*Proceedings of the International Conference on Industrial Engineering and Operations Management*

Publisher: IEOM Society International, USA DOI: 10.46254/AU04.20250060
Published: November 25, 2025

# Quality in the Age of Digitalization – How to Realize the Transformation

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## Abstract

Over the past decades, quality management has developed into a comprehensive management system and reflects in its current structure the complexity of globalization in all its facets (Jochem and Menrath 2015). The system architecture is based on the management pyramid as described in 'The Principles of Scientific Management' by Frederick W. Taylor from 1911 (Morieux and Tollmann 2015). Here planning and execution are separated; work sequences are also defined in the form of processes. Processes, however, require a repeatability of procedures. An almost stable economic environment allows, that process efficiency can be maintained at a high level. In a dynamic environment, even more data, more planning and more agility do not help, according to the authors' experience, because many of the quality problems have their root cause in the fact that the structures and cultures in the companies are not adapted to the increasingly complex market environment (see Baecker 1999). Therefore, the upcoming digitalization alone cannot solve the problem of under-complexity in structures and over-complicatedness in processes. In the future, companies will have to have more variability and flexibility to adapt to the increasing environmental complexity, as digitalization and the growth of complexity take place hand in hand (Menrath and Jochem 2020). For this reason, people and their abilities as complexity managers have to move more and more into the focus of companies despite smart technology. The article provides a general review and argues that digitalization is primarily a social challenge and not a technical problem only. With regard to the thesis "Why quality must be more than quality in the future", it is shown that people and culture in a company - and not digitalization - will decide whether a company can be successful in the future network economy.

## Keywords

Quality Management, Digital Transformation, Leadership, Complexity Management, Culture

## 1. On the Status Quo and Its Limitations

Processes are the heart of quality management and describe - as far as necessary - all procedures and the solutions anticipated in the company. The prerequisite for this is that the processes are understood and accepted by the employees and followed with a high degree of discipline (process compliance). Processes are very well suited for stable repetitive procedures in which internal and external disruptions are always accompanied by little variance in the processes and do not cause any major surprises during execution. Quality management thereby ensures that the

quality policy, processes, guidelines and work instructions are adhered to in accordance with the specifications of the quality system. As Yves Morieux and Peter Tollman have shown for the period from 1955 to 2010, bureaucracy in many companies has increased disproportionately compared to market complexity, which means that companies have reacted, mostly unconsciously, to the increased market complexity with more and more internal structure and bureaucracy (Tayler 2006). The quality systems are structured hierarchically according to the management pyramid. They also determine the formal communication channels and thus the horizontal and vertical communication capabilities of the company via the functions and roles defined in the organizational structure and processes. Communication is thus predetermined and often leads to silo formation within the company via the combination of structural and process organisation. Since the processes are processed sequentially and there is a low social density in the collaboration, because of the limited formal communication channels, the different areas (subsystems) can communicate their respective complexity only to a limited extent. The solution for this problem is therefore not to be found in increasingly detailed, predetermined structures, but in less organised complexity and more horizontal communication (Menrath and Jochem 2020). For it is precisely the uncontrolled variance that overstrains processes and often leads to mistakes and customer complaints and can only be managed through the use of additional informal complexity. However, the increase in complexity is often not perceived by management but rather seen as a problem of discipline and efficiency, since informal processes cannot be measured or controlled. But in reality, it is the informal side that enables the solution of the customer problem. The digitalization of existing structures can indeed make procedures more efficient, but it cannot change the fundamental problem of the under-complexity of many business processes in an increasingly complex environment. For many companies, the environment will become more complex, among other things, because in the future customers will expect more and more individual solutions, meaning that the development will go from Operations Excellence to Service Excellence all the way to Value Excellence (a distinct customer centricity, in order to generate a higher customer benefit with the help of digitalization, with significantly reduced effort). The focus of many companies is still on Operations Excellence and thus on the Quality-Forward-Loop today. The solution of the customer's problem and with it the customer satisfaction are not given the necessary priority (Menrath 2017). The goal is the perfect product but not the customer relationship. However, pure differentiation via product quality is no longer sufficient to survive in the market.

In a survey conducted by McKinsey in 2017 entitled ‘Quality excellence - the new imperative’ (Nick et al. 2017), among others, senior quality managers from various companies were asked what challenges and initiatives they envision for quality management in their companies in the coming years. The results of the interviews are summarised in excerpts in Table 1. All interviews show that the quality managers want to further optimize processes and procedures but also strive for a mindset change towards more quality awareness in the company and want to take the customer and his feedback more consistently into account in the development of their new products. It is also striking that the visions on quality are very general and contain no concrete reference to the company. Hence the question arises whether the goals set, and the initiatives planned will be sufficient to survive in an increasingly complex digital environment?

## 2. The Digital Change

As the last few years have shown, digitalization opens a new cosmos of communication. Indeed, it lets communication literally explode. It generates a new level of complexity in society and thus also in companies through the surplus of meaning, i.e. digitalization and complexity development go hand in hand. As a result, the increase in complexity leads to overload and therefore also to uncertainty as to what possible effects the digitalization will have in society and in companies, and with it the so-called digital revolution becomes a social innovation, essentially caused by the increasing connectivity of the world (Baecker 2007).

This digital change has been taking place for several decades, but the serious effects of digitalization are only now becoming increasingly apparent in society. At the forefront of the discussion is the issue of disruption, although most companies will not reach this phase of digital change. Companies such as Google and Facebook have set new standards for customer loyalty and interaction, but for traditional companies the change will rather take place via phases of conversion, transition and in a few cases up to a disruption, Table 1.

### 2.1 Conversion (Phase 1)

Here, the basic business model of an industry is maintained, but existing procedures and products are brought from analogue into a digital form. Products and processes are equipped with sensors and are networked, integrated into

higher units and provided with simple intelligence. The use of the Internet makes it possible to communicate with customers online, to offer a faster and, if necessary, extended service and to generate customer loyalty with it.

This phase of change is associated with a minimal increase of complexity, as cost reductions and increases in efficiency continue to be in the foreground. From a quality management point of view, this means that, as with lean management, the aim is to further increase operational excellence with the help of digitalization. With reference to Table 1, this applies rather to the Pool Maker and Ship Builder.

Table 1. 'Quality Excellence – the new imperative' (Nick et al. 2017).

| Dimensions of Quality Excellence | Pool Maker | Ship Builder | Car Maker X | Car Maker Y |
|---|---|---|---|---|
| **Quality Vision** | Quality first | Quality for our clients | Quality for life | Industry leader in quality and customer satisfaction |
| **Objectives** | – Q-Leader in industry<br>– Significant reduction in warrenty costs | To be ahead of competition:<br>– Always right the first time<br>– Being on time | – Customer centricity<br>– Surprise customers with outstanding experience | Stay ahead of competition:<br>– More customer centric<br>– Listen to customer voice |
| **Main levers to achieve objectives** | – Improve product quality<br>– Quickly resolve problems<br>– Optimise customer service | – Taking supplier base to a higher level<br>– Training programms<br>– Make quality visible | – Speeding-up field defect resolutions<br>– Optimise quality of products<br>– Premium in customer interaction | – Map whole organisation<br>– Make core functions more efficient and agile<br>– Lever 3rd suppliers for non core functions |
| **How to mobilise the organisation** | – Stop production line in case of quality problems<br>– Delay launch of new products if achieving required quality standards doubtful<br>– Everbody is empowered to raise quality problems | – Change peoples mindset from bureaucratic to preventive | – Key is communication and role modelling<br>– Managers have to hold regular town hall meetings<br>– Never compromise quality for cost and time | – Key is role modelling and accountability<br>– Senior management act as role model for the change of mindset<br>– Discipline in implementation |
| **Advice to leaders** | | – Need curiosity and willingness to confront each other<br>– Do not stop at the first road block<br>– Prevention makes you successful and profitable | – Secure top management commitment<br>– Mobilise the entire organisation through communication and role modelling<br>– Appoint project leaders full time | – Never underestimate the importance of mindset change<br>– Define what quality means to your company<br>– Make organisation understand, that efficiency and quality go hand in hand |

## 2.2 Transition (Phase 2)

Existing industry premises are obsolete and replaced by business intelligence and other competencies such as real-time data analysis, smart products, preventive services and the integration of IoT, the Internet of Things. In this way, customer behaviour can be recognized at an early stage and users can be supported more efficiently. At the same time, it is crucial that customers trust the new business model and cooperate closely with the company. From the perspective of quality management, the focus here is on end-to-end service excellence, which is a goal common to both car makers in Figure 1.

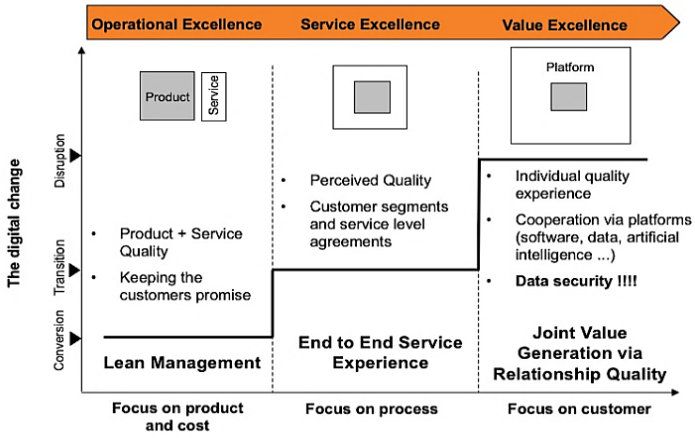


Figure 1. From product to relationship (own work by Menrath)

### 2.3 Disruption (Phase 3)

This highest and most complex stage of digital change turns entire industries and previous business model's upside down and creates entirely new value creation systems. The trend is moving away from physical assets towards the use of data, intelligent algorithms, artificial intelligence in conjunction with machine learning and network effects. The value creation becomes more and more individual, takes place in real time and in close cooperation with the users, whereby it is assumed that the users are willing to share their partly very personal or sensitive data with the provider. As a result, trust in the data security and integrity of the provider becomes the essential basis of the business relationship, as the current problems of Facebook clearly show. From the viewpoint of quality management, the quality of relationship, that is the quality of communication (openness, trust and the sharing of relevant knowledge) of the persons involved in value generation becomes the determining factor and forms the basis for the individually experienced value excellence of each user.

In all phases, communication increasingly takes place via data on networked computers or machines, the Internet and the intelligent algorithms that process this data. The expanded cosmos of communication offers companies the opportunity to develop new digital business models, with the added value or value excellence deriving from the interaction between people and the intelligent environment. Digital products must therefore have the network potential "built in" right from the start and enable new innovative business models through the combination of people, things and relationships or patterns. In other words, the design potential will shift more to the "inside" of the products via intelligent software in the future. However, this also means that the design process itself no longer has to take place top-down, from the idea to marketability. Instead, it must be iterative and open-ended (agile), as well as carried out in small steps together in close cooperation with the customer, e.g. through design thinking. In doing so, the networked society with its potentials and limitations must always be taken into consideration. This applies in particular to the security of data and must be pursued in future by quality assurance with the highest priority through "Design by Security". For the car makers in Table 1, the disruptive danger here is that the brand image "I am what I own" will be replaced by the relationship mantra of generation Z "I am what I do". With this, the automobile loses its individual and social attractiveness.

All in all, companies cannot escape digital change, but as part of their digital strategy they must not lose sight of their responsibility for their employees and society as a whole. To this end, companies have to consider the more informal social and sociological context in their business models, in addition to the business perspective.

## 3. The Company as a Sociological Form

The following explanations go back to the sociologist Dirk Baecker (Baecker 2017), who developed a sociological communication model, the form of the product. In addition to the economic business model, the economic logic assumes that the organisation always functions within the company and therefore excludes itself as a source of its own problems. In this way, business administration completely ignores the informal side of the organisation within the company.

### 3.1 The Informal Part of the Organization

It is helpful to visualize the interplay between organised and informal complexity in the company, as shown in Figure 2. The formal structure and process organisation are variables defined by management and accessible for direct control and monitoring, for example via KPIs (Key Performance Indicator). The informal organisation, expressed in terms of the iceberg of relationships, makes it clear that everything below the waterline is not visible and can therefore not be controlled by management. The informal organisation is often referred to as the culture of the company. Every company has its own culture, which is essentially expressed by the communication behaviour of its employees. Experience has shown that the informal side always adapts to the formal side in an organisation, meaning the everyday practice.

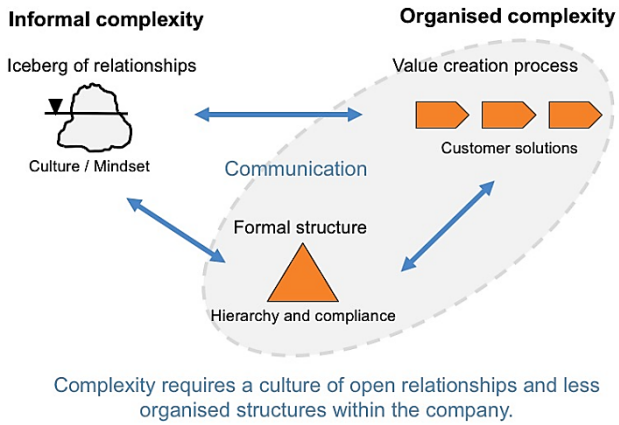


Figure 2. Complexity in the company (own work by Menrath).

In principle, each organizational variant is therefore capable of working but has different connection capabilities with regards to the environment. Today, due to increasing market complexity, it is more and more necessary to allow informal complexity in the company, meaning to trust in the employees and an open culture in the company. For in a complex world there is not a predefined solution for every problem, the problems look for their experts and not vice versa.

### 3.2 The Form of the Product

It is known from cybernetics / system theory that complexity or variability can only be controlled by complexity or variability (Ashby's Law), that is to say, a high variability of the environment also requires companies to have a high internal variability of organisation in order to be able to continuously adapt to environmental complexity. The environment of a company consists of complex subsystems: Market, economy, society and people combined, which as a whole can be represented as a complex form, as sketched in Figure 3.

The subsystems further to the right provide the context or the natural environment for the subsystems located more inwards. The company itself is constituted from the subsystems: product, process / technology and organisation / culture, whereby the product is the central element to which all subsystems refer.

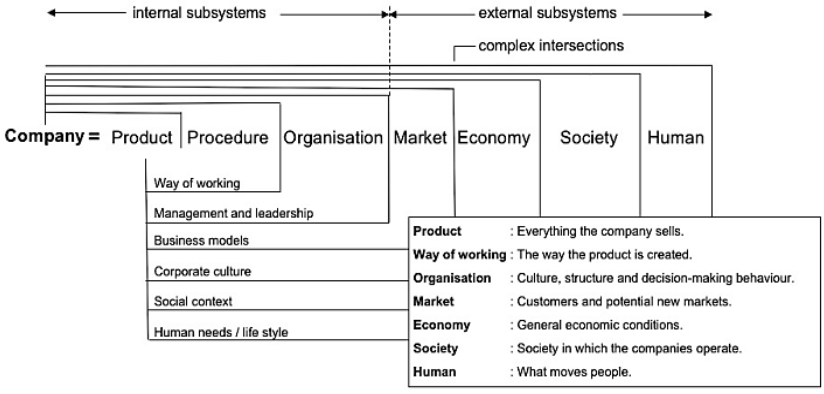


Figure 3. The form of the product (Baecker 2017).

The relationships between the subsystems can be causal, rational or complex, especially when people are included as a complex subsystem. When the relationships are complex in nature, they have a formal and an informal component that cannot be reduced to each other. Due to their complex nature, the subsystems can in general only be predicted rationally to a limited extent in terms of their behaviour, but in terms of their relevant levers can only be grasped through different observer perspectives such as working methods, management and leadership, business models, corporate culture, social context and human needs (lifestyle). People and society as external systems have the greatest

influence on the company, because the company is part of society and people are the basis of every society. The image a company has of a person is very effective in understanding social changes. In general, the contexts further out show a greater leverage effect on the product but exhibit a higher lethargy. The form of the product requires that the complex subsystems should be captured with all human senses, that is, perceptively, emotionally, intellectually and imaginatively. Management's purely rational view of the world, i.e. what cannot be measured cannot be changed, captures reality only in a subcomplex way, since informal observations are usually ignored. However, people can perceive more than they can rationally grasp and express through natural or mathematical language, and it is precisely these emotions that allow direct access to the world, since they always occur in the present and make change possible in the first place. Digitalization cannot fundamentally change this dilemma if organised complexity is not reduced and informal aspects of the company are not strengthened at the same time. In other words, according to the product form, innovations in new digital products and processes, e.g. via Open Innovation Spaces, will not be successful if the organisation related to the market is not able to do so due to its limited variability and thereby view of the world. Why established companies lose the competition for disruptive innovations was investigated in detail by Clayton Christensen in 'The Innovator´s Dilemma' (Christensen et al. 2013). His results confirm that a company culture would trump any attempt to create a strategy that was incompatible with its culture.

The question posed at the beginning whether the initiatives of the quality managers in Table 1 will be sufficient to survive in an increasingly complex digital world has to be judged rather negatively according to the product calculation. The initiatives contain some contradictions that will not lead to the desired "Quality Excellence", as on one side one would like to further strengthen the organised complexity and at the same time increase the commitment of the employees, that is their mindset and thus the informal complexity. There is however no administrative creation of meaning. Both contradict each other and strengthening the customer feedback loop will only succeed if the organisation is inspired by a company-specific vision of quality and can develop more room for emotions and empathy both for employees and customers.

### 3.3 The Corporate Culture

Companies are by nature complex socio-technical systems, with employees being one of the poorest defined subsystems. Although it has the crucial advantage that it allows people or employees to best adapt to the challenges of digitalization. This assumes, however, that the culture in the company, the collectively internalised experiences, values and attitudes, makes it possible to perceive external information about social trends. After all, culture works in the subconscious (informally) and usually shapes perception and sustainability more strongly than information originating from outside. The management can only observe and reflect on the culture and its constitution and open the perception for the outside world by indirect measures towards sustainability in a longer-term process of change. Managers must enable a human image that allows people to be more human. Then they also better understand the customers and their employees. Digitalization, however, is still regarded as an exclusively technical matter in many companies. But the digital transformation cannot be brought about or bought in from outside, rather every company has to find its own digital way, as experience from Lean Management has shown.

Companies are therefore faced with the great challenge of not only integrating new technologies into their business processes but also developing a new culture that is adapted to the digital environment. A study carried out by the Staufen AG (Staufen AG, 2015) shows that the companies that have internalised the Lean Management philosophy in recent years have also laid a solid foundation for digital change. Figure 4 shows a possible road map for digital transformation based on Lean Management, whereby the transformation process can begin at any stage and has to be run through iteratively again and again. However, the individual stages of the transformation are not additive, but at each iteration step the culture in the company must also adapt step by step in order to be sustainably successful. This will often only be possible at the beginning in smaller entities or in "in-house startups", since complexity is a problem that can only be solved on flat hierarchical levels.

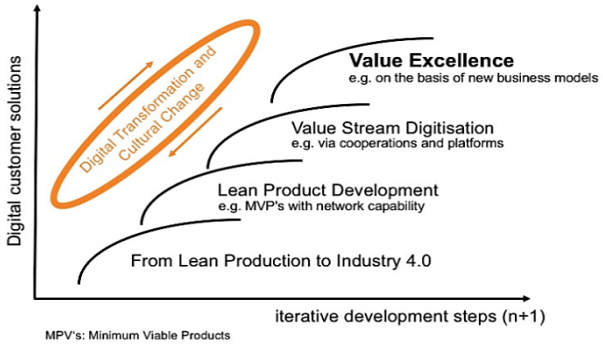


Figure 4. Digital transformation as an evolutionary process (own work by Menrath).

### 3.4 Organizational Development

Many companies have already set up decentralised organizational structures or are already working on an informal basis in a highly networked way. Yet they are often not allowed to act officially as a network, which means that the top-down control and information power are still linked to the management function. But in order to reduce internal silos and build social density through interdisciplinary cooperation, management needs a leap of faith. Because cooperation means that the employees work together at eye level and strive for a common goal and result. They are also willing to make their knowledge available to everyone. This is the only way to create new or emergent potentials for dealing with complexity.

The effect of complexity on work and organisation is described in detail in 'Organize for Complexity' (Pfläging 2015). Quality management and management as a whole must therefore switch from hierarchy and normative specifications to service, whereby service means observing, understanding and selecting adequate solutions (cooperative or processual) for the problems and to integrate them. Because complicated processes that can be efficiently controlled by procedures can quickly become complex problems if unexpected events and associated high variances enter them. The hierarchy in the company is still necessary but must become flatter compared to the status quo. Furthermore, the status symbols of power should also slowly disappear from companies in order to reduce the vertical communication barriers. Figure 5 shows a schematic representation of the interaction between the centre, periphery and environment of the company, namely the market, society and the individual. The service function of the centre towards the periphery is clearly visible. Only the periphery interacts project-related with the global environment, has customer contacts, delivers customer solutions on the basis of self-responsible business models. It is also responsible to measure its own performance. The headquarters acts with the environment as a whole and provides central functions such as strategic planning, legal affairs, finance, IT, expert centres etc. as a service provider. In addition, the centre must also provide the framework within which an open and cooperative corporate culture and especially a quality culture can develop.

For this purpose, directives and normative guidelines should be replaced as far as possible by principles and common concerns of cooperation. Just as, for example, Toyota has always understood the Lean Management philosophy, i.e. replace rules with observation and adaptation. Lean Management has been so successful among companies that are committed to the lean philosophy because it has been seen as a social innovation in the company from the beginning. In other words, the focus was on the customer, the employees, the value stream and the lean principles rather than technologies.

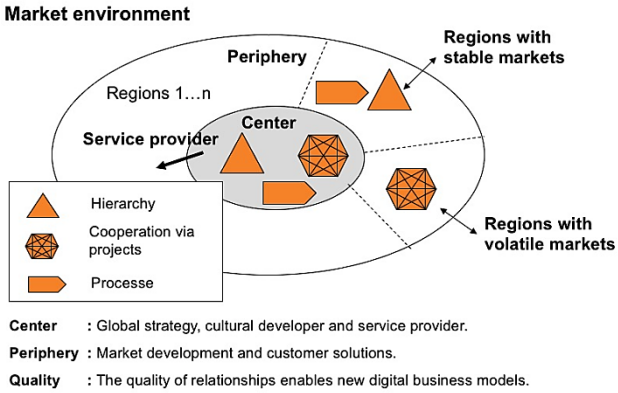


Figure 5. Complexity needs leadership (own work by Menrath).

## 4. From Quality Management to Value Management

As the form of the product has shown, the trends with regard to society and people are the driving factors for the future development of companies. The uncertainty of many market participants triggered by digitalization is increasingly expressed through emotional reactions (positive or negative), which means that emotions will become an important economic factor of the future (Gatterer et al. 2018).

### 4.1 The Emotional Society

Our world today is already confronted with many ambiguities due to its increasing connectivity, which cannot be grasped purely intellectually and lead to emotions that will also shapethe economy of tomorrow. Emotions will therefore have a stronger influence on the quality of business relationships and provide a new basis for value creation. Companies as emotional players must therefore use their emotionality more in order to enthuse customers not only about their products, but also about what they stand for with their identity. Digital business models will only be successful if in B2B and B2C business companies' values match those of their customers. In this way, companies must become aware not only of their products, but also of their culture and identity. They have to qualify for the digital network society of the future in the form of a high-reliable organisation that people trust (Baecker 2007). This applies in particular to the 2nd and 3rd phases of digital change.

Value Excellence, a new dimension of customer benefit, is created when, for example, the benefits for the customer are significantly increased through the digitalization of new relationship areas and at the same time the company's own value-added costs can be significantly reduced. These new and global communication spaces lead via the Internet and social media to an individualisation of the markets and consequently to the fact that companies today are no longer able to control the information that is disseminated in public about their products, services and offers. As a result, the power and credibility of public statements has shifted from companies to customers as individuals or as communities. Companies must counter this development with their own identity and not their brand image. They must act as credible actors in society. What does all this mean for quality understanding and quality management in the emerging network society?

### 4.2 Quality as a Social Factor

In the networked world, quality is thus becoming more and more a social factor which is subject to change and evolution, just like society itself, whereby quality always has an objective (formal) and subjective (informal) component to it. The objective concept of quality can be seen as the sum of the objective characteristics of a product or service. It is therefore a value-free quantity that is often used to compare one's own quality with that of competitors. Many companies still focus on this functional interpretation of the concept of quality. With the subjective part of the quality concept, however, the social interpretation comes into play as to how the actors involved in communication interpret the concept of quality and assess the suitability of the product or service for the purpose in terms of their needs and expectations. This type of emotionalisation primarily refers to the product and is referred to in the literature as "Perceived Quality". In a network society, however, therelationships between people become more important than the products themselves, which make networking possible in the first place (see Generation Z). This makes the Perceived Quality related to the product a quality of relationship related to the community, whose content is not

primarily the product, but the whole world. Although relationship quality cannot be objectively defined and measured as a cultural quantity, it will become the dominant quantity of the concept of quality in the future, as Figure 6 very schematically illustrates. This means that organisations will have to learn again to value what they cannot capture with data and algorithms in the future.

Until now, quality management has focused mainly on the error-free execution of transactions in the processes and has developed a comprehensive set of formal instruments for this purpose. In phase 1 of the digital change, these tasks are now being digitised step by step and the data analysed and evaluated using intelligent algorithms. For the future, quality management must also look at the informal aspects of transactions, in other words the internal and external relationships of the people involved in the transactions, since the digital business models of the future, e.g. Total Care or Power by the Hour solutions, will be more relationship-oriented and less transaction-oriented. What counts is "brain power" and the result to be achieved together with the customer, whereby for both partners the result and not the profit maximisation from the transactions is the main focus. Apart from data and algorithms, this requires similar "digitally empowered cultures" and emotionally empowered employees on both sides. This is only possible, however, if the employees are empowered to do so through more informal complexity in the companies. It is a socio-emotional coupling that is needed, i. e. empathy, mindfulness and interest or rather mutual perception and respect for each other.

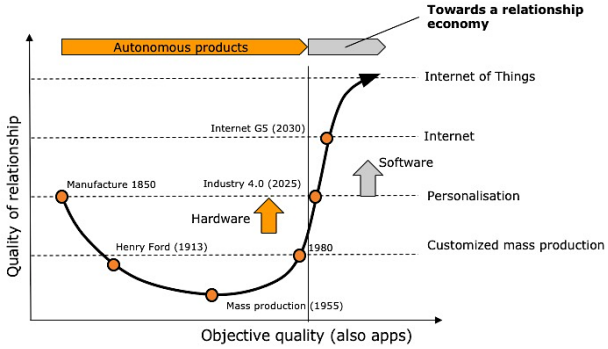


Figure 6. Higher quality of relationships as a global social trend (own work by Menrath).

### 4.3 Quality Management Systems

Quality management systems are complex administrative constructs and require a considerable amount of resources to implement the systems and keep them running. As the experience from many companies shows, the systems develop a life of their own in the daily use in relation to the reality which they describe only exemplarily and produce over it less and less effectiveness in the organisation. The normative specifications are usually limited to relevant ISO standards and the cumulative knowledge gained in the company is documented in the form of best practice solutions, whereby communication is generally limited to formal aspects only. Furthermore, during the growth and maturity phases of a company, processes become more and more comprehensive and complex but lose their "lightness" and willingness to take risks. Companies are therefore focused on incremental innovation, as opposed to external start-ups, and can only act disruptively to a limited extent.

At the same time, value creation and work in a company always contain both a formal and a lively part, that is, a complex part. The formal part can be mastered by having more knowledge (methods and procedures), which answers the question "how something works", but the complex part poses the question of skill, meaning "who can do it"? For instance, in a standardised mass production the process character is crucial and in a production with high variability the human adaptability is essential. Therefore, complex problems require new organizational tools that increase the interaction within the company. In other words, increase the density of relationships, whereby methods and procedures based on causality become secondary. The aim of quality management should therefore not be to primarily create a perfect theoretical management system, but to create communication spaces for current quality problems in order to generate effectiveness through a high relationship density (expert communities). This means that communication must deal with the decisions that have not been made, regardless of what the quality system specifies. This is only possible, though, if work is also done on the organisation and not only on process specifications and methodological knowledge, because skills and knowledge cannot be generated directly, but can only be gained through self-organised learning and problem solving in social contexts, together with the customer. In ‘Komplexithoden’ some of the organizational

tools for the dealing with complex problems are described (Pfläging and Hermann 2015). The normative standard of management systems should therefore be kept to a minimum and expanded to include new areas of freedom for dealing with complex value-added problems. Figure 7 shows such a concept schematically, whereby it becomes clear that the network structures can no longer be mastered using the classical quality pyramids.

In sum, this means decentralising and significantly simplifying quality systems, allowing more freedom for employees to act on their own authority and not only documenting and normatively specifying the functional knowledge of the systems, but also strengthening cooperation and communication and thus the quality of relationships, provided that the human image is right. For in a networked world, cognitive knowledge very quickly belongs to everyone, and only informal consciousness remains as one's own, that is, the social sense as a whole within the company and the jointly internalised quality culture. This poses a very great challenge for management, and it must resist the temptation to try to meet it only technologically, i.e. primarily digitally, today.

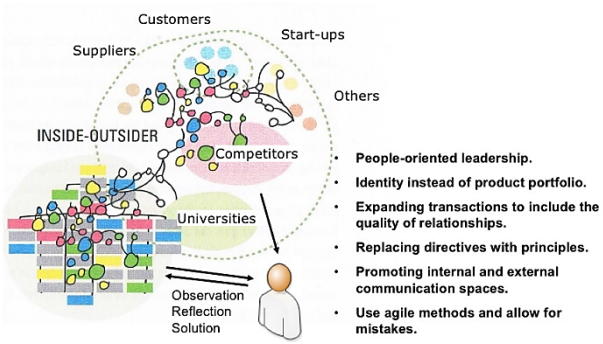


Figure 7. Systemic Quality Management System (with additions from (Lewrick et al. 2017).

### 4.4 Quality and Digitalization

However, the key to digitalization will be how, in addition to data, algorithms and artificial intelligence, etc., the interaction between man and machine or computer is designed in partnership with each other, since man and machine cannot be reduced to one another. In the future, human substitution, i.e. the automation of processes via artificial intelligence, will continue to increase, especially where the strength of the machines predominates. The nature of the problem makes it possible (Friesike and Sprodel 2022; Jochem 2024).

Too much automation, however, means a loss of autonomy in quality management and thus the danger of dealing with complex issues in a subcomplex manner. Although people do not have the capabilities of the machines, they have knowledge of the social context and can often learn much faster and more effectively using heuristics and can also deal with a lack of knowledge in a solution-oriented way.

Due to the future on-line relationship between customers, products and services, the large amount of data must be analysed and interpreted by means of appropriate know-how in data engineering and data science in order to enable a preventive or rather predictive, transparent, fast and thus customer-oriented quality management (BCG et al. 2020). Only the development of real-time analysis methods enables proactive intervention in information processes and can thus serve as a basis for new digital business models. With this, software engineering, will become the focus of future quality assurance and especially data security in order to be able to prove conformity with new regulations, such as the EU data protection basic regulation.

## 5. How Can Change Be Successful?

Today we live in a time of change and digital overestimation, which means that the digital capabilities and the associated impressive achievements of artificial intelligence are often overestimated, and human capabilities often underestimated. This applies in particular to everyday work, because it is precisely everyday intelligence that challenges artificial intelligence. Especially the routine in a company is based on a broad informal knowledge of experience, which can be described formally only to a limited extent (Vahs 2019). But only the informal human knowledge about technology, processes, hierarchy, cultures, social context etc., that is the cumulative cultural

knowledge in the company, is suitable to cope with an increasingly complex environment (Menrath and Jochem 2020). Thus, the following challenges result from digital change for companies and quality management in particular:

- Digitalization can only be realized sustainably through an adapted view of the human image and a new, decentralized and cooperative management style in the company that is based on trust, in other words, digitalization requires leadership.
- The developing culture then also enables a higher degree of informal complexity in the company, with informal complexity not being the problem but the solution for quality management.
- Many rules of quality management can be replaced by common principles and objectives, meaning that principles and objectives enable bureaucracy to be limited.
- The man-machine partnerships are to be used to establish on-line relationships with customers and the intelligent environment, i.e. to generate a higher customer value through digitalization and, last but not least,
- To learn from evolution and not to take one big step on the way to the digital future, but to act in small, reflected steps iteratively and open to results (agile).

With regard to the initial thesis "Why quality must be more than quality in the future", it can be summarized that people and culture in a company - and not digitalization - will decide whether a company can be successful in the future network economy. Today, more than ever, the insight of Louis, V. Gerstner (Gerstner 2002), the former CEO of IBM, is valid: ‘Culture is not one aspect of the game, culture is the game’.

## References

Baecker, D., *Organisation als System*, Suhrkamp Verlag, Frankfurt a. M., 1999.
Baecker, D., *Produktkalkül*, Merve Verlag, Berlin, 2017.
Baecker, D., *Studien zur nächsten Gesellschaft*, Suhrkamp Verlag, Frankfurt a. M., 2007.
BCG, ASQ and DGQ, “Qualität 4.0 erfordert mehr als pure Technologie,” QZ-online, 2020.
Christensen, C., Matzler, K. and von Eichen, S. F., *The Innovator’s Dilemma*, Vahlen Verlag, München, 2013.
Friesike, S. and Sprodel, J., *Träge Transformation – Welche Denkfehler den digitalen Wandel blockieren*, Reclam, Ditzingen, 2022.
Frenzel, U., *Deutscher Industrie 4.0 Index 2015*, Eine Studie der Staufen AG. Available: https://www.staufen.ag/fileadmin/HQ/02-Company/05-Media/2-Studies/STAUFEN.-studie-deutscher-industrie-4.0-index-2015-de_DE.pdf, Accessed on August 17, 2025.
Gatterer, H., Horx, M., Lösch, L., Muntschick, V., Schuldt, C., Seitz, J. and Varga, C., Siegeszug der Emotionen, Zukunftsinstitut GmbH, Frankfurt a. M., 2018.
Gerstner, L., *Who Says Elephants Can’t Dance?* HarperCollins Publishers, New York, 2002.
Jochem, R., *Datenbasiertes Qualitätsmanagement – Mit Datenanalyse und KI-Methoden zur Digital Quality*, Carl Hanser Verlag, München, 2024.
Jochem, R. and Menrath, M., *Globales Qualitätsmanagement – Basis für eine erfolgreiche internationale Unternehmensführung*, Symposion Verlag, Düsseldorf, 2015.
Lewrick, M., Link, P. and Leifer, L., *Das Design Thinking Playbook: mit traditionellen, aktuellen und zukünftigen Erfolgsfaktoren*, Vahlen Verlag, München, 2017.
Menrath, M., *Globales Qualitätsmanagement und Unternehmensführung*, Unpublished Manuscript, script for guest lecture, Technische Universität Berlin, Chair of Quality Science, Berlin, 2017.
Menrath, M. and Jochem, R., *Warum in Zukunft Qualität mehr als Qualität sein muss*, Bericht zur *GQW-Jahrestagung 2018 in Nürnberg*, Springer-Verlag, Berlin, 2020.
Morieux, Y. and Tollmann, P., *Six Simple Rules – How to Manage Complexity Without Getting Complicated*, Harvard Business School Publishing, Boston, Massachusetts, 2015.
Nick, H., Rutten, P., Fuhr, T. and Huber, U., *Quality Excellence – The New Imperative*, McKinsey Operations Practice, brochure, McKinsey & Company, 2017, pp. 18–31.
Pfläging, N., *Organisation für Komplexität*, Redline Verlag, München, 2015.
Pfläging, N. and Hermann, S., *Komplexitätsmethoden*, Redline Verlag, München, 2015.
Taylor, F. W., *The Principles of Scientific Management*, Cosimo, New York, 2006 (Reprinted edition: Harper & Brothers, London, 1911).
Vahs, D., *Qualitätsbewusstsein schaffen*, Carl Hanser Verlag, München, 2019.

## Biographies

**Dr. Martin Menrath** was born in 1955 in Munich and studied aerospace engineering at the Technical University of Munich from 1976 to 1981. He subsequently worked as a research assistant at the Chair of Aircraft Engines and received his doctorate in 1989. This was followed by positions in various industrial sectors, always as a member of the management board, for globally operating companies in aerospace (Rolls-Royce Deutschland), defense technology (Krauss-Maffei-Wegmann), and plant engineering (Bühler AG, Switzerland). After retiring from active professional life in 2015, he has continued to work as a consultant and as a lecturer at the Technical University of Berlin for the subject "Global Quality Management and Sustainable Corporate Management." He is the author of several publications on global quality management and the associated challenges for successful corporate management. This particularly concerns current issues of the digital transformation of companies and the associated social and cultural challenges.

**Prof. Dr.-Ing. Roland Jochem** is Head of Chair Quality Science at the Institute of Machine Tools and Factory Management (IWF), Technical University Berlin, Germany, since 2010. After studying Mechanical Engineering Roland Jochem from 1982-1987 he worked two years as a project engineer in a medium-sized engineering company. In the period from 1989-2001 he worked on research projects at the IWF, TU Berlin, and applied research projects at Fraunhofer-Institute for Production Systems and Design Technology (IPK). In the period 2001-2005 Prof. Jochem performed optimization projects in the area of product creation processes at Bosch Siemens Hausgeräte GmbH. From 2005-2010 he holds the chair of Quality and Process Management at University of Kassel, Germany. Since 2010 he is Extraordinary Professor for Quality Management at Stellenbosch University, South Africa, Guest Lecturer at Vietnamese-German University, Ho-Chi-Min-City and Turkish-German University, Istanbul. His research and consulting focuses are model-based process-oriented quality, standardized quality processes, quality management, quality excellence, organizational design of quality departments, innovation and requirements management as well as Quality 4.0/Digital Quality and AI in Quality Management. Prof. Jochem is the author of eleven books and more than 100 articles published in journals, conference proceedings, or edited books.