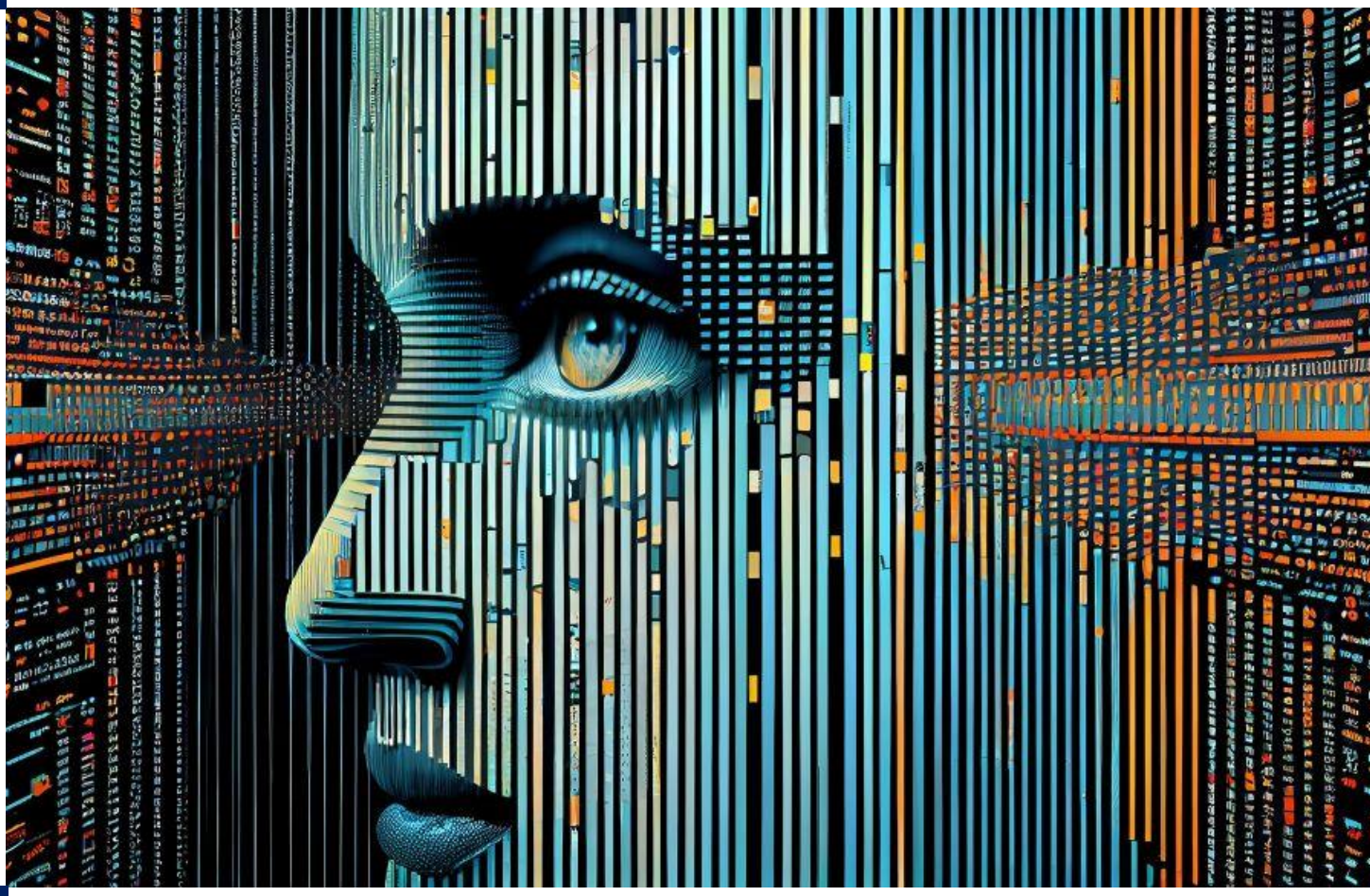
Quality 4.5: Transitioning to Humanization



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1 Introduction

1.1 The Premise

Each industrial revolution has influenced the way quality management is practiced.

The next edition of ISO 9001 quality management system requirements is very likely to emphasize sustainability, innovation management, and the impacts of the present-day exponentially growing digital transformation that are rapidly modifying the approaches to quality management in organizations.

On the whole, the transitions from one phase of the industrial revolution to the next will occur more rapidly than ever before, and due to the shorter durations between one phase and the next, it is now critical to pay attention to the transition intermediates and accordingly make a mark on the milestone of advancement.

"Whether it was mechanical inventions or new ways of doing old things, innovations powered the Industrial Revolution."

(National Geographic)

1.2 Reviewing the Principles of Quality 4.0

In the contemporary era of rapid technological evolution, establishing and implementing Quality 4.0 principles is no longer an option but a necessity for organizations striving for excellence. The quintessence of Quality 4.0 lies in the amalgamation of traditional quality principles with the groundbreaking advancements of the Fourth Industrial Revolution. Figure 1 below shows the evolutionary trends.

The following review, based on the explanations by the American Society of Quality (ASQ), critically evaluates the three pillars that constitute Quality 4.0: people, process, and technology, and explore the accompanying tools and value propositions.

1.2.1 The Human Element: Embracing Change

1. Re-defining Roles: Contrary to common misconceptions, Quality 4.0 transcends the realms of technological novelty; it marks a paradigm shift in the roles of quality professionals. The human element within Quality 4.0 necessitates a transition from merely enforcing standards to pioneering navigation through the turbulent waters of digital disruption. Proficiency in digital tools is a prerequisite for quality professionals, who must become adept at integrating these tools to facilitate organizational transformation and growth. They must become the helmsmen, steering the ship with insight and expertise.
2. The Role of Communication: Quality 4.0 demands that professionals be not only well-versed in digital language but also efficacious communicators. The ability to articulate the implications of digital transformation on quality and to make a compelling case for strategic alignment is pivotal. This ensures that quality management remains a fundamental consideration in organizational strategies.

1.2.2 Process Innovation: The Linchpin

1. Automation and Perfection: The advent of automation has increased the importance of impeccable processes. The inertia of automated systems means that any imperfection is repeated incessantly, thus amplifying the consequences. Quality 4.0 necessitates the reengineering of processes to eliminate inefficiencies and ensure robustness in the face of automation.
2. Educating the Workforce: To maintain the integrity of processes amidst digital transformation, a commitment to continuous education is essential. The workforce must be equipped with the knowledge and skills to adapt to new processes and strategies. Quality management, being the adhesive that binds an organization, should be at the forefront of strategic planning for education and workforce development.

1.2.3 Technology: The Engine of Progress

1. The Pace of Evolution: Technological advancements are occurring at an unprecedented rate. Organizational structures must evolve in tandem to maintain relevancy and effectiveness. Technology is a formidable equalizer, offering unparalleled capabilities to even small entities.
2. Data Wrangling: A New Frontier: Quality professionals should pivot from traditional data analysis to data wrangling. Engaging with emergent technologies, understanding their potential, and discerning their applicability are critical in Quality 4.0.

1.2.4 Tools for Implementing Quality 4.0

A wide range of tools that support Quality 4.0 drive the digital strategy. From Artificial Intelligence to Big Data, Blockchain, Deep Learning, and enabling technologies, these tools are the bedrock upon which Quality 4.0 stands. Each tool offers unique capabilities

that, when effectively harnessed, can significantly alleviate the challenges of implementing quality management in the era of digital transformation.

Period	Summary description	Quality	Summary description
Industry 1.0—Prior to 1890	+ Humans harness water and steam power to build industrial infrastructure. + Crude machines gain productivity over independent craft work. + Increased output is achieved using mechanical advantages. + Work focuses on performing tasks faster and more consistently. + Transportation/moving goods occurs more frequently.	Quality 1.0	+ Quality is assured through measurement and inspection. + Production volume is emphasized rather than quality. + Inspection does not focus on cost reduction, eliminating wastes, or loss and inefficiency. + Work conditions are not important; maximizing worker productivity takes precedence.
Industry 2.0—1890 to 1940	+ Electricity powers industrial machines. + Performance capability gains occur through application of new mechanisms. + Scale of automation becomes broader as motor size can be varied to fit specific circumstances.	Quality 2.0	+ Maximizing productivity continues to be the primary focus. + Adherence to standards that reflect the minimally acceptable quality level is prevalent. + Financial quality is measured based on scrap and rework. + Labor performance is used to measure productivity.
Industry 3.0—1940 to 1995	+ Computer power provided to workers to increase productivity. + Use of information and communication technology drives improvements. + Human participation in workplaces declines. + Stand-alone robotic systems replace manual work.	Quality 3.0	+ Quality is a business imperative. + Meeting customer requirements (customer satisfaction) is emphasized. + Continual improvement is applied. + Gains in productivity occur by stabilizing highly efficient processes, standardizing work and involving all workers in the activities that create quality. + Standardization activities (ISO 9001) and achieving business excellence through organizationwide assessment (such as the *Baldrige Criteria for Performance Excellence*) emerge.
Anticipated changes that will occur during Industry 4.0—1995 to present	+ Integrated cyber-physical interfaces automate working environments. + Automated processes deal with end-to-end systems. + Humans serve only in positions where human judgment cannot be automated and human interactions cannot be simulated. + Machines learn to learn (artificial intelligence).	Quality 4.0	+ Digitization is used to optimize signal feedback and process adjustment, and adaptive learning supports self-induced system corrections. + Quality shifts its control-oriented focus from the process operators to the process designers. + Machines learn how to self-regulate and manage their own productivity and quality. + Human performance is essential; the emphasis shifts from production to system design and integration with the business system.

Figure 1: Quality 4.0 Evolution through the Industrial Revolution (Source: ASQ)

1.2.5 Quality 4.0 Value Propositions: The Six Tenets

Clear value propositions have been highlighted through quality 4.0 initiatives. These include augmenting human intelligence, expediting decision-making, enhancing transparency, facilitating adaptation, evolving organizational relationships, and cultivating learning capabilities. These tenets are the guiding principles that ensure that technological adoption yields tangible benefits.

But more about the practical applications of the tools and demonstrations of the value propositions in later editions of the QIIN insight series.

Finally, Quality 4.0 signifies a new epoch in quality management. By intricately weaving the strands of people, processes, and technology, it provides the blueprint for organizational excellence in the digital age. Quality professionals must don the mantle of change agents, guiding their organizations through the labyrinthine pathways of digital transformation with sagacity and determination.

1.3 What is likely to drive the fifth industrial revolution?

The fifth industrial revolution, or Industry 5.0 (5IR). has not been formally defined, and it is mostly speculative. However, it is possible to make educated guesses on what might drive the fifth industrial revolution based on emerging trends and technologies. Some of the potential drivers are:

1. Human Augmentation: This involves the use of technology to enhance human capabilities, both physically and mentally. This can range from the use of exoskeletons to increase physical strength to brain-computer interfaces that could potentially enhance human intelligence or enable direct communication with machines.
2. Sustainable Technologies: There is an increasing focus on sustainability and environmental concerns. Technologies that aim to lower carbon emissions,

promote renewable energy, and develop sustainable business models might be the driving force behind the fifth industrial revolution. Sustainability initiative has already begun impacting quality management for the future as illustrate in Figure 2.

3. Decentralization and Democratization of Technology: With blockchain and other decentralized technologies, we might see a shift away from centralized control. This could empower individuals and smaller organizations with access to technologies and markets that were previously only accessible to large corporations.
4. Advanced AI and Robotics: While AI is part of the fourth industrial revolution, its evolution is expected to continue. This could lead to even more sophisticated AI systems that can perform tasks currently deemed too complex. In addition, the convergence of AI with other technologies, such as quantum computing, could be a major driver.
5. Quantum Computing: Once it becomes more commercially viable, quantum computing could revolutionize various fields, including cryptography, materials science, and artificial intelligence, leading to breakthroughs we cannot even imagine right now.
6. Biotechnology: Advances in biotechnology, including genetic engineering, might become a key driver. This can range from medical applications, such as personalized medicine, to environmental applications, such as bio-engineered crops.
7. Personalized Education and Work: AI-driven personalization could result in more specialized education systems that adapt to individual needs. Similarly, the future of work might be redefined, with more focus on individual skills and remote working environments.

8. Social and Emotional Connection: Unlike previous industrial revolutions that primarily focused on technological advancement, the fifth might also emphasize human values and emotional connections. Technologies could be more centered around improving the human experience, mental health, and societal wellbeing.
9. Space Exploration and Exploitation: As space technology advances, we might see an industrial revolution that extends beyond our planet. This includes space mining, colonization, and other forms of economic activity in space.

It is important to recognize that predicting the future is fraught with a lot of uncertainties, and the actual drivers of the fifth industrial revolution could be something entirely unexpected.

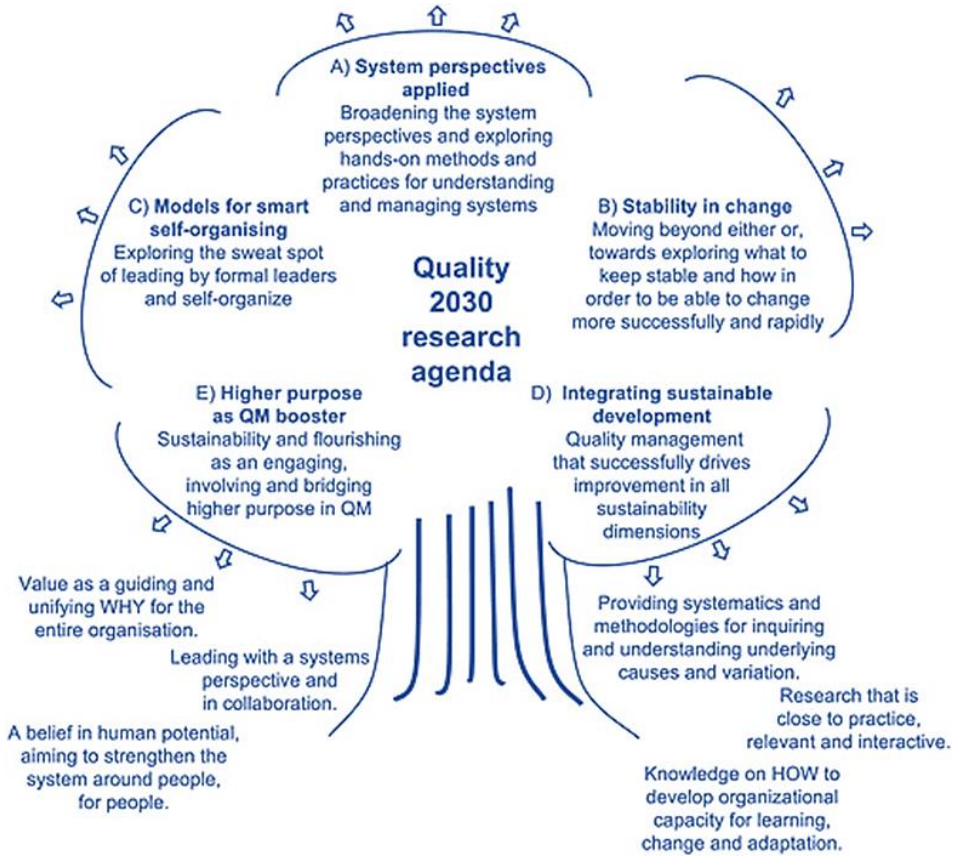

Figure 2: Future of Quality Management - 2023 (Source: Fundin, et al., 2020)

2 Transition Intermediates

It is crucial to understand the potential milestones that mark imminent transformational changes in the course of the industrial revolution.

2.1 Review of Industry 1.0 to Industry 4.0 and the Transition Intermediates

Industry 1.0: This was characterized by the transition from manual production methods to mechanized production using water and steam power. The key transition intermediate during this period (late 18th to early 19th centuries) was the development of basic machinery and the steam engine.

Industry 2.0: Here, the world saw a shift from steam-powered machines to mass production using electrical energy. This took place in the late 19th and early 20th centuries. The transition intermediates included the development of the assembly line (pioneered by Ford) as well as advancements in electrical engineering.

Industry 3.0: In the late 20th century, Industry 3.0 emerged with the advent of computers and automation. The transition intermediates in this phase included the development of early computers, semiconductor technology, and basic automation systems.

Industry 4.0: This represents the current state of the industry, characterized by smart and autonomous systems, IoT, AI, and cloud computing. The transition intermediates here include the development of the internet, advanced robotics, big data analytics, and AI systems.

2.2 Examination of the Rate of Change

The transition from Industry 1.0 to 2.0 took about half a century (Figure 3). This was a period where basic mechanization was evolving into more advanced forms of production. The transition from Industry 2.0 to 3.0, happening also over approximately half a century.

This was largely due to rapid advancements in technology, especially in electronics and computing.

The transition from Industry 3.0 to 4.0 has been even more rapid, happening over a few decades. This is due to the exponential growth of computing power and the rapid innovation in internet technologies and data analytics. By 2015, the concept of sustainability had begun to shape the thoughts of innovation, coupled with the drive to connect digital technology with human intelligence and emotions.

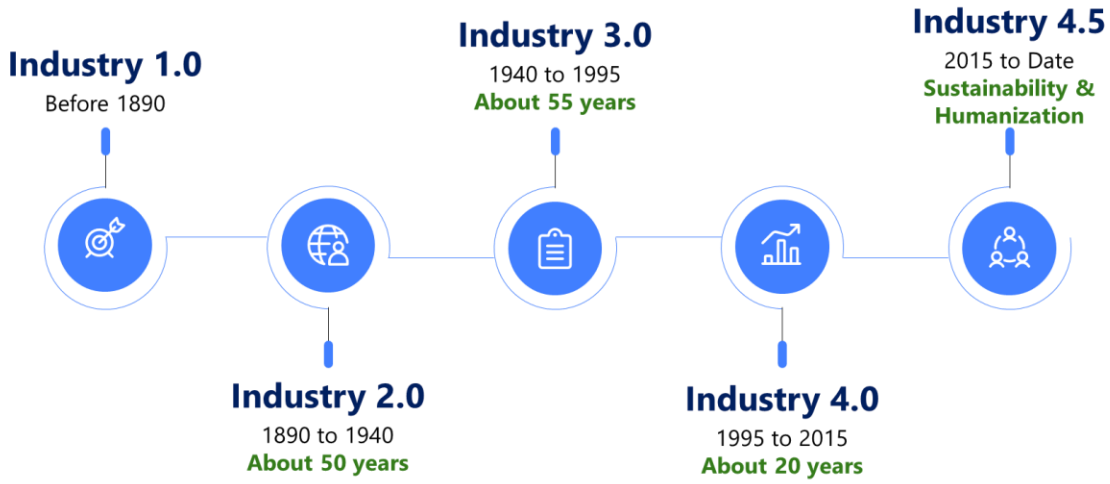

Figure 3: Industry transitions rates (Source: Adapted from ASQ)

2.3 Justification for Being Halfway to Industry 5.0

Considering the acceleration in the rate of change and innovation, it is plausible that we might be close to or past the halfway point to Industry 5.0.

Some reasons include:

1. Exponential Technological Growth: Technologies like AI, IoT, and data analytics are evolving at an exponential rate. New, previously unanticipated technologies are emerging.
2. Emerging Concepts and Technologies: Concepts like human augmentation, quantum computing, and advanced biotechnologies that are anticipated to drive Industry 5.0 are already in various stages of development.
3. Need for Sustainability and Human-centric Focus: There is a growing realization that future industrial revolutions need to be more sustainable and human-centric. This shift in thinking is substantial and indicative of a transition.

While it is possible that we are nearing an intermediary phase which we would like to classify as Industry 4.5, it is also important to recognize that these transitions are not always clearly defined, and there can be overlaps between phases. However, the numbering (4.0, 4.5, 5.0, etc.) is a convenient way to denote obvious huge changes disrupting the status quo. These transitions can be fluid and multifaceted.

If one lacks knowledge of the intended target, there is a risk of indiscriminately engaging with ill-defined objectives, which can prove challenging to successfully achieve and showcase as accomplishments.

3 Transitioning to Humanization

3.1 Beyond Automation: Unveiling Quality 4.5, the Nexus of Sustainability and Human-centric Evolution

In the ever-evolving landscape of industrial revolutions, the role of quality management systems like ISO 9001:2015 has been pivotal in ensuring organizational excellence. With Industry 4.0, we have seen an integration of digital technologies into the quality management processes, aptly termed as Quality 4.0. While Quality 4.0 focused on harnessing technological advancements for quality enhancement, it has become evident that a new wave is on the horizon. Quality 4.5 represents an intermediary phase which is set to bridge the transition by infusing sustainability and human-centric values into the quality management framework. This article delves into why Quality 4.5 is the stepping stone to the next industrial revolution.

3.2 Re-evaluating Sustainability

It is striking that the ISO 9001:2015 quality management standard mentions “sustainable” development in only a limited context. However, the contemporary understanding of sustainability encompasses environmental, social, and economic facets. Quality 4.5 addresses this shortfall by integrating comprehensive sustainability as a core principle. In this light, quality management is not just about adhering to standards, but also ensuring that organizational processes have a positive impact on society and the environment. Companies like Patagonia and Unilever, as mentioned earlier, have started to adopt this approach, aligning their values with those of the modern consumer.

3.3 Refining Quality 4.0 Principles

ASQ’s outline of Quality 4.0 lays the foundation on three pillars: People, Process, and Technology. Quality 4.5 builds on these principles by refining and expanding them.

3.4 People – The Human-Centric Shift

While Quality 4.0 recognized the value of human resources, Quality 4.5 takes a leap by putting humans at the core of the quality management process. Human augmentation, which is an integral part of Quality 4.5, empowers individuals to work synergistically with machines. Moreover, Quality 4.5 fosters a culture that promotes human welfare, creativity, and innovation.

3.5 Process – Sustainable and Flawless

Quality 4.5 emphasizes the need for sustainable processes. This involves the adoption of circular economic models, resource optimization, and recycling. Furthermore, with an increasing reliance on automation, Quality 4.5 underscores the need for flawless processes that are not just efficient but also socially and environmentally responsible.

3.6 Technology – Beyond Automation

Quality 4.0 was heavily reliant on automation and data analytics. Quality 4.5, however, recognizes that technology is a tool to achieve larger objectives. This involves using technology not just for efficiency but also for ensuring transparency, adaptability, and traceability. Decentralized technologies like blockchain come into play, making quality management more collaborative and transparent.

3.7 The Ecosystem of Tools

Quality 4.0 provided an ecosystem of tools including artificial intelligence, big data, and machine learning. Quality 4.5 takes a step further by integrating these tools with sustainability and human-centric values. For instance, big data can be used for environmental monitoring, while AI can be leveraged for social impact assessments.

3.8 Positioning for the Future

With the accelerating pace of change, it is crucial to recognize Quality 4.5 as an essential evolutionary phase. It prepares organizations for the upcoming Fifth Industrial Revolution, which is likely to be centered around sustainability and human values. Quality 4.5, therefore, is not just an intermediary phase, but a transformative movement that sets the stage for the future of quality management.

3.9 Conclusion

Quality 4.5 is the nexus where technological innovation meets sustainability and human-centric evolution. It refines the principles of Quality 4.0 by embedding comprehensive sustainability and placing humans at the core of innovation and quality management. As we gear up for the Fifth Industrial Revolution, Quality 4.5 is the harbinger that ensures that quality management is not just about adherence to standards but is a holistic approach aimed at creating a positive impact on society and the environment.

As trials for AI chip implants in humans are ongoing, the future of quality management is here. Hence, we propose that Industry 5.0 be tagged "Humanization."

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