e-book

Successful implementation of sensor technology

sentech
the sensor integrators

challenge accepted.

How do you successfully implement sensor technology?

Successful sensor implementation is very complex. There are many challenges and issues to consider. In the future, sensors will become smarter and smarter. Sensor data is also indispensable to optimize your machine. This requires more knowledge and a well-considered approach. Discover practical tips and tricks in this e-book.

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Future sensor technology: 21 expected trends

Sensors in the future will be more intelligent and measure more accurately. Sensor technology is the foundation within machine applications. An (R&D) Engineer without the right knowledge about sensors will find it extremely challenging to successfully implement new sensor technologies! What can you expect in the future for sensors? Our list of 21 technology trends in sensor applications will provide you with a complete picture.

For your issue, it is becoming increasingly unclear which type of sensor is available for your specific situation. You face challenges and issues at the component level that you need help resolving. This article describes, amongst other things, what's what about smart sensors, sensor data fusion, and the most important development objectives.

Why is the demand for smart sensors growing?

Our need for new knowledge is growing and this knowledge helps provide you with more options for making decisions. Reacting faster allows processes to become more effective and more efficient. So, you achieve more with less effort. We always strive toward more efficiency.

Previously, we did not focus on measurement, but on cost savings. This is now possible due to the transition we have made from a world with primarily mechanical measurement principles to a digital era with sensor technology. This has directly led to us expecting more from ourselves and our machines.

Digitization has had a positive impact on, amongst other things, costs, quality, and production lead time. We want to produce more, more quickly. This provides us with more time to engage in other activities. And this is why the demand for intelligent sensors is growing.

The drive to know more and measure more

A machine must never ever fail. This is the ultimate outcome... we strive for perfection. “Good” is never enough for an engineer. However, from the sales perspective, “ready for sale” is good enough as an eventual solution. This immediately creates tension between the two disciplines.

The demand that we ourselves have created ensures that we do not stop innovation. On the contrary, we spur it on. Of course, this is a vicious circle, a continuous process. It is all about a need for new and increasingly better technology. This leads to you and me stimulating and inspiring ourselves and to look for partners, connections, and to challenge each other.

Digital senses in the future will fulfill human needs

When a new technology is discovered and catches on where you, for example, can better locate yourself indoors, the party that acquires that technology will be successful. This is due to the human

need to evolve and grow. Companies that are left behind or step in too late will eventually not survive.

There is also a push by innovators to introduce new technologies. There may not be a market for the product or technology yet, but we are triggered by the idea and the possibilities that it can bring to your application area. This leads us to consider what benefits the innovation will provide to our customers and their sector.

> ***"We can also cut back on the number of accidents by using new sensor technology."***

Moreover, such opportunities are often experienced positively by companies due to the continuous drive towards improvement and growth. This need will be increasingly fulfilled in the future by sensors... our digital senses.

Necessity is the mother of invention

We do not just want to increasingly know more and measure more solely because people change. No, a need has arisen. For example, the food shortage, autonomous driving., etc. We are not yet completely on safe ground in these areas, which must become really efficient and reduce their environmental footprint. We can also cut back on the number of accidents by using new sensor technology.

The most important development objectives for sensor technology

Sensor technology developers, suppliers, and customers all have different interests that you must consider. For example, costs, quality, and lead time. For example, this influences the decision to accept lesser quality because it is cheaper and may be deliverable the next day.

The Lely company helps farmers with intelligent agricultural machines that make food production more efficient

When it comes to innovation, we realized that we are exhausting the earth and resources. Considering your interests is different for everyone, especially when you know that your choice will completely exhaust these resources within two or a hundred years. Sustainability is already an important goal now with sensor development and innovation. In the future, it will be a 100% necessity.

Efficiency and sustainability

The balance between sustainability and economic gain is always present in an innovation process. You can consider making a large agricultural machine heavy and extremely sustainable. Of course, the cost will be more fuel (i.e. money) to convey it across the ground compared to a lighter machine.

If you make the "same" agricultural machine "with lower quality", you harm the environment more. However, the production costs are lower. At the same time, a shorter lifespan provides more room to innovate more quickly. A machine that is very sustainable makes it impossible or unnecessary to innovate in the long term.

The above-mentioned consideration always involves the relationship between costs and benefits. So, sustainability is always an advantage on multiple fronts when developing a new machine with smart sensors.

Smart sensor innovation at the chip level

The same applies to reducing the size of an on-board computer, such that a chip must be smaller and have higher track densities. Consequently, the chip production process must be more efficient and effective. So, efficiency is embedded throughout the entire chain for sensor innovation.

> ***"The trick in the future is to pass the correct information from the sensor to the customer."***

The transition from mechanical measurement principles to digital principles is part of the transition from Industry 1.0 to Industry 4.0. We expects that digitization will continue. For example, all sensors can be included on a single chip, have exactly the same structural design, be watertight, and satisfy the IP69K standard. The difference will be how you use the smart sensor via the software application.

As to hardware, we now add value by developing a smart sensor with a specific structural design and make it usable for the customer's machine. The trick in the future is to pass the correct information from the sensor to the customer. This is only possible when you fully understand both the application and area of application.

Expertise lies with the expert

Everyone will know about the existence of sensors in the future. But, the understanding of what magnitudes these will measure is diminishing steadily. A party, such as Sentech, adds value with respect to this point because our sensor experts have the necessary underlying expertise.

The customer is assisted in choosing the right sensor technology for their needs and how to integrate it properly. Expertise will soon be lacking even more, which will create odd situations, for example, someone trying to measure a length using a pressure sensor.

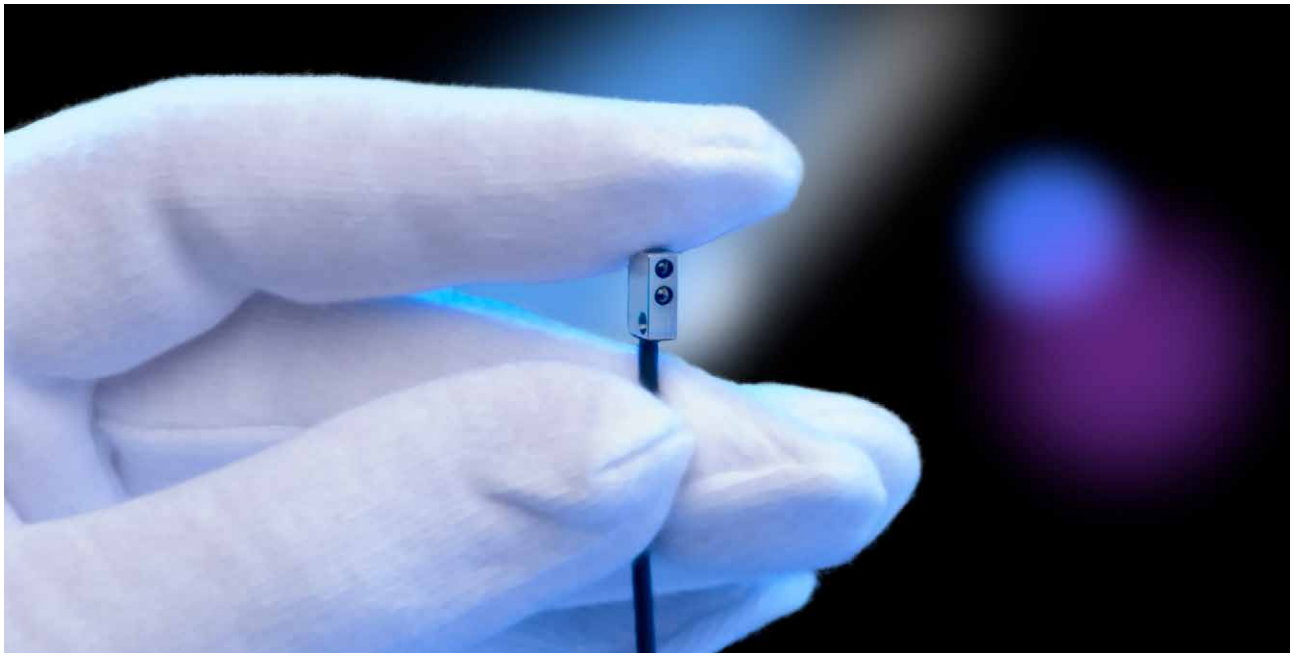
> ***“The combination of two sensor technologies provides more new information to make applications more intelligent and more efficient.”***

This may seem like a crazy example, but deeper expertise really is lacking and this changes the added value of a sensor expert.

The basis of new applications for sensors

Striving to improve a customer’s machine is the basis for developing new applications for sensors. What is important to the customer? What exactly do they need to help them further? And, do they see this themselves or must a sensor expert provide their added value? This makes it crucial to learn continuously and innovate with new technologies. Are you already up to date on the sensor trends in the coming years?

Innovation occurs increasingly quickly partly due to the arrival of “sensor fusion”. This is when you integrate different sensors into a single compact sensor application. The combination of two sensor technologies provides more new information to make applications more intelligent and more efficient. This is “sensor data fusion”



A sensor that measures light reflections can work wirelessly in the future.

Sensor fusion in a person

The best example of sensor data fusion is you yourself as a person. You collect together senses of different magnitudes and then are able to predict and anticipate in an efficient manner. You need all of your body's senses to do so. In the future, sensors will also be able to work autonomously in the same manner. A machine will then become self-learning. So, artificial intelligence with deep learning algorithms is the future.

Using sensors to make large quantities of data available, analyzing the data quickly, and then discovering relationships (between areas of application) is the power of modern applications. Smart devices will also be able to discover more possibilities and models than people can.

If sensors can work together like a brain, people and jobs will be replaced in the future. Once again, this involves efficiency and cost savings. Given our human needs, and sometimes also a necessity, new developments will be implemented rapidly. For example, the cycle is once again repeated thanks to sensor fusion.

Hesitant to share data

Making large amounts of data available is the key to future sensor developments. This data is not just for yourself. You also share (with appropriate agreements in place) with partners that each have their own specialism. Only collaboration will allow you to make new earnings models possible and improve your machine.

> ***"Only collaboration will allow you to make new earnings models possible and improve your machine."***

The biggest threshold is making (sensor fusion) data immediately public. In fact, data is power, your money, your trade secret. Sharing data with a partner is giving away value. So, your 64 million-

dollar question is what you will get in return. Sensor innovation and the data it provides not only creates new opportunities, but collaboration challenges.

Working with wireless sensors

I also believe that we will work with wireless sensors, which will have its ups and downs. The ease, efficiency, data transfer speed, and reliability will ensure that we can make a success of wireless networks.

The absence of a cable in a machine can determine whether the movement speed (acceleration) that a machine must achieve is feasible. So, the wireless variant wins out as a necessity. This type of innovation in sensor technology must also be examined from a very customer specific viewpoint with respect to its usability.

> ***"Sensors will replace our own senses."***

The development process for wireless systems will continue until battery capacity has sufficient power and the chips are really small enough to use less power.

In other words, battery efficiency will improve. Collectively, this means that wireless sensors will be successful.

The innovation wheel only turns more quickly

In the future, you will see that sensors provide more than one advantage. You will see a combination of advantages that are focused on the area of application. The concept "this gain" will be greater for everyone and simultaneously pressure the margin on products and services.

So, we will become more aware of the opportunities provided by technological advances as well as the associated costs and lead times. We will measure everything and do more in the future, which will increasingly accelerate the turning of the "innovation wheel" and increase our needs. Moreover, sensors will replace our own senses.

Why was an R&D department set up within Sentech?

Our ultimate goal as a sensor expert is to be always able to anticipate your need (market pull). To this end, we proactively share knowledge about new technologies (market push), such that you can create a picture of your own needs.

Challenges also often give rise to new solutions for the initial question that you might have thought about at first glance. The combination between these is particularly good and also makes you a good partner for a customer who focuses primarily on mechanical engineering in a certain sector.

21 sensor trends in future applications

Smarter, more accurate, quicker, wireless, safer, self-learning, smaller, standardized, etc. Many sensor developments are underway that involve all of these points. As an (R&D) Engineer in the coming years, you can expect it to be more challenging to keep up to date on all developments and possibilities. You can use this list of 21 intelligent sensor applications to fine tune your expectations to your projects.

Sensor innovation and increasingly quicker development of sensor fusion at the chip level will lead to:

1. Predictive maintenance for machines and devices will become increasingly more efficient, easier, cheaper, and improve uptime. In the future, maintenance will rely on sensors instead of being carried out according to a needs-based timetable.
2. Safety will also improve because unsafe situation will be easily predicted.
3. Autonomous sensor technology will become possible. Wireless connections over long distances with an integrated power supply.
4. Sensors will be self-learning over the entire lifespan without maintenance, modifications, or calibration.
5. The possibilities and areas of application for robot technology will increase significantly.
6. Old and new technologies at the chip level are arising. More will be possible with sensor fusion because transmitters, receivers, and printed circuit boards are increasingly smaller.
7. More complex detection will be possible... technologies will counterbalance each other.
8. Sensors will increasingly provide a better understanding of our behavior. This will lead us to set other requirements with respect to air quality, travel, automobile maintenance, lifestyle, insurance, energy consumption, etc.
9. Fully automated management of livestock is possible. Precision agriculture will also be within reach.
10. Farmer's yields will improve so much that they will be better able to compete with high quality and crop yields. Sensors will be increasingly used to research soil quality, climate, crops, diseases, plagues, and weeds.

11 Farmer's (production) costs will be lower and working conditions will improve in the fields and stalls. New lidar systems will equip autonomous vehicles with real 'vision'.

12 Soccer balls will be fitted with sensor technology.

13 We will use synthetic sensors.

14 Cities will become more intelligent and we will be able to 'complete' the ecosystem. For example, flood management, air quality, blue alga, parking, safe playgrounds, monumental trees will survive, and soil conditions will improve.

15 Components will take over the role of human senses. Data will become more reliable and collected continuously. Data will be converted into useful information using intelligent software and algorithms.

16 We will increasingly make more decisions ourselves based on sensor information that we ourselves collect.

17 We will no longer leave things to chance.

18 We will encounter sensor technology in every aspect of our lives.

19 We will use more sensors to improve the environment, improve energy management, and build green office buildings.

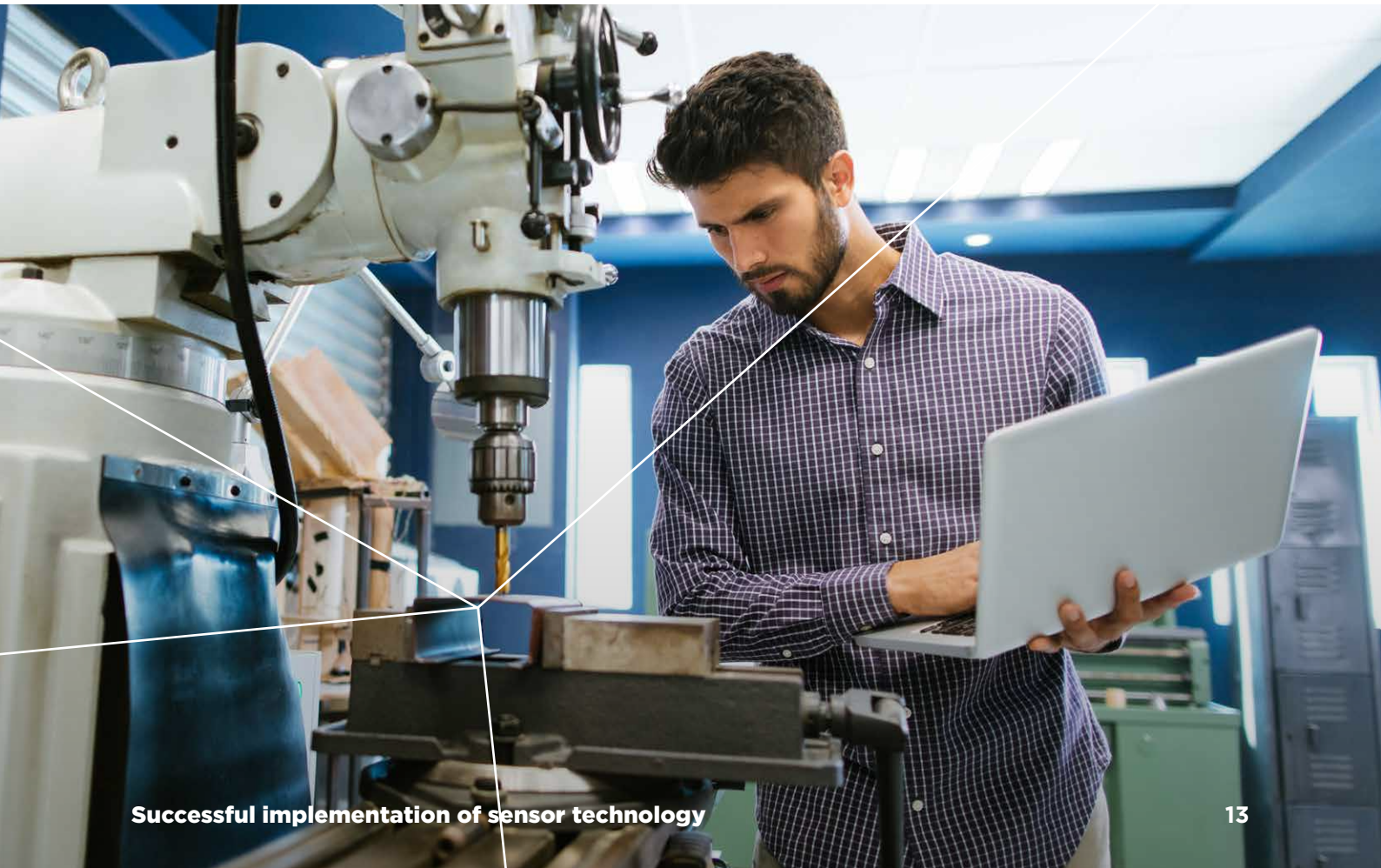
20 Sensors will be well-integrated measurement modules that are easy to use and can be rapidly adjusted to the application being used.

21 Sensors will become real 'smart sensors': intelligent measurement units that self-monitor, transmit status diagnoses to the operating system, and create a reliable network of measurement and calibration data.

Optimize your machine with big data sensors

Mechanical engineers and OEMs optimize machines by intelligently using big data sensors. End customer requirements and production methods have changed because of the industrial revolution. Flexible production lines, optimal yield, and maintenance friendly machines are the order of the day. You always need sensor data when you want to improve machines.

As an (R&D) Engineer, you want to make your machines more intelligent, often based on customer requirements. You know sensor technologies and their associated possibilities. But, how do you use sensor data to improve efficiency? Whether your machine optimization will be successful depends on collecting the right data and the use thereof.



Big data sensors are indispensable for machine optimization

Machines are loaded with technologies, such as sensors, that collect a lot of data about the machine. You will always need data regardless of what you want to improve in your machine. The main outcome is accomplished by automated actions. If you measure all of these actions, you can examine what can be done faster and better for each subject. You can also research which processes can be run synchronously.

> ***"The end customer can recover their investment more quickly when the machine failures are at a minimum and processes are efficient."***

Machines will work more efficiently when downtime is reduced and processes are faster. You can predict failures by identifying how often a specific motor or machine component fails. You can then improve processes based on this data. The end customer can recover their investment more quickly when the machine failures are at a minimum and processes are efficient.

Big data also makes autonomous driving increasingly safe. By collecting data, we can recognize patterns that allow us to learn a lot about improving our machines. For example, we equip self-driving vehicles with technologies such as lidar, radar, ultrasonic sensors, and cameras. The combination of these four technologies provides valuable information. It allows an Automated Guided Vehicle (AGV) to distinguish between a person or other vehicle and a stationary or moving vehicle.

Responding to the market need

To continue satisfying the end customer's requirements, you must take a future perspective. A nice example is AGVs. These autonomous vehicles now drive on enclosed terrains. Despite self-driving vehicles just being introduced, we - the consumer - already have a picture of the future. And this picture is also influenced by what we have seen in science fiction movies.

> ***"Eventually, we will drive vehicles completely autonomously in the future. You will simply get in a car that is available in your direct vicinity."***

Eventually, we will drive vehicles completely autonomously in the future. We will not need a driving license to do so and you won't even have to own a car. You will simply get in a car that is available in your direct vicinity. This vision is far in the future. But, step by step, we are getting closer to that vision

Incremental technology development

If you know the future, you can also sketch out logical intermediate increments. Concerning autonomous driving, we know that we can advance in this area. This means that we must work in small incremental steps. A lot needs to happen before vehicles can be completely autonomous. For example, safety, laws and regulations, responsibilities, and infrastructure.

We expect that self-driving vehicles will be permitted on public highways in the future. But, before we get there, a huge amount of data must be collected to limit the risks so that autonomous driving becomes more reliable. Data is needed to program self-driving vehicles so that the vehicles can make the correct decision in emergency situations.

In 5 intermediate steps to fully autonomous driving

With each incremental step, big data teaches us something. For example, we optimize the technology so that autonomous driving becomes increasingly safe. The intermediate incremental steps of this development are as follows:

1. AGVs drive on enclosed terrains, such as warehouses, to take over the function of trucks and forklifts. These drive autonomously in an environment that is closed off to people.

2. The next step is to allow people to be present in the enclosed environments. This will require the AGV speed to be adjusted. In addition, the impact must be calculated should a vehicle collide with a person. After adjustments and risk calculations, the vehicles will drive around in a safe manner.

3. Consequently, AGVs will be able to drive on an enclosed outside terrain where trucks are driving. The risks also have to be restricted in this situation because it is still an enclosed terrain.

4. Allowing self-driving buses to use a separate driving lane would be a logical next step. This would allow us to learn how autonomous driving works in traffic. This is already happening in a few cities.

5. Subsequently, autonomous cars can be allowed on separate driving lanes in traffic. This will require the infrastructure to be changed: both the cars and the infrastructure will be equipped with sensors. We expect that this will be one of the last steps before self-driving cars can drive safely in regular traffic.

The influence of technological developments

Technologies continue to become more intelligent as the years pass. The sensors used today are not necessarily the sensors of tomorrow. We need to allow for other developments that can influence your product.

In ten years or so, we may no longer use phones, but have a sub-dermal tag with GPS. If you then sit in a self-driving car, the tags will use multilateration (MLAT) to position itself and follow vehicles. The outcome is that we would no longer need sensors in the car.

How do you collect data?

Data and making your machines more intelligent goes hand in hand with each other. Sensors in machines collect enormous amounts of data. In addition to big data from a machine, you can also combine that sensor data with data from other machines.

Internet of Things

You can make your machine even more intelligent with unidentified data. If you share your sensor data with others via the internet, information from others will also be available to you. Combining your data sets with those of others via the Internet of Things can yield surprising new insights. You can accrue significant new insights when you combine your datasets with those of others. You cannot foresee what you will be able to learn from it.

End-user data

End-user machines collect a lot of data. This information is valuable in helping you improve your own machine. But, the end user is the owner of their data. So, how do you deal with that?

For example, you see this with mechanical engineers who make dairy machinery. Milking robots collect huge amounts of data, for instance, on milk quality. The farmer owns this data. On the one hand, the farmer wants more intelligent machines to improve his yield. On the other hand, the farmer does not want others to get his data.

Some functionality is only possible when the end customer shares their sensor data with you. For example, predictive maintenance. How do you prepare your end customer to share their big data?

Privacy legislation

The strict privacy act GDPR may create a challenge when collecting data. If you collect data with personal characteristics, you are required to inform those people using a privacy statement about the goal of the data collection. It must also indicate what data you use and the other organizations that you share the data with. Moreover, you must save the information in a secure manner.

How do you make data usable?

If you collect a lot of data, you can analyze the data to recognize patterns. These algorithms look for a specific event, which you can associate with actions.

You do not need different big data sensors for every measurement. You can also combine data from different sensors to draw new conclusions. After analyzing data from different sensors, you create algorithms to recognize patterns. You use these algorithms to optimize your machine.

We discovered an example during the development of our mobile IoT toilet. Despite the lack of a sensor to detect dirt, we were able to measure whether the toilet was clean or dirty. The combination of the door sensor and the occupied sensor allowed us to create algorithms. If the door is opened several times, but no one goes in, we can assume the toilet is dirty or defective.

Recognizing trends by personalizing

More and more products can be personalized: from cars to shoes. These production lines are incrementally optimized to be able to produce them flexibly. Take Nike, for example. You can use their webshop to build your sneakers in many different colors, finishes, and sizes. Nike can use these orders to recognize trends. That is also valuable data.

Door het integreren van sensoren in een mobiel toilet, en sensordata te koppelen met een platform in de cloud, ontstond onze IoT Toilet.

Scoping sensor improves SolayTec's ALD machinery

It was a far from simple task for PV machine manufacturer, SolayTec, to find a sensor that was both within budget and suitable to establish the position of solar wafers in its deposition machines. The firm ultimately opted for Sentech, which developed a customized solution.

Sentech and SolayTec – a TNO spin-off – have been cooperating with one another in the development of atomic layer deposition (ALD) machines since 2012. This nanotechnology, which was optimized by SolayTec, enables manufacturers to produce solar cells with a higher output.

As SolayTec's R&D partner, Sentech developed sensor solutions to adequately monitor the ALD process performed by the machinery – solutions which rival sensor suppliers were unable to provide within SolayTec's budget. The two firms based in the Dutch province of Brabant have since proceeded to supply this splendid example of precision mechanics worldwide.

Higher output from solar cells thanks to ALD

ALD is a deposition technology which is used to apply layers at an atomic level. A substrate is exposed to sequential gas phase chemical processes. The chemical reactions that occur during exposure deposit a layer that is exactly the thickness of a single atom.

The cycle is then repeated until the desired layer thickness is achieved. ALD offers one particular advantage in this regard: it is a self-limiting process, as the chemical reaction halts as soon as the surface is covered. This makes for amazingly accurate control of both the layer thickness and homogeneity of the material.

Although ALD was invented quite some time ago, the technology was too laborious and expensive to be applied on an industrial scale. This recently changed, however, thanks to the efforts of the Netherlands Organization for Applied Scientific Research (TNO). In 2008, it launched a research project aimed at rendering ALD significantly quicker.

> ***“The application of aluminum oxide in the form of an extremely thin ALD film raises the overall output of a solar cell by more than 1%.”***

At the time, a number of other institutes, including the Eindhoven University of Technology, began publishing findings which showed that a thin layer of aluminum oxide applied to silicon solar cells using ALD produced substantially improved output.

“A nice homogeneous aluminum oxide film is vital to achieving the optimum effect,” SolayTec’s CTO, Ronald van Dijk, explains. The average solar panel has an efficiency level of around 18% to 20%. The application of aluminum oxide in the form of an extremely thin ALD film raises the overall output of a solar cell by more than 1%. This amounts to a relative increase of 5% to 7%.

ALD machine processes 4,000 wafers per hour

In 2009, TNO made a breakthrough that would enable solar cell manufacturers to benefit from the performance enhancing application of an ALD layer of aluminum oxide to their products: the spatial ALD process developed by the research institute make it possible to apply the film swiftly yet highly accurately.

Until then, TNO had simply been applying the standard temporal ALD process, whereby the substrate is exposed to the various gases in one room. Spatial ALD enabled it to shorten the rinsing phase by a factor of one thousand.

The resulting single cycle, in which the silicon solar wafer is conveyed contact-free through a series deposition units, takes just a few milliseconds instead of the previous six seconds.

In the first unit, the precursor gas, trimethyl aluminum (TMA), forms half the initial monolayer. In the next unit, water vapor completes the layer due to a chemical reaction between the TMA and water.

The process in the deposition unit can then be repeated several times to achieve the required thickness. Curtains of inert nitrogen gas between the deposition units prevent the precursor gases from coming into contact with one another.

TNO's research culminated in the installation of a patented deposition head in a prototype ALD machine in 2010. "This breakthrough placed a business case within reach," Mr. Van Dijk explains. "In 2010, the spin-off firm SolayTec was founded with a view to marketing the TNO invention together with the prototype ALD machine."

Mr. Van Dijk says that the challenge faced at that time was to wring more electric power out of an identical solar cell at equivalent cost. "The hectic start-up phase led to the introduction of the first production machine which had one deposition unit. We went on to further develop it into a machine comprising several deposition units, which can currently process up to four thousand wafers an hour."

While SolayTec has customers throughout the world, the greatest demand for its machines is from China. Mr. Van Dijk: "The solar energy market is a growth market, which is sensitive to economic fluctuations. China has both energy and pollution problems, despite mass producing solar panels for the rest of the world."

Only Sentech was able to meet Solaytec's sensor needs

Sentech was the only party capable of meeting SolayTec's sensor requirements. Erik Kremers, system architect at SolayTec, explains how Sentech became a candidate: "Our initial machine contained a number of

motion sensors, with which to monitor the progress of the wafer through the deposition unit. The sensor that we were using for this purpose did not fully comply with our requirements in terms of both reliability and cost price, however. Reliable measurement of the wafer position within the sealed deposition unit, at a temperature of 200 degrees Celsius, is absolutely vital to the performance and uptime of our machines. If the wafer fails to proceed according to the set point, this can lead to breakdowns and damage, which then forces our customers to cease production. Downtime costs our customers money, of course."

> ***"You won't find what SolayTec needed in any sensor catalogue."***

The sensor measures the edge of the wafer as it passes various points in the deposition unit. The measurement data acquired in this manner enables SolayTec to adjust the position of the wafer using software, so that it complies with the desired set point. Mr. Kremers: "We compiled specifications for a new sensor, which we then presented to both our existing and other sensor suppliers. However, none proved capable of supplying such a sensor within our budget. Then, Sentech suddenly popped up."

Peter Verstappen, Sentech Account Manager, then organized roundtable talks with SolayTec, with a view to entirely developing a cost-effective sensor solution from scratch. Mr. Verstappen: "Sentech is an expert in the field of sensor integration and the development of sensor solutions. We like to sit down with customers first, to establish their concrete requirements. You won't find what SolayTec needed in any sensor catalogue. SolayTec basically required an R&D partner. The technology was not the problem, but the price at which the sensor solution was to be supplied. Too high a sensor price would render the ALD machine too expensive to achieve the efficiency benefits envisaged by solar panel manufacturers."

Temperature and cost price – the greatest challenges

Mr. Verstappen admits that the high temperature in the deposition unit posed the greatest challenge. Within just a few months of open cooperation with SolayTec, Sentech nevertheless succeeded in integrating an entirely new sensor solution in the first generation deposition unit in keeping with the envisaged production budget.

It was dubbed the DU 1.0. This optical positioning sensor comprises a glass fiber transmitter and amplifier, which transmit a beam of red light to a receiver. Digital detection is carried out at various points, where the edge of the wafer is measured as it passes the sensor, interrupting the light beam, and this provides 11 measurement readings.

Mr. Van Dijk proudly admits that, in supplying the DU 1.0, Sentech met SolayTec's R&D requirements for its production machines to the latter's complete satisfaction. "However, SolayTec wanted more," Mr. Kremers continues.

"I still harbored the wish to incorporate a sensor that could monitor the wafer position continuously, instead of only at the existing discrete points. We would have much preferred to have a linear sensor that can monitor the entire 200-millimeter cycle of the wafer within the deposition unit. When I outlined this idea during a brainstorming session, Peter Verstappen did not immediately reject it as wishful thinking. Sentech fully comprehended my eagerness to closely monitor the position of the wafer: in order to improve the reliability of future models."

Co-research & development yields scoping sensor that improves ALD machine reliability

"Digital detection using the DU 1.0 does have its limitations, as the sensor only takes a few readings. We therefore started experimenting with analogue signaling, as this enables one to determine positions within the space. This resulted in a scoping sensor, which can also monitor lateral movement, in complement to the positioning sensor. The combined readings of the two sensors provide a spatial impression of the wafer's progress through the deposition unit."

Mr. Kremers agrees that this solution comes pretty close to meeting his original wishes. "The new version offers a wealth of further information, which helps us proceed a few more steps."
Messrs. Kremers and Van Dijk greatly appreciate Sentech's frankness with regard to its development process.

> ***"We literally carry out open innovation together. The success of co-research & development is determined by the partners' sincerity and willingness to share R&D insights."***

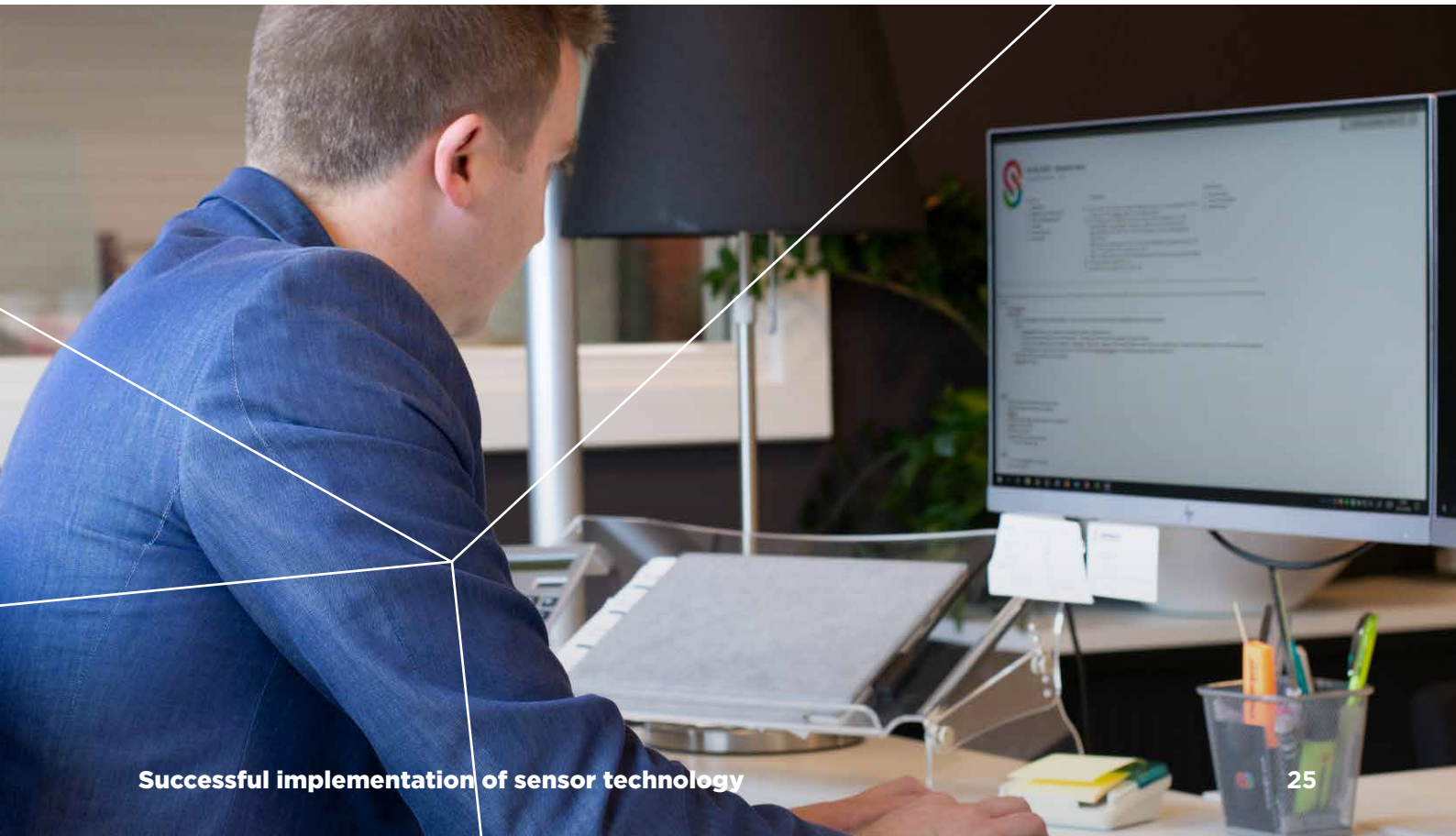
Mr. Van Dijk: "We literally carry out open innovation together. The success of co-research & development is determined by the partners' sincerity and willingness to share R&D insights. And both Sentech and SolayTec have cultures based on this kind of open attitude."

Your sensor issue resolved with proven project management

Your sensor issue is what we call a challenge. The path to the sensor solution you actually need revolves around three items: cost, quality, and delivery time. These never go hand in hand with each other. We identify and manage risks based on our manner of working, which is derived from the automotive sector. A collaboration with you as our customer is indispensable for this!

As an (R&D) Engineer, you often already have a potential solution at hand. But, is it really the absolute most suitable solution for your needs? It is possible that another technology is better for your application and may even cost less.

As a buyer, you also want clarity about the price, delivery time, and quality. Signaling and managing risks is paramount in our manner of working. It is how we safeguard quality and ensure there is a predictable logistics chain.



Balancing interests

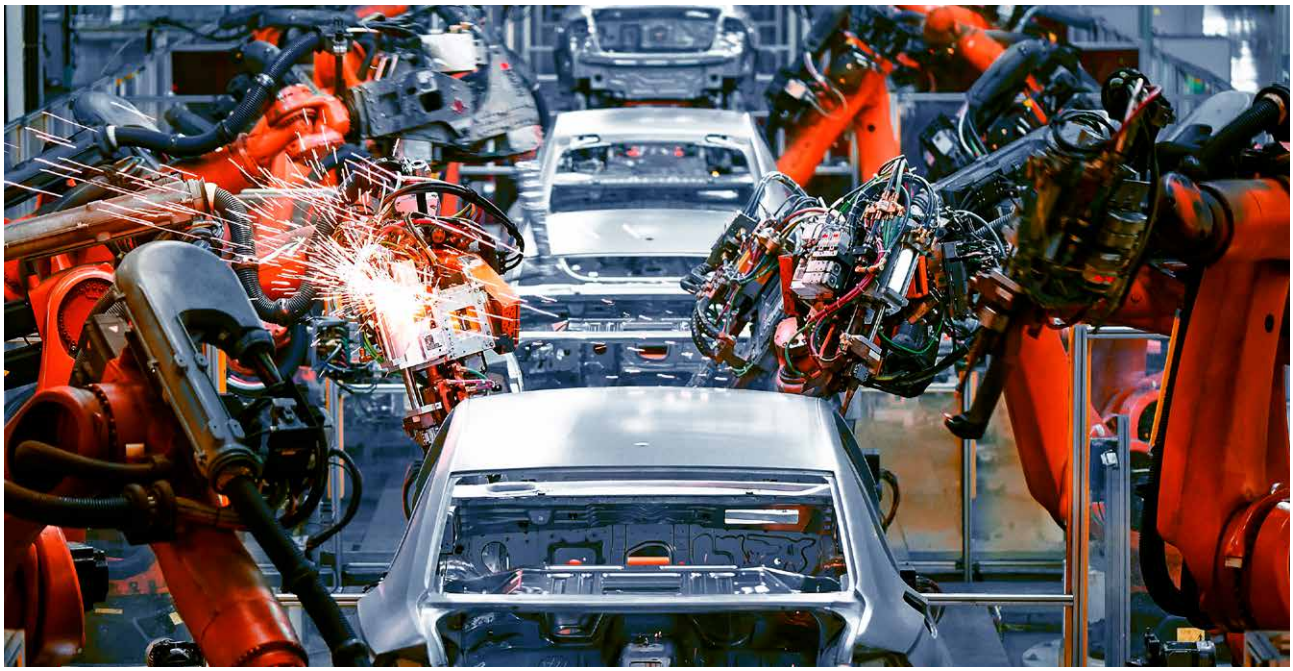
In addition to finding a balance between cost, quality, and delivery time, it is important to find a balance between the interests of customers, suppliers and Sentech. If interests lie too far apart, it makes it difficult to align with each other. You look for what you can do to help everyone understand each other. If something is not working out, you need to be honest about it and discontinue the collaboration.

A variety of interests even play a role at the internal level. Engineers always wants to find the best solution because they consider things from the perspective of the technical interest. If something works well, they still say 'We can do better'. After an engineer once again spends a lot more hours developing the product, it may turn out better, but also unnecessarily more expensive.

> ***"Engineers always wants to find the best solution because they consider things from technical perspective. If something works well, they still say 'We can do better'."***

Optimum work processes

We work with you to identify what is really important for you. We do so using our work process that is based on the high-quality standards from IATF 16949 (previously ISO TS 16949). We safeguard these strict standards using the development process know as APQP (Advanced Product Quality Planning). This model was developed in the automotive sector by Ford, Chrysler, and General Motors in order to develop new products at the agreed time and deliver



Automobile manufacturers prefer to work with companies that are IATF 16949 certified. This standard helps draw up work processes that are efficient and effective.

them at the budgeted costs. We identify and manage risks by following the phases of the APQP.

Documents with understandable language

APQP documents are complicated to work with. Terms are used that are not known to everyone. We simplified this model so that all parties can work with it efficiently. Documents and templates for the processes are written in clear understandable language.

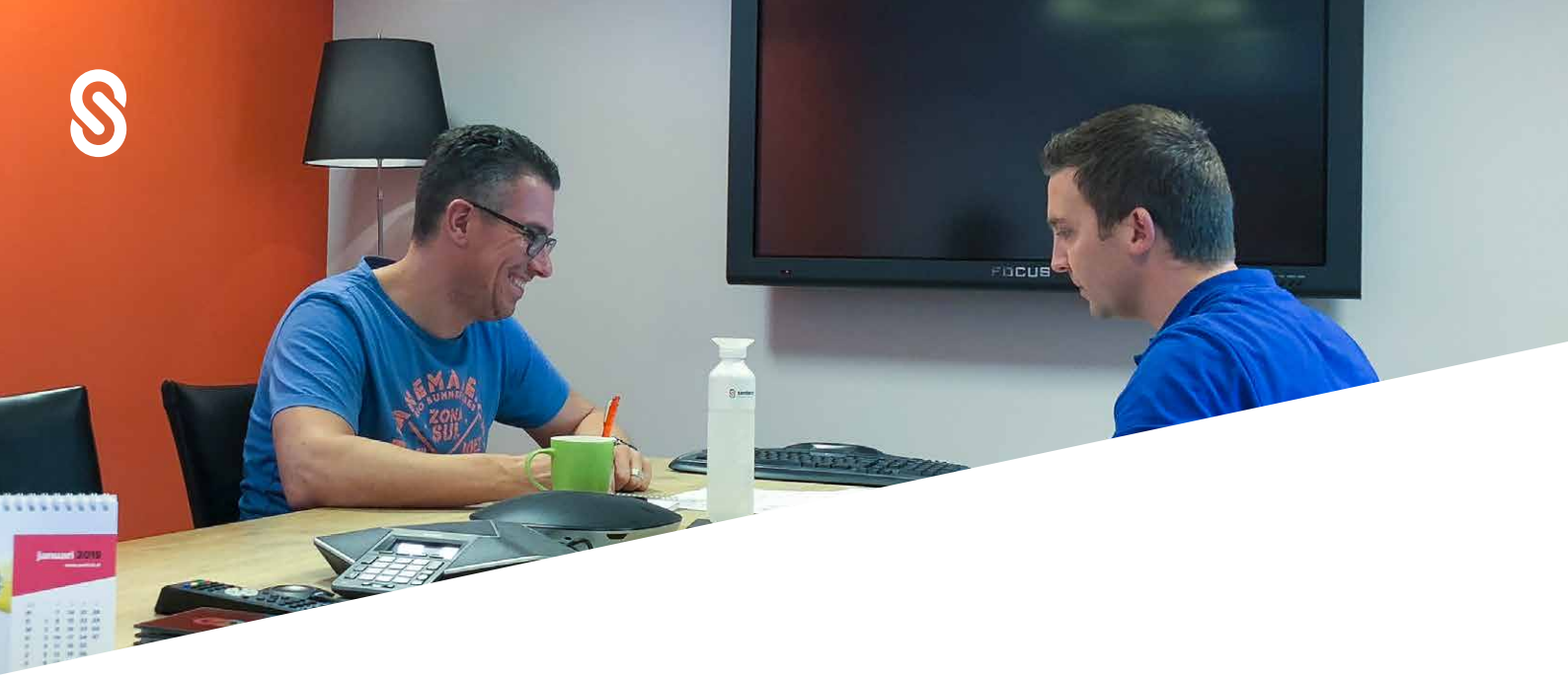
> ***"It is possible to adjust certain steps depending on your expectations with respect to quality, time, and price."***

One step at a time, never skip a step

Sometimes it is not efficient to comprehensively follow all of the steps in the APQP. It is possible to adjust certain steps depending on your expectations with respect to quality, time, and price. From the perspective of "adjust, don't skip", we never skip entire steps because we always want to weigh up all of the risks.

At each process step, we - as a multidisciplinary team - ask ourselves: 'Should we go through this step in its entirety or can we do it in some other quicker manner?' Of course, we are aware there is a certain risk in doing so. We identify the risks and weigh these up against the quality standards that are important to you.

For example, if the length of a product is important, it is sensible to perform an incoming inspection on measurements. When I discover that a product is too long or too short, I will not accidentally put extra work into it and send it on to the customer. That costs money. Moreover, hours of work have already been spent. Everything is aimed at quality assurance. You must work together to determine whether the risk is high or not.



Five phases from challenge to sensor solution

We go through a project in five phases based on the APQP. By following the phases, we identify the risks in a timely manner and make them manageable. This way, you will receive your sensor solution at the agreed quality, price, and lead time.

Phase 0: Identify the problem

As an engineer, you contact us because you need a specific sensor solution. You may already have considered a potential solution. But, can you really be sure it is the best solution for your issue?

By asking critical questions and by continuing to ask questions, our Account Team helps you identify what you really need.

The importance of keeping asking questions

Asking critical questions and continuing to ask questions is important so you can make risks clear. For example, when a customer asks for a watertight sensor. There are various degrees of watertightness: from rainwater proof (IP X3) to resistant to water pressure (IP X8).

By continuing to ask questions in this situation, we will learn what the customer means by “watertight”. The choice also influences the price.

For example: the customer said ‘I want a pressure sensor’, but it actually turned out that he needed a pressure switch. That may seem like a minor difference. However, there is a big difference when it comes to cost. A switch can be more expensive than a sensor.

When we deliver a product that satisfies all of the specifications, but does not fit your application, we did not do our job properly.

Discussing your challenge

Phase 0 ends with an open-up meeting with the entire project team: Sales, RD&E (Research & Development and Engineering), Supply Chain, Quality, Finance and Production. This is where we pitch the issue and all of the sensor experts together propose a solution. We record this in a Product Initiation Document (PID).

Phase 1: Feasibility and capacity

Sales passes on the responsibility to RD&E. In this phase, our Project and Production Engineers determine the feasibility of and capacity needed for a project.

Capacity

Being able and willing to make the product is key to capacity. Are we going to make 100,000 products with an assembly time of 20 minutes per piece? That affects our capacity. We may need additional staff to do so.

Technical and financial feasibility

We also research the technical feasibility. The customer requires certain specifications. Can we satisfy these? Is that technically feasible? With financial feasibility, our sensor experts together with the account team examine whether we can make the product for the agreed upon price.

Phase 2: Product design and development

After we are granted the assignment, we can elaborate the draft project plan. The practical lead time is determined in this phase: we make it clear when which project results will be delivered, based on your needs. Project results vary from documents, drawing packages, samples, prototypes, etc.

> ***"We can make a prototype to show you - the (R&D) engineer - a functional working product."***

Prototype

We can make a prototype to show you - the (R&D) engineer - a functional working product. The prototype is not yet made using the eventual resources. For example, if the eventual product must be made in an injection mold.

This is too expensive for a single piece. In this case, we can print the housing using a 3D printer. Of course, the material and the color may deviate. But, in the interim, it does give the customer an impression of the final product. They can make some tests: is this really what I want.

> ***"We prioritize risks based on the Risk Priority Number (RPN). In any event we tackle the highest RPNs to reduce risks."***

Managing design risks

We capture design risks in a Design Failure Mode Effects Analysis (DFMEA). We prioritize risks based on the Risk Priority Number (RPN). In any event we tackle the highest RPNs to reduce risks.

The component is so sensitive to vibrations that we expect it will break when there are vibrations in the machine. If the risk is too high, we must consider an action that will reduce the risk. The description of this is included in the Control Plan.

Critical to quality

This phase deals with the product design. This involves the drawings and software for the product. Separately from the drawings, we also have critical dimensions. Such as the development of a load pin. The customer uses the pin in a gearbox. Gears pass over the pin, such that the clearance has a specific size tolerance. In addition, the pin must not bend slightly. We describe here the critical dimensions, i.e. what is critical to quality.

Phase 3: Process design and development

We now start drawing up the process for mass production and assembly. We pay attention to safeguard quality as determined in the previous phases. Details that are critical to quality receive additional attention in this process.

Process risk management

All process-related risks are captured in a Process Failure Mode Effects Analysis (PFMEA). For example, what can go wrong when we receive components in accordance with agreements with our suppliers.

We have taken on the risk of doing business with a particular supplier whose delivery time is between three and five weeks. But, we must deliver 200 sensor solutions to our end customer every two weeks. In this case, it will be identified in the FMEA Process that we will need that supplier to deliver a large stock of the product. This way, we create a buffer just in case the supplier delivers late.

Measuring system analysis

We use a Measurement System Analysis (MSA) to identify the reliability and reproducibility of our measuring systems. We manage the variation of our measuring systems so that the quality of your end product is the same with each measurement. We also do this when multiple assembly engineers read off data from the same measuring system.

> ***"All process-related risks are captured in a Process Failure Mode Effects Analysis (PFMEA)."***

We make products where it makes a difference at what time of the day we make a measurement. In the morning, it is colder than during the afternoon. So, it is sometimes important that the assembly occurs at a fixed temperature.

Transition to production

To ensure the transition from engineering to production is successful, we draw up work instructions for your sensor solution. In addition, the project engineer teaches the assembly and test engineers how they must assemble and test the product.

Phase 4: Product and process validation

Now that our people are trained, we start the validation phase by producing a small series, for example, 20 pieces. We pay attention to ensuring that your end product satisfies the desired quality requirements. We also test feasibility in order to determine the exact lead time and price.

Feasibility in time

If we must make 100 sensor solutions per week, we want to know whether that time is technically feasible. We time exactly how long we take to make it. We will then know how many pieces we can make per week and whether the costs from the previous calculation have been covered.

Monitor quality

We use the Statistical Process Control (SPC) to determine the limits to quality: by how much can the quality deviate? We use a control chart to check the quality requirements that are important for your product.

For example, if the length of the product is important, we determine how much this length may deviate. We check this using a control chart and test tool. Any item that is outside the standard is discarded.

Lessons learned meeting
We finish off in phase 4 with a lessons-learned meeting. All involved team members gather together. You, as an (R&D) engineer, also join us. We discuss what went well, what did not go so well, and what we need to do differently next time.

It might turn out that we carried out a vibration test in phase 4, but looking back it would have been better for us to have carried it out in phase 2. This is how we continuously improve our work processes.

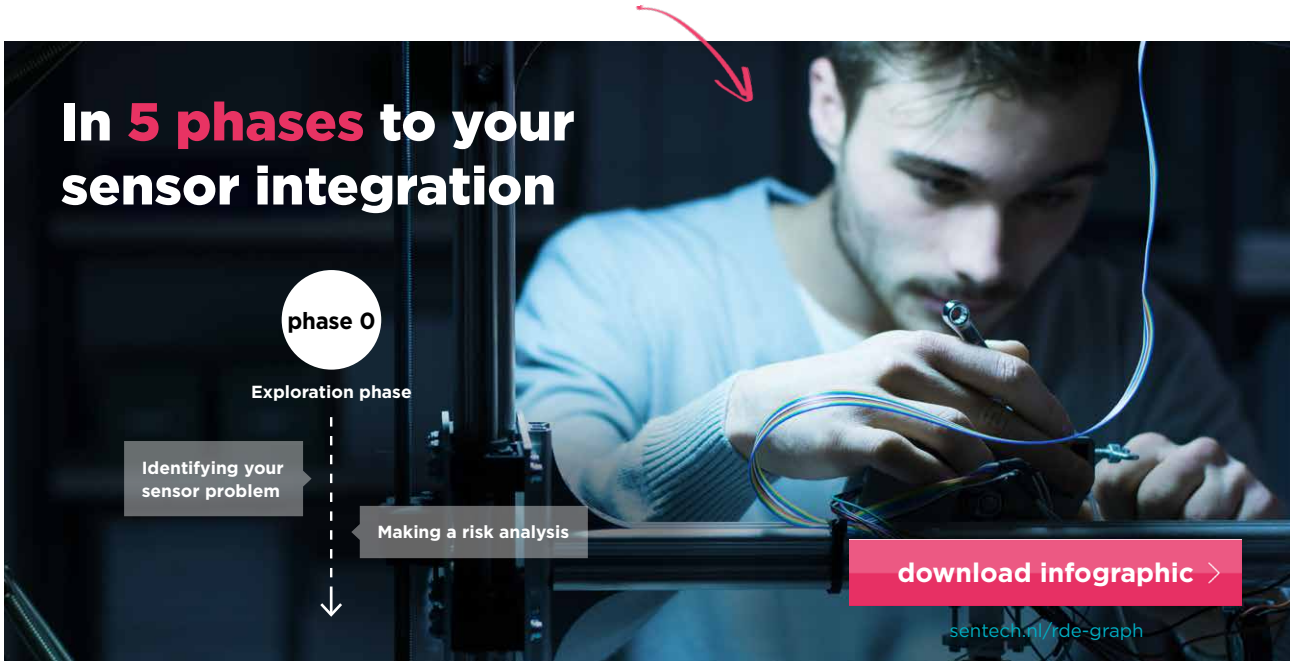
> ***"All involved team members gather together. You, as an (R&D) engineer, also join us."***

Starting mass production
We now know in detail how your sensor solution must be made and what we should take into account. We now also have certainty about the lead time and price. We draw up our quotation for mass production based on this data.

Once we have received your order, the production department commences with the mass assembly of your sensor solution.

Supply chain management

Quality and selecting the right supplier go hand and hand with each other. A supplier delivers quality products to me with an agreed upon ppm level of 6,000. This means that 6,000 parts per million may be faulty. Our customer requests 30 ppm for their end product. In this case, I'd better do business with a supplier that can deliver at 30 ppm, even if the supplier is more expensive.



The tension between sales and engineering

The interests of sales and engineering can sometimes be far apart in a project. Sales wants to offer the customer flexibility while engineering sticks to its guns regarding processes to safeguard quality.

If a customer requests that a product be delivered more quickly, sales will apply pressure on engineering to make this happen. The quality manager is in engineering, so they strictly follow the process. The process steps cost time and that sometimes cuts into the interests of the sales department.

The teams have to find a middle ground in this tension between flexibility and lead time. This leads them to develop sensor assemblies efficiently and with attention to quality and costs.

> ***If a customer requests that a product be delivered more quickly, sales will apply pressure on engineering to make this happen.***

5 tips for a a successful collaboration

Every collaboration has to deal with challenges. We consider these to be points of attention that ensure a project runs smoothly.

1 Aligning twith other cultures
A customer base in a variety of sectors provides collaborations with a variety of organizational cultures. The decision-making at a large organization may take longer, which can lead to delays within the project plan. It is important to be flexible with your process and to align yourself with every culture.

2 Managing expectations
Do our expectations and those of the customer align with each other? If we want to deliver a prototype quickly, the customer may expect a series to be produced shortly thereafter. Usually, this is not how things are done. This is why we share a roadmap of the entire process so that our customers know when and what they can expect.

3 Personalizing processes
We believe in our work processes. This helps us to deliver high-quality sensor assemblies at the right time. Each organization is familiar with its own processes. In a collaboration, our processes and those of the customer align with each other so that everyone feels confident in a project.

4 Communicating in the same language
Every project approach has concepts in their own languages that share the same meaning. For example, we talk about prototypes and the customer talks about samples. Drawing up an overview in which the project concepts are clarified ensures that you can communicate clearly with each other. In that document, the concepts are described in the customer's language.

5 Failure to share issues
The issue may be ongoing for a while now for you before you contact us. The knowledge and experience that you have gained around the issue is valuable for follow-up. As this happens during the start-up process, trust is yet to be built up. It can be difficult to share confidential data, such as competition-sensitive information.

7 benefits from working with Sentech as your sensor specialist

A reliable, thrifty, safe, and/or economical machine can be developed and assembled without technical defects. The choice between a standard sensor solution and a focused integrated solution will strongly influence the outcome. You engage a sensor expert who helps you discover your final objective, challenges you, shares their vision and knowledge, really helps you, and does not immediately focus on sales. This is the only way that your assembled product will be rapidly a success for your end customer.

One of the advantages of working with Sentech is that we all work together to determine the very best and most suitable sensor technology. And, we do so with short management lines and a high degree of engagement. In this article, we share seven reasons why companies decide to collaborate with Sentech. And, naturally, we'll give practical examples!

1 How do you find the appropriate sensor technology? With challenges!

If we begin discussions with you, we first listen objectively to your needs and do not consider which product you think you might need. What exactly do you want to build? What signal do you need? What is the final objective of your measurement or application?

> ***"In a solution-oriented collaboration, we determine what the very best and appropriate sensor technology is for you."***

These questions will bring exactly what you need to the fore. It might be an existing sensor technology, a combination of multiple technologies, and that will be used in specific environmental conditions. We consider solutions independently of products and challenge you to critically look at your initial issue.

Simply put: in a solution-oriented collaboration, we determine what the very best and appropriate sensor technology is for you.

Why choose a sensor specialist? Research and Development takes you further

It is impossible to have 100% expertise in all sensor technologies because there are so many of them. To be able to help you, Sentech drills down into its knowledge of technologies to find those that are suitable for you as a customer. To this end, Sentech tests technologies against the market.

This is why we have an R&D department, why we innovate, and why we continuously research new options. We use these in Product Market Combinations (PMCs) and share these with you. If we did not do so, it would be impossible to determine what the very best and appropriate sensor solution was for you.

2 Work (cost) efficiently with an expert

With sensor development, you always have to consider project costs. However, this is not of the same importance for every customer. One customer makes decisions based on cost controls, while another decides based on the right quality or safety. If it is the latter, it will directly influence the magnitude of the costs.

So, how efficient you can work will depend on your customer's needs. We always work together to determine this and then present multiple creative scenarios. As a sensor expert, we also work on a project basis and as efficiently as possible using qualitative and quantitative processes. The eventual outcome is a high-quality product that is delivered on time for assembly in your machine.

3 Speed

Sentech added speed as a factor in a project for a large customer because they were very specific about the approach and

multiple processes ran synchronously. Both parties were well organized. Companies that are not as large are organized differently than Sentech and may be used to switching gears extremely quickly. Sentech synchronizes itself with your processes and does not cause delays.

We work at the same pace as small companies because we expand their capacity. We obviate certain tasks for them by sharing our knowledge and people. This ensures that the integration products to be delivered will be of a high quality and very stable.

A sensor project is always focused on the correct relationship between quality, delivering the end product at the right time and place, and the agreed-upon specifications.

4 Flexibility selects the sensor specialist

At Sentech we're growing fast as a sensor supplier, yet our current (large) customers continue to experience Sentech as a small and flexible company. This is demonstrated in how quickly we can switch gear, think along with you, and synchronize with you as a customer.

> ***"In particular, sharing knowledge directs the flexibility of the collaboration, especially with smaller organizations."***

In particular, sharing knowledge directs the flexibility of the collaboration, especially with smaller organizations. They often have less engineering capacity with a limited range of competencies. Introducing knowledge makes such companies more flexible. This is one of the factors that you can pay attention to when selecting a sensor specialist.

Sentech works with flexible processes focused on automotive quality. Rules and processes are drawn up and the customer need is worked on using five steps per project. Each phase is modular and we look for the very best manner of achieving the solution for each project.

Quality management system

Obviously, you expect that a reliable expert always has their systems and processes in order. Sentech optimally manages all of its established processes, selects suitable suppliers, safeguards quality, and takes responsibility.

This does not immediately distinguish us from other companies, but it does show that we are serious about how we deal with your needs to achieve the very best solution for you.

5 Two decades of passion for sensor technology accrues sensor and market experience

We have worked in the sensor technology market for a long time and have accumulated a lot of knowledge, which is safeguarded in our organization. We are directly supported by our suppliers and manufacturers who think along with us at the engineering level and during development. They now come to us on their own.

Our knowledge makes us the technological intermediary between you as a customer and the manufacturer who developed the technology. Our role is to help guide you integrate the developed sensor assembly in your machine. Without Sentech, it is extremely difficult for the manufacturer to bring their technology to the market.

Large corporations acquire the original smaller technology manufacturers after they have proven themselves with their own technology that they developed themselves. Sentech has worked with these manufacturers for a long time because our company is able to spot (new) technologies more quickly and to find you the right contacts. Sentech knows the market and has a relationship with all of its players.

I truly believe that we can improve your machine. Engineers at our customers have a general acquaintance with sensors, motion, and mechatronics. In general, their knowledge is not very specific. Our expert knowledge allows us to present technologies both new or generally known. This allows us to add value to your machine.

Supplier POSIC shares knowledge with our sensor experts about inductive encoders.

6 Always helping

Sentech always helps whatever the background of your (original) need. If we do not have an answer immediately at hand, we are committed to looking for options outside the standard process. For example, if we do not have sufficient production capacity in-house, we take direct action to acquire sufficient capacity. This might be hiring someone, introducing overtime, or subcontracting out to a partner.

7 Committed (customer) contact

Other organizations regularly indicate that Sentech is a very committed sensor expert that maintains direct and personal contact. The sales director of a large automotive manufacturer said exactly this during an escalation. He directly confirmed that Sentech does everything it can to find a good solution for their challenge.

> ***"Customers that do business with us see how we are fully committed in all disciplines."***

He called me in person to ask that we collaborate on the next improvement phase. Customers that do business with us see how we are fully committed in all disciplines. For example, account management, logistics, and quality. We also see a real commitment to the company's core values like working in a reliable and solution-oriented manner.

We go beyond just knowing our colleagues well. Sentech also knows its customers. It's excellent that everyone helps each other. That ensures there is an informal work atmosphere with an advantageous open system.

What is your sensor challenge?

With a market of countless sensor technologies, you can never be 100% expert in everything. To help you, Sentech explores and refines its knowledge of technologies. Moreover, we test these against the market.

Share your challenge with our sensor expert Jeroen

We like to share our knowledge with you. So you can quickly continue with your sensor integration project. All you have to do is let Jeroen know that you have a question. He will call you back within 1 working day.

make a call

sentech.nl/rde-book-call

challenge accepted.