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The Olching brewery currently produces four own types of beer for catering establishments and markets in the vicinity.

The Olching brewery

World-class beer produced by the Olching brewery. Co-founder and brewing engineer Julius Langosch explains in an interview how the company, still in its infancy, came into being, how the traditional amber fluid is brewed and what role ifm sensors play in this.

**The Olching brewery:
the local brewery north-west of Munich can currently produce up to 2,500 hectolitres of its own four types of beer.**

Mr Langosch, what gave you the idea to start your own brewery?

The idea for the Olching Brewery was born during a ski trip in 2016. We came up with it because there had been no local brewery here in Olching, Bavaria, a town which now has 30,000 inhabitants.

To find out whether an Olching beer would be well received, we started by marketing our lager through licence brewing. This means that we rented a brewery where we brewed according to our own recipes. The result was our "Olchinger Naturhell" pale lager, a naturally cloudy, untreated and unfiltered beer. Shortly afterwards, we started producing wheat beer, too, due to the high demand. These two brands were well received. We now also offer two other types of beer, the "Olchinger Dunkel" ale, served for the first time at the Olching folk festival, and our "Hopfn Bua" hop beer. This is a special type of lager to which hops have been added again for a particularly fresh and fruity note.

Modern art of brewing meets *tradition*

These are the four varieties we currently have on offer. Since April, we now also have our own brewing facility planned in parallel over the past few years. We purchased it from the brewery equipment manufacturer JBT (Joh. Albrecht Brautechnik in Munich, editor's note), where I had previously worked for 8 years. I had the chance to take charge of the equipment planning and incorporate my own experiences. It goes without saying that some special requests could be fulfilled, too, in the process. Among other things, there are a lot of ifm sensors, as I already knew ifm from my work at JBT and have always been very satisfied with them.

" How big is your brewery?

There are currently four of us. My business partner and co-founder Dr. Guido Amendt takes care of marketing and sales, whereas I am responsible for all brewery-related technological questions. Then we have somebody for the office work and a trainee because we are also a training company for brewers and maltsters recognised by Chamber of Commerce and Industry.

Our medium-term target is 1,000 hectolitres per year. The equipment, as it is now, allows us to produce up to 2,500 hectolitres, and even up to 4,500 hectolitres per year with a tank extension.

" Where can I buy your beer?

The beer can be purchased in local retail outlets or beverage stores here in the district. Moreover, you can get it at the brewery or order it online. Since Corona times, we have also introduced a delivery service, which has made a promising start in the vicinity and with which we also supply people at home. We also supply various restaurants in Olching and Munich.

*Julius Langosch,
co-founder and brewing engineer
at Olching brewery.*

" Can you roughly describe the brewing process?

Producing beer starts traditionally with malt and water, which is mashed in the brewhouse on brew day. Lautering is the next step, i.e. the liquid that we call wort is separated from the grains and afterwards boiled in the brew kettle. This is also where the hops come in. At the end of the boil, the solid particles in the hopped wort are separated out in the whirlpool. For the separation of the solids a tangential inflow is used. Then the wort is cooled before yeast is added in the tank. At this point, we start calling the liquid beer. Depending on the type of beer and yeast, fermentation takes 2 to 12 days. After the fermentation, the beers are conditioned for 10 to 80 days in cold storage.

" Temperatures play an essential role in the brewing process. How much leeway is there in this?

During mashing, precision to the degree is required, because the enzymes have a narrow temperature optimum. While deviations do not make the beer undrinkable, they nevertheless affect its taste, changing it for example from light and fine to rather malty or bread-like.

And I also have to keep a close eye on the temperature during fermentation. If the temperature is too high, the yeast ferments too quickly and produces too many fermentation by-products. If the temperature is too low, fermentation can come to a complete halt.

Therefore we monitor the temperatures very closely in the different process steps. For this purpose, we use TA and TN temperature sensors from ifm.

*ifm pressure sensor for hydrostatic
level measurement in tanks.*

" Which other important points in the brewing process are monitored by sensors?

We use the SM8100 flow meter to measure water quantities, for example at the mash tun. The meter counts the amount of water supplied to the exact litre. This is important, because too much water dilutes the brew, while an insufficient water supply would lead to an overly thick mash.

Another application for the SM8100 is the cleaning process, i.e. the cleaning lye preparation. I need a defined amount of water for this to make sure the lye concentration is as required. The flow meter ensures control of the inflow.

The second flow meter is the SM6050. It is also of essential importance because it measures the flow during lautering and controls the coupled drain valve to ensure that the liquids neither drain too quickly nor too slowly.

That is why, besides temperature measurement, these two flow controllers are certainly the most important sensors in the brewing process.

" Do you also use the integrated temperature measurement in the flow sensors?

Yes, exactly. I can query the flow rate and also the temperature values via IO-Link. Although the temperature is not necessarily relevant to the process at this point, it is a very good indicator of the speed and quality of lautering. For example, the information that the wort runs through at only 50 degrees tells me that the lauter tun is already much too cold. If it runs through at 70 to 75 degrees, however, the process is supposed to go well and fast. The additional temperature value I get with the SM6500 is therefore a good extra reference point provided via IO-Link.

" Are there any other sensors integrated in the brewing process?

We also use the LMT100 point level sensor. You can find it in three places, in the kettle, in the lauter tun and in the tube. It informs the controller whether a vessel is empty and initiates the subsequent process step, for example in the plant control system.

We also have pressure sensors for level measurement in the brew kettle and lauter tun. They give me information about the quantities in the vessels.

" What about the digitalisation of the equipment?

Our method of choice in this respect is IO-Link. We use it to connect all sensors and actuators directly to the control system. A CODESYS V3 controller application ensures that our brewhouse can operate fully automatically.

There is a 24-volt power supply for various parts of the equipment and we use electronic circuit breakers from ifm here. The latter can be monitored and switched via IO-Link.

" Where do you see the advantages of IO-Link?

With IO-Link, I can get additional information from the sensors. One example is the SM6050 flow meter. In addition to the flow rates, it also provides me with a temperature value via IO-Link. This saves me the effort of installing another temperature sensor at this point.

Another advantage of IO-Link becomes apparent when a sensor breaks down and I have to replace it. The parameters of the broken-down device are automatically transmitted to the new sensor. I do not have to set its parameters manually and it works immediately.

" What parameter settings do you make via IO-Link?

For example the LMT100 settings for transmission of the "empty signal". Using IO-Link, we have set the switching point such that it provides empty or full signals reliably even in case of deposits or soiling.

Or take the SM8100. We have set its parameters so that it provides both flow and temperature information. What is more, the sensor now emits a switching pulse for a defined quantity of litres.

As for the temperature sensors, there was no need to set their parameters. We access the process values directly via IO-Link.

" One final question: How do you see the cooperation with ifm?

ifm's sales specialists on site have always been very motivating and proved incredible expertise in advising me.

What I have noticed, too, is that suggestions are often taken up. Three years ago, for example, we repeatedly asked for a flush mount temperature sensor. Eventually, ifm provided one. I am of course well aware that we had not been the only customer with this requirement. But still, suggestions have been taken into account.

And the same goes for the new SM8120, which has an extended temperature range. We asked for it, the idea has been taken up and is now reflected in the sensor. In brief: ifm sensors are developed on the basis of practical requirements and also improved over time.

Moreover, the price-performance ratio at ifm is good. You may buy sensors that are three times more expensive, but also break down three times as often. Or find sensors that are five to eight times more expensive than their ifm counterparts, but not suitable for our application. Hence we get on well with ifm.

Mr Langosch, thank you very much for this interview!

Temperature transmitters of the TD series monitor the various process steps.

Sorting with

Up to 6,000 packages per day can be handled with the solution, consisting of a collaborative robot arm, a 3D sensor from ifm and software from Unchained Robotics.

Depending on the customer's requirements, other robots can be used to achieve higher frequency rates or move heavier loads.

3D sensor as the heart of a pick & place solution

Christmas time is calendar time. When the turn of the year approaches, the production of personalised calendars reaches its peak. Individually designed calendars are appreciated as a year-round reminder of happy moments. By means of their pick & place solution in a printing shop, the start-up Unchained Robotics help to deliver the personalised calendars to the customers as quickly as possible. The central elements: a collaborative robot and the 3D sensor from ifm.

The young company Unchained Robotics aims at simplifying the configuration of cobots and their process integration.

An industrial area on the outskirts of Paderborn in East Westphalia: this is where large quantities of calendars are produced. Whether 100 copies for business customers or individual copies for private individuals who create their own personal calendar on online portals: a great variety of calendars in different formats from DIN A5 to DIN A3 are packed for shipment and fed to the pick & place station from Unchained Robotics. Here, a laser scanner automatically detects the bar code to allow tracking via track & trace, before the calendar is picked from the conveyor belt by a collaborative robot and placed on a transport pallet or in a post box – neatly sorted by size.

unfailing
Precision

■ Convinced by the 3D sensor – and ifm's technical support

The heart of the robot installation is the 3D sensor from ifm, the O3D. The operating principle of the O3D is based on the time-of-flight principle.

By means of 23,000 pixels arranged in a matrix, the 3D sensor detects the time needed by the light emitted to reach the sensor again as a reflection per capture. Based on this data, the O3D precisely calculates the spatial dimensions of objects and scenes.

"This aspect played an important role in our decision for the O3D," says **Mladen Milicevic,** one of the founders of Unchained Robotics. *"No other equipment or process stops are necessary, because the sensor exactly detects the height, basic form, angle and displacement of each package. This means that the packages can be placed on the conveyor belt without observing a particular arrangement or orientation. This reduces the strain on the employees and accelerates the manual process,"* explains **Milicevi.**

Based on the data transferred by the sensor, the software calculates the robot arm's movements to ensure precise positioning of the package at the placement location.

"

*We particularly opted for the O3D
and for ifm because of the easy integration
into our in-house developed software*

*Exact data and precise calculation are required
to avoid collisions when space is at a premium.*

■ Easy integration into existing software

"We particularly opted for the O3D and for ifm because of the easy integration into our in-house developed software," **Milicevic** continues. *"And if we had questions, ifm's support helped us quickly and competently."*

Based on the data, the software from Unchained Robotics can exactly calculate where the robot has to place its suction cups on the package to be handled. This ensures that the calendar is always picked up at equilibrium and at optimum orientation.

■ Precision prevents collisions

The high precision obtained by the 3D sensor is indispensable for the pick & place task carried out by the robot.

"Particularly if the calendars are placed in post boxes, space is at a premium. The robot has to move with great precision and within small tolerance values to prevent its arm or the calendar from colliding with the metal walls." explains **Milicevic.**

Depending on the format, the robot places up to 12 calendars in a 3 x 4 pattern at the placement location. Thanks to the precise positioning, a stack height of up to 70 centimetres is possible even on open pallets.

"The reliable and precise detection of the height also plays an important role when it comes to selecting the placement location within the pattern," says **Milicevic.** *"The robot places the packages according to a special height algorithm taking into account the individual package heights. The packages are sorted so that the highest point is always furthest from the robot. Besides, the packed calendars form a virtually homogeneous, flat surface when the maximum stack height is reached."*

■ The camera and the software are the core of the solution

With a frequency rate of eight seconds, the pick & place solution of the start-up also masters the high requirements placed on it in the time before Christmas, when up to 6,000 calendars per day leave the printing shop. The packages can have a weight of up to eight kilograms.

"This is within the limits of the technical data of a collaborative robot arm," explains **Milicevic.** *"If heavier weights were to be moved or faster frequency rates were required, we would use a more powerful industrial robot. This would be no great problem, as the robot only*

plays a minor role in our solution. The core of our universal solution is the combination of camera and software, which makes the solution not only suitable for calendars: It is also suitable for any pick & and place process in which products are placed on or picked up from pallets."

Another advantage of this powerful combination of sensor and software: As no other system components are required besides the robot arm, the costs for implementation are kept to a minimum.

■ Conclusion

The O3D is a central element of the pick & place solution from Unchained Robotics. Thanks to the exact detection in three dimensions of the packages, the 3D sensor provides reliable information to the software which helps to precisely control the robot arm. Even during the printing shop's busiest times, the calendars are reliably put in the correct placement location – and reach the customers in time.

Detecting flaws
in production

The company "ia: industrial analytics GmbH" from Aachen offers a comprehensive solution for the digitisation of production plants – from data acquisition to visualisation.

Transparent processes:
looking into the black box

ia: industrial analytics use IO-Link sensors from ifm which enable easy, plug & play data extraction from production processes. The goal: By visualisation in an OEE waterfall, the causes of a bumpy transition between production steps are shown transparently with their respective effects. Based on these insights, individual production steps can be optimally interlocked. This leads to increased efficiency, as the application example from the steel processing industry shows.

The heart of the plant is the ia:factorycube. With its computing unit, router and evaluation software, it contains all the IT components required to collect, evaluate and visualise generated data – and to transfer it to the cloud if required.

Jeremy Theocharis, founder and CEO of industrial analytics: *"Via the factorycube we can connect the different IO-Link sensors or use completely different data sources, for example camera solutions for quality assurance or barcode scanners for product tracking. In this plant, however, the focus is on IO-Link sensors, which*

Increasing performance ⬆

Nicolas Altenhofen, Marketing Manager at industrial analytics, adds: *"Our approach is not only about data storage. Much more important is the second step, the processing and visualisation of the data. We are less concerned with optimising production processes. We focus on performance figures. For example, we use an optical sensor to find out whether the machine is running or not, or to determine the number of pieces. We want to know: When did the machine stop? When did the machine run? What were the reasons for a machine downtime? This data is then prepared and visualised in different ways."*

In order to make the use of the factorycube as versatile and thus as efficient as possible, industrial analytics deliberately rely on open interfaces. This means that extensions can be easily implemented. Currently, for example, solutions are being developed for quality assurance with camera systems and machine learning as well as for capacity planning, capacity distribution or predictive maintenance with high-frequency vibration analysis. Thanks to the great modularity, every customer receives exactly the solutions they need on their way to Industry 4.0.

Jeremy Theocharis explains what it is all about: *„We can uncover optimisation potential. There are expensive plants that are not used efficiently. Many customers simply lack transparency on how long, for example, order*

give us a very good opportunity to digitise plants very quickly and very efficiently in order to derive key figures."

The complete information processing is done in the factorycube. In addition, the system can be modularly adapted to the customer's wishes.

"It is possible to store the data on the factorycube or to integrate the device into the customer's own IT infrastructure. The third option is the storage and evaluation of the data in our cloud system, which we make available to our customer if desired."

Measure utilisation: ifm sensors detect whether machines are running or in a waiting state.

processing takes. The actual capacity utilisation of the plant is also often unknown. We open this black box and enable the customer to make data-based decisions and gain relevant insights, for example that the bottleneck is not the machine but the material procurement."

One example is the case of a major customer in the steel processing industry whose machines at two locations were retrofitted by industrial analytics within a few weeks, so that comprehensive performance management is now possible.

■ No data transparency on the shop floor

The customer's machine park consists of plasma cutting machines, oxyfuel cutting machines and blasting machines, among others. These machines are used to cut steel plates and rework them.

Jeremy Theocharis: *"Our customer's problem was that they had no transparency regarding their production processes and performance. For example, the company didn't know how long it actually takes to produce a particular workpiece on a particular machine".*

Although theoretical target times existed for the various products, these were not compared with the actual time

> ## " At the beginning we compared many suppliers of sensor technology. We ended up in the ifm webshop.

required. There was also a lack of knowledge about the availability and capacity utilisation of the machines. Machine downtimes and their causes were not recorded. Without this valuable information, the company had no way to monitor production performance, identify problems and make data-driven decisions to improve production processes.

■ Real-time data through ifm sensors

With the help of the factorycube and various sensors from ifm, it was possible to collect the non-existent data and achieve the necessary transparency of the production processes. A total of 14 optical distance sensors of type O5D100 and O1D108 were installed on eight plasma and oxyfuel cutting machines. These sensors are used to determine whether the respective machine is in operation and how long this has been the case. The sensors were positioned so that the light beam points to the cutting head of the machine. As soon as the machine is started, the cutting head is lowered and the distance to the distance sensor changes. Through this change in distance, the system detects that the machine is in operation. In addition, vibration sensors of type VTV122 and optical sensors of type O5D100 were installed on three blasting machines. These sensors also help to determine the operating status of the machines.

The distance sensor O1D108 detects whether the cutting head is in operation or in the rest position by means of time-of-flight measurement.

■ Reduced machine downtime and increased productivity

The data collected by the ifm sensors is processed in the factorycube, sent to a cloud and visualised in a dashboard. The company's decision-makers can check machine conditions and production key figures, such as OEE (Overall Equipment Effectiveness), in real time. Based on the data, measures can be taken to optimise the production processes.

Success was not long in coming: A few weeks after installing the sensors, the company had considerably increased its efficiency and productivity.

■ Simple order process

The fact that industrial analytics relies on sensor technology from ifm is mainly due to their good search engine presence and the ifm web shop.

Jeremy Theocharis explains: *"At the beginning we compared many suppliers of sensor technology. We ended up in the ifm webshop. I was very enthusiastic about the fact that you could see the prices right away and that you could simply click on "Order" without having to spend ages defining a project. Then we ordered the sensors. Thanks to IO-Link, they were quickly set up, and they work well and provide precise results. Maybe the sensors are a bit more expensive, but they work reliably, and we can simply order sensors at the press of a button in the shop."*

■ Conclusion

"It doesn't matter what industry 4.0 solution you're looking for – without reliable and accurate data, you won't get a satisfactory result," says **Jeremy Theocharis.**

With powerful IO-Link sensors, ifm creates the database which is collected, processed and visualised by means of the factorycube from ia: industrial analytics. This interaction makes it possible to create transparency, improve performance and ultimately reduce production costs.

In Love with Detail

How the PMD Profiler ensures error-free construction of car bodies.

Automation in the automotive industry is closely associated with Henry Ford. His Model T was the first vehicle to be produced on a conveyor belt system – thus paving the way for mass car production. Following in the spirit of its founder, Ford continues to focus on innovative technologies and automation solutions to combine and increase quality and efficiency in vehicle production. This also applies to the plant in Valencia, Spain, where ifm's contour sensor PMD Profiler looks very closely during the production of the Ford Kuga.

In 1903, Henry Ford founded the Ford Motor Company, which is still one of the leading automobile manufacturers today. The European locations are managed from Cologne.

Even back then, Henry Ford recognised the importance of maintaining strict quality assurance standards, using components of the highest quality throughout and with as few deviations as possible to ensure efficient mass production and consistent vehicle quality.

These principles have remained to this day, but car body construction alone is now much more complex and multi-faceted. Quality assurance in modern vehicle production involves many rigorous procedures.

A particular challenge emerged in the production of Ford Kuga, which is manufactured alongside other models at Ford's plants in Valencia, Spain. The actual work step involves welding a small, completely flat reinforcing sheet onto a larger assembly.

"The machine operator inserts a large body shell component into a turntable before placing a smaller metal sheet on top," explains **Mario Eschweiler,** Manufacturing Engineer Bodyside at Ford Europe. He oversaw the corresponding quality assurance project from the German Ford site in Cologne.

"It's important at this stage to be able to reliably recognise whether the smaller metal sheet is positioned correctly or not. Further, you also need to make sure that two or more of the reinforcing sheets have not been

> **The number of errors per thousand was just 0.2 during the first month of regular operation.**

loaded inadvertently. During the next step, the turntable is rotated and a robot welds and removes both components."

■ A task where camera systems give up

Due to this fixed production sequence, a conventional photoelectric distance sensor for presence detection was not an option. The reason: It would not have been possible to install the sensor without it getting in the way of machine operators or robots.

When explaining the selection of suitable solutions, **Eschweiler** says: *"Inductive and mechanical sensors were not suitable for the same reason. Single-sided inductive double sheet detection was ruled out due to the diminutive dimensions of the small part and also the associated positioning capability."*

Further: The diminutive dimensions and the flat surface already posed a demanding challenge. In addition, strongly fluctuating lighting conditions caused by sunlight during the day and artificial light at night made the task even more difficult.

"As initial tests showed, these requirements pushed conventional camera systems to the limits of their capabilities and beyond," explains **Eschweiler**.

During the commissioning phase, the tested camera solutions generated a misreading rate of one percent and over.

"However, the criterion that made use of the camera system impossible was another aspect: We couldn't make sure that only one reinforcing sheet was inserted at a time."

All in all, the perfect challenge for the PMD Profiler from ifm.

The PMD profiler reliably ensures correct usage and assembly of components. To do this the optoelectronic line scanner projects a laser line on the working area that is being tested and determines the height profile by means of the reflected light. If the height profile matches the profile specified during teach-in, the PMD profiler detects a correct assembly If the profile deviates beyond a freely definable tolerance value, the sensor generates an error signal.

With a measuring accuracy of 500µm, the PMD profiler detects even the smallest deviations – and thus also whether the thin reinforcing plate is missing, or if too

> **"** *By using the PMD Profiler, we have been able to solve the task in a technically proficient way, thereby effectively minimising downtime through reliable error detection.*

many of them have been placed. Correct alignment of the component can also be tested by comparing the actual height profile with the specified height profile. The PMD profiler's working precision is matched by its tolerance in terms of its working environment: Immunity to extraneous light, independence of distance and flexibility in positioning of the component along the laser line.

■ A technically robust solution

Both in an initial test setup and during a functional demonstration by ifm's German automotive experts as well as in the actual test phase, which was supervised by

ifm's Spanish subsidiary, the line scanner managed to convince the project participants at Ford.

The result: *"By using the PMD Profiler, we have been able to solve the task in a technically proficient way, thereby effectively minimising downtime through reliable error detection,"* says **Eschweiler**. *"Today, the task is solved excellently during ongoing operation. This point is underlined by the fact that the number of errors per thousand was just 0.2 during the first month of regular operation. It is quite likely that these were real incorrect loads where the Profiler correctly pointed out the incorrect load."*

In order to ensure that, in the end, the quality of the vehicle is right down to the smallest detail, every production step must be carried out precisely.

> "
> *We experienced consistent, competent and personal support from the industry experts of ifm throughout the entire project.*

■ Conclusion

With the PMD profiler, Ford was able to reliably ensure the quality of the manufacturing step.

However, the German project manager attributes that to more than the high performance level of the line scanner alone: *"We experienced consistent, competent and personal support from the industry experts of ifm throughout the entire project – both here in Germany and also on site in Spain. That is also a crucial factor as I see it, which contributed to finding the ideal solution and implementing it successfully."*

The PMD Profiler detects whether the smaller metal sheet is positioned correctly or not.

Spaetzle al dente

Precise control of the cooking process.

Cook the dough in hot water, drain and refresh with cold water, ready. The spaetzle cooker from staedler uses the same method we all know from home but on industrial dimensions, accurately controlled using sensors from ifm – to ensure the product quality remains at a high level.

staedler automation AG is located in Henau, Switzerland and has over 10 years of experience manufacturing systems for process automation.

Among other things, the company staedler automation produces fully automated cooking systems for the food industry. The system illustrated here is for a customer who makes spaetzle, a special southern german pasta.

Lukas Staedler, the CEO of staedler automation AG, explains how the system works: *"You have to imagine a saucepan which is continually on the go. That means the fresh dough is loaded at the beginning of the cooking line and is passed through during a defined period so that at the end you have a product which is cooked to the right degree. Using a defined cooking time we ensure constant product quality."*

The foodstuff which is being cooked is transferred to hot water using a paddle. As there are hardly any mechanical contacts between the machine and the product during the cooking process this minimizes any damage to the product. At the end of the cooking process the

Cooking system type staedler CK1600, manufactured by staedler automation AG. This system will be used to cook spaetzle.

Temperature sensors type TA monitor the required temperature values in the cooker as well as in the cooling bath.

product is transferred quickly over a waterfall edge to the cooling zone. This blanching with cold water stops the product from cooking any further.

"In principle, systems like this can cook anything that floats" emphasizes **Lukas Staedler.** *"In this specific line we process fresh pasta such as ravioli, tortellini or in this case spaetzle. But it could also be cold meats or vegetables. This system reaches a product output of 2.5 tons per hour".*

■ Maintaining the exact temperature

When cooking at home and we see the water starts to boil we know this is the right temperature, however, in industrial cooking processes the temperatures used have to be more accurate. Only in this way is it possible to provide the constant product quality the customer requires.

In this system the temperature is measured at two points providing the most important process values also known as Critical Control Points, in short CCP. One is the temperature of water which is nearly boiling. In this case it has to be exactly 95 °C. The other is the temperature of the cooling bath where the cooking process is stopped.

Two temperature sensors control the heat exchanger ensuring exact temperatures.

For these critical points staedler relies on temperature sensors type TA2502 from ifm. These sensors have a highly accurate, fast response Pt1000-measuring element covering a wide temperature range of -50 … 200 °C. Also the sensors have a high repeatability and long-time stability which are pre-requisites for optimum and stable product quality.

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Basically automation means
more effort but IO-Link provides
a definite added-value.

In the future staedler plans to use the self-monitoring temperature sensors type TCC from ifm to monitor these points. ((Foto 8)) The special feature of this unit: It has two independent measuring elements with opposing temperature characteristics that counteract each other. Deviations in accuracy are thus recognised immediately and signalised by alarm switching signals. They are also clearly visualized via a LED directly on the unit. This simplifies reliable product quality enormously, as between calibration intervals the temperature is safe at all times so long as the sensor does not detect a drift which it then signals. With other industrial temperature sensors deviations in temperature or a drift can occur even a day after calibration has taken place. They are not recognized and only detected during the next calibration. Worst case would be an expensive product recall which would have a negative effect on the manufacturer's reputation.

■ Monitoring CIP-cleaning process with conductivity

After each production charge the system undergoes a CIP-cleaning process. A separate pump is used to rinse the product lines with alkaline and acidic cleaning agents. They are then rinsed with clear water before production is restarted. During this process the ifm conductivity sensor LDL200 plays an important role. Based on precise conductivity measurement it is possible to confirm if the line contains a cleaning agent and at which concentration. According to the measurement values the control system recognizes, for example, if further cleaning agents are to be added or if the pre-, intermediate and final rinsing has taken place. The final stage of the cleaning process is rinsing with clear water. Only when the exact conductivity of the final rinsing water is reached, is the system then released for production. This ensures clear phase separation during the CIP-process.

Simultaneous to the conductivity, LDL200 measures the medium temperature and transfers the values using the communication protocol IO-Link to the control system. This is also used to control the heat exchanger to ensure that it always has sufficient energy to regulate the temperature of the boiling water.

The conductivity sensor LDL200 reliably recognizes if clear water or cleaning detergents from the CIP process are in the lines. Simultaneously it also measures the temperature and transfers both measuring values using IO-Link to the control system.

Pressure sensors type PM use the hydrostatic pressure to detect the level in the cooker and the cooling bath.

■ Level at a glance

The system has two large water tanks: The bath with the hot water and the cooling bath at the end of the process. Pressure sensors are installed at the bottom of each tank. They are used to measure the hydrostatic pressure. The ifm sensors which are used have an ideal pressure range 100 mbar … 2.5 bar. They determine the exact level and are used to regulate it. It is therefore possible to avoid the tank overflowing when it is refilled with water.

■ Detect water supply

Water is lost during the cooking process. One reason being that the product itself, in this case spaetzle, absorbs water, and also water escapes in the form of steam during the cooking process. For those reasons water has to be continuously added.

Lukas Staedler: *"We use the magmeter SM2100 from ifm to regulate the replenishment of fresh water. It continuously measures the flow during the cooking process. This takes place in cooperation with level sensors. When the level sensors signal that the level of the water is decreasing then fresh water is added and the flowmeter determines how much water has been lost, having been absorbed by the product or as steam. Water is also lost during the removal of residual sludge. Used water is drained off and fresh water is added. This takes place during a time factor which is determined by the recipe. Also in this case the SM is used to measure the quantity of water which is to be added."*

The flowmeter also plays an important part during the cleaning process as it monitors the quantity of fresh water used for rinsing. In doing so it provides transparency throughout the entire cooking process.

The magmeter SM2100 is used to detect the current flow velocity as well as the total quantity of the feed water supply. Both values are transferred using IO-Link to the control system.

"" *We are very satisfied with ifm. We have also used ifm in earlier projects.*

■ Position monitoring with inductive sensors

Inductive sensors for position detection are also installed. Even though they are not directly part of the cooking process they have an important monitoring function. The cooling band with which the product is transferred to and from the cooling bath can be lifted out of the bath using a lift for the purpose of being cleaned manually. Two inductive sensors are used for non-contact detection of the top and bottom position. They also ensure that the system can only be restarted if the band is in the correct lower position.

A third inductive sensor is mounted on the slot screen. This is also removed for manual cleaning purposes. The sensor checks if is correctly fitted before production can be resumed.

■ Sensor communication using IO-Link

All sensors are connected to the control system via IO-Link. This digital communication protocol transfers the measuring values to the control system in digital form. This means that measurement errors caused by conversion loss are reliably avoided. However, IO-Link can do more.

Lukas Staedler: *"Each sensor which is a CCP sensor has to be checked on an annual or six-monthly basis. The temperature sensors are placed in a reference tempera-*

The cooling band can be lifted out for cleaning purposes using a pulley. Inductive sensors are used to detect the relevant top and bottom position.

ture liquid and calibrated. We calibrate temperature sensors using IO-Link. With the conductivity sensor LDL we use both process values, temperature and conductivity over a single wire. The flowmeter SM transfers the counter values as well as the current velocity over one output via IO-Link to the control system."

In reply to the question whether IO-Link simplifies automation, **Lukas Staedler** has a clear opinion: *"Basically automation means more effort but IO-Link provides a definite added-value. It is possible to transfer several signal values over one wire. That saves mounting costs. Or if we look at the temperature sensors: Calibration takes place directly on the sensor and not as before using corrective values in the control system. This simplifies programming the controls. All in all the advantages of IO-Link are greater by far."*

After the slot screen has been cleaned manually and returned in place, production can only be resumed after it has been released by the inductive sensor.

■ Conclusion

staedler is convinced by the automation solutions provided by ifm.

Lukas Staedler summarizes: *"We are very satisfied with ifm. We have also used ifm in earlier projects. The reason being that ifm has a comprehensive sensor concept, from inductive sensors, magmeters, temperature sensors, pressure sensors through to conductivity measurement. In short: We can cover all our needs in the system with ifm sensors. A further reason is that the price performance ratio is right. The sensors make sense for this type of system and are also affordable. We will also use ifm for future projects."*

Retrofit your vehicles with collision protection

The 3D camera monitors the rear area of the forklift truck.

Forklift drivers need a high level of concentration when manoeuvring in reverse. The camera-based anti-collision system from ifm, which automatically detects persons and obstacles in the rear area of the vehicle, warns the driver and stops the vehicle, if necessary, provides support. The innovation: Existing vehicles can be easily retrofitted with this plus in safety.

The cold rolling mill Risse + Wilke Kaltband GmbH in Iserlohn produces metal sheets of different thicknesses and qualities. The unmachined steel strips, wound into coils, are repeatedly rolled by means of cold rolls until they have the required material properties. Then saw blades, clutch plates and other metal parts are punched from them.

Heavy forklift trucks transport the coils from the storage location to the rolling stand and back. Enormous masses have to be moved: The forklift trucks and their freight can weigh up to 30 tons. One steel sheet roll alone can weigh more than 12 tons. This means that the trucks' braking distance is quite a bit longer than that of a regular car.

■ Caution when manoeuvring

Particularly when reversing, e.g. after the coil has been picked up from the storage location or the rolling stand, the drivers need to be very cautious to avoid collisions with other forklift trucks or persons when turning into the lane. They do not only have to keep an eye on the rear area of the vehicle, but must also ensure that the carrying ram, with its load swaying from side to side, does not collide with anything.

Florian Rolf, production manager at Risse + Wilke, explains the enormous challenges the drivers have to face: *"The forklift trucks are equipped with aids such as mirrors and cameras. Nevertheless, the drivers must still be fully alert at any time, they must always have 360° vision and monitor their load and where they are going. At the same time they have to be aware of what is happening around them, e.g. colleagues and contractors crossing their path. Otherwise it can easily come to critical situations which we want to avoid."*

For more than 100 years, Risse + Wilke has been based in the western Sauerland region where the traditional steel processing industry goes back a long time.

Special coil forklifts transport loads of several tons. A high level of concentration is required from the drivers due to limited visibility.

The 3D camera of the anti-collision system is mounted at eye level and monitors the rear area of the forklift truck.

■ Collision warning system

In order to avoid such critical situations, the sensor specialist ifm from Essen has developed an automatic collision detection system. By means of a 3D camera, the system permanently monitors the rear of the forklift truck and gives the driver visual and acoustic feedback. Depending on the configuration level, the assistance system can even stop the vehicle, if necessary.

All obstacles are reliably detected. Thanks to a special classification of reflective materials, e.g. reflective vests or clothing, the collision warning for persons can be given priority over other objects. This increases the safety of persons and leaves the driver enough time to slow the truck down and stop in time. This provides maximum safety when manoeuvring.

> **The system is very good at minimising risk. This means that the anti-collision system, which can be integrated very easily, provides maximum safety for all types of mobile machines.**

The driver sees the rear area of the forklift truck on the monitor. Colour-graded frames indicate objects in the path and display further warnings up to an e-stop.

Persons behind the forklift truck are difficult to see for the driver. The anti-collision system helps to avoid critical situations when reversing.

■ Easy retrofitting

ifm offers the anti-collision system as a ready-to-start application package (order no. ZZ1103). The package includes all components to set up a fully functioning collision warning system on a mobile machine, e.g. a forklift, wheel loader, excavator, reach stacker or transport vehicle within a few minutes.

In addition to the camera, the monitor and the controller, the package contains all necessary cables and mounting accessories. This means it can be easily retrofitted on all mobile machines with 24 V on-board system voltage.

Commissioning the system is very easy: After mechanical installation of the system and plug & play wiring, set-up is carried out within a few minutes via the pushbuttons and the colour display of the control unit. Only a few parameters (height and inclination angle of the camera, vehicle width) are required in the intuitive set-up process. Then the system is ready for operation. In contrast to other systems, no PC is required for parameter setting.

Different zones can be defined so that the driver is only warned when it is really necessary. This means that the O3M can be used to its full potential depending on the situation, which helps to reliably prevent accidents. At

Via extended parameter setting, different warning zones can be defined which will trigger certain output signals.

■ Conclusion

Florian Rolf, summary: *"The system is very good at minimising risk. I can use it on forklift trucks to prevent employees from entering the danger zone and to prevent a dangerous situation or risk situation from occurring in the first place."*

This means that the anti-collision system, which can be integrated very easily into existing vehicles, provides maximum safety for all types of mobile machines and supports the daily work of the drivers.

the same time, false alarms are virtually impossible due to the patented PMD time-of-flight technology.

For special requirements, expert settings are available during set-up. Pre-programmed inputs and outputs are available for an additional signal light, buzzers, standby operation or the ready status of the system.

The 3D sensors are suitable for robust applications in indoor and outdoor areas. A high protecting rating and shock and vibration resistance as well as a wide temperature range meet all requirements for use in mobile machines.

To set up the system, the user only needs to measure the height and inclination angle of the camera as well as the vehicle width and enter them in the controller.

Baggage position control and measurement using a 3D sensor

Summer time is peak travel season. During this busy time of the year, maximum efficiency is paramount for airports all over the world. Fast and reliable handling of large amounts of baggage must be ensured to meet the tight flight schedule, with bags sometimes travelling several kilometres between check-in and aircraft. Each delayed flight not only costs nerves and time, but also a lot of money. In a high-speed baggage handling system of the BEUMER Group, 3D sensors from ifm ensure highest levels of efficiency and an error-free performance.

The BEUMER Group is an international manu-facturing leader in intralogistics in the fields of conveying, loading, palletising, packaging, sortation and distribution technology. The BEUMER Group and its group companies and sales agencies provide their customers with high-quality system solutions and an exten-sive customer support network around the globe and across a wide range of industries, including airport baggage handling.

With its autover® Independent Carrier System, the BEUMER Group offers the right solution for the daily baggage handling challenge. On a passive rail system, intelligent transport vehicles called BEUMER autoca® carriers, which are driven by contactless power transmission, transport each item of checked baggage safely to its correct desti-nation. BEUMER autover® is already in use at major air-port hubs such as Dubai, Moscow, Nice, Gdansk and Montreal. With Denver and London Stansted, further hubs will soon be putting the system into operation.

3D safety check for the suitcase roller coaster

"With a throughput of up to 900 items of baggage per hour and transfer point, our system achieves a high handling speed," says BEUMER Group HLC Software Engineer **Michael Baumeister**, who is responsible for constantly improving the BEUMER autover®.

Hundreds of BEUMER autoca® carriers can travel simultaneously at speeds of up to 10 metres per second along the roller coaster-like rail system with its tight curves, steep inclines and declines of up to 18° and long straights to transport the passengers' suitcases, bags and out-of-gauge baggage.

"Each carrier collects a single item of baggage, providing 100% tracking and traceability during transport."

■ Optimal placement of baggage

The second important factor besides reliable tracking is the correct positioning of the baggage items. From check-in, the baggage items are carried by conveyor belt to the BEUMER autover® system. Before being picked up by a BEUMER autoca® carrier, each piece of baggage is detected and measured by an O3D camera positioned above the conveyor belt. The camera operates on the time-of-flight principle. While laser scanners, which rely on a similar principle, use only one pixel for the measurement, the O3D camera has 23,000 pixels arranged in a matrix. In this way, the camera can detect objects and scenes in three dimensions at a glance.

■ Optical detection improves performance of BEUMER autover®

"We use the camera to check compliance with the permitted outer dimensions, that is, length, width and height of the baggage items", says **Baumeister**. "We do this because we can reach physical limits when transporting baggage due to the very high transport speeds, for example in bends. This is why it is important for us to determine the baggage position, e.g. whether a suitcase is in an upright position before it enters our transport system. The O3D camera from ifm allows us to do this very reliably before loading."

If an upright suitcase is detected, the staff in charge at the airport is either advised to bring the suitcase into the correct lying position or the travel behaviour, especially the speed in bends, of the BEUMER autoca® is adjusted preventively due to the expected instability.

ifm's O3D camera convinced Michael Baumeister and his team because of its highly accurate recognition and measurement capabilities, but also because of the potential the image evaluation offers in terms of perspective.

"Theoretically it is also possible to determine the position by means of a light grid", says **Baumeister**. "However, the use of the 3D camera has a decisive advantage. The temporary storage of the captured images helps us in the rare case of a complaint from a passenger or the airport. On the one hand, we can determine to the nearest second when and in what

" *We use the camera to check compliance with the permitted outer dimensions, that is, length, width and height of the baggage items*

condition a piece of baggage was fed into the BEUMER autover®. For this purpose, we also store the dimensions and positions. Another benefit is the easy parameter setting of the camera and the evaluation of the image data using the ifm Vision Assistant, which can display the measured baggage items in various 2D and 3D views. This allows us to analyse warning messages that occur and to continuously improve the control system."

According to **Baumeister**, the optical baggage detection system will be capable of indicating rare scenarios such as extended trolley handles even more reliably in the future.

"This situation hardly ever occurs, as this is already monitored at check-in. But there is still the possibility that the trolley gets jammed in the system, which would cause a delay in the process. We want to avoid even such unlikely scenarios at all costs."

■ Conclusion

With the O3D camera from ifm, the BEUMER Group is able to ensure the correct placement of baggage items at a critical interface – the baggage transfer from the in-feeding conveyor belt to the independent carrier system. The system can then fully harness its high degree of efficiency – to the benefit of the airport operator, the airlines, and the passengers.
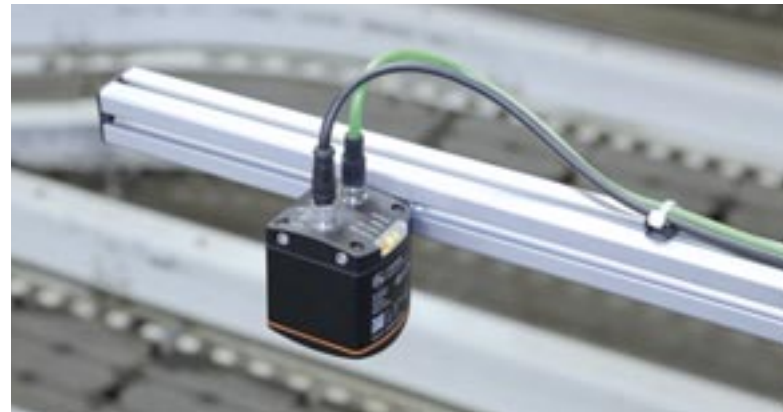
The O3D camera detects the three-dimensional dimensions of the piece of luggage from above.
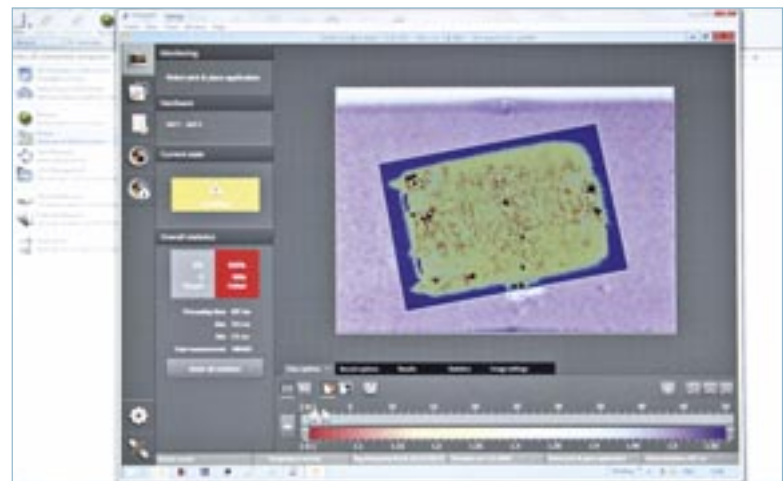
The baggage position can be checked with the ifm Vision Assistant using a 2D image. The camera also provides distance and grey-scale images.

3D inspection: Thanks to 23,000 pixels, baggage items are displayed in three dimensions.

View from the top

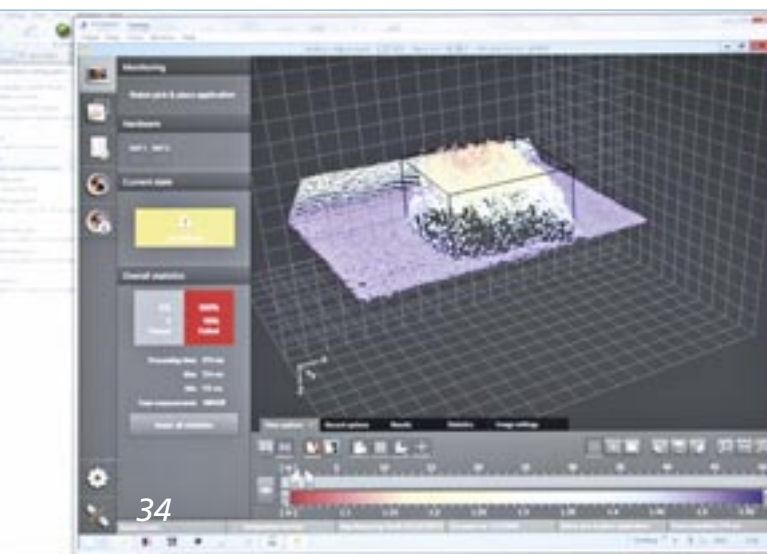Not only vehicles but also the production facilities for the locations worldwide are made at the main plant of the German car manufacturer Opel in Rüsselsheim.

3D camera replaces several sensors
for position monitoring

The automotive manufacturer Opel in Rüsselsheim relies on innovative technology in production. At a welding robot various stamped and deep-drawn metal sheets are welded to form a supporting element of the bodywork. A 3D camera monitors the position and the fixing of the sheet metal parts.

The operator places several prepared sheet metal parts on top of each other so that a welding robot can weld them together at several points to form one piece. Toggle clamps are used to fix the sheet metal parts. They are L-shaped levers which fold down and fix the sheet metal in the equipment from the top.

Usually dozens of sensors are installed at that point to monitor the correct position of the clamps and the presence of the workpieces. Because only if the component is detected as "present" and all clamps have been signalled to be "closed", would the controller release the welding process.

„ *Using the O3D sensor from ifm, we can replace the conventional sensors and detect positions visually.*

The 3D sensor simultaneously monitors several positions.

At Opel people thought about how to optimise this position detection. The idea: The O3D sensor from ifm looks at the scene from above.

Claus Moog, Supervisor Operation Planning, Electric & Commissioning at fixture and plant engineering at Opel in Rüsselsheim: *"In 2017, we considered how to design our tools more cost effectively and efficiently. At first we started with analysing the market of different vision sensors and eventually came across the company ifm. Using their O3D sensor, we can replace the conventional sensors and detect positions visually."*

Several prepared sheet metal plates are welded together to form a subassembly.

" *The use of the O3D sensor provides us with completely new possibilities.*

■ The O3D sensor

ifm's O3D302 vision sensor is a 3D camera with integrated image evaluation. The resolution of the PMD image sensor is 176 by 132 pixels. For each of the 23,232 pixels the sensor supplies a precise distance value – up to 25 times per second. In contrast to laser scanners, the ifm 3D sensor has no moving parts. Therefore, it is especially robust, small and cost effective.

Since the 3D image is evaluated in the sensor, external image evaluation is not needed. The distance between the clamp and the sensor is evaluated via definable positions in the camera image (called ROIs, region of interest). The integrated evaluation detects if the tension lever is "open" or "closed". The events are transferred to the controller using the integrated Ethernet interface via TCP/IP, PROFINET IO or EtherNet/IP. The live camera image can also be provided.

Using the "Vision Assistant" software, the user can easily set the sensor parameters, define ROIs or configure the output function, for example. This software is available both for Windows PCs and for iPads.

The individual components are fixed by means of a clamp in the fixture. Their positions ("open", or, as in this photo, "closed") are monitored by a 3D sensor from the top.

■ Looking down from above

Two of these sensors are installed above the welding system, one in the placement area (component placed), the other in the actual welding area. Both look down from above to the sheet metal to be welded and their clamps in the installation equipment.

Fabian Gulla application engineer for image processing and robotics in plant construction at Opel, explains the function of the sensors, *"We use the sensor for distance measurement. To do so, we have defined several regions of interest which we detect. For once, there is the clamp and its end positions, and then there is the component as such, i.e. present or not present. You could, of course, also detect this using several one-dimensional photoelectric sensors if you align one sensor to each area. The advantage of the O3D is that you only need one sensor and can then redefine ROIs in the software. We have aligned the ROIs to the end positions of the clamps and the workpieces and then we simply use the distance measurement for detection: 'Is a component present' or 'Has the clamp reached its end position?'"*

■ Cost savings

Instead of many sensors only one single 3D sensor simultaneously detects the position at several points in the equipment. Using the O3D vision sensor, approx. 80 % of the conventional sensors can be replaced in this plant.

Claus Moog: *"Usually, 30 to 40 sensors would be installed on the tool. Now we need only 10 sensors for the detection of actuators in concealed installation positions, which the vision sensor cannot detect. That means we could replace a major part of the sensors. We could achieve cost savings amounting to about 20 to 30 %.*

*Welding system in the area
of body-in-white.*

*ifm VisionAssistant for parameter setting
and visualisation of the O3D camera.*

*Free installation space:
No more sensors are required in the area of
the welding tongues and weld spatter.*

Furthermore, we have compared how much power conventional sensors use and how much the O3D consumes. Here again, significant cost savings result."

There are even more saving potentials by reducing cabling, installation accessories and I/O points at the controller.

■ Visualisation

For transparency in the process, Opel have installed a monitor for visualisation in the plant. Besides graphic process visualisation, the O3D can also provide a live image.

Fabian Gulla explains: *"The standard display shows the operator which components are to be placed and if the components are correctly positioned in the tool. Currently, these are graphics that have to be designed and animated by a programmer and are composed of several images. Different markers are added which show the operator which components are still missing and which he still needs to place. Thanks to the live image, the advantage of the ifm sensor is that we have assigned end positions to the clamps and components, which are visualised in the image. The red-green colour change*

symbolises to the operator if a workpiece has been placed and if the clamp is open or closed. This does not mean any more programming work because the sensor parameters have to be set anyway and the live image is provided by the sensor."

■ Space saving

Due to the fact that instead of several sensors, now only one sensor is needed for the detection of several positions and this sensor is installed high above the plant, there are advantages for the construction of the plant.

Claus Moog: *"The use of the O3D sensor provides us with completely new possibilities; for example, we have more construction space and more space for accessibility to welding tongues. Furthermore, we can eliminate the susceptibility to failure of conventional sensors. Since the sensor is installed high above the welding area, weld spatter cannot reach it which would damage it over time as is possible with conventional sensors installed close to the welding tongues."*

> *We believe that the use of vision sensors will establish itself in the future because using the vision sensors we can create artificial intelligence which is not yet possible like this today.*

Visualisation ensures transparency and indicates the operating steps to the operator.
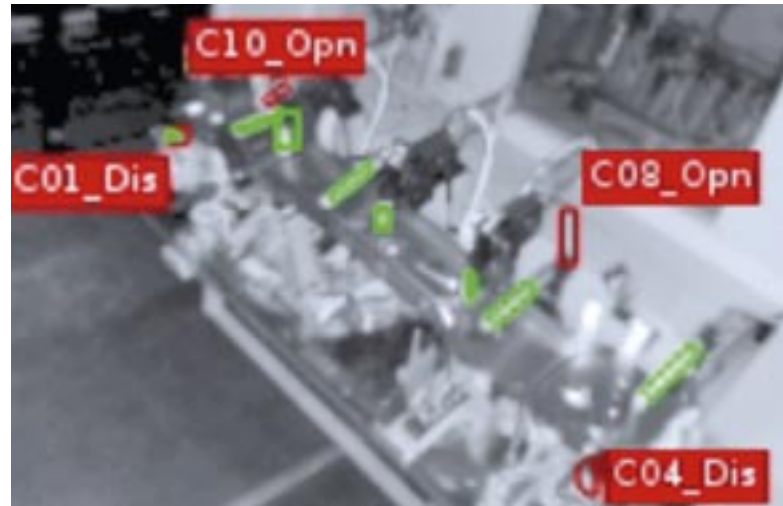
The live image of the 3D sensor with regions of interest marked in colour.

■ Prospects

The experience made in this pioneer plant at Opel is overall positive. This will influence future developments in plant construction.

Claus Moog: *"We believe that the use of vision sensors will establish itself in the future because using the vision sensors we can create artificial intelligence which is not yet possible like this today."*

Fabian Gulla adds, *"In the context of cameras we will be able to make enormous progress. For example, robot grippers and suckers can be made considerably more flexible and therefore considerably more intelligent. However, this does not only concern the subject of cameras but, for example, also technologies such as IO-Link, artificial intelligence, deep learning or machine learning. At any rate, there will be many new things. It is always a question of consideration: What makes sense, what fits my price-performance segment and: Do I generate added value for the company or the application at the end of the day?"*

The O3D vision sensor was introduced in close cooperation with the developers of the vision sensor.

Fabian Gulla: "*The cooperation with ifm is very good. We had several meetings directly with the developers. So we could gain insight into important findings such as 'how does the sensor work?', 'what do I have to note?', 'what size must my clamp be so that it can be reliably detected'?"* .

■ Conclusion

Fewer sensors, simpler plant construction, no interference due to weld spatter – the vision sensor as a monitoring system provides numerous advantages and considerably reduces the plant cost. Other production plants can also be equipped with the vision sensor and thus optimised.

Engine production
without turbulences

GKN Aerospace is one of the world's largest suppliers for the aerospace industry.

Sensors monitor the production process and make maintenance calculable

The Swedish company GKN Aerospace from Trollhättan produces high-precision parts for aircraft engines and for aerospace industries. The machine tools have sensors that ensure maximum transparency and the highest product quality.

GKN Aerospace is the worldwide leading cross-technological supplier of aerospace technology. With 50 production sites in 15 countries, the company supplies over 90 % of the aircraft and engine manufacturers in the world. They develop and manufacture innovative intelligent systems and technologies for aerospace, that are used for example in cargo planes and in the world's largest passenger aircraft. The company also works on space technology. For instance they produced the rocket nozzle of the well known Ariane 5.

Mikael Alm, Industrial IoT Engineer at GKN: "*We produce components for aircraft engines. In my department ND Digital we work on precise machine tools. We monitor our machines with the help of sensors, so that everything works perfectly and nothing unexpected happens. We use different sensors to ensure a flawless production process. For about 3 years we have been using vibration sensors from ifm. They monitor the spindles in our machine tools.*"

*Machine tool for
high-precision metalworking.*

There are various operations in metalworking that are fully automated carried out by computers. Milling heads work their way through the metal with high rotational speeds. Cutting tools create shafts to the micromillimetre and drills place exact drilling holes. This is how high-precision components for aircraft turbines, among others, are manufactured in the shortest amount of time.

Ensuring fault and trouble-free machining of the workpiece is of the utmost priority. This is the only way to continuously guarantee high product quality. Due to the high machining speed and process forces, quickly reacting diagnostic systems are required, that immediately detect damage occurring on the tool or collisions during machining and that stop the process immediately thus preventing damage to the machine and the workpiece. Permanent vibration diagnosis has proven to be the optimum procedure.

■ Minimum unbalances reveal problems

The centrepiece of this system is a highly sensitive and extremely reliable vibration sensor from the sensor specialist ifm electronic, that is mounted directly onto the spindle housing. The vibration sensor of type VSA is a small micromechanical acceleration sensor that continuously detects vibration on non-rotating machine surfaces.

The VSA is so sensitive that it detects even the slightest damage on a milling head that itself only has the size of a millimetre due to occurring unbalance. Changes in the cutting forces that may, for example, be caused by a blunt drill or too much swarf are detected and reported to a diagnostic unit on account of the changed vibration characteristics. At GKN, the evaluation unit VSE100 is from ifm. It processes signals from up to four vibration sensors and can trigger a warning or machine stop in case of a fault. The data is transmitted to the higher-level controller via Ethernet.

Limit values for vibration and collision detection can be stored in the machine controller for each tool and for every step in the process. To determine them in advance, a program cycle is carried out in the teach mode. Individual vibration data and adjustable tolerance values are stored in the controller for each tool. If those values are exceeded during machining, this is interpreted as an error and provides a warning message or stops the machining depending on the amplitude of the vibration.

Another protective function is spindle condition monitoring. Wear on the bearings of the complex spindle mechanics is detected and signalled on the basis of unusual vibration characteristics. This provides the user with additional safety.

For transparency and optimisation: The Smartobserver software collects, visualises and analyses all sensor data.

Constantly listening:
Vibration sensor VSA004 from ifm placed right on the spindle.

Pressure sensors monitor the pressure in the cooling circuit.

■ Further sensors

The evaluation system has two analogue inputs, where additional sensors for monitoring measuring parameters can be integrated. GKN uses countless PN7 pressure sensors to constantly control the pressure in the cooling pipe. A pressure drop could stop the cooling process and damage the tool and workpiece. This is why sensors signal if the operating pressure is too low in a case of fault.

Mikael Alm: "*I work with sensors from ifm since I started working at GKN Aerospace. ifm has a good and broad selection of sensors, so that there is always a solution that suits our requirements.*"

GKN connected all sensors to the central controller via the AS-i bus system. A two-wire flat cable transmits signals from up to 127 sensors with the help of AS-i IO-modules to the AS-i master. Bus wiring significantly reduces the cabling costs and provides a higher flexibility of installation.

■ Evaluation

GKN uses Smartobserver to monitor and analyse the machine condition. This software was especially developed by ifm for condition monitoring of installations.

> **"** *The combined solution of ifm's sensors and software will help us understand and improve our equipment in future as it does now.*

The VSE100 evaluation unit detects the smallest deviations and gives a signal in case of exceeded limit values.

All measured values of the sensors meet here. Next to illustrating all process values and their limits, the software creates for example trend analyses, helping to optimize the production process.

Mikael Alm explains, "*It is very important for us to understand what happens during the production process. Our products are very expensive and we have to be able to make improvements when the processes are not entirely true. We can use the collected data from Smartobserver in our own analysis tool, thus making precise assessments and acting accordingly.*"

The extensive alarm management of the ifm software allows condition-based maintenance of the machines.

Mikael Alm's conclusion is, *"For many years I worked with this type of maintenance and it works the way it is supposed to. The combined solution of ifm's sensors and software will help us understand and improve our equipment in future as it does now. ifm provides excellent customer support which has always helped us finding a solution to our problems."*

The close cooperation with the customer is also reflected in the ifm slogan, "ifm – close to you".

■ Conclusion

With the help of sensors and Smartobserver, machine tools can be monitored automatically and reliably. Faults are detected in time and the maintenance operation is calculable and condition-based. This does not only save costs, but it also ensures maximum availability and the highest product quality.

Reduces wiring: AS-i modules collect sensor data and transfer it to the controller via the 2-wired bus cable.

Automated
tradition

The company **"Leksands Knäckebröd"** was founded in 1920 and has been family-owned since then, today in the 4th generation.

*Typical of Leksands' crisp bread:
the round shape with a hole in the middle.*

Sensors support the crisp bread production in Sweden

What is the most typical Swedish product? It does not take long to give the answer: crisp bread. In the little town of Leksand in Central Sweden, there is Sweden's largest producer of the traditional round crisp bred. Also involved: ifm as the automation specialist.

While the recipes are still the same after about 100 years, the production process is completely different now. Production is automated according to the latest state-of-the-art technology. To ensure that the systems run smoothly, different sensors monitor the production process – from the supply of the ingredients to the dispatch area.

Capacitive sensors detect the flour through the walls of the pipes.

Peter Joon, Managing Director at Leksands Knäckebröd: *"We use many sensors since this is a very modern production and a highly automated process. Since we have a very high productivity of 99.6 %, we need sensors we can trust and which are of high quality. Today we use many sensors from ifm. They are of high quality and function very well with our products."*

Lars Ohlner, Automation Engineer at Leksands Knäckebröd adds, *"We use products from ifm because they are easy to configure and which are cost effective; they simply function reliably. We mainly use photoelectric and*

" Since we have a very high productivity of 99.6 %, we need sensors we can trust and which are of high quality. Today, we are using many sensors from ifm.

capacitive sensors and some flow sensors. This should ensure a high degree of automation, good automation and a reliable process. "

Some particularly innovative sensors as example:

■ Capacitive sensors

The main ingredients of crisp bread are rye meal and finely ground rye and wheat flour. They are supplied to the mixing tools via various pipes. Capacitive sensors monitor the supply at the pipes or the level in the temporary storage tanks. Capacitive sensors are distinguished by detecting different materials, even through the tank wall, unless they are of metal. If a pipe is no longer completely filled with flour, the capacitive sensor detects this state and sends a switching signal to the controller.

Often, several capacitive sensors are used on storage tanks or silos, for example at the very top, to signal a possible overflow in time or at the very bottom of the silo to signal a critical empty state. Potentiometers are used to adjust the sensors after installation. the switch point is adjusted depending on the wall thickness of the pipe and the type of the medium to be detected. The new KI6000 sensors from ifm are to be set particularly precisely. Since they have a unique LED signal display for the perfect switch point setting.

The 12-point LED display makes it much easier for the user to set the optimal switch point, which is in the centre of the display. The green LEDs on either side of the switch point indicate the reliability of the switch point. Deposits, material changes etc. are directly displayed on the sensor and the user can readjust perfectly the switch point as needed. That means that an imminent error can be detected in good time and avoided.

If help is needed with the effects of process changes this is much easier to explain
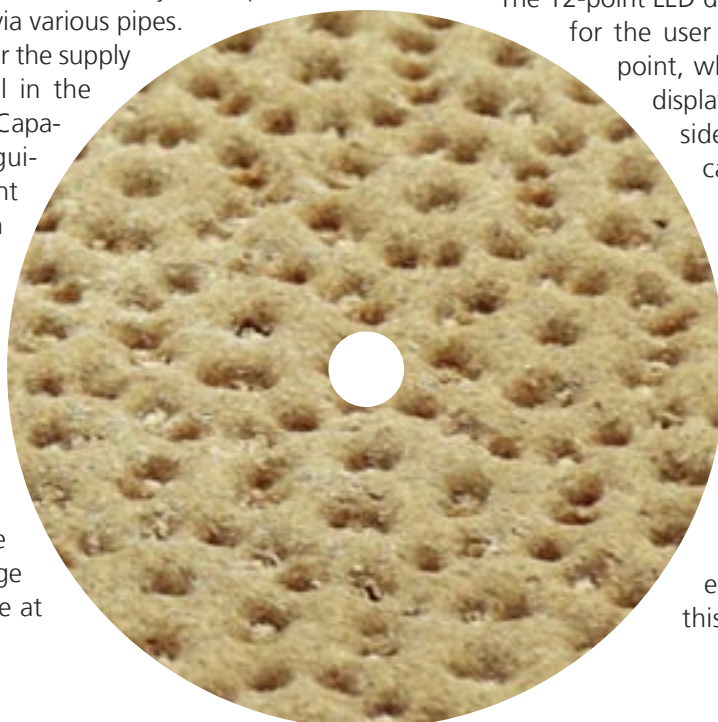
" *ifm is our first choice when it comes to sensors because they have the products we need.*

and rectify with the clear switch-point visualisation. Over the phone the user can describe the LED behaviour and a support engineer can easily advise corrective measures.

By using non-contact potentiometers, the new units have the high protection rating IP 69K and are perfectly suited for medium temperatures up to 110 °C. Moreover, different functions such as PNP/NPN or NC/NO can be selected. The ifm sensors are equipped with IO-Link and prepare the user optimally for Industry 4.0.

■ O6 photoelectric sensor

Diffuse reflection sensors are installed at various places in production. They monitor the flow of material on conveyor belts. These are, for example, individual slices of crisp bread but also completely packed products in the dispatch area.

In most cases, they use the ifm diffuse reflection sensors of type O6 at Lecksands Knäckebröd.

Their optical performance is excellent. They are distinguished by a particularly noise-immune background suppression while the range of up to 200 mm is independent of the object colour. This is important since the crisp bread slices have a different surface depending on the type and recipes.

Even in the event of vapour, dust and highly reflective environments the automatic sensitivity compensation

The ifm O6-series diffuse reflection sensors monitor the flow of material.

guarantees a reliable function. The clean round light spot in the operating area ensures a consistent light distribution in the light cone. Scattered light around the light spot is avoided. The compact O6 WetLine is perfectly sealed. The two setting potentiometers are fitted with a double seal. Front pane and potentiometer are embedded flush to allow residue-free cleaning. These compact powerful units from ifm can also be supplied as through-beam and retro-reflective systems.

The particularly resistant stainless steel housing with protection rating IP 68 / IP 69K ensures reliable use even

Distance measurement for position detection across longer distances: O1D with time of flight technology.

The amount of water for dough production is precisely detected by means of magnetic-inductive flow meters.

under severe conditions and ensures an extremely long life time. The O6 sensors are now also available as versions with IO-Link. Via this interface, the range, sensitivity, light-on / dark-on modes, switching delay or deactivation of the operating elements can, for example, be set remotely.

■ O1D distance sensor

When position detection across longer distances is of importance, the O1D distance sensor is a cost-effective and also very precise problem solver. Thanks to laser beam and time of flight measurement, it provides reliable and precise distance measurement with a long range of up to 10 m. It is ideal for applications with background suppression.

Thanks to the innovative on-chip time-of-flight process with PMD technology, the detection is independent of

100 years of Swedish tradition:
Leksands are Sweden's largest producers of crisp bread.

the object colour or its surface, e.g. mat or shiny. O1D is insensitive to extraneous light up to 100,000 lux and remains unaffected even if direct sunlight hits the sensor or object thus operating reliably and accurately at all times. The user can choose switching outputs, analogue outputs or IO-Link for data provision.

■ MID flow sensor

Besides the grain, water is an elementary part of the crisp bread dough. In the field of dough production, a magnetic-inductive flow meter from ifm is used.

These units feature high accuracy, measurement dynamics and repeatability. They are suited for conductive media as from 20 µS/cm. The 4-digit alphanumeric LED display is highly visible. Besides the volumetric flow, the units also measure temperatures from -10…70 °C. Furthermore, an additional measuring point is no longer needed thanks to the integrated temperature monitoring. The robust compact housing, use of resistant materials and pressure rating up to 16 bar allow flexible use.

Using the IO-technology, process values are not only available via the analogue output but also digitally. Conversion losses during measured value transmission are a thing of the past. Saving all sensor parameters not only allows an easy replacement of sensors but also a simple and quick configuration and remote parameter setting. The user is well prepared for Industry 4.0 with the new IO-Link functionality.

■ Continuing with ifm in the future

At Leksands, they have been using the reliable and long-life sensors from ifm for a long time. No wonder that you can find ifm sensors which are older than 25 years in some places in the plant. Also in the future, they want to tackle new challenges in automation with ifm as their partner.

Peter Joon: *"For the future we have to develop sensors that can perceive the different colours of the bread and their shades. ifm is part of the development of these sensors. We have created a new area which is based mainly on ifm products and which has proved its worth so that we will further develop our future areas with sensors from ifm."*

He concludes, *"ifm is our first choice when it comes to sensors because they have the products we need."*

Automatic machine protection

The Swedish company Scania located in Södertälje near Stockholm is one of the world's largest manufacturers of heavy-duty utility vehicles.

Vibration monitoring protects machine tools

The Swedish vehicle manufacturer Scania is one of the world's largest manufacturers of utility vehicles, buses as well as ship's and industrial engines. The plant in Stockholm produces, among other things, powerful engines for trucks and buses. Sensors are monitoring the automated production.

Sensor technology is used to prevent unplanned production downtime. It constantly monitors the condition of machines and installations. If any limit values are exceeded, the maintenance staff will receive an automatic message or, in critical situations, the machine will even be stopped automatically to avoid any damage.

Robert Bergkvist, automation engineer for IT and automation questions at Scania says, *"We are, for example, using flow and level sensors as well as common inductive sensors to have an overview of our production*

lines. What is more, the sensor data is of very great value to us. It helps us when we make all kinds of decisions concerning maintenance options. The data is also very useful to optimise the processes. What is more, the sensor data is of very great value to us. It helps us when we make all kinds of decisions concerning maintenance options. The data is also very useful to optimise the processes."

■ Diagnostics explained using the example of a machine tool

Scania uses countless machine tools. It seems as if the milling heads were cutting through butter when they work their way through metal blocks while lathe chisels are creating shafts to the nearest millimetre and drills are accurately placing boreholes. All process steps are fully automated and carried out by computer-controlled lathes and milling machines. They create moulds for cylinder heads or shafts for engines in the twinkling of an eye.

To meet the high quality standards, machine tools must guarantee flawless and trouble-free workpiece machining. The high machining speed and the great process forces require quickly responding diagnostic systems that will immediately detect any damage to the tool or any collision in the machining process, so that it will be

> " *We are, for example, using flow and level sensors as well as common inductive sensors to have an overview of our production lines.*

stopped instantly to prevent damage to the machine or the workpiece. Permanent vibration diagnostics has proven to be the ideal solution to reduce damage to a minimum.

■ Tiny fault, dramatic consequences

You can hardly imagine how great the process forces actually are when you see how easily the milling heads cut through the material with extreme rotational speeds. However, the tools are in fact subjected to extreme mechanical stress.

5-axis machine tool to lathe, drill and mill large metal blocks.

Even if their quality is at its best, no operator will be able to prevent that tools will break while they are in use. Even a tiny mechanical defect may have serious consequences if it occurs during the machining process. A broken tooth of a milling head, for example, can damage the workpiece and make it useless. When this happens to a complex workpiece, such as an engine block, the damage may become very expensive. Not only would the expensive workpiece become useless, but the required quantity could no longer be produced. The production process would be severely disrupted.

Micro-mechanical VSA accelerometer for screw mounting in the housing wall of rotating drives.

■ Unusual vibration indicates tool failure

This is why Scania provide their tool machines with an automatic fault detection system. The centrepiece of this system is a highly sensitive and extremely reliable vibration sensor from the sensor specialist ifm electronic.

"We monitor the vibration on the motor spindle, so that we can replace it in time before it breaks. What is more, the diagnostic software shows us the condition of the spindles and whether we need to adapt any process parameters," says **Robert Bergkvist**.

Thanks to the sensor data, the process efficiency can be increased to a maximum without the risk of critical machine conditions like a lathe chisel being driven too fast into the material.

This is where ifm's compact VSA vibration sensor joins in to help. It is firmly screwed into a borehole in the spindle head housing. There, it continuously detects the vibration characteristics during the machining process. The micro-mechanical accelerometer is so sensitive that it will detect even the slightest unbalance caused by a missing tooth on a milling head that itself only has the size of a millimetre. Changes in the cutting forces that may, for example, be caused by a blunt drill or too much swarf will be detected and reported on account of the changed vibration characteristics.

Individual tolerance limits can be assigned to teach tool, for example, warning and a switch-off thresholds. In case of the latter, the rotating tool spindle will be stopped via the command "stop spindle advance", so that the head can be removed from the workpiece. This reliably prevents that the expensive workpiece will be damaged.

■ Collision detection

Another function of vibration monitoring is collision detection. In series production, the entire milling, lathing and drilling process is usually tested by means of a simulation. Program-related collisions between the tool and the workpiece will be detected reliably and considered in the programming. In particular when fabricating individual components, programming flaws may lead to collisions between the tool and the workpiece or machine parts. In this case, the machine will be stopped as quickly as possible to minimise the damage to the machine and the workpiece.

■ Spindle monitoring

Another protective function offered by vibration diagnostics is spindle condition monitoring. The vibration characteristics of the rolling bearing element are measured in a reference run and saved as "good value". If the bearings in the complex spindle mechanics are worn, this will be detected due to unusual vibration characteristics. If configurable tolerances are exceeded, an error message will be given. This guarantees permanent condition monitoring offering the operator additional safety.

■ How does vibration diagnostics work?

ifm's VSA vibration sensor is a micro-mechanical accelerometer. It continuously detects the vibration on non-rotating machine surfaces.

Processes the vibration signals from up to four sensors: the VSE100 evaluation unit.

It is connected to the corresponding VSE evaluation unit. The evaluation unit evaluates the sensor signals of up to four vibration sensors and sends them directly to the machine control system. This ensures easy and stable integration.

Limit values for vibration and collision detection can be stored in the machine controller for each tool. To determine them in advance, a program cycle is carried out in the teach mode. Separate vibration data will be stored in the controller and provided with adjustable tolerance values. Individual limit value setting is possible down to each cut.

Exceeded tolerance values during the machining process are interpreted as a fault and will, depending on amplitude of the vibration, lead to a warning message or even stop the machining process.

■ Conclusion

Tool breakage, collision or bearing damage: process monitoring based on vibration diagnostics cannot prevent them. However, by stopping the machine, the damage will not get worse while additional consequential damage to the workpiece and the machine will be effectively prevented. Permanent vibration diagnostics even detects imminent problems and will notify the maintenance staff with a warning message. This ensures efficient machine capacity utilisation and maximum machine protection.
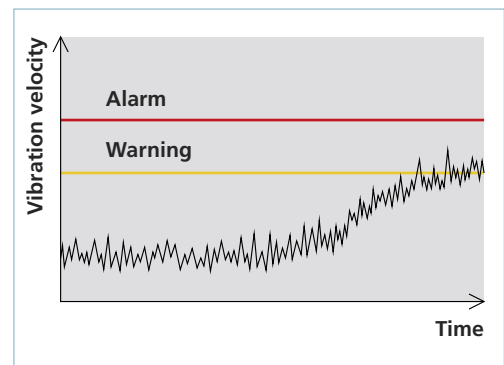
It is possible to set individual warning and switch-off thresholds for each tool.
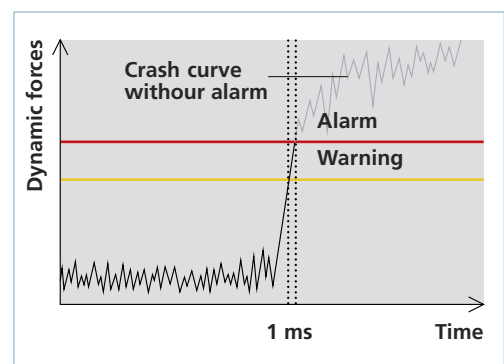
Collisions are detected on the basis of the vibration characteristics within a millisecond. The machining process will be stopped immediately to prevent serious consequential damage.

Flexible sensors
for individual **beer**

IO-Link sensors guarantee an optimum brewing process

A variety of individual beers – this characterises the regional brewery "Skanderborg Bryghus" in the Danish town of Skanderborg. Unlike large commercial breweries, this brewery is largely promoted and operated by beer lovers on a voluntary basis.

The demand was so immense that only three years after its foundation the brewery had to be expanded significantly. On this occasion, modern sensors from ifm were implemented to monitor the numerous tanks.

The regional brewery in Skanderborg, Denmark that is mainly run by beer aficionados working voluntarily offers a wide range of individual beers.

Allan Pedersen, Technical Manager of Skanderborg Bryghus, "present from day one", explains, *"In 2015 our company started with a brewing capacity of 125,000 litres of beer per year. In 2018 and 2019 we significantly expanded the brewery that now has a capacity of 4 million litres per year."*

The large expansion of the plant was carried out by the company GEA.

Kåre Hjortkjær, GEA Denmark, was responsible for the electrical work. *"GEA is an international engineering company. We make process systems for different industries. For this project we developed a completely new*

> **Since the planning phase to the present day ifm has proven a valuable partner.**

*Level sensor LMT from ifm
as overflow prevention at the top of the tank.*

and also monitor level. To do so, we installed several ifm sensors at each tank. The controller visualises how much beer is in the tank and what temperature it has. The many sensors make it possible to run the brewing process automatically so that production can be controlled with a minimum of employees."

Allan Pedersen adds, *"GEA installed more than 300 ifm sensors. We can remotely set, calibrate and monitor them via IO-Link. We are happy that we can use the complete solution of a supplier instead of having to buy components from different manufacturers."*

Most ifm sensors are installed at the numerous tanks. Three types of sensors are used especially frequently.

■ Resistant pressure sensor ensures a smooth process

An ifm pressure sensor, type PI2795, is mounted at the bottom of the tank. The level is determined via the hydrostatic pressure the beer in the tank exerts on the sensor's measuring cell. The measuring range of the sensor is -1 to 4 bar. It is resolved in steps of 0.005 bar. The measured value is transmitted to the plant controller via an analogue signal or IO-Link. Since the tank geometry is known the controller calculates the exact contents in litres from the measured pressure.

The measuring cell is mounted flush in the process connection, especially for use in food applications. This prevents build-up at the measuring point and allows residue-free cleaning, for example, during CIP cleaning. An important feature for the brewery: The sensor is

brewery. It was our responsibility to decide on all sensors to be used in this brewery. There were no requirements for certain product brands from the brewery. The price was, of course, part of the decision. All the factors we considered pointed to ifm. We selected the sensors needed for process monitoring because of their flexibility and focussed on the hygienic design. One requirement, for example, was to detect the level in a tank and to differentiate between beer and CIP liquid. We decided on sensors from ifm because we know the company from many years of good and close cooperation. We measure pressure and temperature at several points in each tank

*Numerous tanks are precisely monitored
for level and temperature.*

,, *GEA installed more than 300 ifm sensors. We can remotely set, calibrate and monitor them via IO-Link.*

designed for medium temperatures up to 80 °C. The sensor housing is made of stainless steel and has the protection rating IP 68 / 69K. Therefore, it is resistant to high-pressure cleaning with aggressive cleaning agents.

■ Intelligent level sensor ensures process reliability

The LMT102 is an electronic point level sensor for hygienic applications. When installed at the lower end of the tank, it signals empty state, when installed in the upper part it is used for overflow prevention. A second function of the sensor: it can differentiate different media. For the brewery this exactly means that the sensor detects if beer or CIP liquid is in the tank. In addition to point level detection, this information adds to the process reliability because a mixture of product and cleaning agents can reliably be excluded.

Especially in the food industry build-up and foam often make a reliable level detection difficult. As opposed to the vibration forks often used, the electronic point level sensor LMT from ifm ignores build-up. In the brewing process this ensures that foam does not affect level detection.

The smooth surface of the PEEK tip does not allow dirt or medium residue to adhere. Furthermore high-quality materials such as stainless steel and PEEK meet all requirements for demanding hygienic areas. Flush sealing is ensured by pressing the measuring probe onto the metal sealing edge of the adapter. This avoids dead space and contamination. Approvals such as EHEDG and 3-A certify the food conformity.

■ Precise temperature sensor for demanding applications

The temperature of the beer is exactly monitored in the upper, middle and lower part of the tank using ifm temperature transmitters of the series TA22 that have a high accuracy over the whole temperature range. Thanks to the good dynamic response they quickly react to temperature changes. These sensors also feature a hygienic design to meet the high requirements in the food and beverage industry.

■ IO-Link – the perfect basis for intelligent control

All sensors used in the brewery feature IO-Link. Advantage: As an alternative to the analogue signal, they also transmit the measured values as digital values. This avoids, for example, inaccuracies which may occur when AD converters are used. In addition, IO-Link allows extensive and easy parameter setting. Thus, the level sensor LMT can be adjusted to different media via IO-Link. For the pressure sensors it is, for example, possible to adjust switch points via the controller. This offers maximum flexibility, for example, when formulas are changed.

Moreover, IO-Link transfers the diagnostic data of the sensors to the controller. The LMT level sensor, for example, signals heavy build-up that prevents a reliable detection or differentiation of media.

Pressure sensors for hydrostatic level detection (left)
and temperature transmitters (right) are used to ensure
*a reliable brewing process.*

Strong partner

Apart from high-performance products, ifm is distinguished by their close contact with customers.

Kåre Hjortkjær from GEA emphasises, "*Since the planning phase to the present day ifm has proven a valuable partner. We know the process and ifm knows their devices, so we can work well together.*"

Allan Pedersen from Skanderborg Bryghus sums up the cooperation, "*I have been working with ifm since 1999 and I am very satisfied. We get support on site at all times and inspirations to implement our applications easily and reliably.*"

Conclusion

ifm offers a wide range of powerful sensors to monitor the processes in the brewery reliably and at low cost. IO-Link sensors not only offer a maximum of automation and safety but also an optimum product quality.
Both OEMs and customers appreciate the particularly close contact with customers according to the slogan "ifm – close to you!"
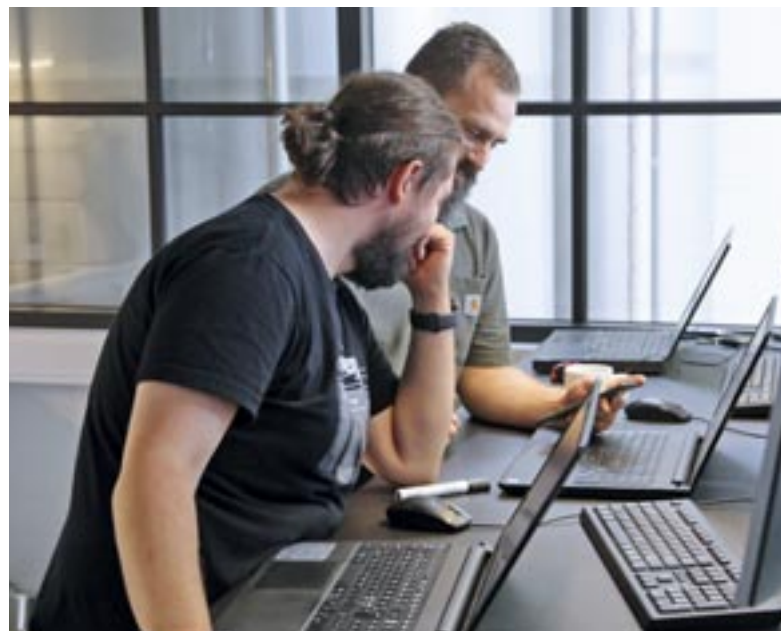
Thanks to IO-Link measured values are reliably monitored at the control desk. Parameter setting and diagnostics of each sensor are also centralised.

Cleaning machine 4.0

Industrial parts cleaning digitised down to the sensor level

For the digitisation of their industrial cleaning machines, the French company Mecanolav counts on ifm. By connecting intelligent IO-Link sensors with the Smart-observer software, Mecanolav has become the first company to offer cleaning machines on the market that are fit for Industry 4.0.

The data is collected by IO-Link masters, stored and visualised using the Smart-observer software. This is how monitoring and maintenance can be ensured for each connected machine around the globe.

The family-owned company from the French Normandy makes washing systems to clean machined workpieces for the automotive and aviation industries.

Mecanolav is a family-owned company from Normandy. The company was founded in 1924 and today has about 40 employees. It produces cleaning machines for mechanical components that are used in the automotive and aviation industries. As a rule, the workpieces are washed and dried in the cleaning machine within 30 seconds after mechanical processing, e.g. pressing.

Various sensors are used in the system, especially pressure, flow, level and temperature sensors. In addition, laser sensors are used to detect the position of the components. Their common feature is that all sensors allow digital communication via IO-Link.

Managing Director **Matthieu Vollois**: *"Most of the sensors we use are in fact from ifm. We have chosen to digitise our machines because this is the road to the future. Industry 4.0 is coming, and we want to be the first on the market to offer fully connected cleaning machines."*

> *Industry 4.0 is coming, and we want to be the first on the market to offer fully connected cleaning machines.*

■ The individual processes at a glance

The level in the water tank is controlled with an LR2050 level sensor. It features a probe and detects the level by means of guided wave radar. Four switch points are programmed via IO-Link. Two of them detect the high and low levels. The third, upper switch point serves as over-fill protection. The fourth, lower switching point serves as run-dry protection. It protects the suction mechanism of the wash pump and also ensures that the heating unit is constantly below the water surface.

The water temperature is controlled and monitored by a TA2437 temperature sensor. The target value is 60 °C. If the temperature drops below 45 °C due to a malfunction of the heating unit, a switch-off will occur as the cleaning agent will no longer be effective.

While the machine is running, water is pumped out with a pump and filtered with a bag filter. A PN7094 pressure sensor behind the filter checks the filter for contamination. The target value is 5 bar. At 3.5 bar a warning alarm is triggered, and at 3 bar the alarm is triggered.

During rinsing of the metal parts, an SM9000 flow meter controls the flow rate required for cleaning. To ensure optimum cleaning of the workpieces, a flow rate of 150 l/min is necessary. The SM9000 flow meter also features a total quantity meter and measures the medium temperature. The water circuits are controlled via valves. Behind each valve, a PN7094 pressure sensor ensures the correct water pressure (5 bar).

In both drying circuits the air flow is monitored with an SD2000 air meter. For the workpiece to dry completely, the flow rate must be 250 m3/h.

When lifting the part to be cleaned at the beginning of the cleaning cycle and lowering it at the end of the cycle, an O5D100 laser sensor detects the presence of the part carrier.

In addition, an IO-Link DV2510 light tower clearly indicates the machine and alarm state.

■ Vibration analysis

Four VSA001 acceleration sensors in combination with the VSE002 diagnostic electronics monitor the rotating elements of the cleaning machine for wear and malfunctions. These include the wash pump, the rotary engine of the mechanical ramp, the fan for the extraction of vapours and the servo motor. Early detection of imminent mechanical damage to the bearings enables condition-based maintenance. Unplanned failures are reliably avoided.

The airflow used for drying is measured using the SD2000.

IO-Link

■ Head start with IO-Link

Today IO-Link sensors offer completely new options. For example, additional sensor data is generated to achieve maximum efficiency and cost savings. This allows process transparency from the machine to ERP to optimise your existing automation. Furthermore IO-Link has a lot more to offer:

"
We need a good service and good support.
We receive this support from ifm.

The entire measured value transmission is digital. Transmission that is prone to errors and conversion of analogue signals is replaced. The digitally transmitted measured values can be directly displayed in the control room.

IO-Link data transfer is based on a 24 V signal and is therefore extremely insensitive to external influence. IO-Link sensors are connected with standard M12 connectors. Screened cables and associated grounding are no longer necessary.

The IO-Link master saves all parameters of the connected sensors. After replacement the previous parameters are automatically written to the new sensor. It is no longer necessary to look up the required sensor settings.

IO-Link ensures unambiguous device identification. Sensors with IO-Link capability are clearly identified by vendor and device ID. Exclusive use of original spares is ensured.

The standardised parameter setting allows locking of the operating keys on the device. This rules out any chance of values being incorrectly set. Documentation of the parameters is possible at any time.

With IO-Link, the transfer of process and service data takes place simultaneously. Wire-break or short-circuit is immediately detected by the master. The diagnostic data can be accessed even during operation.

No additional analogue cards are required for the controller. Space is saved in the control cabinet since the IO-Link I/O modules rated IP 67 are located outside the cabinet.

Mecanolav relies on the AL1102 IO-Link masters with Profinet and eight ports and the AL2330 IO-Link I/O modules from ifm.

The SD9000 from ifm
monitors flow and temperature
of the cleaning liquid.

All sensors and actuators communicate
with the controller via IO-Link modules.

> ❝ *ifm offers Mecanolav a complete solution ranging from intelligent sensors to the collection of data that is made available via the Smartobserver.*

■ Production data acquisition with the Smartobserver

The ifm software Smartobserver is used to monitor and analyse all sensor data.

Michel Astier, Sales Manager for the automotive industry: „*ifm offers Mecanolav a complete solution ranging from intelligent sensors to the collection of data that is made available via the Smartobserver. The Smartobserver is used to visualise all sensors and actuators on the machine, which makes maintenance a lot easier. Moreover, we can visualise this data anywhere around the globe using a web browser, no matter where the machine is actually located.*"

The Smartobserver also offers the corresponding tools for condition-based maintenance, in this case vibration monitoring.

■ Conclusion

Digital communication down to the sensor level in combination with powerful software for analysis and visualisation forms the basis for the digital factory and Industry 4.0. Mecanolav has followed this path successfully with the support of automation specialist ifm.

Mecanolav Managing Director Matthieu Vollois: *"ifm is not only a very innovative, but also a very reliable company, which is particularly important to us. With ifm we not only have support in France, but also in the whole world. We need a good service and good support. We receive this support from ifm."*

ifm – close to you!

How *Champagne* automatically becomes a quality product

The robot's 3D sensors allow for independent work in the vineyards

Before the exquisite grapes are harvested and used to produce a fine Champagne, the vines need to be cared for over the course of several months. An autonomously driving robot relieves the winemakers of this work. Eight electronic "eyes" in form of 3D cameras ensure an autonomous navigation through the vineyards.

The young company Vitibot in Champagne (France) makes self-driving robots to work in vineyards.

A vineyard somewhere in the Champagne region in France: as if by magic, the four-wheeled robot rolls along the rows of vines systematically, makes a turn at the end of each line and starts working on the next row.

"Bakus" is the name of this autonomously driving vehicle, developed and manufactured by the relatively young company Vitibot in the French city of Reims. Founder Cédric Bache is not only an engineer, but also the son of a winemaker. Thus he precisely knows the challenges which modern viticulture must face. Enough reason for him to found the company Vitibot in 2016.

The goal: coming up with solutions together with a team of 50 people to automatise most of the work in the vineyards. The result after two years of development is now the autonomously driving robot "Bakus", ready for series production.

It is a moving "Tooling platform".

After two years of development and tests, the first autonomously driving robots are now ready for series production.

Automatised working on the vineyard:
the "Bakus" of the French company Vitibot.

Jocelyn Vermillet, Senior Manager for mechanics at Vitibot: *"The machine meets the requirements of our customers, the winemakers, who want to automatise all tasks in the vineyard. We produce everything ourselves, from body to chassis, drive, controller on to machining tools. With this stand-alone solution, the winemaker can act a lot more flexibly and can take care of tasks automatically (which used to be carried out by hand and be very time-consuming) during the day as well as by night."*

Various tools are attached to the vehicle which take care of different tasks on the field like loosening earth, cutting leaves and weeds and spraying the plants.

"Bakus is capable of precisely spraying the plants at the right spot with exactly the right dose. We can thereby cut the amount of pesticides by half. This does not only save money but also preserves the environment," says **Jocelyn Vermillet**.

For various types of work,
tools can be mounted below the vehicle.
Here: hooks for loosening the ground.

" *We wanted a solution that would work reliably by day and night. That is why we decided for the 3D cameras from ifm.*

> **In cooperation with ifm we found
> a solution that meets our needs.**

■ Powerful performance

The electrically powered robot takes its energy from bat-
teries with a capacity of 80 kWh. This enables 10 hours
of autonomous work, before the battery needs to be
charged again for two hours. Its all-wheel drive and the
four big, individually driven and steered wheels provide
for maximum agility even on rough terrain, while at the
same time they enable turning manoeuvres where space
is restricted. Even steep slopes with a 45 % gradient pose
no problem to the Bakus.

Cédric Bache is the founder and Managing Director
of Vitibot: *"This machine is special in the way that it's not
just electrically powered, but also drives completely auto-
nomously. It is placed by the winemaker at a corner of
the vineyard and runs through the entire field on its own.
Bakus follows the vine rows and as soon as it reaches the
end, it lifts its tools and starts working on the next row."*

■ Autonomous navigation

What makes Bakus unique is its autonomous navigation
and obstacle detection. The vehicle is equipped with
eight precise 3D cameras from ifm: two cameras at the
front, back and on the sides.

Cédric Bache explains, *"The 3D cameras use time of
flight technology and can capture the surroundings in
three dimensions. With the software developed by our-
selves we can depict the surroundings around the vehicle
via the transferred image data. The software offers two
functions: on the one hand, it enables an autonomous
navigation through the rows of the vines and on the
other hand, we can detect obstacles and stop the vehicle
in time. In order to navigate our machine safely, we need
sensors that can "see" by day and by night. We have
experimented with LIDAR-based systems, but they came
with a lot of restrictions. Other solutions were too
expensive to bring on the market. We have also tested
solutions on the basis of standard cameras. However, this
also proved to have difficulties: during the day with too
much brightness, during the night with too little light. We
wanted a solution that would work reliably by day and
night. That is why we decided for the 3D cameras from
ifm. Their image sensor transmits a clear 3D image of the
surroundings no matter what the light conditions are."*

*Autonomous turning manoeuvre: thanks to several 3D cameras
potential obstacles are avoided and the Vitibot can drive
through the rows with the vines perfectly centred below the
vehicle.*
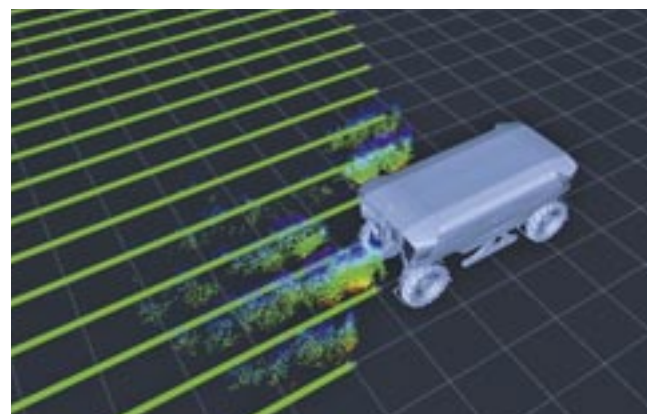
*The software puts the point cloud images from the eight
cameras together into a three dimensional image of the environ-
ment. This serves the robot to navigate autonomously through
the fields.*

The "eyes" of the robot:
PMD cameras from ifm generate a 3D image of their
surroundings thanks to time of flight technology.

■ The 3D camera from ifm

The core element of this system is the 3D camera chip from the automation specialist ifm. It creates a 3D image using PMD technology (= photonic mixer device). The resolution of the PMD image sensor is 176 by 132 pixels. For each of the 23,232 pixels the camera supplies a precise distance value – up to 25 times per second. Compared to laser scanners, the ifm 3D camera does not need moveable parts. Therefore, it is especially robust, small, light and cost effective.

With the PMD technology used, the image sensor can work without being influenced by ambient light. Advantage: despite direct sunlight or complete darkness, the camera generates its 3D image.

■ 3D image evaluated by software

Centrepiece of the Bakus is without doubt the evaluation algorithm, which generates a 360° 3D scenery out of the eight 3D camera images.

Damien Legrand, Product Manager 3D Vision at ifm: *"Every camera generates a three dimensional point cloud of the scenery in its vision. Complex algorithms create a virtual image of the scenery out of these point clouds, which depicts the direct surroundings around the vehicle,* *for instance vines or other objects. This image is then used for the autonomous navigation of the vehicle between the rows of vines and the turning manoeuvre at the end of each row."*

Vitibot Managing Director Cédric Bache adds, *"It was a real challenge to put the 3D images together. In cooperation with ifm we found a solution that meets our needs."*

■ Conclusion

Autonomous vehicles in viticulture do not only relieve the winemakers of work, they also ensure highest product quality with minimal use of resources, e.g. when it comes to spraying the plants. Additionally, the winemaker can let the vehicle run independently at night without needing a supervising worker. As a result, the winemaker can make a large financial profit by using a robot like this, as he lowers the operating costs for most of the mechanical work on a vine by three quarters.

ifm is contributing by providing 3D cameras, which are essentially the "sensory organs" of the robot. By the way, the close cooperation with the customer is reflected in the ifm slogan "close to you".

Robust
PLC
for field applications

The Danish company Agrometer produces pump vehicles used for spreading liquids and substances on agricultural land. The units are controlled by a powerful mobile controller from ifm.

Agrometer was founded in Grindsted in 1977 and is a global supplier for business divisions such as agriculture, the public sector, industry and shipyards.

Many farmers use the slurry produced by their animals as a fertiliser for crop production. However, the average slurry vehicle with slurry tank is at best suitable for small fields.

The Danish company Agrometer headquartered in Grindsted develops solutions that allow quick, cost-effective and soil-friendly spreading of natural fertilisers even on large fields. A hose is used to transport the slurry from a central location to the fields. For this purpose, special vehicles are equipped with a huge hose reel. The electro-hydraulically powered reel unwinds and rewinds the hose as needed while driving across the field. When changing the direction, for example at the end of the field, a guide arm positions the hose in an even radius.

> **"** *So we scoured the market for technologies that could withstand the harsh requirements of mobile applications. We came across ifm.*

The self-propelled slurry spreader SDS 8000 can spread up to 200 tons of slurry per hour via the hose.

The umbilical injector SRS 1500 is pulled over the field by a tractor to spread slurry.

The performance is remarkable: Up to 200 tons of slurry can be spread per hour. The advantage: As no slurry tank is required on the vehicle, the vehicle weight is reduced. This reduces the soil pressure to a value lower than a footprint. The low self-weight means the farmers can enter their fields early in the year when the soil is still soft. The fertiliser is pumped directly to the machine via pipes and hoses, removing smell issues from the roads. Agrometer builds these slurry spreaders as independent vehicles with a spreading width of up to 30 metres or as trailers for tractors called umbilical injectors.

■ Central PLC for machine control

Both variants combined: The important functions, such as the coiling of the hose, are controlled automatically by a central PLC. A large number of sensors is used to monitor the movement of the hose guide arm and other positioning tasks, which are signalled to the controller via decentralised IO modules. Sensors also monitor the pressure in the slurry pipes or temperature values.

Oluf Kristensen, Technical Manager at Agrometer, explains, *"For our machines, we use the new mobile controllers as well as decentralised IO modules from ifm. They simplify the wiring and maintenance of the machines, which can be set up faster. When developing the machines, we primarily work with the system integrator Pagaard. They supplied us with the complete ifm system and developed the software. Pagaard is also our service partner for error-handling."*

The system integrator Pagaard relies on ifm's "ecomat-Controller", which is specifically designed for use in mobile machines.

,,
For our machines, we use the new mobile controllers as well as decentralised I/O modules from ifm.

Robust decentralised I/O modules receive sensor signals and transmit them to the PLC via CAN bus.

ifm's ecomatController for mobile applications (bottom right) is mounted in the control cabinet outside the vehicle.

Pagaard's Managing Director and co-owner Torben Lund explains the decision to use ifm, *"Initially, we were using an industrial PLC at Agrometer. But we soon realised that the durability of industrial products used on mobile machines is a huge challenge, as they are not designed for such purposes. So we scoured the market for technologies that could withstand the harsh requirements of mobile applications. We came across ifm where we had already bought sensors. ifm offers a controller we believe is best suited for this task."*

■ Designed for extreme operating conditions

For many decades, ifm has been one of the leading suppliers of robust control systems for mobile use, offering extensive application know-how in this field.
The "ecomat" series comprises PLCs, IO modules and sensors that can withstand the harsh environmental influences of mobile applications.

Slurry, water, permanent condensation or dirt are no problem for the ifm systems for mobile applications. The special mechanical design of the housing and a reliable sealing concept prevent the penetration of moisture. Suitable connectors and connection cables ensure that protection rating IP 69K does not end at the housing connections.

Extreme weather conditions with iciness or blazing heat: The wide temperature range of the control components from ifm allows use in all climatic zones. All sensors and controllers must prove their resistance in cyclical temperature shock tests. Resistant housing materials ensure that salt deposits, as they may be caused by grit in winter, do not affect the products.

Where the going gets tough, the material is exposed to permanent vibrations or extreme impact. This is why the sensors for mobile applications are fully potted. Connectors are protected against unintended loosening by a special vibration protection. The mechanical design of controllers and modules is especially rated for permanent shock and vibration.

The complex electronics is protected against electromagnetic interference as detailed EMC tests have shown. Conducted interference is reliably filtered out and cannot affect the controllers. This ensures that the data exchange via the CAN interfaces functions reliably even under most adverse conditions such as in outdoor applications of transport and logistics.

Pagaard Software Engineer **Michael Lindbjerg** explains, *"The voltage of a mobile machine fluctuates strongly. An industrial PLC is not designed for this. A PLC for mobile applications is better suited as it operates with a wide voltage range between 8 and 32 volts."*

The yellow guide arm places the supply hose of up to several hundred metres in length on the field in the form of curves, ensuring that the hose is coiled correctly on the drum.

In addition, all ecomat components have an e1 type approval by the German Federal Motor Transport Authority. This allows installation of the units on vehicles without invalidating their operating permit. Beyond the required EMC limit value of the e1 type approval all units have an extended EMC resistance of 100 V/m and withstand pulses from the on-board vehicle supply system without problems.

■ Powerful controller

The ecomatController CR721S used at Agrometer consists of two internal PLC units, one of them certified for safety-related applications up to EN 13849 PL d and EN 62061 SIL cl2. The advantage of this double PLC: Two internal, independently programmable controllers allow for subdivision of the application software if required. Consequently, the safe program part can be executed without interference from the general program execution. Powerful 32-bit multi-core processors ensure fast program execution even with complex control tasks.

The ecomatController CR721S features 68 multifunctional inputs and outputs.

Pagaard Software Engineer **Michael Lindbjerg** explains the benefits, *"All inputs can be configured as digital, analogue or frequency inputs. We used to have problems with the monitoring of our outputs, which were purely digital in the industry, but the ifm controllers have PWM outputs. This is an important feature in the mobile world, for example for controlling hydraulic valves with pulse-width modulated outputs."*

In mobile machines and equipment most functions are carried out by hydraulic systems. Electronic valve and pump control has become a standard in modern machines. ifm's ecomatmobile system provides current-controlled PWM outputs and optimised control functions for the power outputs. This leads to a manufacturer-independent interface between hydraulics and electronics.

■ Conclusion

The mobile controllers from ifm ensure ultimate reliability and a powerful performance even in challenging operating conditions. Thanks to their versatile connectivity and functions, they offer maximum flexibility. With this robust PLC, ifm guarantees the quality that is indispensable for harsh mobile applications. ifm – close to you!

A powerful controller
for automated pipe cleaning

Automation technology for municipal vehicles

Sensors and control components used in municipal vehicles must meet the highest of demands: Their components are exposed to extreme temperatures, humidity, dust, dirt and vibrations. With the "ecomat*mobile*" series, ifm offers automation components for these harsh environmental conditions. The company Bucher Municipal uses the ecomat*mobile* products for its sewer cleaning vehicles.
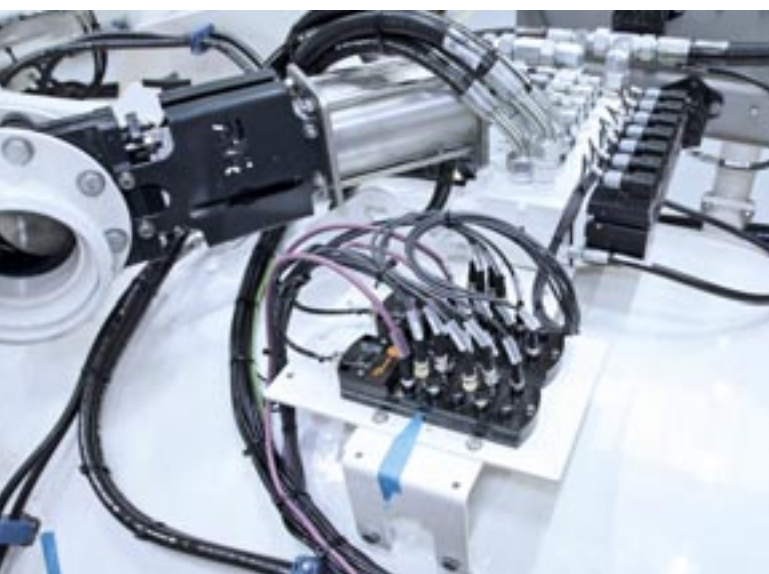
Decentralised CAN I/O modules outside the vehicle connect the sensors and actuators to the controller.

Bucher Municipal is a global supplier of special vehicles such as refuse collection vehicles, sweepers and winter maintenance equipment. In the Danish city of Silkeborg, at the Competence Center Special Vehicles (CCSV), among others the company manufactures sewer cleaning vehicles.

Brian Munk Andersen, Technology Director at Bucher Municipal in Denmark, explains the structure and function of this vehicle type, *"Sewer cleaning units from Bucher Municipal feature two pump systems. The jetting pump cleans sewers and tanks. With the vacuum pump, we can suck sludge and industrial waste into the tank mounted on the vehicle."*

With two ifm control units for mobile applications installed outside the vehicle, the vehicle operator can perform a variety of work steps: rotate the boom, unwind and rewind the hose, switch the pumps or empty the sewage water tank. The displays of the dialogue modules show the relevant system parameters and process values and

A sewer cleaning vehicle with the uncoiled jetting and suction pump for sewer cleaning.

Bucher Municipal is a division of Bucher Industries AG, a global leading technology group in special fields of mechanical and vehicle engineering.

assist the user in performing the work steps. A control unit inside the vehicle – also supplied by ifm – ensures that the individual processes run smoothly.

"*The intelligent control of our sewer cleaning vehicles ensures efficient processes and enables maximum focus on the task, guaranteeing the highest possible added value for our end users,*" says Andersen.

ifm as a partner

For several years now, the automation specialist ifm has been supporting Bucher Municipal as a partner for sensor components and control technology.

Brian Munk Andersen: *"At Bucher Municipal, we have a constant focus on innovation and development. That's why we use automated and intelligent solutions. When we entered into a cooperation with ifm in 2016, we were looking for a reliable supplier of control solutions. ifm offers a wide range of components for our* product – from sensors to displays and IO systems to controllers. Throughout the development phase, we worked closely with ifm to develop a solution and choose the ideal products. Our vehicles have to operate reliably in very varied conditions such as cold, heat, dust and dirt. This places particularly high demands on the components. Together with ifm, we have created a good and reliable solution with many automated features that offers the operator high quality and safety standards when our machines are on the road."*

The central components in detail

The core element of the system is the ecomatController CR711S, an extremely robust PLC for mobile applications. What makes it so special is that is has two independent internal PLCs – one of them a certified safety controller. Powerful integrated multi-core processors allow even complex control functions to be processed

" *Together with ifm,
we have created a good
and reliable solution with
many automated features.*

quickly. The application programs can be divided between the two internal PLCs if necessary. Consequently, the safe program part can be executed without interference from the general program execution. This ensures reliable operation even with complex control functions. The controller can be used in safety-related applications up to ISO 13849 PL d and IEC 62061 SIL CL 2.

In addition to its many multifunctional inputs and outputs with diagnostic capabilities, the ecomatController features two Ethernet ports and four CAN interfaces. The CAN interfaces support all important bus protocols (CANopen, CANopen Safety and J1939) as well as the transparent and preprocessed data exchange.

The control functions are easily integrated into the application program thanks to CODESYS programming (version 3.5).

At Bucher, the controller is additionally connected to a GSM radio module.

Brian Munk Andersen: *"In many cases, our remote connection allows us to solve issues while the vehicle is still on the road. This saves our customers a lot of time. Only in cases where remote troubleshooting is not possible the municipal vehicle needs to be checked at one of our many service centres."*

The BasicDisplay CR0451 indicates the most important parameters on the control panel.

The core element at the top right of the control cabinet: the powerful ecomatController CR711S with two integrated PLCs (1x standard, 1x safety).

■ I/O modules

Various sensors and actuators are installed on the sewer cleaning vehicle to monitor and control the different work steps and process values. Using decentralised I/O modules, they communicate with the controller via CAN bus.

Brian Munk Andersen explains the benefit: *"With CAN units installed at different positions on the truck, we reduce wiring and also achieve greater reliability and an easier operation of the equipment."*

The type CR2032 control modules each have 16 ports that can be configured multifunctionally, for example as digital inputs or outputs or as PWM outputs for controlling proportional valves. A controller integrated in the modules enables decentralised evaluation of the sensor signals in advance.

This pre-filtering of the data not only reduces the data flow on the CAN bus to the controller, but also simplifies the application program on the PLC.

The robust metal housing is designed specifically for the harsh outdoor use of mobile machines and offers protection rating IP 67 for high ingress resistance of the connectors.

■ Dialogue modules

A range of displays for mobile applications are mounted outside the vehicle as human-machine interfaces.

Brian Munk Andersen: *"On the large display in the main cabinet, the operator can control the entire system and make the basic settings. After this, the system can be operated via the remote control or the operating panels."*

Dialogue modules are programmable graphic displays for controlling, parameter setting and operation of mobile machines and installations. They can be used in conjunction with a mobile controller or as a stand-alone solution. Data and device functions are safely transferred via CAN interfaces. The displays feature many freely programmable backlit function keys. The units offer increased EMC levels and an e1 type approval for operation on public roads. Thanks to the high protection rating of the housing, the modules are suited for outside panel and surface mounting as well as for cabin installation. Just like the other ifm components for mobile applications, the displays are vibration resistant and have protection rating IP 67.

■ Conclusion

ifm offers a comprehensive portfolio of products for efficient and reliable automation of functional units on municipal vehicles.

Brian Munk Andersen concludes: *"With ifm's solution, we can create a highly automated system that offers us superior reliability and makes the lives of those operating our equipment a lot easier."*

ifm – close to you!
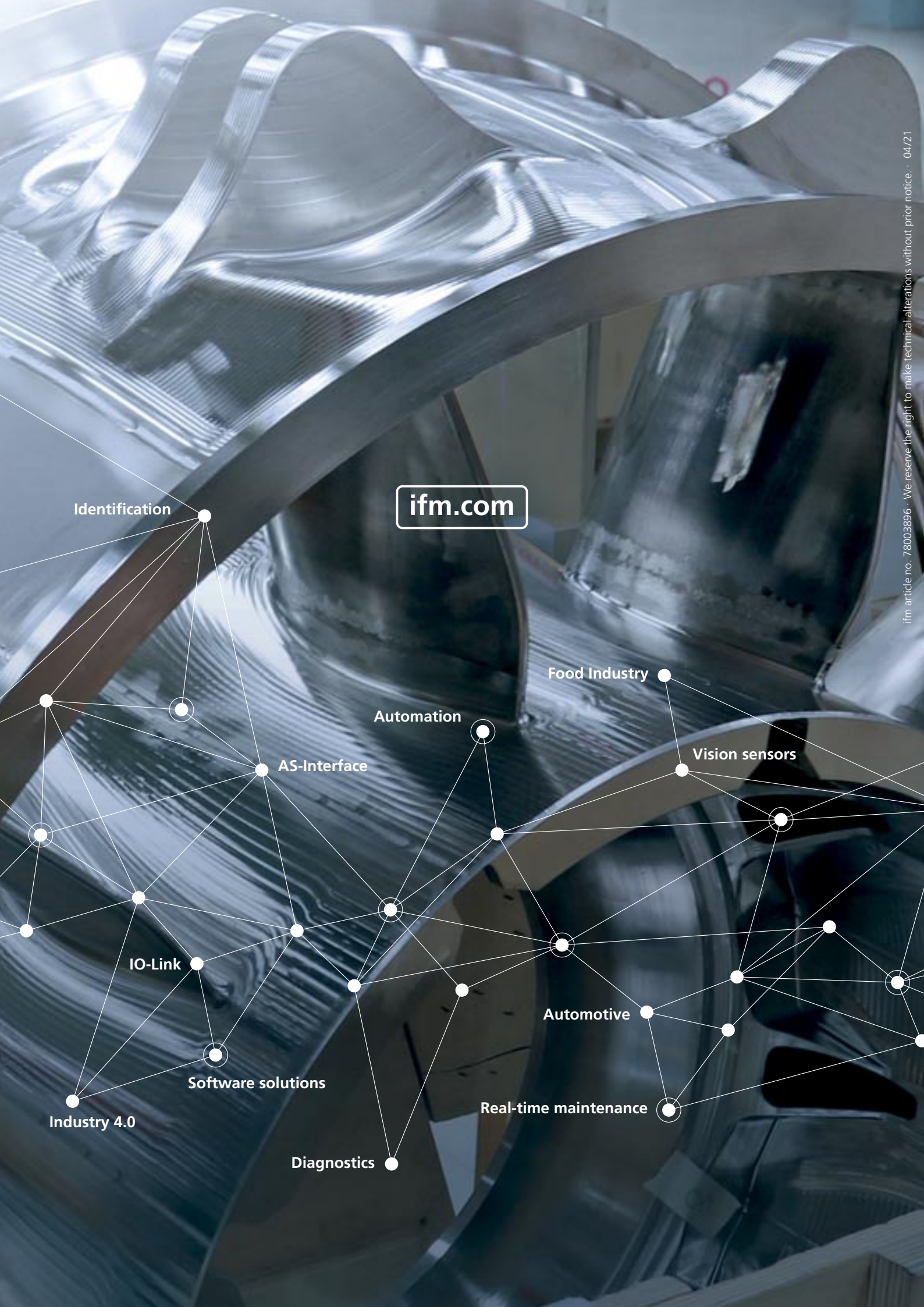
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