about employee expectations? I think Mr Taigel probably has to deal with a lot of store managers. How do they react when you come along and say that your system can manage orders better?

**Fabian Taigel:** We don't say that. Of course, we still need someone who is responsible for planning at the head office. There has to be one person who collates all the information and makes the management decisions. This is particularly important when you move from decentralised planning in the branches to centralised and more standardised planning. As a result, some shops will suddenly have significantly less stock and others will have significantly more. This initially feels wrong for those affected. That's why we support our customers with change management. For example, it is important that there is a point of contact at the head office who can explain the new processes and is available for feedback.

**Dirk Waclawek:** What does change management normally look like? Is there a staff meeting where everything is explained to the store managers? What advice would you give the baker to avoid provoking a rebellion?

**Fabian Taigel:** Exactly. Typically, we make sure that the responsible people from the head office are

involved in the kick-off and that they start communicating with the branches at an early stage. When it comes to the rollout, the system is rolled out step by step according to sales region. The sales assistants will then be briefed and trained by their divisional managers and taken on board.

**Dirk Waclawek:** What do the other gentlemen say about the role of the employees?

**Christian Gugenberger:** It is important to utilise the experience and knowledge of the employees because they know the production process in detail - for example, they know exactly how the bread behaves during processing or how deep the cuts need to be. When employees recognise their own importance in the process, their motivation to work towards the success of the project increases. They also play a key role in the smooth operation of the plant. It is therefore important to involve the workforce in the project right from the start.

**Sven Fürer:** I can confirm that, integration is very important. The employees who work with the system must be 100 per cent behind it. Then you can gradually improve the system and develop an optimum solution for the customer.

**Stefan Schütter:** Who would like to take a look into the crystal ball? What other possible applications for robots in the bakery are conceivable in the future?

**Sven Fürer:** I think a lot is conceivable, especially with human robots. Their development is progressing rapidly and at some point they will go into mass production. Then they will no longer be so expensive, and when such robots only cost 20,000 or 30,000 euros, a lot can be automated with them. But it will still be a few years before then.

**Harald Burgstaller:** The cutting sector will definitely develop very dynamically over the next few years. I also believe that the loading of rack trolleys and ovens will be done with robots in the future. In general, robots will be used wherever you can save on labour and increase quality. You can already see that in our enquiries. As I said, we are already no longer delivering a single project without robotics.

**Christian Gugenberger:** It is clear that the bakery industry is undergoing profound change, which is characterised in particular by increasing automation using robot technology. The drivers of this development are complex. On the one hand, it is becoming increasingly difficult to find qualified skilled labour for the traditional bakery trade. On the other hand, young talents are bringing new perspectives and innovations with them, which are leading to a change in the use of automation technologies in production processes. Even though this development is still in its infancy in Switzerland, the potential for the use of robotics in combination with sensor technology and image processing to recognise and process baked goods is estimated to be considerable. These technological advances offer the opportunity to expand established production processes and make them more efficient.

**Stefan Schütter:** The difference between the university environment and practice has already been discussed and the buzzword batch size one has been mentioned several times. There is a vision of the individual bakery that produces truly customised baked goods with a batch size of one. For example, the tray or baking tin should have an identification code that specifies exactly what the product should look like.

**And this then runs through the entire process of dough preparation, processing, baking and perhaps finishing or packaging. Do you think it's conceivable that one day there will be an automated bakery that can produce customised baked goods at economical conditions? Or is that simply utopian?**

**Harald Burgstaller:** There are already approaches to this, for example at an American manufacturer. However, quality requirements are increasing, both for producers and end customers. I therefore believe that a batch size of one is certainly possible for test purposes, but I personally think it is utopian for an economically viable product.

**Christian Gugenberger:** In Switzerland, there is great potential for innovative processes in the baked goods industry. Larger companies are often geared towards mass production, which can limit flexibility. In contrast, there are numerous smaller companies that specialise in the production of customised baked goods for special occasions such as weddings or celebrations. For these businesses, future technology could prove revolutionary if they could produce personalised baked goods, such as bread, in terms of size, design or weight according to individual customer requirements. It is worth noting that research is already being carried out at universities that is laying the foundations for technologies such as robot-assisted 3D printing of bread, which could enable customised production - i.e. batch size 1.

**Fabian Taigel:** Such customised products can then be shipped. More and more of our customers are already operating an online shop to significantly expand their reach.

**Sven FÜRER:** I don't believe that the entire baking process can be broken down to a batch size of one in the

near future. I'm thinking of gripping technology, for example. There are simply so many different processes that people do intuitively. It will be very difficult to replicate these with a robot. I refer again to human robots. They may be an approach in 20 years' time, but it won't be economically viable in the next few years.

**Dirk Waclawek:** We've now heard a lot about the hardware, but what about the software, Mr Taigel? Are there any functions that are not yet realisable, but are likely to be in one or two years' time?

**Fabian Taigel:** An incredible amount is happening. For example, customers also want to incorporate telecommunications planning in the shop into our system. But first you have to bring intelligence into the freezers to know what else is in there. Such data bases, which are only now being created, make much more possible. Employees in the shops, who are currently hard to come by, can then simply concentrate on selling. The entire planning process, on the other hand, is fully automated, and not just for the fresh bakery range.

**Stefan Schütter:** Couldn't a higher-level Material Execution System or Material Control System also provide important data? Or are these still rather rare in bakeries?

**Fabian Taigel:** We don't yet have customer access to such production planning systems, so I don't know exactly how often they are already in use. However, I have heard from some customers that planning has to be completed by 6 p.m. in the evening. I assume that this is the step on the software side where the data from the ERP system is transferred to the production systems. There it is then translated into mate-

rial requirements, oven allocations and all other processes. But as far as I can see, there are still interfaces in between. At the moment, it is sufficient for us if the classic sales master data is properly maintained in the merchandise management system. In other words, merchandise management provides product shelf lives, delivery or batch sizes and other data that is relevant for us, but not actually decisive for production at the head office. However, perhaps we could take a look at the production systems of customers where the data in the ERP system is not yet complete to see whether we can simply read out parameters such as production units. They are then translated into material requirements, oven allocations and all other processes. But as far as I can see, there are still interfaces in between. At the moment, it's enough for us if the classic sales master data is properly maintained in merchandise management. In other words, merchandise management provides product shelf lives, delivery or batch sizes and other data that is relevant for us, but not actually decisive for production at the head office. However, perhaps we could take a look at the production systems of customers where the data in the ERP system is not yet complete to see whether we can simply read out parameters such as production units.

**Harald Burgstaller:** I would also like to add that there are large corporations that have such production planning systems, for example SAP applications. The data from each individual system is actually brought together there and stored at a higher level. Accessing this data across the entire production line would of course be very interesting for us at König. We could do a lot with this data and I also believe that the customer could do a lot with it.

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