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Automated
Quality Assurance

Make your production sustainably more profitable

Executive Summary

Automated quality assurance along your product life cycle

In this whitepaper, we discuss the **why and how of automating your quality assurance** (processes). Automated quality assurance can lower the cost of good quality, for example by reducing recall costs due to bad quality or the duration of inspection time by skilled labor. Thus, automated quality assurance is a powerful tool to **increase profit margins** and **independence from external factors**, like supply chain stability.

You can automatically monitor the quality of specific features or detect OOS (out-of-specification) errors with different sensors. From **one-dimensional sensors** (e.g. a simple thermometer) to **more-dimensional sensors** (e.g. spectrometric images), you can monitor (almost) everything automatedly. However, with increasing sensor complexity, you also face **increasing costs** of implementation and maintenance. This means, choosing the right sensor solution depends on your **needs and potential savings**.

Adding artificial intelligence to your sensor data will help you to increase the return on invest of automating your quality assurance. One of the most widespread ways to do this is so-called **computer vision**, as it is closest to human vision. We used computer vision in projects **across different industries** to automate quality assurance along the standards of the Industrial Internet of Things. For instance, to automatedly detect and classify engine components with **MTU** or monitor packaging quality for **Tetra Pak**.

01. **The Cost of Quality**
Why bother with quality assurance?

02. **Use Cases & their ROI**
Identify which processes you could automate

03. **How About AI?**
Make more out of your data

04. **Cross-Industry Projects**
Automating QA along IIoT standards

05. **Tech Glossary**
Definition of technical terms

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01.

The Cost of Quality

Why Quality Matters

Quality control directly impacts profits and reputation by maintaining manufacturing standards and customer satisfaction.

Did you know that ...

- The cost of quality can add up to 15-20% of their annual revenue. At larger organizations, it can be up to 20-30%.
- In 2018, manufacturers in the United States paid out an estimated $26 billion in claims (about $80 per person in the US).

Ref1: What is Cost of Quality (COQ)? | ASQ
Ref2: Analyzing the Impact of Quality Tools and Techniques on Quality Related Costs : Comparing German Industries, Michael Donauer, Henning Mertens and Martin Boehme, 2015
Ref3: Warranty Week, "Warranty Claims Rates by industry"

A Traditional Business

Quality Assurance boosts your profitability by lowering your costs of quality.

Quality assurance still relies heavily on humans and traditional machine vision solutions, that use **inflexible, rules-based analysis methods**. This inflates *Detection Costs* and thus *Cost of Good Quality*.

While there is less and less wiggle room to optimize traditional quality assurance, **external factors like skilled labor shortage** make prevention & detection costs more expensive.

Combined with the **rising pressure to increase profit margins** due to a slow economy and inflation – this is an explosive mix calling for new ways to assure your production quality: Automated quality assurance.

Cost of Good Quality = Prevention and Detection Costs

Improving Your Quality Assurance

The main advantages of automating quality assurance:

1. **Accuracy**
   Ensure high accuracy within accepted tolerances in every manufacturing process. Even with specific equipment, such as a magnifying glass, machines are more accurate than humans.

2. **Repeatability and Consistency**
   Automated QA can perform repetitive tasks with a very high level of consistency. This is hard or even impossible to achieve with manual inspection, as it depends on operators, their experience, perception, and their current cognitive load.

3. **Downtime and Notifications**
   24/7 quality control without any downtime. This includes automated CAPAs (corrective and preventive actions) notifications with different levels of escalation.

4. **Costs**
   Less manual inspection, means more time for other important tasks. In addition, increasing accuracy decreases the risk of shipping defective pieces to costumers. You reduce upfront and hidden costs due to reputation and recalls.

5. **Safety**
   Safe quality inspection in dangerous production environments.

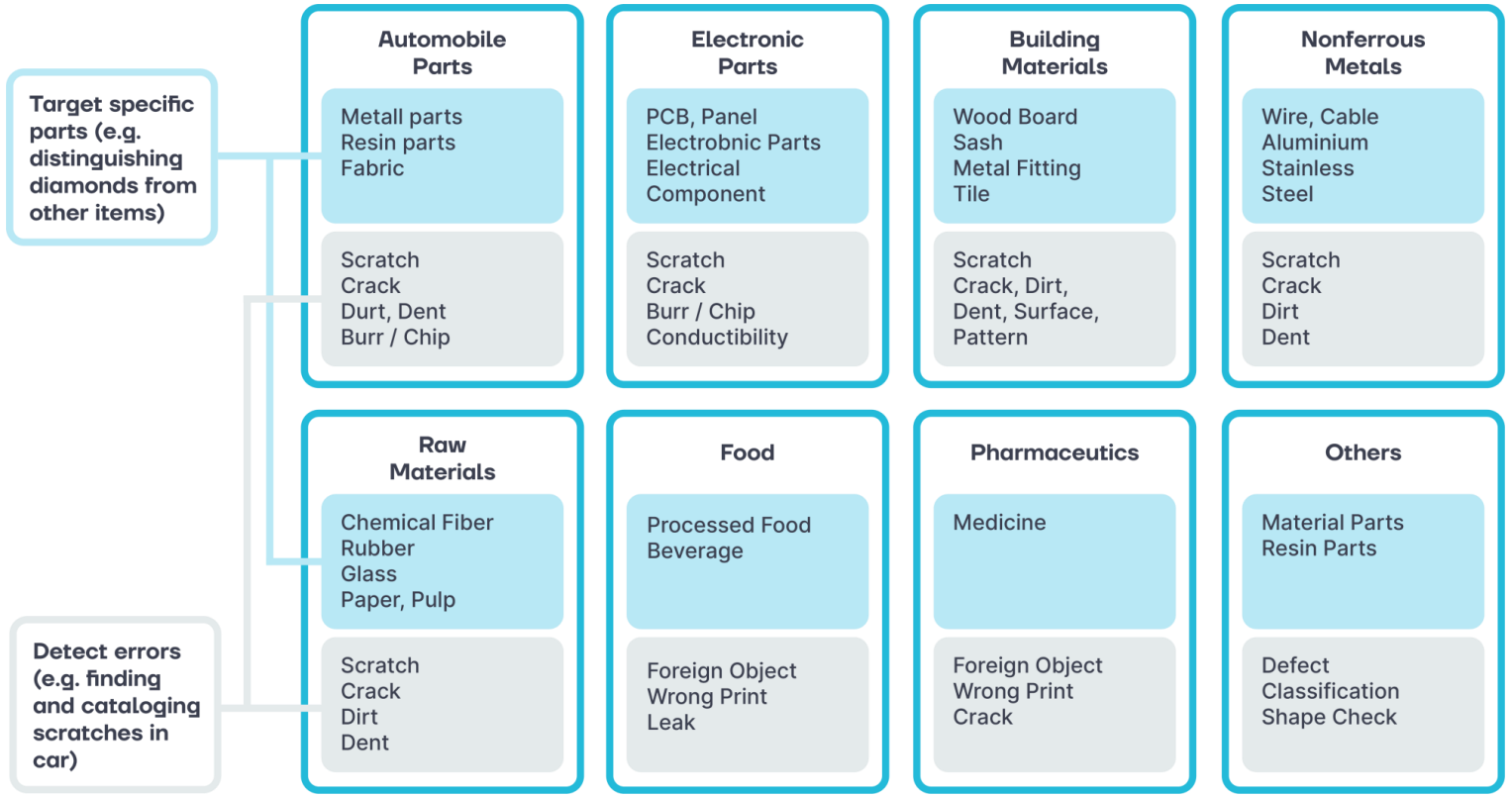
02.

Use Cases &
their ROI

Use Cases

Let’s move from theory to practice

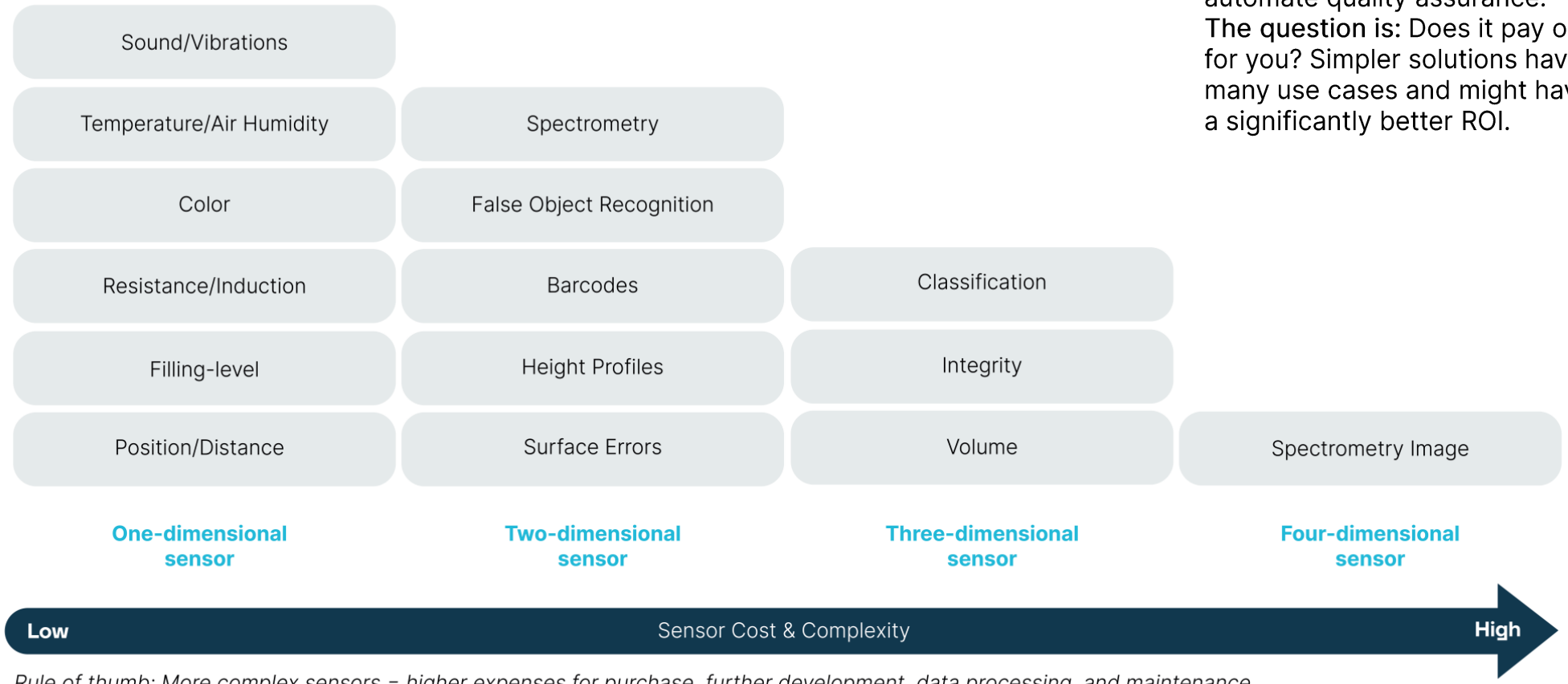
Where could you automate your quality assurance? This is a general overview:



Sensor Complexity x Use Cases

Sophisticated sensors don't necessarily have the best ROI

You can monitor almost all levels of complexity to automate quality assurance. **The question is:** Does it pay off for you? Simpler solutions have many use cases and might have a significantly better ROI.



Rule of thumb: More complex sensors = higher expenses for purchase, further development, data processing, and maintenance.

How Does It Work?

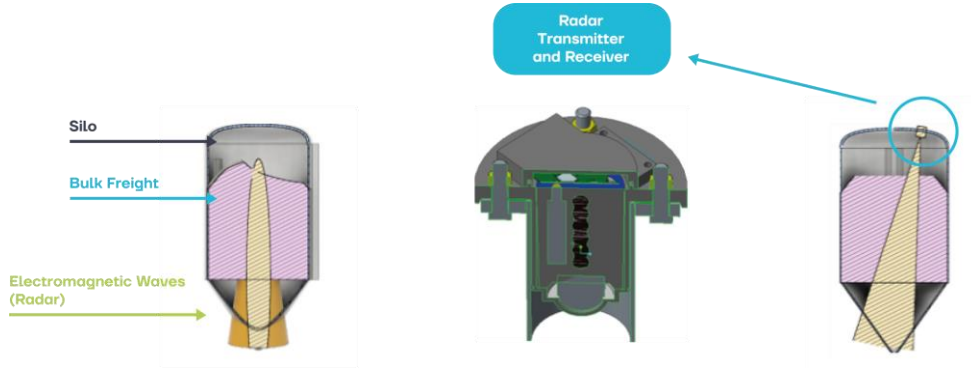
Let's make it a bit more tangible. Here are some sensors and how they work.

1

Radar Sensor

Measure the filling level of heavy bulk freight, as we did with Rosenberger.

By transmitting electromagnetic waves that bounce off the silo content and return to a receiver, you receive a distance measurement and can derive its filling level.

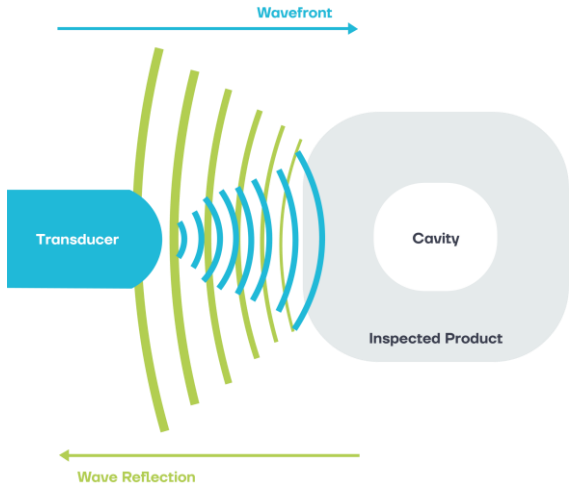


2

Vibration Sensor

Assess the position, size, and volume of cavities under surfaces.

Each interface reflects the incoming wavefront. Cavities under surf ace will reflect the wave differently.



How Does It Work?

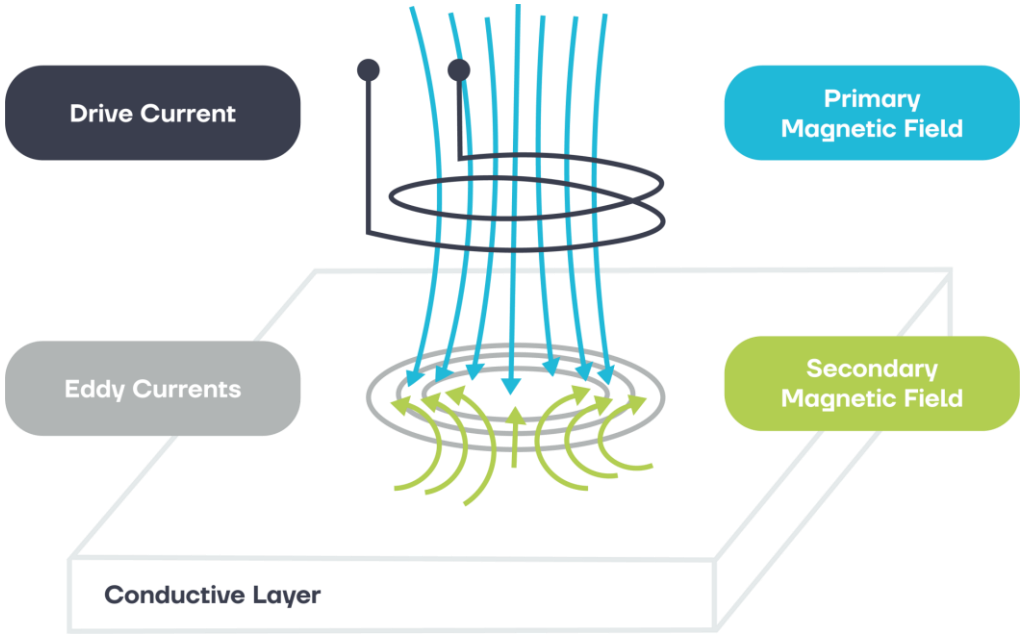
Let's make it a bit more tangible. Here are some sensors and how they work.

3

Eddy Current Testing

Mapping of conductivity of surfaces to control layer thickness of coating, even if it's very thin.

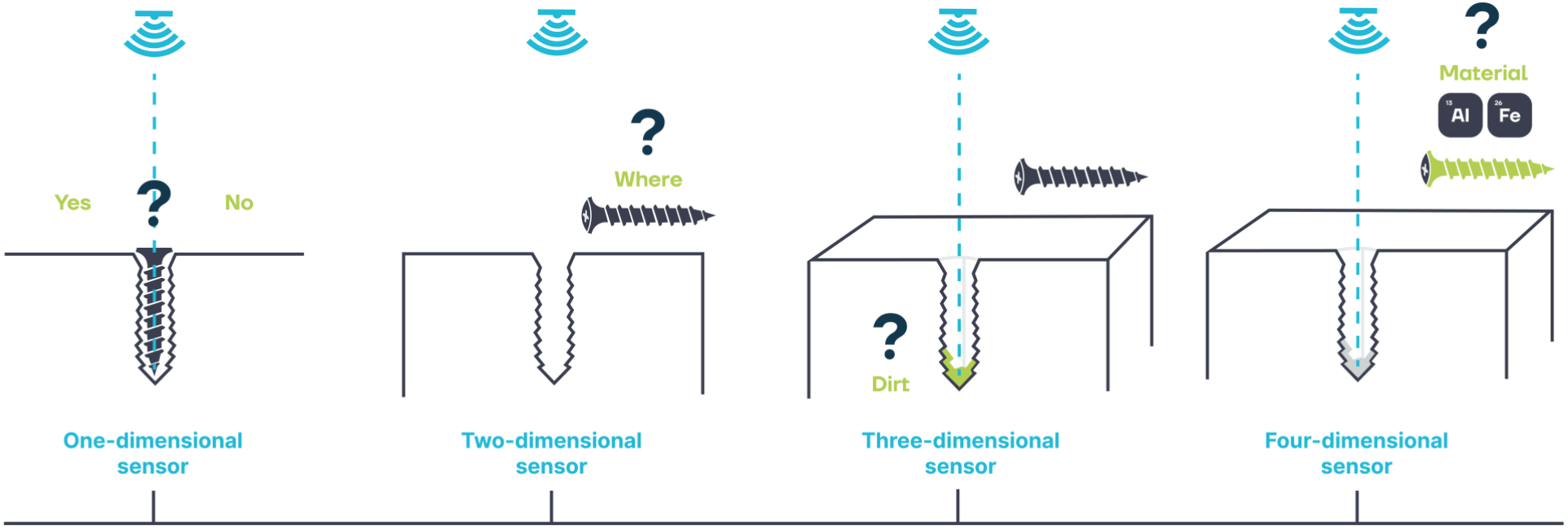
Eddy current testing is a non-contact inspection technique, utilizing a time-varying magnetic field.
This creates a secondary magnetic field, which can be measured to calculate thickness of conductive layer.
Respective resistivity maps can highlight film uniformity, quality, and other process variation.



Sensor Complexity in a Nutshell

Choosing the “right” sensor depends on your quality assurance needs. Generally, there are different levels of sensor complexity. To illustrate this, let’s assume you use a screw in one of your production steps:

One-dimensional sensor	Two-dimensional sensor	Three-dimensional sensor	Four-dimensional sensor
You want to know **if there is a screw** or not? e.g. distance sensor 1 - 100€	You want to know where your screw is if it's not **in place**? e.g. traditional camera 50 - 300€	In addition to that, you want to know if there is **dirt** on the screw or in the hole? e.g. depth-sensitive camera 150 - 1000€	On top, you have **chemically different** screws at your plant and want to know which one is being used? e.g. spectrometric camera 500€ +++



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How About AI?

Make More of Your Data

Make More of Your Data

Add AI to your sensor

Choosing a suitable sensor is one thing. Another way to influence your ROI positively is by adding AI to the mix. For example, you can collect data with a traditional camera (a two-dimensional sensor) and enhance it with AI to get so-called **Computer Vision (CV)**.

Industry 4.0 technologies are widely spread in production lines to increase the efficiency of manufacturing processes. So why not extend this with quality assurance as well?

> **"Computer Vision is Building Artificial Systems that Process, Perceive, and Reason about Visual Data."**

Let's explore Computer Vision a bit deeper here, to showcase how sensor data can benefit from AI. It's a very tangible example because it's probably the closest to human vision.

Why Computer Vision?

Here are to fundamental factors you should consider:

1

Quantity

We generate billions of visual data every day. For instance, people upload more than 300 hours of video content per minute - just on YouTube. We observe the same trend in the industrial domain. The quantity is so enormous, that it can't be processed by humans anymore. But it can be processed by machines and leveraged to train and improve models.

2

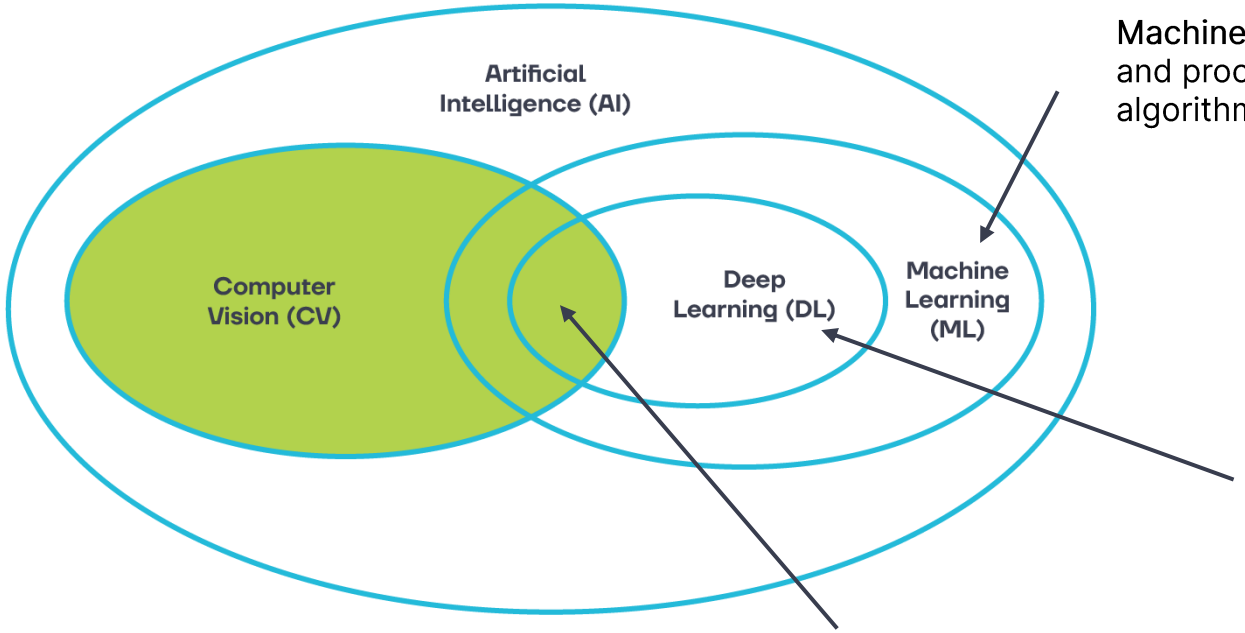
Variety

There are more and more **different types of visual data sensors**. New technologies like augmented reality, autonomous vehicles, drones or other new types of sensors are emerging every day and they can't all be interpreted or processed in the same way.

Now We Need AI

So, we have a lot and very different (visual) data, but how do we make sense of it?

Computer vision systems are artificial intelligence systems (= algorithms) that process, perceive, and reason visual data. We create CV systems to see and derive meaningful information from the data. If you are not familiar with Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL), read our AI Essentials.



Machine learning algorithms and models can perceive reason and process data from Computer Vision systems. These algorithms have to learn from data and experiences.

Deep learning is the modern technique of machine learning that has been used in recent years to learn from data. It adapts to what a machine sees.

Computer Vision (CV)
with Deep Learning (DL)

Source: http://www.technologystories.org/ai-evolution/

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04.

Cross-Industry Projects

Automated QA @Motius

We collaborated with several leading companies to automate quality assurance (processes)

Get some insights into how we automated QA along IIoT (Industrial Internet of Things) standards, utilizing the SE (systems engineering) framework.

1 **Automatic Components Detection at MTU**

2 **Quality assurance of food packaging with Tetra Pak**

Motius x MTU

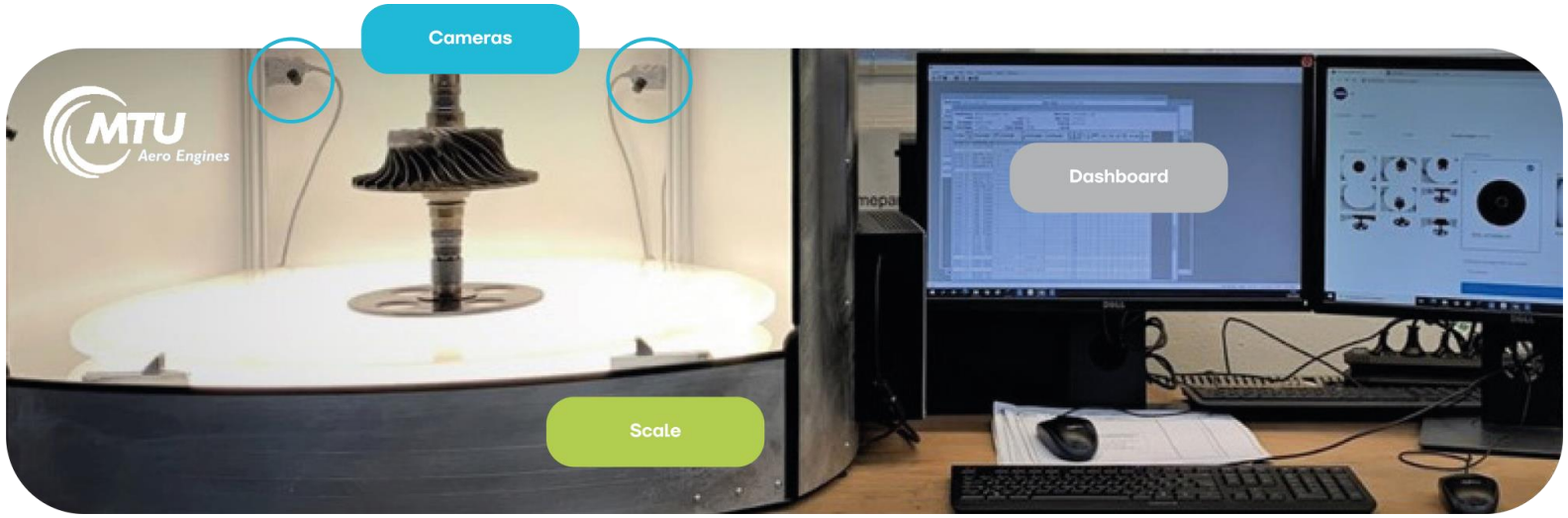
Saved 30% of machine part identification time on average

Used Sensors

- **Scale**
- **4K Cameras**
- **Laser Distance Sensor**

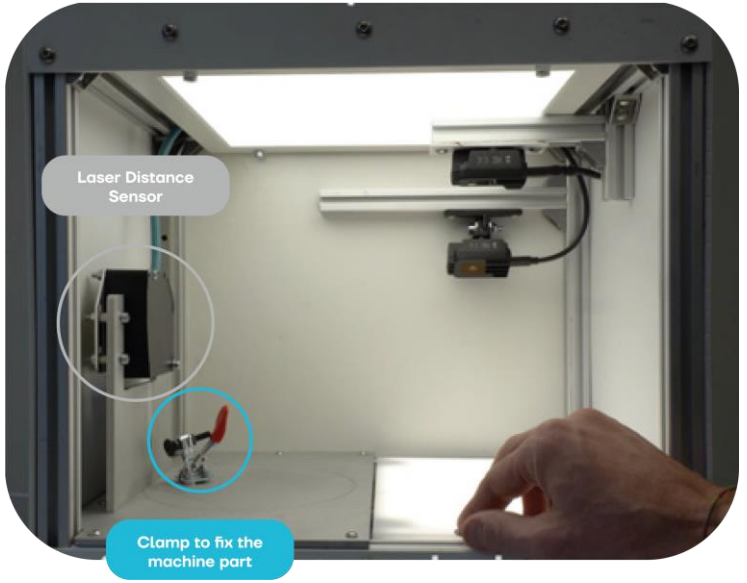
The Challenge: During the maintenance of aircraft engines, the entire engine is taken apart – in the process, all important components are registered. To shorten this time-intensive process and free up valuable time for skilled experts, MTU wanted to (semi-) automate it.

Motius came up with a Computer Vision solution in conjunction with a custom-built box that includes different cameras and provides for optimal lighting conditions. The dashboard shows example image of detected machine part to the user.



The Benefits: On average, MTU was able to reduce 30% of their machine part identification time. Additionally, the reliable classification of costly precision machine parts enabled their re-utilization and thus reduced spare part expenses.

Estimated amortization time: 8 years



Motius x Hilti

15% reduction in failure rate and defect costs

Used Technologies

Industrial Cameras

Django, Celery, React

Open CV

The Challenge: Hilti wanted to improve the quality assurance for one of their production processes. The challenge was to detect defects almost unrecognizable to the human eye in a complex production process in which multiple interdependent indicators define quality.

Motius came up with a Computer Vision solution that provides the necessary information to the employee directly at the production line to monitor the process and quality and a management dashboard that provides information for the whole production line.

The Benefits: By establishing a 100% inline quality inspection with direct feedback from the system to the operators, Hilti was able to reduce the failure rate and defect costs by 15%. The automated quality assurance process resulted in guaranteed product outperformance and high customer satisfaction due to stable quality standards.

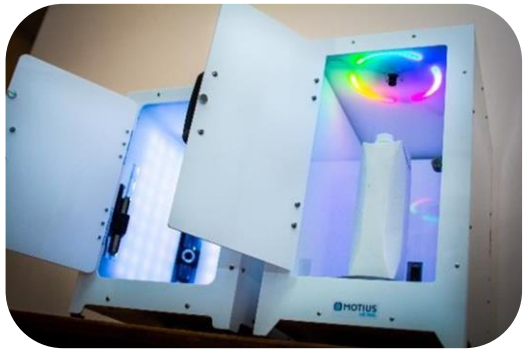
Motius x Tetra Pak

Leveraging Computer Vision for the quality assurance of food packaging

Used Sensors

- **RGB Camera**
- **Thermometer**
- **Hydrometer**
- **Scale**

For Tetra Pak we improved the quality assurance process of food packaging. Instead of manual control, the packaging is analyzed with sensors, cameras, and computer vision. The gathered data is automatically sent to a backend database and visualized by a Web App.



Next Steps

Bottom line and outlook

In short, this is what you need to know about automating your quality assurance:

- Automated QA can improve your manufacturing accuracy, consistency, and safety while lowering costs and downtime.
- With the right sensor(s), you can monitor almost everything across all industries.
- Try to keep it simple: Make sure that development and maintenance costs stay lower than your potential savings.
- Adding AI to your quality assurance will help you to make your automated QA more efficient. Computer Vision is the most typical but not the only way to do this.

Now, what would be your next steps?

- Take a close look at your problem statement to choose a suitable solution.
- Start with a relatively simple sensor. If it fits your problem, it will have a positive impact on your business already.
- Once you've got the ball rolling you can easily scale it up or make it more sophisticated. Plus, you got proof to get more stakeholders on board.
- We can guide you from finding your problem statement to a fully-fledged QA automation with our lightweight, battle-tested QA solution.

05.

Tech Glossary

Tech Glossary

Here is an overview of technical terms we're using in this whitepaper

Industry 4.0

Describes the trend in manufacturing towards the integration of cutting-edge technologies like machine learning, IIoT, virtual reality, or 3D printing. Industry 4.0 technologies aim to create *smart factories* that are more efficient, flexible, and responsive to customer needs.

Industrial Internet of Things (IIoT)

IIoT is the integration of industrial equipment with sensors, software, and network connectivity to enable the collection, analysis, and sharing of data. Its purpose is to optimize industrial processes and performance, like your quality assurance.

Systems Engineering (SE) Framework

A systems engineering framework is a structured approach to designing, analyzing, and managing complex systems that considers all aspects of the system's life cycle. In the context of QA it is the holistic approach to monitoring your production processes.

Computer Vision (CV)

CV is a field of artificial intelligence and computer science that focuses on enabling computers to interpret and understand the visual world through digital images or video. It works similarly to human vision and thus is an industry 4.0 technology that is often used for automated QA.

Sensor Data

When automating quality assurance, sensor data is collected to detect errors or monitor specific features. But sensor data can also help you to identify areas of improvement in your process.

Out-of-specification (OOS) error

An OOS error refers to a test result that falls outside the acceptable limits or requirements for a product or process.

Corrective and predictive action (CAPA)

CAPA is a quality management process to investigate and correct identified OOS errors. This involves notifying responsible parties on different escalation levels, so they can pin down the cause, take actions, and implement measures to prevent a recurrence.

06.

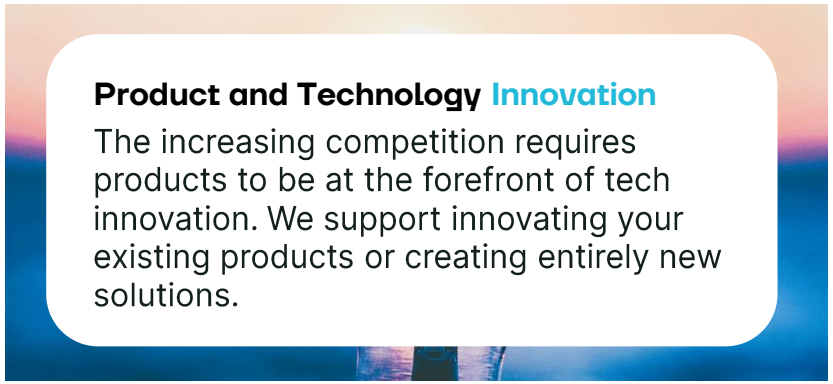
About Motius

Re-inventing Your Business With Emerging Tech

New technologies change rapidly, creating countless opportunities for your businesses to grow. However, many companies are struggling to facilitate these emerging technologies for actual value creation. Motius is specialized in tackling these technological challenges. We support you in applying the latest tech and in creating a lasting return for your business.

Production Automation

Through tailored solutions we help automate manufacturing processes to increase efficiencies, reduce costs and improve overall productivity.

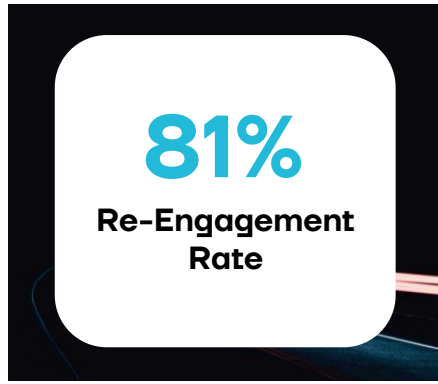


Product and Technology Innovation

The increasing competition requires products to be at the forefront of tech innovation. We support innovating your existing products or creating entirely new solutions.

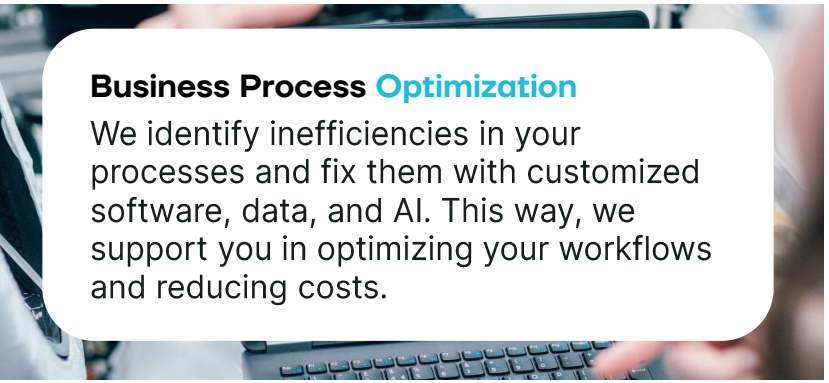
>700

Projects



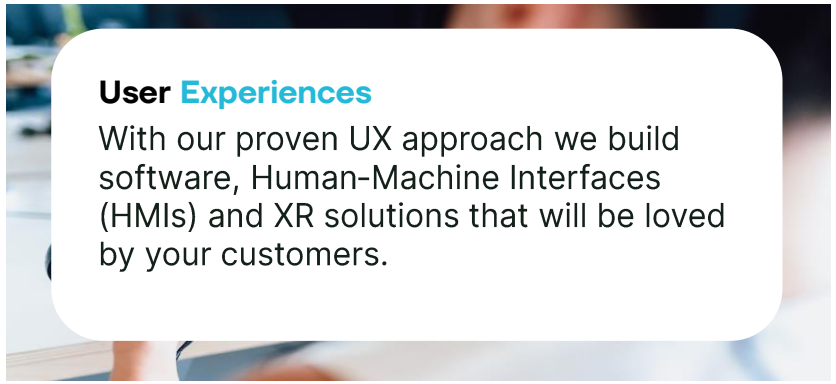
81%

Re-Engagement Rate



Business Process Optimization

We identify inefficiencies in your processes and fix them with customized software, data, and AI. This way, we support you in optimizing your workflows and reducing costs.



User Experiences

With our proven UX approach we build software, Human-Machine Interfaces (HMIs) and XR solutions that will be loved by your customers.

3

Offices (Munich, Stuttgart, Belgrade)

>110

Employees

Get in Touch With Us

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Let's talk

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