CAR Master training

CONTENT UNIT 3

QUALITY CONTROL METHODS

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3 Quality control methods

3.1 The introduction

The topic

A certain quality is of course always desirable. In only a few sectors, however, is it as essential and even vital as in the automotive industry. In road traffic, a lack of quality can quickly lead to very serious accidents. One is not only thinking of safety systems such as airbags, automatic braking systems or warnings in the cockpit, but also of new technical assistance systems such as autopilot or lane-keeping systems.

In the end, however, poor quality is not only damaging to a company's reputation but also very costly - recall actions and subsequent repairs to cars are very expensive due to the large quantity and often global delivery. Even the mere suspicion of quality defects requires an immediate response - this applies equally to series production and smaller factories. Therefore, quality defects must be avoided at all costs, also from an economic point of view.

Quality control is therefore an extremely important part of the automotive industry. Quality control (sometimes also called quality assurance) is, along with quality planning and quality improvement, a part of quality management. It is nothing more than a collective term for a wide variety of measures and approaches that serve to ensure defined quality requirements - or more simply, how to control and thus also guarantee the quality targeted in quality management.

To understand this important and cross-company aspect, you will

- Know what quality planning involves
- Able to name the levels of quality planning
- Know quality characteristics
- Able to describe internal and external advantages of quality management systems
- Know the objectives, principles, and benefits of quality management systems
- Know the continuous improvement process (CIP) approach to product, process and service quality
- Able to name the phases of CIP
- Know the differences between CIP and Kaizen
- Four important quality management tools and their use in the automotive industry (Ishikawa/fishbone diagram, 5 Why method, Poka-Yoke, 8D method)

3.2 Basics of quality planning

Quality planning, along with quality control and quality improvement, is **a part of quality management**. With quality planning, one defines on the one hand the required **quality standards** in the company and on the other hand also the **measures that are** necessary to maintain these standards.

Planning is therefore the **starting point in quality management** and lays the foundation for success in quality control as well as improvement. Regarding quality control, **rules** are established here, which, however, must be continuously analyzed and adapted. The goal here is to define **quality characteristics**, weigh them and derive the requirements for quality control as well as the associated processes from them.

There are three levels:

1. **Analysis of error risks:** The aim here is to find out which sources of error exist or could exist that could negatively influence the targeted quality. From these potential sources of error, measures are to be derived with which errors can be eliminated as far as possible and further sources of error can be identified. Essentially, it is a question of which errors should NOT happen.
2. **Documentation of the quality assurance measures:** Any quality planning aims to create documentation that regulates the internal process, but also ensures instructions for the correct use of the product. From this documentation, a process plan is derived that covers the entire value chain in the company.
3. **Design of control procedures:** This level is the direct link to quality control. Here, procedures are to be defined with which the production processes are monitored to ensure the established quality standards.

Important

Quality planning is **not something that depends only on internal corporate goals or ideas in companies**. Rather, it is about **identifying the needs of the market**. The famous Steve Jobs once said about the quality that it is such a difficult subject because people "usually don't know what they want until you show it to them".

But other factors also play a role, such as an **environment** or the **current competitive situation**. In the automotive industry in particular, quality requirements are increasing and changing due to technical advancements - think of digitalization in the cockpit, electric engines and drive systems and the question of environmentally friendly energy generation.

For the quality planning levels to be implemented accordingly, measurement methods must be applied and these must also be newly developed in the case of new requirements. In the automotive industry, there are usually four particularly important quality characteristics for this purpose:

- **Functionality:** All the features on offer must meet current standards in terms of quality. Especially when it comes to safety, this is essential - think here, as already discussed, of airbags, internal navigation systems, and indicator lights, but also future technologies such as self-driving cars.
- **Reliability:** Assistance systems, such as the so-called autopilot, are still rather dreams of the future. Nevertheless, there are already many driving aids, such as parking aids and lane-keeping systems. These must function reliably in international road traffic. There is absolutely no leeway here as far as fault tolerance is concerned - this is a particularly important and also challenging quality feature in quality planning and also in quality control.
- **Operability:** The many technical innovations must be easy and safe to operate - the design of the driver's seat in the car, for example, plays a major role here. With more and more technology, the driver's seat is turning into a command centre, so to speak, in which the status of the vehicle and its technical possibilities must also be easy to keep track of.
- **Efficiency:** An important part is also the energy consumption of a vehicle. This must not only meet market requirements but also follow legal requirements.

Hint

To be able to serve these quality characteristics, the field of **quality planning** is **very interdisciplinary.** This means that there must be a **constant exchange with all departments in the company,** such as research and development, sales, service and of course production.

Example

Below are just a few examples of how automotive companies deal with quality planning. Each company may have its own unique approach, but the goal is always the same: to produce vehicles that are safe, reliable, and meet or exceed customer expectations for quality.

Toyota is known for its focus on quality, and the company uses a quality planning approach called "Advanced Product Quality Planning" (APQP). APQP is a structured approach to quality planning that involves defining customer requirements, identifying potential failure modes, and developing plans to prevent those failures from occurring. Toyota uses APQP to ensure that its vehicles meet or exceed customer expectations for quality and reliability.

Ford uses a similar approach to quality planning, called "Production Part Approval Process" (PPAP). PPAP is a standardized approach to quality planning that involves documenting the design and manufacturing process for each component of a vehicle. This ensures that all parts meet the necessary quality standards and are compatible with the rest of the vehicle.

General Motors uses a quality planning approach called "Design for Six Sigma" (DFSS). DFSS is a data-driven approach to quality planning that involves using statistical analysis to identify and eliminate potential sources of variation in the design and manufacturing process. This approach helps GM to produce vehicles that meet or exceed customer expectations for quality and reliability.

3.3 Aims and benefits

Quality planning is therefore an essential part of quality management. But what are the concrete goals of quality management? Simply put, it is about companies adapting their processes, internal structures and procedures to their business models as efficiently as possible and at the same time making them measurable.

Important

Quality management does not automatically mean that the product itself must be of high quality. Companies that produce cheap products also have a form of quality management - here, for example, the goal can be to make the production process as cheap as possible while still maintaining at least an acceptable quality of the end product. So it is always a question of ensuring the best processes relative to the quality demand.

There is a standard (ISO 9001) that defines **seven goals** in this regard:

- **Customer orientation as well as sustainable success**: Expectations of the products or services should be met or exceeded - this applies not only to external persons but also internally, for example, employees in a subsequent production step. By always meeting expectations externally and internally, the added value should always be created.
- **Management and leadership**: Managers should always act as role models to contribute to the success of the entire company.
- **Commitment of people**: Personal initiative, proactivity and motivation of employees should always be kept high - this is the only way to ensure internal quality.
- **Process-oriented approach**: The company is defined by processes instead of functions. These processes must be continuously improved. This applies above all to the interfaces, i.e. where processes are connected - these interfaces are, after all, particularly often sources of errors.
- **Improvement process**: The core objective is a continuous improvement process that is to be used systematically and repeatedly (more on this in the next chapter).
- **Evidence-based decision-making**: Decisions should be made based on clearly attributable data and measurements - the more complex a company is, the more important this aspect is.
- **Relationship management**: As far as possible, all persons connected with the company (also called "stakeholders") should be actively involved in quality management to be able to build up good relationships both internally and externally.

Note

The goals just learned are to be understood as continuous improvement - i.e. as a **control loop**. This control loop consists of **quality planning** (clarification of the actual state and the framework conditions), **quality control** (implementation of the planned measures), **quality assurance** (cost-benefit consideration and evaluation) and **quality gain** (use of the evaluated data and communication of the results).

Effective quality management is an important driver of many of a company's benefits, both internal and external. **Internal advantages** are good for the company, but also the individual employees:

- Processes become more transparent, and interfaces and areas of responsibility are clearer.

- Cost-causing errors are reduced or avoided altogether.
- Structures and working conditions are improving.
- Quality awareness and intrinsic motivation for continuous improvement are built up and sharpened among the employees.
- Internal communication processes become simpler and more efficient

Externally, there are also predominantly three advantages:

- Based on the ISO standard, companies receive neutral and international proof of their quality capability.
- Results and data collected in the course of quality management are traceable.
- The company achieves strong bonds and relationships in sales and with partner companies by maintaining quality standards.

Example

Foremen play an important role in ensuring quality in an automotive company. Here are a few ways they can contribute:

Training and development: Foremen can ensure that their team members have the necessary knowledge and skills to perform their jobs effectively and efficiently. This includes providing training on quality standards and procedures, as well as on specific tasks and equipment.

Monitoring and inspection: Foremen can regularly monitor and inspect their team's work to ensure that it meets the necessary quality standards. This includes checking for defects, verifying that work has been completed correctly, and identifying any areas for improvement.

Communication: Foremen can facilitate communication between team members and other departments to ensure that everyone is working towards the same quality goals. This includes providing feedback and guidance to their team members, as well as communicating any issues or concerns to higher-level management.

Continuous improvement: Foremen can lead their teams in continuous improvement efforts by identifying opportunities for process improvement, implementing changes, and measuring the results. This includes gathering data, analyzing trends, and making adjustments as needed to ensure that quality standards are met and exceeded.

Overall, foremen can contribute to ensuring quality in an automotive company by providing training and development, monitoring and inspecting work, facilitating

communication, and leading continuous improvement efforts. By doing so, they can help ensure that their teams are producing high-quality products that meet customer expectations and drive business success.

3.4 Improvement

An important component of ISO 9001 that has just been discussed needs to be looked at more closely - namely the process of continuous improvement (also called continuous improvement process or simply CIP). This is indispensable in quality management and applies equally to product, process and service quality.

Definition

CIP essentially means implementing constant smaller steps for improvement. This contrasts with innovation management, for example, which involves larger, more radical innovations or improvements.

To implement CIP, working groups are always formed - these can either be moderated internally (for example by managers) or sometimes companies also bring in external persons to moderate. Just like the equally well-known principle of Kaizen, CIP, as it is currently used, was developed in Japan in the automotive industry (mainly in the factories of Toyota).

Since CIP involves a great deal of initiative and commitment on the part of employees, management must introduce and live CIP as part of the corporate culture - that is, resources must be made available for the immediate implementation of ideas and findings and commitment must be recognized accordingly. Further training of employees is also an important aspect of CIP.

The implementation of CIP projects varies - but a typical process could look like this:

1. Define and delimit the relevant work system
2. Describe the current state and the target state with the help of key figures.
3. Describe and evaluate possible problems and analyze causes and interrelationships
4. Collect, evaluate and select ideas for solutions
5. Derive measures and evaluate effort and possible gain
6. Present results, agree and allocate measures and clarify required resources
7. Implementation of the measures and review of the success

Typically, the individual phases are divided into phases based on a Deming circle (also known as a PDCA cycle). Here again, the control loop of quality planning, quality control, quality assurance and quality gain learned above becomes important.

Note

The PDCA cycle always consists of four phases that are applied continuously and repeatedly for a wide variety of process improvements. PDCA stands for Plan, Do, Check and Act - more precisely for **planning**, **implementing**, **checking** and **deriving the results** for further practice.

Let us now look at the phases of CIP using a PDCA cycle:

- **Plan - Quality Planning:** In this phase, the quality standards are defined, the framework conditions for possible implementations are discussed and measures are planned based on the available resources, identified opportunities as well as possible risks.
- **Do - Quality control:** This phase determines the implementation of the measures that have been planned. The aim is to meet or exceed the quality management requirements that have been developed.
- **Check - quality assurance:** In this phase, the results are checked and evaluated internally. In particular, it is evaluated which goals from the planning phase could be implemented and which possible sources of error or weak points were identified.
- **Act - Quality gain:** To improve the process sustainably, the results of the previous three phases are used as new rules and standards for future improvements - i.e. as a basis for a new planning phase. This is how the desired cycle of continuous improvement is created.

If CIP is implemented in the company accordingly, several **advantages** arise in competition with other companies: Processes and organizational efforts are streamlined, the waste of resources is reduced, the cooperation and satisfaction of the employees are strengthened and, of course, product quality and product satisfaction also increase.

Hint

CIP and the above-mentioned Kaizen are **often mistakenly seen as the same**. However, there are significant differences. In **Japan, for** example, **Kaizen is a kind of philosophy** or attitude to life that goes beyond business issues - the constant improvement of all things.
In the western world, however, Kaizen is simply limited to **methods of quality improvement in companies, such as CIP,** especially in management circles. To distinguish the term from Kaizen, **CIP can be** described as the **business management part of Kaizen,** which prescribes clear courses of action in the corporate environment.

A foreman's daily work in an automotive company is focused on ensuring that the team is working safely and efficiently, meeting production goals, and continuously improving

processes and products. They play a critical role in the success of the organization and are responsible for leading their team members to achieve their best work.

Example

A foreman responsible for continuous improvement might spend their day identifying opportunities for improvement, developing action plans to implement changes, and tracking progress towards improvement goals. They may work with cross-functional teams to implement process improvements, participate in brainstorming sessions to identify new ideas, and track metrics to measure the success of improvement initiatives.

Overall, foremen can deal with PDCA by contributing to each stage of the cycle, from planning to acting. By doing so, they can help drive continuous improvement in their team's performance and contribute to the success of the automotive company.

3.5 Quality management tools

You now have a broad understanding of quality planning and quality management at large. But how do you use this understanding? We will now look at some of the **most important tools**, i.e. procedures and tricks that are often used by working groups in quality management.

Let's first look at the so-called **fishbone diagram** (sometimes called the after its inventor or simply the cause-effect diagram). This method is used to find the causes of a problem. The following procedure is followed:

1. First, the **problem in question is** defined in **as much detail as possible.** This problem is if you want to illustrate it, the "fish head". Starting from the problem, all possible causes are worked out in a joint brainstorming session.
2. The causes are classified according to the **5M method.** For this purpose, five words begin with M (usually these are: machine, manpower, method, material, management or measurement, but others are also possible). These five categories form the "bones" of the fish (hence the name "fishbone" diagram) and the causes are then also assigned to these categories.
3. To be able to identify the causes as fundamentally as possible based on a causal chain, we now apply the **5W method**. Each cause is questioned with a "why". The answer is in turn discussed with a "why" - a total of five times if possible. The resulting causal chains serve to develop a particularly transparent solution.
4. Now there are probably many causes of the problem for discussion. **Decisions must now be made** about these - anonymously, for example, to avoid, as far as possible, interest-based approaches to solutions by individual employees.

Hint

The tools presented are **not self-contained systems** that stand alone. Rather, they are **combinations of the most diverse techniques that** have developed and proven themselves in the course of the history of quality management and its approaches. The 5W method (also called the **5-Why method**), for example, has its origins in Lean Management and can also be used effectively for other solution-oriented work without combining it with the fishbone diagram.

Another tool in quality management is the so-called **Poka Yoke**. This is not about finding the causes of problems, but about effectively preventing them. Incidentally, an umbrella term for such techniques that have a **problem-preventive** effect is "**zero-defect methods**".

Poka Yoke was again developed in Japan and its name means "**avoiding unfortunate mistakes**". The approach is system-based - that is, problems or mistakes are not the responsibility of people, but always the "fault" of a system. The Japanese engineer Shigeo Shingō also developed this concept so that employees would be more likely to report existing problems - according to this approach, they cannot be to blame for them.

Errors can therefore always be traced back to faulty systems. Accordingly, systems can also be designed in such a way that errors cannot occur in the first place. In industry, this means above all the use of the right tools. **According to this concept, each tool has only one correct task - and that in only one correct sequence** - so that inadvertent incorrect assembly of components cannot happen in the first place. In other words, employees are properly trained in work environments that follow Poka Yoke (which also makes it extremely easy to train new staff).

Example

One component must be mounted on another. The correct steps are indicated at the workstation by **lights flashing at the currently correct tool or component.** Independent thinking during assembly is therefore hardly necessary.

At the same time, a so-called **Mistake Proofing System** checks whether the current work step has been carried out correctly and only then releases the next one. This practice is also and especially common in the cooperation between robots and humans and is an important point in the developments of Industry 4.0.

Finally, we look at the **8D method.** This is a quality assurance measure that was developed in the course of complaints management and is therefore particularly well suited when the causes of problems need to be **identified and remedied with** particular **urgency.** 8D stands for eight disciplines or, simply put, for **eight steps that are** carried out when a complaint is made:

1. A broad-based **team of** competent employees is formed.
2. The **problem** is objectively defined according to the target and actual state.

3. An **emergency measure** is developed and implemented (until the causes of the problem are found).
4. Possible sources of error or causes of the problem are **systematically analysed** (for example with the help of the fishbone diagram discussed earlier).
5. Measures to solve the problem are **implemented.**
6. The effectiveness of these measures is **checked** - if the error could not be eliminated, one starts again at step 1.
7. **Preventive measures** are determined that can be applied to other similar processes, for example.
8. The successful work of the team is **acknowledged** and the problem is thus symbolically closed.

Hint

The eight steps of the 8D method are usually recorded in writing in a so-called **8D report.** In the B2B sector (business-to-business - i.e., when companies have a business relationship with each other), this report is often explicitly requested by the complaining party as an assurance that the problem has been investigated.

3.6 Summary

Save knowledge

Quality management is an extremely **important aspect of the automotive industry** due to rapid technological progress and the necessary safety factors. In practice, quality management consists of three levels: **Quality planning**, quality **control** and **quality improvement**.

In quality planning, **quality characteristics** are defined, these are weighted and the requirements for quality control and the associated processes are derived from them. The four most important quality characteristics in the automotive industry are **functionality**, **reliability**, **usability** and **efficiency**. Quality planning is therefore the starting point in quality management. There are again three levels: the **analysis of** defect risks, the **documentation of** quality assurance measures and the **design of** control processes.

The aim is for a company to **adapt** its process and its internal structures and procedures as **efficiently as possible** to **the business model** and at the same time make them **measurable. The** ISO 9001 standard specifies **seven qualitative goals that** companies can orient themselves to: Customer orientation and sustainable success, leadership and leadership, the commitment of people, process-oriented approach, improvement process, fact-based decision-making and relationship management.

A special component of quality management is CIP, i.e. implementing a continuous improvement process in the company. With CIP, all processes taking place in the company are to be improved continuously and in small steps by internal working groups. The basis for this is the four phases in the PDCA cycle, which are used to analyse a process or system (for example, a work step). CIP is strongly dependent on the commitment and motivation of all employees and offers important advantages such as leaner processes, smoother cooperation and less waste of resources.

There are several tools and methods available for quality control, which can also be combined and applied to different scenarios.

The fishbone diagram is an effective approach to finding out the causes of an existing problem as thoroughly as possible. First, possible causes are discussed and ordered using the 5M method. Then, using the 5W method, the possible causes are discussed based on causal chains.

Poka Yoke is a preventive approach that states that the process is always to blame for errors. If this process is designed as clearly as possible and employees are guided through the process, errors cannot even happen. This method is common practice in the automotive industry, especially in areas where humans and robots work together.

The 8D method is a sequence of eight steps that are applied to complaints - on the one hand, to resolve problems as quickly as possible, and on the other hand to avoid them in the future. The result is usually an 8D report that documents the implementation of the eight steps and is also handed out in the course of complaints management.

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Co-funded by the European Union

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