Sensor technology heralds an exciting era for industry

Developments in sensor technology and the demands placed upon it by industry are resulting in a new generation of devices. **Rachael Winter** gets a feel for the changes by asking a number of sensor manufacturers about the developments that are resulting in the products we see today, the industry sectors for which the use of sensors is growing, how companies are meeting customer requirements, and how the applications for these interesting devices are evolving

Although sensors have been around for many years, developments and changes in the technology are making this a very exciting time for these devices. Add to this the fact that the demand for sensors is also growing, with their applications extending into even more applications and industries, plus any new advances we can expect to see in the coming years, and we're looking at a topic with some highly interesting facts.

Commenting on these points, Tony Ingham of Sensor Technology, says: "The need for sensors continues to grow as manufacturing industry automates and other machines of all types become more sophisticated. One may even speculate that with the economy in general turning down, but manufacturing continuing to grow (at a comparatively healthy 1% per annum, according to the Office of National Statistics), that investment will increase and that this will reflect into sensors' sales."

Backing this up, Chris Jones, managing director of Micro-Epsilon UK, recognises that while there is a general growth in demand for sensors in most industry sectors at the moment, the military/aerospace, automotive, and oil and gas sectors are pushing new sensor technology to the limits.

There are also some very interesting developments in the technology, as Jones explains: "Miniaturisation of sensors and integrated electronics is a key area of development, which is enabling applications to be solved that weren't possible before. Also, customers require all measurements to be more accurate and to be made more quickly – Micro-Epsilon has therefore developed products that are 'smarter' and more accurate. This does not mean that they are more complex to use, the complexity is happening inside the products – resulting in devices that are simple to use, but which offer excellent results. We've also tried to reduce the manufacturing costs so that we can pass this on to the customer in the sales price.

"3D area measurement is going to be the next leap forward in terms of sensor technology. Already, 3D measurement systems exist, but they are limited in terms of market acceptance by either high cost, relatively slow measurement rates, or they are simply not of high enough accuracy. If this technology can be reduced in size and complexity, therefore reducing the cost, then I think this type of measurement system will see huge take-up in the market," he explains.

Such advances have resulted in some very interesting applications. One which proved to be of particular interest to Jones was a UK application involving the high throughput testing of biomedical samples.

Jones takes up the story: "The sensors are required to measure the liquid level (volume) in the plate wells on the tray, each of which is made up of a grid of 96 (12 x 8) wells. Cycle times are fast and the sensor also has to be small enough to measure each well, which is just 8mm wide and there is a gap of 1mm between each well.

"The miniature confocal sensors supplied by Micro-Epsilon are small enough (4mm diameter) and accurate enough to measure the liquid levels to micron-level accuracies in a cycle time of one to two seconds per tray. The solution involves a row of eight, fixed confocal miniature sensors, positioned side-by-side, with the microtiter plate trays being moved underneath the sensors.

Miniature confocal displacement sensors from Micro-Epsilon have resulted in interesting applications

"Previously, customers had been using a larger, more costly, vision-based measurement system, in which each well was measured individually. Micro-Epsilon's solution has increased cycle times significantly, reducing costs for the end user and providing more accurate measurement results.

"Micro-Epsilon's range of miniature confocal displacement measurement sensors have a diameter of just 4mm (standard sensor diameters are 27mm) and are therefore ideal for measuring inside confined spaces such as narrow cavities, drilled holes and bores, and for checking liquid levels in medical test tubes.

"The optoNCDT 2402 range of sensors is a confocal miniature displacement sensor based on the company's patented lens design. Manufactured using Micro-Epsilon's own special optical production technology, the sensor is currently the smallest diameter confocal displacement sensor available on the market.

"At a measuring range of 1.5mm, the sensor has a resolution of 0.06mm at 0.004% FSO (full scale output). Measuring rate is from 30Hz up to 30kHz and operating temperature is from 10°C up to 50°C," he adds.

Buoyant markets

The TorqSense product from Sensor Technology is finding applications in many sectors of the market, but in recent months there has been a notable growth in the continuous process industries, Ingham explains.

He adds: "The vast majority of process applications involve the pumping and mixing of liquids. A torque sensor attached to the pump will allow the monitoring of flow speed, while one working with a mixer will provide intelligence on the state of the working liquid.

"By collecting such data over a period of time, another level of intelligence is developed, that of monitoring the performance of the processing equipment. Thus diagnostics are provided to drive an intelligent maintenance programme, so that plant availability is optimised."

Talking about other sectors that are currently proving buoyant for Sensor Technology, Ingham adds aerospace, automotive and domestic appliance development. "In aerospace there is a concerted effort to drive up productivity in the manufacturing processes, many of which are still largely craft-based," he explains. "Moves to automation, or even semi-automation, open up many potential opportunities for the deployment of torque sensors, and Torqsense's non-contact operation is particularly attractive because it avoids the time consuming placement of leads, sliprings, etc.

"Automotive and domestic appliance manufacture are already highly automated, but new techniques are being developed constantly, many of which – particularly those using precision servodrives – will require torque monitoring. Product development in both fields is imperative and on-going, and torque is one of the key parameters for assessing the effectiveness of new designs. Again, TorqSense's wirelessness provides an ease of use that is very attractive in test and development work where instruments are constantly being set up for new tests and dismantled again soon afterwards."

One example of this is at automotive development company, Elektro Magnetix (EMX) of Brighton, where engineers are working on a number of projects including an electric/petrol hybrid with partners Lotus Engineering. Ingham said: "Finalising the design of, say, a motor-generator requires comprehensive mapping of the prototypes' performance over all conditions. This requires the collection and interpretation of vast amounts of data and – inevitably – the setting and resetting of the sensors. Digital, wireless sensors, such as TorqSense, therefore have obvious attractions for such work."

Moore Industries, meanwhile, has seen all areas of process control and automation increasing their use of temperature sensors, but there is significant growth in the oil and gas industries too.

JR Madden, senior application engineer at the company, puts one reason for this down to the development of flexible sensors which, he says, makes it much easier for maintenance technicians to replace sensors in the field and permits sensors to be used in locations that were previously inaccessible.

Madden explains: "Most temperature sensing applications for the past 30 years or so have used a thermowell and a rigid sensor. Replacing a rigid sensor is a maintenance person's nightmare, because of the need to disassemble the entire thermowell/transmitter assembly, including transmitter head, conduit, fittings, etc. With a flexible sensor – such as the Moore Industries WORM – it is only necessary to remove the transmitter, and a new WORM slides in and out.

The TorqSense product from Sensor Technology is finding applications in many sectors of the market, but in recent months there has been a notable growth in the continuous process industries

"Also, thermowells require a rigid sensor of the correct length. Therefore, plants must keep a large, expensive inventory of spares on hand. A flexible sensor can be cut to fit, so one or two models can be used throughout the plant, thus minimising spare parts cost.

"As refineries and process plants learn more about flexible sensors, they tend to convert all their old rigid sensors to flexible sensors because of the huge savings in maintenance time and spare parts cost. This helps account for the increasing sales of temperature sensors in oil and gas."

Design advances

There are also many exciting advances in sensor design which involve a similar change from doing things 'the old way', Madden comments. "For example, users are learning that it is not necessary to install a transmitter at the thermowell and to enclose everything in conduit. With a flexible sensor – which can be made to any length – it is possible to encase the sensor leads in a flexible armour cover and run the leads a considerable distance, so that a transmitter can be put in a safer, more convenient location. Instead of putting the transmitter at the top of a distillation column, for example, it can be installed at ground level.

"Users are also discovering that it is not necessary to use thermowells in all installations. Instead, they are discovering that protection tubes and pipe thermowells can be used. Protection tubes are flexible metal pipes that allow sensors to be located deep within a process. For example, large boilers and furnaces often have hundreds of welded thermocouples installed. If one fails, it cannot be replaced unless the boiler or furnace is shut down. With protection tubes, the thermocouple can be replaced from outside the unit without shutting it down, thus saving thousands or perhaps hundreds of thousands of dollars in lost revenue.

"Pipe thermowells are simply any length of stainless steel pipe – up to 100 ft long – into which a flexible sensor can be inserted. Moore Industries makes a kit that allows users to fabricate their own pipe thermowells at about 1/10th the cost of a traditional thermowell."

Because of the flexibility of these sensors, however, the company is also seeing a huge growth in the use of surface temperature measurement in the coming years. With a simple bracket and either armoured cable or a protection tube, a flexible sensor can measure surface temperature virtually anywhere – from deep inside boilers to the surface of pipes, motors and bearings.

In fact, there have been a number of interesting applications this year which give a good insight into the capabilities of flexible sensors, explains Madden.

One such example took place in Louisiana where the intense humidity causes 'Green Rot' at the wire termination points with thermocouples, so engineers and technicians try to avoid as many termination points as possible.

Madden adds: " Because a flexible sensor can be made with any length of wire, we now have several plants in the area that do not use terminal blocks any more; instead, they run the wires directly to temperature transmitters located in a separate cabinet. The sensor wires are run inside rigid or flexible conduit, all the way from the thermowell to the remote mounted transmitter, without using any intervening termination blocks. This eliminates one major source of failure."

Another plant noted that since the sensor wire did not carry any dangerous voltage or current, it was not necessary to encase it inside conduit – so all their sensor cables run directly from the thermowell to a remote transmitter without conduit.

In one application, a plant had a burner with dozens of temperature sensors, but none of them could be replaced without shutting down the entire burner due to the high temperature. By using flexible sensors inside long protection tubes attached to the points of measurement, it was possible to slide a flexible sensor in and out of the tube from a safe location without shutting down the burner.

In a similar situation, a refinery had a problem with calibrating and replacing sensors with transmitters on top of columns or towers, so all the rigid sensors have been replaced with flexible

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sensors, and the transmitters installed at the bottom of the towers for easy access. Again, because a flexible sensor can be made to any wire length, the transmitter could be calibrated or replaced from the bottom of the tower, and the flexible sensors were easier to change out if they failed, he explains.

Commenting on the benefits, Madden says: "Over the last year, several refineries in Louisiana have begun systematically replacing all their rigid temperature sensors with flexible sensors because of the cost savings they expect to gain. Maintenance will be easier, take less time, and cause fewer shut downs or process interruptions. Fewer thermowells will have to be replaced because of sagging or foreign debris clogging the wells. Only two or three standard sensor lengths will be needed for an entire plant, reducing the spare parts inventory. They will get better measurements in shorter thermowell applications, leading to increased accuracy and energy savings."

Raising concerns

HBM is another company that is seeing exciting developments taking place in sensors – and puts this down to the resistance that has characterised the market is gradually disappearing. This means that European automation companies are becoming receptive to new ideas such as TEDS, where the data sheet information is electronically embedded in the sensor, reducing overall set-up time.

Looking into advances in the technology, the company believes that developments such as the use of fibre optic and piezo-electric sensors – like HBM's PACEline series – are also beginning to interest the market with manufacturers looking at different ways in which the new technologies can be used. Ultimately, their aim is to cut production cost with improved sensors. Any any improvements in sensor technology have, however, to be affordable and price constraints need to be considered before undertaking any development work.

Moves towards including more electronics in the sensors is leading to the inclusion of digital fieldbus technology. However, HBM warns that this technology is not standardised with some manufacturers preferring open systems such as EtherCAT in Germany rather than being tied into proprietary systems like Siemens' ProfiNET. This means that sensor manufacturers must be able to meet the demands of a diversified market with a wide range of different outputs.

HBM also says that digital fieldbus is not really suitable for extreme operating conditions when better performance is achieved by separating the sensor from the fieldbus. This is because digital devices have accuracy limits that demand a separate amplifier for applications demanding a higher level of accuracy. One area of concern with digital solutions is the stability of any software platform since this has to be robust and trusted by the end user.

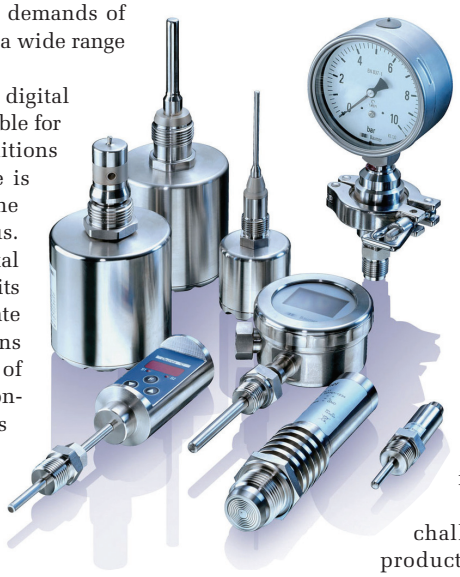
Arguably the biggest area of concern for manufacturers is the increasing numbers of sensors that meet certification requirements but fail to actually meet the applicable standards. Recently, inaccurate sensors in the UK's National Health Service were found to be giving inaccurate pharmaceutical dosages, while in Germany inadequately shielded sensors used for checking truck weights were affected by mobile phones in the area.

HBM would like to see much more rigorous checks taken to ensure sensors do perform to the correct standards. It argues that it costs European manufacturers an additional 30% to meet the requirements of the CE mark that is wasted if the system is not being properly implemented.

Meeting requirements

"With the trend of automating tasks and processes in production plants rising, the number of sensors used for various applications has grown as well," comments Steve Husband, product market manager at Baumer UK. "Since machine failures and production stops cause significant expenses and could damage the company's reputation, the industry is facing increasing demands on the quality of their products, for example high availability, reliability, functionality and error elimination."

He adds: "Highly resistant sensors are required especially for applications under extreme conditions, such as packaging units where acids and leaches are being used, or in petrochemical environments with harsh exterior conditions. Sensors with stainless steel housings are required to ensure both reliable results and maximum durability. The demands are just as complex as the applications: high protection class, wide temperature range, electromagnetic compatibility, acid resistance or high reproducibility, to name just a few of them.



Baumer has developed a portfolio of products to meet customer application requirements

"No company can afford to operate a sensor at the limit of its technical specification or above, since the power reserves so often required are not available under extreme conditions. The significance of follow-up costs due to necessary maintenance and repair work, as well as a product's lifecycle, has become more prominent during recent years, with the actual acquisition costs being less decisive. 'High availability at low maintenance costs' is the industry's slogan."

Baumer meets this challenge with a portfolio of products ranging from basic solutions with plastic housings and brass nickel plated devices, to rugged and resistant products with stainless steel housings. Its specially developed sensor design also supports the customer when it comes to meeting the market's requirements. With developments resulting in the products available today, not only are the solutions suitable for a wide range of temperatures, they have EMC protection, a wide choice of housing material, and ensure stability for all applications, explains Husband. There is also a large choice of process connections and miniature devices that meet the demands for small designs in compact and space saving units.

Husband adds: "Increasing demands and growing quality awareness on the part of customers show that 99% performance is never enough. Baumer will happily face this challenge in the future by continuing to offer precise and reliable high quality products."

The future

We can see from the above that companies today are very positive about the future of sensor technology. Applications are highly interesting, industries are reporting good growth rates in the use of sensors, and the technology is resulting in developments that offer more and more benefits to the user and customer. It seems that things can only get better!

Left: HBM's PACEline product group. The company, however, would like to see much more rigorous checks taken to ensure sensors perform to the correct standards

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