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Ferry Nolte

Alexander Richter

Nadine Guhr

MIS Quarterly Executive

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Digitally transforming an organization's workspace requires parallel evolution across interdependent layers that influence and reinforce one another. Drawing on our analysis of multinational automotive supplier Continental AG's shop floor digital transformation journey, we propose a practical, three-layer model—IT evolution, work practices evolution and mindset evolution—that, with the associated dynamic capabilities, will ensure successful transformation. We provide recommended actions for aligning and managing interdependencies across the three layers, resulting in reduced implementation risks and improved transformation outcomes.[1,2]

Ferry Nolte
Continental Tires the Americas (U.S.)

Alexander Richter
Victoria University of Wellington (New Zealand)

Nadine Guhr
OWL University of Applied Sciences and Arts (Germany)

The Complexities of a Shop Floor Digital Transformation Journey

Many industrial work environments worldwide are still poorly digitally integrated, placing their workers on the offline side of the intra-organizational digital divide.[3] However, many industrial companies often see digital transformation as a key enabler of improved efficiency and cost reduction as they face the challenges of finding skilled labor for manual tasks.[4] Comprehensive shop floor transformations often lead to a "big bang" experience, where workers suddenly have to adapt to new information technologies, revised work practices and significantly different responsibilities.[5]

An organization embarks on a digital transformation journey with the aim of empowering workers and enabling them to develop new skills both in information gathering and processing,

1 Jan vom Brocke is the senior accepting editor for this article.
2 The authors thank the representatives of Continental AG for their cooperation on this research project.
3 *Future of Jobs Report 2025*, World Economic Forum. January 2025, from contributions made at the World Economic Forum Centre for the New Economy and Society, available at https://reports.weforum.org/docs/WEF_Future_of_Jobs_Report_2025.pdf.
4 van der Meulen, N., Weill, P. and Woerner, S. L. "Managing Organizational Explosions during Digital Business Transformations," *MIS Quarterly Executive* (19:3) September 2020, pp. 165-182.
5 Dery, K., Sebastian, I. M. and van der Meulen, N. "The Digital Workplace Is Key to Digital Innovation," *MIS Quarterly Executive* (16:2), June 2017, pp. 135-152.

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and in digital collaboration.[6,7] The challenge, however, is to deal with the structural changes that ensue from extensive digital transformation efforts. For instance, most technological innovations require new (or adjusted) ways of working, often resulting in the most experienced workers opting for early retirement because they are unable (or unwilling) to keep up with the related need for upskilling. To avoid losing experienced workers, organizations should therefore empower workers in a way that allows them to embark on a digital transformation journey in as seamless a way as possible.[8,9]

In this article, we describe a comprehensive model for navigating a digital transformation journey. The model comprises three critical layers—IT evolution, work practices evolution and mindset evolution—and serves as a sensitizing device by providing a focused lens to examine each layer in the context of a case study detailing the digital shop floor digital transformation at Continental AG, a multinational automotive supplier.[10] This case study provides a longitudinal review of Continental's efforts to digitally transform its shop floor, along with the organization's reflections on this process. (The case study methodology is summarized in the Appendix.) By addressing these layers in a synchronized manner, we provide academics and organizations with a tool to surface and effectively navigate the complexities of shop floor digital transformation. The three-layer model helps identify key enablers for achieving a digitally integrated shop floor and outlines actions that organizations can take to holistically guide their transformation across the layers.

The Three-Layer Model and Associated Dynamic Capabilities

The three-layer model, and the dynamic capabilities associated with each layer, offers a general roadmap for the organizational adaptability resulting from digital transformation, and gives rise to practical actions organizations can take to operationalize the dynamic capabilities specifically for digital transformation. In summary, the three layers are:

- *The IT evolution layer*, which is concerned with the strategic implementation and continual upgrading of digital technologies and IT infrastructure. This layer ensures that technological investments align closely with organizational objectives, supporting new work practices and cultural shifts.
- *The work practices evolution layer*, which reflects the changes required in everyday operational routines and workflows. Effective digital transformation demands embedding digital tools into daily practices, realigning work processes, and enhancing collaboration and efficiency through digitalization.
- *The mindset evolution layer*, which focuses on shifts in organizational attitudes, beliefs and culture essential for embracing digital transformation. Cultivating a digital mindset involves fostering openness to innovation, agility in decision-making and a collective readiness for continuous change.

Note that we explicitly refer to the *IT evolution layer* rather than *information system evolution layer* because the sociotechnical aspects traditionally associated with information systems are specifically addressed within the work practices and mindset layers. This allows the IT Evolution Layer to explicitly focus on the technical infrastructure required to support digital transformation initiatives.

By clearly distinguishing these layers, organizations can better understand how

6 Leyer, M., Richter, A. and Steinhüser, M. "'Power to the workers': Empowering shop floor workers with worker-centric digital designs," *International Journal of Operations & Production Management* (39:1), January 2019, pp. 24-42.

7 Mocker, M. and Boochever, J. O. "How to Avoid Enterprise Systems Landscape Complexity," *MIS Quarterly Executive* (19:1), March 2020, pp. 57-68.

8 Mandviwalla, M., Desai, D., Descano, L., Dignan, L., Kearns, C. and Sankaran, R. "Guest Editorial: An Industry Perspective on Major Post-Pandemic Issues," *MIS Quarterly Executive* (20:1), March 2021, pp. 1-9.

9 Caroll, N., Conboy, K., Hassan, N. R., Hess, T. and Junglas, I. "Problematizing Assumptions on Digital Transformation Research in the Information Systems Field," *Communications of the Association for Information Systems* (53), 2023, pp. 508-531.

10 The case study is based on internal documents, interviews with workers and focus groups with organizational experts over the course of four years. The empirical insights in this article also resulted in a paper presented at an ICIS conference. See Nolte, F., Guhr, N. and Richter, A. "The Journey towards Digital Work Empowerment—Conceptualizing IS-Induced Change on the Shop Floor," in *Proceedings of the Forty-First International Conference on Information Systems (ICIS)*, December 2020, pp. 1-17.

to concretely apply the associated dynamic capabilities (see below) in the complex environment of digital transformation. This layered approach not only simplifies the practical application of dynamic capabilities but also clarifies the interactions and interdependencies critical to a successful digital transformation.

However, many shop floor workers find a digital transformation journey to be challenging. As well as having to cope with the introduction of unfamiliar IT systems, they also find themselves confronted with new ways of collaborating.[11] This can result in different interpretations of the information systems' potential and risks. Those different viewpoints can ultimately influence the adoption of IT throughout the organization.[12] To address this issue, an organization needs to develop dynamic capabilities for each of the three layers of our model.[13] These capabilities enable an organization to systematically sense opportunities and threats in its environment, seize these opportunities effectively, and reconfigure its resources in response to evolving market and technological conditions.[14] The dynamic capabilities associated with each layer provide organizations with a structured approach to continuously adapt and evolve in dynamic environments:

- *Reconfiguring the IT landscape.* This dynamic capability enables an organization to evolve its IT resources in response to significant environmental changes, technological advancements or strategic shifts. It allows it to restructure its resource base dynamically to maintain competitiveness and strategic alignment.
- *Integrating work practices.* This dynamic capability enables an organization to evolve its work practices by effectively combining and coordinating internal and external resources to achieve synergy and coherence across diverse organizational activities. Integration ensures that newly acquired or developed resources work seamlessly with existing resources and operations.
- *Building a digital mindset.* This dynamic capability enables an organization to evolve its corporate mindset so it can create or acquire new resources and capabilities essential for innovation and adaptation. The organization proactively builds a mindset that allows it to respond to environmental changes, support continuous learning and stimulate innovation.

These dynamic capabilities equip an organization for successfully navigating the complexities and challenges faced by shop floor workers during a digital transformation journey as they adapt to unfamiliar technologies and new collaboration methods. They highlight an organization's need to build new competencies, integrate diverse digital resources and reconfigure existing resources to match evolving digital goals.

Acquiring these dynamic capabilities allows organizations to proactively build the necessary skills and technologies required for digital transformation. Integration ensures that new digital assets are effectively combined with current organizational practices, fostering seamless adoption across various functions. Finally, reconfiguration supports continuous adjustments to existing structures and processes, ensuring that an organization can flexibly respond to rapid technological advancements and shifting market dynamics.

By leveraging these dynamic capabilities, organizations can systematically and successfully manage their digital transformation journeys, fostering adaptability and resilience amidst continuous change.

Table 1 summarizes the dynamic capabilities underpinning the three-layer model.

11 Richter, A., Leyer, M. and Steinhüser, M. "Workers United: Digitally Enhancing Social Connectedness on the Shop Floor," *International Journal of Information Management* (52), Article 102101, 2020.

12 Davidson, E. J. "Technology Frames and Framing: A Socio-Cognitive Investigation of Requirements Determination," *MIS Quarterly* (26:4), December 2002. pp. 329-358.

13 The capabilities for each layer were derived through the Dynamic Capabilities Framework, which focuses on a firm's ability to adapt and create competitive advantage in rapidly changing environments by integrating, building, and reconfiguring internal and external resources and capabilities. For an explanation of this framework, see Teece, D. J. "Dynamic Capabilities as (Workable) Management Systems Theory," *Journal of Management & Organization*, (24:3), January 2018, pp. 359-368.

14 Teece, D. J., Pisano, G. and Shuen, A. "Dynamic Capabilities and Strategic Management," *Strategic Management Journal*, (18:7), August 1997, pp. 509-533.

Table 1: Dynamic Capabilities Associated with the Three Layers of Organizational Digital Transformation

Dynamic Capability	Description of Dynamic Capability	Digital Transformation Layer	Description of Digital Transformation Layer
Reconfigure	Adapting the organization's resource base and restructuring operations to respond to environmental changes and technological advancements, such as smart factories.	**IT Evolution**	Implementing and upgrading IT infrastructure to support digital transformation.
Integrate	Effectively combining and coordinating internal and external resources to achieve synergy, ensuring that disparate capabilities work together seamlessly.	**Work Practices Evolution**	Embedding digital tools into daily workflows and aligning processes to improve efficiency and collaboration.
Build	Creating or acquiring capabilities to respond to environmental changes, focusing on innovation and learning.	**Mindset Evolution**	Shifting attitudes, beliefs and culture to embrace digital transformation and innovation.

Summary of Continental's Digital Transformation Journey

Continental AG, headquartered in Hanover, Germany, develops pioneering technologies and services for sustainable and connected mobility of people and their goods. Founded in 1871, the company offers safe, efficient, intelligent and affordable solutions for vehicles, machines, traffic and transportation. In 2022, Continental generated sales of €39.4 billion ($46.1 billion)[15] and currently employs around 200,000 people in 57 countries and markets.

Continental's digital turnaround started in 2010 with a "workplace of the future" initiative, which was part of the company's overall transformation vision that addresses, among other things, the digitalization, efficiency and sustainability of digital solutions across all areas of the company, The business driver behind the initiative was to respond to the increasing speed and complexity of global operations and the resulting unpredictability of business events. As part of the initiative, a new improved company-wide approach to digital collaboration was envisioned to connect all parts of the organization. The first step in Continental's digital transformation journey was the transition from a highly formalized and hierarchical office-based environment to a knowledge-based work environment that allows digital interaction throughout all levels of the company.

However, Continental realized that digital transformation means more than just offering digital services and introducing digital technologies. Its transformation journey aimed at rethinking the organization, including changing the understanding of its employees' roles within the organization. To achieve the desired integration and change in work practices, the company started an organizational transformation campaign with the intention of transforming the 1990s' inflexible corporate culture into a 21st-century culture. This campaign included the introduction of new technologies in 2012—specifically, enterprise social media (ESM)[16]—annual global employee feedback and new employee feedback processes to promote a new knowledge-work-based style and value-based culture. ESM roll-out support was based on a volunteer "guide concept," a stewardship-based implementation style. The

15 Currency conversion as of August 2025.

16 The ESM service implemented is a company-branded, white-label application known as IBM Connections. This platform offers an extensive array of social media tools, ranging from networking features like profile pages, to collaborative and knowledge-sharing functionalities such as communities, wikis, microblogs, blogs and forums. Integration with corporate HR data enhances the service, enabling users to identify departmental, expert and relational connections. To access the ESM, a personalized computer access was needed.

organizational transformation campaign was a crucial element of the first steps of digitally transforming Continental's office-based operations.

In a second step, Continental's leadership board, together with work council representatives, identified that shop floor workers at that time were not integrated in the digital exchange. This meant there was information access asymmetry between office and factory workers. Moreover, many processes that were being digitized and enhanced for office workers remained slow "pen and paper" processes for the shop floor. Hence, the target of integrating the shop floor at Continental was twofold: equal treatment of factory workers and rapid and significant advancements on the shop floor toward the vision of a smart factory and digitally enabled production processes. In the future, the main skill on the shop floor would no longer be operating a machine but using digital interfaces and contributing to troubleshooting solutions—skill sets and a role that shop floor workers did not broadly understand at that time.

Continental saw the ESM platform as a "convenient" option for engaging shop floor workers. Many were already familiar with social media from private use, and it was the first platform within the company that would allow them to engage seamlessly with the rest of the organization. This approach had the potential benefit of faster problem resolution on the shop floor, leading to more efficient operations and enhanced collaboration between shop floor and office employees. In 2012, Continental therefore chose the ESM platform as the basis for initiating its company-wide digital transformation journey and for introducing a knowledge-based work culture across both office and shop floor environments. First, the company integrated the platform with office-based employees, who already had digital access. In 2016, after a successful office worker roll-out, Continental started shop floor integration, driven by the vision to prepare workers for a more digitized future shop floor and for a new role as knowledge providers.

At the time, this was a novel concept for the shop floor and required investments in new digital infrastructure. Continental decided to start with two shop floor ESM pilots at geographically separated and different product field locations (see the table in the Appendix). However, because of the low shop floor usage during the pilots, Continental decided to evaluate the pilots in more depth (as described below), to prepare it for the coming large-scale digital transformation that would alter the shop floor significantly.

Zooming In on Continental's Digital Transformation Layers

The starting point for Continental's digital shop floor transformation journey is rather unclear. Initially, the overall digital transformation began in the office environment, where knowledge workers were eager to use new digital tools, wanted greater empowerment and were ready to reevaluate their work practices. The intention was for the journey to progress proactively to areas deemed ready for change. However, the shop floors in the two pilot locations were largely unaffected by the new technological initiative. Below, we use our three-level model as a lens to assess the status of each level and propose essential learnings and insights. These insights will allow practitioners to give their organizations time to learn and assimilate new developments in a more evolutionary and organic manner and, ultimately, to synchronize the change layers.

Reconfiguring the IT Landscape

We identified two groups of workers that had a different understanding of the features of the new IT systems. One group perceived ESM rather as a recreational tool that would be used for non-work-related topics and found it difficult to make sense of the IT in a work context, as illustrated in the following quote by a medium-skilled shop floor worker:

> *"The features that go beyond work and those that are the main idea of social networks are not interesting. I am not interested in socially engaging with an unknown person from accounting, who is maybe sympathetic because of similar interests."*

The second group was already using the ESM platform in their normal work tasks, and saw a business purpose for the IT system, as highlighted by a high-skilled shop floor worker:

> *"It [the problem] might not be solved, but something in there might get you thinking. Or [the users] might give you a hint about something and you start from there. So, it solves problems for sure. If everyone is contributing."*

Using the ESM platform as a digital tool to empower employees, improve organizational connectedness and engage them in organizational knowledge exchanges requires them to understand how the platform will be used. However, Continental's leadership was unaware of the conflicting understanding of the two groups, as underlined by the head of shop floor development:

> *"What was very interesting was that this awareness of how we are set up in the shop floor area without the IT devices … is not present at all. … There were a lot of people who said: 'But where is the problem? Why don't you just do apps or why don't you just do any e-learning? Because we can't use them.'"*

Thus, asking all involved organizational members the question "What is this technology about?" would have helped to identify the different interpretations of lower/medium-skilled workers and higher-skilled workers. Acknowledging the existence of these differences would have prepared management for addressing each group's needs differently during the ESM implementation, as stated by the digital transformation manager:

> *"I would definitely prefer to treat the whole thing dynamically. Because that would be the aspects of individual needs, individual jobs and individual situations. One business unit is in lean mode and the other is in start-up mode because it is developing a new business model. So now pour a bucket [of water] over it and say, you have to do it this way and that way, with the equipment, and that's forbidden. I think this alone is a killer for the organization."*

This statement also highlights the dynamic interrelation of the IT evolution layer with the other layers. Work practices might differ in different shop floor areas, which might also have different mindsets because of their different development stages (e.g., start-up mode not driven by efficiency vs. efficiency-driven lean mode).

Integrating Work Practices

Installing computer terminals on the shop floor did not initially result in the anticipated interaction rates of the workers with the new IT systems. Low- and medium-skilled shop floor workers had a relatively simple causal relationship with the way work was organized. A medium-skilled shop floor worker said:

> *"In the majority of cases, we just do not have the time at hand. … The machine is original equipment customer monitored. That means the machine detects in a certain situation if it is not used for more than two minutes. And if that goes on for longer …, the shift supervisor would ask himself what the worker is doing. 'He is not working.'"*

Not knowing how to integrate the ESM platform into their work routines and how to use the IT systems beneficially for their work purpose was the "killer argument." The pressure to meet performance expectations resulted in shop floor workers decoupling from the intent of the implementation, unlike higher-skilled employees who could actually use the systems in their work as stated by a shift supervisor:

> *"I do not know how they should or could use it. [Shop floor] workers arrive at work five [minutes] before six. They do the shift change and work together as a team. ... Then, they have their two 15-minute breaks. When they have a break, they smoke a cigarette, drink a coffee and eat. I am not able to fit this ESM time into their daily rhythm."*

Our model and the related question "How will this IT be used?" would have led to the realization that, unlike office-based employees, the conditions on the shop floor were not conducive to integrating the ESM platform into work practices.

Building a Digital Mindset

The most challenging conflict identified in the Continental case was in the mindset evolution layer. Specifically, low- and medium-skilled workers had difficulties in understanding the rationale behind the introduction of the ESM platform. As a result, they were confused or skeptical about the potential benefits of ESM introduction, as stated by a shop floor worker:

> *"For our staff in production, I don't think it makes any sense, because what should I write there? … The link is missing somehow. … I think it's great for [my supervisor], but what should I write there? We are doing our daily routine tasks. It is just unsuitable I would say."*

Moreover, shop floor workers found the IT systems incompatible with the hierarchical culture, as one described:

> *"Social networks benefit from being democratic, from not having hierarchies, and that cannot function in an enterprise. Hence, I must admit it is a nice idea, but we will most certainly not have any value-added from it …"*

However, the digital transformation manager emphasized that the ESM platform had ushered in a new era for shop floor workers:

> *"Through the innovation on the shop floor, workers will be more and more connected. …. In the corporate realm we have optimized over 2,000 years; this hierarchy, and this bureaucracy, where someone tells me exactly when, what, how and with which people I have to do what. And now we are getting more into this 'Freedom to Act' phase."*

By using our model and asking the question "Why do we want to use this IT," organizations can quickly assess the state of mind of groups affected by digital change Providing workers with a greater degree of IT-enabled freedom without them having the right understanding of the IT and without changing the work conditions creates a massive challenge for organizations attempting to build a digital mindset.

Our model especially highlights and identifies the interrelations that the different layers have with each other. Once an organization has assessed each layer, it can derive a clear map that can help it advance on its digital transformation journey. As the digital transformation manager put it:

> *"At the moment we see workers too much as a resource, like a machine that should run uninterrupted for as long as possible. And as long as that mindset is in place, …, we're going to have this discussion about time and access and trust and all of that; it's going to be very difficult or it's easy."*

This statement shows the interrelation of the work practices and mindset layers, and highlights how difficult it is to move forward if both layers are not aligned.

In contrast, higher-skilled workers appear to understand and see the potential benefits of the ESM platform, such as improved information sharing and communication throughout the organization.

Interestingly, after a short explanation of the ESM features, lower-skilled workers showed a more positive attitude toward the platform and started to describe use cases, as they realized that the IT system opens new opportunities for them.

Insights from Continental's Shop Floor Digital Transformation Journey

The Continental case yields insights into each of the three layers of our model and also into the interrelationships between the layers. In particular, it shows that a digital transformation journey must address the three interrelated layers in a synchronized and iterative manner to achieve sustainable change. By considering the three layers independently and in relation to one another, organizations can explore in detail the challenges and interdependencies that shape digital transformation outcomes. The key challenges that surfaced in the case study through the lens of our model were:

- *Misalignment between IT and existing work conditions* can create resistance, as tools are introduced without adapting

workflows or addressing employees' time constraints
- *Divergent interpretations of how IT will be used* to underscore the importance of tailoring support to workers at different digital starting points, particularly lower- and medium-skilled employees who lack confidence or see limited relevance
- *Cultural and mindset barriers* highlight the need to address hierarchical norms and skepticism to ensure employees see IT as an enabler rather than as an obstacle.

By applying the dynamic capabilities for each of the three layers of our model, an organizations can: 1) evolve its IT landscape to align digital resources with new objectives; 2) integrate these resources into work practices to ensure they are effectively used and embedded into daily operations; and 3) build a digital mindset and culture to embrace the changes brought about by digital transformation.

Insights Relating to the IT Evolution Layer

The IT evolution layer is concerned with the strategic implementation and continual upgrading of digital technologies and IT infrastructure. This layer ensures that technological investments align closely with organizational objectives, supporting new work practices and cultural shifts. It specifically addresses "what" technological infrastructure is required to facilitate digital transformation, and explicitly identifies which technologies, systems and tools must be implemented or upgraded to support organizational change. The IT evolution layer involves leveraging IT strategically to align with the organization's evolving needs. To achieve this requires continuous efforts to enhance employee understanding and effective use of new technologies and their features introduced within the work environment.[17]

Insights Relating to the Work Practices Evolution Layer

As IT evolves, workers' roles adapt, placing them at the center of the broader digital transformation journey. An essential capability is being able to integrate periodical IT reconfigurations into organizational routines and employees' work practices. The work practices evolution layer explicitly addresses this socio-technical integration through digitalization by answering the "How?" question—specifically, how reconfigured IT assets can be integrated into daily operations. This layer ensures that employees clearly understand how to leverage new digital tools within their workflows, enabling more efficient task execution and rendering outdated methods obsolete.[18] To ensure these changes lead to lasting improvements, the focus must be on enabling workers and managers with the tools and skills needed to adapt to new processes, including data-driven decision-making. Overlooking comprehensive alignment of work practices with new technologies risks frustration among employees and may result in temporary, inefficient changes rather than lasting improvement.

Insights Relating to the Mindset Evolution Layer

The mindset evolution layer explicitly focuses on the necessary shifts in organizational culture, attitudes, beliefs and norms crucial for embracing and sustaining digital transformation. This layer answers the fundamental "why" question—clarifying the rationale behind the introduction and integration of new technologies and digital practices. Successful digital transformation requires cultivating a digital-first culture characterized by openness, flexibility and continuous learning. Leaders, such as production managers, must rethink established perspectives, encouraging employees to actively engage in and adapt to digital interactions.

Digital transformation is very challenging, often radical, and involves changes in norms, shared values, attitudes and behaviors. Such cultural shifts extend beyond management, reaching employees at all organizational levels, particularly those traditionally excluded from digital workflows. When digital transformation extends to previously unconnected organizational areas (such as the shop floor), it requires all

17 Benbya, H. and McKelvey, B. "Using Coevolutionary and Complexity Theories to Improve IS Alignment: A Multi-Level Approach," *Journal of Information Technology* (21:4), December 2006, pp. 284-298.

18 Majchrzak, A., Markus, M. L. and Wareham, J. "Designing for Digital Transformation: Lessons for Information Systems Research from the Study of ICT and Societal Challenges," *MIS Quarterly* (40:2), June 2016, pp. 267-277.

employees to actively reevaluate their roles within the organization. This reassessment can significantly alter internal organizational dynamics, requiring inclusive leadership practices that actively integrate and acknowledge newly connected individuals. As a consequence, organizations must foster a collective digital mindset to ensure that cultural evolution matches technological advancements and evolving work practices.

Insights Relating to Interactions Between the Three Layers

To be successful in digital transformation, organizations must achieve a synchronized evolution across all three layers of our model: IT evolution, work practices evolution and mindset evolution. Such a holistic approach will ensure that all aspects of the organization advance together, enabling a sustainable digital transformation.

Each layer is associated with specific questions that help the organization distinguish between the layers of transformation, treating them as distinct but interrelated reference points. Our model highlights that the layers are interrelated, influencing one another in a manner that demands an integrated approach to managing digital transformation. As described below, managing the interactions among these layers is an ongoing process that evolves over time.

IT evolution needs work practice and mindset evolution. Consider the example of the introduction of a workflow application for digital approval processes in a global company, but management in one subsidiary demands paper signatures to ensure legally valid documents. It's not surprising that employees in the subsidiary reject this aspect of digital transformation because they will have to do the same thing twice. In another example, imagine introducing a team space for more transparent communication (compared to the closed nature of emails). To successfully adopt this new way of communication demands a new mindset ("sharing helps all of us") and new practices (reflecting what and how news can be shared with the team).

Mindset evolution needs IT and work-practices evolution. In many cases, employees want to use technologies they are familiar with in their personal lives. Because of their ease of use, this has resulted in "shadow" technologies that bypass organizational IT investment policies. Using shadow technologies means that employees don't have to learn new digital skills when the organization next invests in automation.[19] In this situation, employees have developed a digital mindset, but need to be "digitally empowered." This entails not only providing them with appropriate tools, but also with new policies that govern how they use the new tools.

Aligning the three layers. By ensuring the three layers of our model are aligned, organizations can more effectively navigate their digital transformation journeys, creating a cohesive and sustainable change across IT, work practices and digital mindset. They will also be able to address the challenges Continental faced, which represent universal obstacles for leaders navigating the complexities of digital transformation.

Recommended Actions for Practitioners

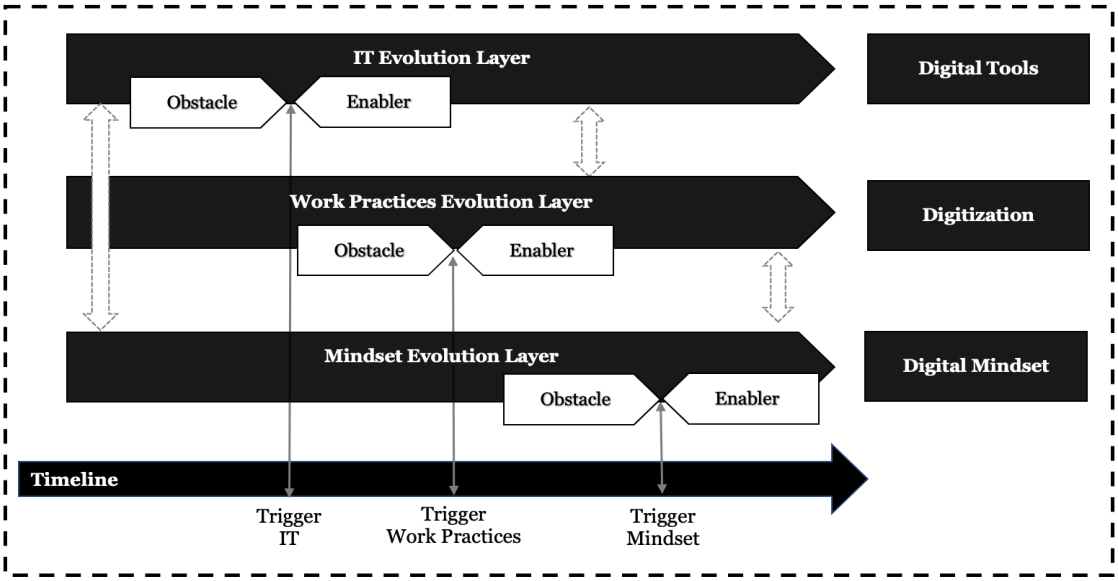
By examining the Continental case through the lens of our three-layered model we have identified actionable strategies for a successful shop floor digital transformation. As shown in Figure 1, these actions relate to digital tools (IT evolution layer), digitalization (work practices layer) and digital mindset (mindset evolution layer), and will enable organizations to bridge digital divides, empower employees and align transformation efforts across all three model layers.

Digital Tools: Develop User-Centric Interfaces

The Continental case indicates that, at the IT evolution layer, the organizational conditions for lower-skilled workers were not yet fully aligned with the specific characteristics of new knowledge-based digital tools. To address this issue, organizations need to develop worker-centric interfaces. They should design these interfaces specifically to cater to the needs and working conditions of employees, offering

19 Dery, K., Sebastian, I. M. and van der Meulen, N., op. cit., June 2017.

Figure 1: Multi-Layered Model of Organizational Digital Transformation



an intuitive and user-friendly interface that encourages use of new IT systems.

A crucial aspect of worker-centric interfaces is that they should be flexible and adaptable to various contexts and situations. For instance, a worker-centric interface may be optimized for mobile device use, enabling workers to access the new systems while on the move, during breaks or when their primary workstation is temporarily unavailable. The mobile interface could incorporate features such as push notifications, messaging and quick access to pertinent information.

Another important feature of worker-centric interface design is to ensure the interface can accommodate the different needs and preferences of workers. For example, lower-skilled workers may require a more passive IT usage mode, focusing on consuming information rather than actively engaging with others. In contrast, higher-skilled workers may demand more active participation and be more likely to become information providers in the early stage of a digital transformation. A worker-centric interface should therefore allow for different interaction modes based on the user's skills and current work preferences.

In summary, digital tools can play a vital role in empowering workers to effectively use new IT systems and foster interaction throughout the organization. The IT evolution layer impacts work practices by introducing tools that enable new workflows. However, without sufficient mindset shifts, employees may resist these changes, perceiving the tools as irrelevant or burdensome. By addressing the specific needs and work conditions of employees, worker-centric interfaces can help bring workers closer to the anticipated ways of working. Gradually bridging the digital divide by consuming information can trigger evolutions in workers' mindsets, allowing them to recognize the potential or change how they operate on the shop floor. Information consumption brings workers one step closer to contributing information, thereby empowering the shop floor to drive innovation and knowledge sharing within the organization.

Digitalization: Empower Employees and Adapt Workflows

Looking at the digital transformation journey from the work practices evolution layer perspective shows that merely introducing new IT systems into an organization, even with a work-centric interface, does not ensure

successful adoption. Though digital tools are a necessary condition for digital transformation, they are not sufficient on their own. Many employees, especially shop floor workers, may lack the required digital comprehension to effectively use new tools in their work context. The majority of these workers will likely consider themselves digital immigrants, harking back to working life before digital technologies. Employee empowerment and digital understanding play a crucial role in the sustainable and human-centered design of the work environment, particularly on the shop floor. Workers must understand their new roles within the organization. Without skill development and empowerment to use the new digital tools and adjusting prevailing work practices to be digitally supported by digitalization, digital transformation can cause employee stress, ultimately resulting in the failure of the digital transformation journey.

All employees require education about the new IT features, digital rules and policies, and the organization must redesign work practices to align with the digital transformation. This will involve empowering, structurally as well as psychologically, all employees, including lower- and medium-skilled workers, to feel confident in their ability to use social technologies. Education will enable employees to see the opportunities that the new IT systems present for improving business interactions.

Organizations also need to reassess their work practices to ensure the practices are ready for the drastic change brought about by digital transformation. At Continental, the focus in the past was primarily on hierarchical process optimization that did not allow employees any real freedom to explore and act. Organizations may be reluctant to provide additional support for shop floor workers if the transition to knowledge work is not yet complete or just starting. One option could be to use line coordinators, but this would pose a barrier to workers' empowerment because it reinforces hierarchical work structures. Digital empowerment is easier to achieve for higher-skilled workers, because they are already competent in knowledge work and it is part of their performance measurement The challenge is to create the same awareness via education and similar conditions for lower-skilled workers.

The challenge for management is to take all workers on the digital transformation journey, regardless of their different starting points. Recognizing that employees have varying skill levels—and that some areas of the organization will be harder to integrate than others—can help to foster greater empathy toward the transformation and prevent anti-transformation sentiments from developing. Expanding employees' understanding of the digital prerequisites is one of the most powerful actions leaders can take to drive engagement and buy-in to the digital transformation. However, the organization must be ready to accept that there may be temporary production efficiency decreases as workers start to invest their time differently. All changes in the work practices evolution layer require IT support and must be aligned with cultural norms (mindset evolution layer) to ensure successful adoption.

Digital Mindset: Change the Organizational Culture

The perspective provided by the mindset evolution layer helps to address the misconceptions surrounding the evolving roles of employees. This often requires a reassessment of organizational culture, particularly on the shop floor. Outside of work, many shop floor employees are empowered and capable decision makers, often serving as coaches or leaders in their communities. However, at work, they may feel restricted by a performance-driven culture that hinders experimentation and the adoption of new practices or digital tools.

Introducing digital IT to the shop floor can cause a cultural shock that necessitates a shift in mindset. Changing the mindset is one of the key aspects of successful digital transformation, because it determines the way employees think and behave. To facilitate the necessary change and encourage employees to embrace digital transformation, organizations should offer dedicated time for digital upskilling. For example, encouraging shop floor workers to allocate 10% of their weekly hours to developing digital skills would enable them to experiment with new tools and practices, eventually creating success stories

that gradually change their perspective on digital transformation.

It is important to make leaders aware of common misconceptions to avoid disjointed narratives and ensure a safe space for employees to explore new technologies. Examples of these misconceptions include assuming that all employees have the same level of access to technology, that work practices developed for an office environment will seamlessly transfer to the shop floor or that all workers learn and adapt to digital tools at the same pace. By fostering a culture that supports empowerment and continuous learning through education, the entire workforce will become more attuned to the challenges and opportunities associated with the shop floor digital transformation journey.

Summary of Recommended Actions

In summary, shop floor digital transformation is a long-term effort—the more effort you put into aligning the layers, the greater and faster the payoff becomes. The mindset evolution layer shapes how employees perceive and engage with both IT and new digital workflows, either enabling or obstructing transformation efforts.

Systematically addressing the three layers both independently and the interconnections between them will enable organizations to identify actionable strategies in the areas of digital tools, digitalization and digital mindset. Doing this will mean that organizational leaders can effectively synchronize their digital transformation efforts. Table 2 summarizes these action areas, their organizational impact, the key insights gained from the Continental case and the recommended actions derived from the case. Together, these provide a structured, practical approach that will ensure lasting change and position an organization to fully capitalize on the benefits of digital transformation.

Concluding Comments

Digital transformation is a multifaceted and inherently complex endeavor, requiring a synchronized evolution across multiple organizational dimensions rather than isolated technological implementation. Drawing on the rich Continental case study, this article highlights the critical need for coordinated progression across three explicitly defined and interrelated layers: IT evolution, work practices evolution and mindset evolution. Each layer plays a crucial role in enabling sustainable change, yet success hinges on understanding and addressing their interdependencies. We found that digital transformation is not linear or hierarchical but instead unfolds dynamically, with progress often driven by context-specific triggers. For example, mindset obstacles (e.g., skepticism toward IT) can delay the effective integration of new work practices, while inadequate alignment of IT infrastructure with existing workflows can lead to adoption challenges (e.g., needing to take a break to use the IT system). This interplay underscores the importance of taking a holistic view, balancing structural, operational and cultural shifts simultaneously.

The primary theoretical contribution of our study lies in explicitly applying and operationalizing the dynamic capabilities associated with each layer—reconfiguring IT resources, integrating the resources in work practices and building a digital mindset— within the nuanced context of digital transformation. The Continental case analysis illustrates how these dynamic capabilities, structured within our three-layer model, translate into valuable, actionable insights for organizational leaders navigating digital transformation.

By following the detailed guidelines and actionable recommendations for each of the three layers, leaders can effectively manage the complex interplay among technology, work practices and cultural evolution. In particular, we have emphasized the need for inclusive strategies tailored to match the diverse skill levels of employees, which will help organizations bridge digital divides, address cultural skepticism and align work practices with evolving technological capabilities.

Key insights from Continental's journey reveal that successful digital transformation requires:

1. *Tailored support:* Digital tools and training must cater to the diverse starting points of employees, particularly for lower-skilled workers who face greater barriers to adoption
2. *Strategic alignment:* Work practices and performance metrics should be adapted to incorporate digital tools seamlessly,

Table 2: Summary of Key Insights and Recommended Actions

Action Area	Organizational Impact	Key Insights	Recommended Actions
Digital Tools	**Interfaces and Access**	Employees make sense of the new tool via use cases and practical demonstrations.	Create relatable examples of how digital tools can enhance tasks and performance outcomes.
		Tools need to be easy to integrate into various work scenarios.	Prioritize features like mobile compatibility, push notifications and simple navigation.
		Acknowledge that incorporating the tools in diverse work conditions takes time.	Allow workers to experiment with tools in safe, low-pressure environments to build familiarity and trust.
		Worker-centric interfaces enable better adoption.	Provide workers with interfaces that integrate with their tasks and allow easy access during nonfunctional time.
Digitalization	**Empowerment and Processes**	New tools and existing work practices need to align.	Adapt workflows to incorporate digital tools seamlessly into daily operations.
		Workers, especially those with lower digital skills, need guidance to embed new processes into their routines.	Provide training that focuses on providing easy-to-use digital tools and integrating them into specific tasks.
		The shift from manual to digital requires structural and psychological empowerment.	Empower employees through targeted education about digital rules, policies and opportunities.
		Resistance increases if performance metrics or work rhythms are not adjusted to accommodate digital practices.	Accept temporary efficiency reductions during the transition to allow for proper skill development.
Digital Mindset	**Organizational Culture**	Embracing digital transformation requires a fundamental cultural shift across the organization.	Communicate the "why" behind IT changes to all stakeholders.
		Workers' skepticism or resistance often stems from a lack of understanding or perceived relevance.	Foster a positive culture that supports experimentation and reduces fear of failure.
		Hierarchical and rigid cultures hinder the adoption of open, collaborative technologies.	Encourage leadership to build trust and promote empowerment through inclusive decision-making processes.
		Employees need to perceive digital transformation as an enabler rather than as a disruptor.	Dedicate time for workers to explore and adapt to digital tools (e.g., 10% of weekly hours for upskilling).

avoiding misaligned incentives or workflows that hinder adoption

3. *Cultural transformation:* Organizations must actively reassess hierarchical norms, empower employees with digital autonomy and create safe spaces for experimentation and upskilling.

The insights gained from the Continental case are relevant for organizations with similar characteristics. Continental operates in a hierarchical, complex environment with a

Overview of Continental's Shop Floor Digital Transformation Journey

Category	Details
Context	• Following a successful rollout of enterprise social media (ESM) for office workers, Continental aimed to expand digitalization to the shop floor.
Pilot Sites	• Subunit A (Northern Germany): Heavy natural rubber products, low automation level. • Subunit B (Southern Germany): Electronics production, semi-automated.
Infrastructure	• ESM terminals requiring unique Windows accounts, with mandatory login and logout for each session.
Promotion	• Localized communication via shop floor area newspapers and information events.
Usage Statistics	• After three months, only 1% of target group actively used ESM • Terminal usage under 5% of shift hours.

diverse workforce, ranging from highly skilled knowledge workers to lower-skilled shop floor employees. Our three-layer model is particularly relevant for manufacturing, logistics and large-scale production industries, where bridging the digital divide, addressing skill gaps and shifting entrenched cultural norms are critical. However, it may be less applicable to smaller, more agile companies or those with digitally native workforces. By addressing these shared challenges, the model enables these types of organizations to address the digital transformation challenges and provides transferable guidance for navigating the transformation journey.

By adopting the three-layered approach—IT evolution, work practices evolution and mindset evolution—leaders can design digital transformation initiatives that are inclusive, sustainable and responsive to the evolving needs of both their employees and their operations. Ultimately, the alignment of these three layers will enable organizations to achieve digital excellence while fostering long-term employee empowerment and operational resilience.

Appendix: Case Study Methodology

We interviewed a total of 24 workers at Continental AG. Apart from two experts (the digital transformation manager and the shop floor development manager in charge of pilot projects), interviewees were classified into four profile groups (shift supervisors, low-skilled, medium-skilled and high-skilled).[20] The table above provides an overview of Continental's shop floor digital transformation journey.

About the Authors

Ferry Nolte

Ferry Nolte (ferry.nolte@conti-na.com) is a practitioner researcher specializing in information systems. He earned his Ph.D. from Leibniz University Hannover, Germany, in 2022 and has worked for over a decade at Continental Tires in financial control and key account management, contributing to the company's digital transformation. His research focuses on information system-driven organizational change and has been presented at leading conferences such as the International Conference on Information Systems (ICIS), European Conference on Information Systems (ECIS) and Hawaii International Conference on System Sciences (HICCS), as well as published in leading journals including *Journal of Computer Information Systems*.

Alexander Richter

Alexander Richter (alex.richter@vuw.ac.nz) is a professor of information systems at Victoria University of Wellington, New Zealand. He researches the future of work, focusing on human-AI collaboration, value-driven design and the transformative impact of IT. His research, often in collaboration with and funded by

20 Further information can be found in Nolte, F., Guhr, N. and Richter, op. cit., December 2020.

practice, has been published in leading journals and conferences and cited over 11,000 times. He serves as a journal co-editor and department editor, and frequently chairs major information systems conferences.

Nadine Guhr

Nadine Guhr (nadine.guhr@th-owl.de) is a professor of information systems at the OWL University of Applied Sciences and Arts, Germany. She received her Ph.D. from Leibniz University Hannover in 2013. Her research interests include the adoption, diffusion and impact of information systems and behavioral and organizational security and privacy issues. Nadine's research has been published in leading international conferences, such as the International Conference on Information Systems (ICIS), European Conference on Information Systems (ECIS) and Hawaii International Conference on System Sciences (HICCS), and in leading international journals, including *Information Systems Journal*, *SN Applied Sciences* and *Journal of Decision Systems*.