CHAPTER 1

The Challenge of Digital Transformation

Towards the end of the first quarter of the 21st century, technological change is happening at a faster pace than ever experienced before. With ChatGPT, Generative Artificial Intelligence (GenAI) moved from a scientific lab context to widespread commercial dissemination reaching a hundred million users in just two months, according to the World of Statistics (2023). By contrast, it took the mobile phone 16 years to obtain the same user base. Another disruptive technology, the World Wide Web, still needed 7 years to reach a hundred million users (ibid.).

Why does technological change accelerate? Intrinsic and extrinsic factors may contribute.

Intrinsic factors for the acceleration of technological change include, for example, the pace of progress in applied R&D. Based on a meta-dataset of the world's three most important producers of graphics processing units (GPUs), Hobbhahn and Besiroglu (2022) estimate that the processing speed of IT hardware components doubled every 2–3 years between 2006 and 2021. This exponential growth has allowed for increasingly complex applications, such as large language models (LLMs).

Since the financial crisis in 2007, the world has also witnessed numerous *extrinsic* factors that acted as catalysts for an accelerated development and dissemination of disruptive digital technologies. The long lockdown periods of the COVID 19 pandemic led to leapfrogging into home office work and remote operations, with video conferencing and the paperless organization (Amankwah-Amoah, Khan, Wood, & Knight, 2021) emerging much faster than anticipated. After the Russian attack on Ukraine, global military expenditures rose by 3.7 percent to record investments in 2022 (Pollard, 2023), trickling down to R&D budgets and «potentially producing revolutionary new

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technologies» (Hashim, 2022), as digital warfare will increasingly determine the fate of adversaries.

These extrinsic shocks revealed a «digital divide» among organizations, more specifically between the digital-first companies and more reluctant players, especially small and medium-sized enterprises and large, traditional corporations with legacy information systems and a high degree of procedural complexity. For the case of the global Corona pandemic, Amankwah-Amoah et al. (2021) identify several constraints on the organizational level that impede fast digitalization. These include a lack of technical expertise, missing awareness of latest technologies and potential gains from digitalization, as well as organizational inflexibility and unwillingness to change, as typified by «hard-to-change organizational routines, process and traditional ethos of the organization» (ibid.).

Those companies that hesitate to move from products to solutions, platforms or X-as-a-Service business models are potentially left behind their faster-moving competitors. They might fail to acquire the necessary capital on financial markets and might lose the trust of their investors and shareholders. As Grigory Shevchenko, Senior Account Manager at German mid-stream energy company Uniper, coins it in Case 8 of this volume: «The rationale was better to deal with disruption before disruption deals with you.»

Notwithstanding, digital transformation requires a decisive vision of top management and division leaders to invest money and human resources into new business models. Yet, digital transformation typically does not occur as a Big Bang that catapults the existing organization like a sub-atomic particle on the next quantum level. It rather consists of small, labor-intensive, and often tedious improvements of the existing IT legacy infrastructure, a bottom-up movement with each functional unit identifying opportunities and use cases for process optimization and efficiency gains.

The change in corporate culture and organizational configuration starts with the mindset of each individual employee, willing to embark on a life-long learning journey, coping with new software interfaces and acquiring the necessary skillset to filter, channel and deploy an ever-increasing amount of information in daily routines.

The fundament of a digitally-affine organization is data. However, establishing a data lake does not suffice for a company to succeed in digital transformation. Novel digital technologies are necessary to harvest insights and generate value added.

How to implement these new technologies and leverage digital innovations? How to overcome organizational hurdles? How to convince top management, or – conversely – how to take executives and middle managers on board? This book presents best-practice cases, which may serve as concrete pathways and inspirations for «rainmakers» and corporate ambassadors of change.

Digital technologies as Strategic Enablers in the Strategy Pyramid

Compared to many other books on digital transformation, the ambition of this compilation of interviews is narrow and modest. It does not aim to provide a framework for a fundamental strategic reorientation or business model transformation. Most of its cases start with a hands-on initiative of individuals in a progressive business unit and derive insights from the experience of implementing a disruptive digital technology in a given corporate context.

The focus of this book can be best illustrated by using the metaphor of the so-called «Strategy Pyramid», as suggested by Thompson and Strickland (2001). It typically contains various horizontal layers. For this book's purpose, we assume a prototypical Strategy Pyramid with three layers.

The top level of the pyramid formulates the abstract vision of the company's desired future. It can be identified as the Strategic Intention, that is, what an organization wants to achieve, often also called its vision or mission. This level obviously differs from company to company. German technology company Siemens Energy, for example, «is determined to become the world's most valued energy technology company» (FPSO Network, 2022). Cosmetics and adhesives company Henkel intends to «win the 20s through purposeful growth» (Henkel, 2022). US American retail platform and cloud provider Amazon wants to become «the Earth's most customer centric company» (Amazon, 2022), while Berlin-based fashion retailer Zalando intends to «digitize fashion» (Cadieux & Heyn, 2018). Level 1 might entail elements of a digital strategy, but typically focuses on the most important, overarching strategic objective of the firm.

By contrast, the Strategic Priorities on level 2 are tasks that need to be performed to fulfill the higher-level intention expressed on level 1. Priorities among companies tend to show communalities and may include elements such as customer centricity, the move from products to services and solutions, an increase in process efficiency connected to cost-cutting and optimization, or – on an ecosystem level – becoming a platform provider in the respective market. On the second level, digital transformation often plays a key role. For instance, Siemens Energy considers «digitalization as a value driver» and defines three priorities in its mission of «digitalizing the energy transformation» (Siemens Energy, 2022):

- «New digital revenue: We create new revenue streams by offering software as a service seamlessly across our product range;
- Increasing the value of our offering: We combine our domain expertise with our digital expertise to differentiate our value and offerings for our customers;
- Internal digitalization: We automate our internal processes and build the necessary digital infrastructure to react to rapid changes of the digital world.»

In level 3 of the Strategy Pyramid, a company defines the means to implement and operationalize the Strategic Priorities. They can be called the Strategic Enablers and are the technical and organizational prerequisites necessary to accomplish the overarching objective or vision of an organization. These can be projects or tasks, but also functional capabilities, resources, or technologies that must be acquired. Again, depending on the company and its respective industry, Strategic Enablers may be defined in different ways.

This third level of the Strategy Pyramid is the focus of this book. With respect to digital transformation, two Strategic Enablers will be analyzed in greater detail:

- *Technological Enablers:* On the one hand, a company needs the (digital) technological equipment to pursue its Strategic Priorities. These include algorithm-driven tools, particularly the usual data analytics toolkit, including resources to undertake descriptive, predictive and prescriptive statistics, customer segmentation and cluster analysis, various types of regressions, risk analysis with Monte Carlo simulation and Decision Trees, corporate dashboards, and the like. More advanced algorithm-driven tools include Machine Learning and Artificial Intelligence (AI), Robotic Process Automation (RPA) and Blockchain/Distributed Ledger Technologies (DLTs). On the other side of the spectrum of enablers are device-driven technologies. They are characterized by hardware requirements that exceed the typical binary computer systems, such as Additive Manufacturing (3D printing), Augmented Reality/ Virtual Reality applications, drones, and – in the near-term future – Quantum Computers.
- *Organizational Enablers:* Beyond the technological endowment, a company is likely to adapt and revamp its organizational setup to initiate and sustain the digital transformation process. This may include introducing a new position of a «Chief Digital Officer» (CDO) directly reporting to the CEO, a strengthening of the role of the information technology (IT) department, or an internal, cross-departmental task force that identifies processes and use cases prone to be digitally transformed. It also encompasses the human resources aspect of digital transformation, such as the training of the existing workforce, the identification of deficits in the current spectrum of organizational capabilities, and potentially hiring of new (digital) talents. However, the organizational implementation may also imply broadening the perspective beyond the traditional boundaries of the firm – by tapping into the larger innovation ecosystem, establishing Joint Ventures (JVs) or collaborations with startups, or joining consortia and platforms.

The following figure illustrates the Strategy Pyramid, adapted to the digital transformation of a company.

Figure 1: Strategy Pyramid with Strategic Intention, Priorities, and Enablers.
Source: Own illustration, adapted from Thompson and Strickland (2001).

The remainder of this introductory chapter zooms into the two dimensions of Strategic Enablers. First, it introduces the most relevant Technological Enablers, based on the results of an international survey on disruptive digital technologies. Second, it provides a conceptual framework to characterize pathways of organizational implementation, serving as a bridge towards the subsequent best practice cases, sketching how companies have successfully accomplished the hurdles of technological and organizational implementation of disruptive digital technologies in their respective corporate context.

Technological Enablers

Which disruptive digital technologies are most relevant for executives in their digital transformation strategy? As a first step of the analysis, an international survey was conducted. It comprised a total of 609 upper management executives from IT, manufacturing and service industries (finance, healthcare, legal, logistics, real estate, public administration and infrastructure), with around 55 percent of participants residing in Europe, 41 percent in North America, 2 percent in Australasia, and the remaining respondents in Africa, South America, and Asia[1].

[1] The survey took place in mid-2020 and was conducted by a commercial provider (Prolific). The authors obtained the original data and performed the descriptive statistics and analysis.

The aim was to explore how executives currently deploy the abovementioned digital technologies in their business practice.

The survey includes three device-driven and three algorithm-driven digital technologies. The following two sections of this chapter are dedicated to presenting these six technologies, with a short description and some illustrative use cases.

Device-driven digital technologies

The following device-driven technologies are part of the survey:

- **Additive Manufacturing**, more colloquially called 3D-Printing, transforms a digital, three-dimensional model of an object, typically programmed in CAD (computer-aided design) software, into a haptic artefact. The most common technology is sintering, adding layer by layer of a metal-based or plastic-based granulate on top of each other, until the object is completed. Additive manufacturing has become commercially attractive in three key areas (Attaran, 2017; Khorram Niaki, Nonino, Palombi, & Torabi, 2019; Lacroix, Seifert, & Timonina-Farkas, 2021):
  (1) Rapid prototyping and innovation, for example for printing new shuffles of gas turbines in R&D departments;
  (2) Printing spare parts and rare components for manufacturing and infrastructure operations, especially in remote locations where ordering and delivering a spare part may take weeks or even months;
  (3) Mass customization, for example by printing individualized tooth replacements or in-ear headphone plugs.
  More exotic applications include printing entire houses with fast-drying concrete as the raw material (Valente, Sibai, & Sambucci, 2019), or food items, such as Japanese Sushi (Watkins, Logan, & Bhandari, 2022).
- **Augmented Reality** (AR) is a technology that extends reality with additional visual information, combining the actual camera view of a handheld device such as a tablet or smartphone with a digital projection of certain features on the visual environment. Most prominently, Nintendo's mobile game «Pokémon Go» received worldwide attention in 2016 when literally millions of digital natives all across the world used their phones to chase Japanese virtual mini monsters in real urban settings. Companies like Ikea use Augmented Reality apps to become more user-centric, helping their customers in choosing, for example, the right furniture for their interior design by projecting digital sofas or wardrobes into the camera footage of their living rooms. German original equipment manufacturer (OEM) Bosch supports garage technicians in repairing combustion engine, for example by pointing to the location of hidden components, thereby allowing for time savings of around 15 percent in the repair processes

(Waldmann, 2019). Bosch also uses the technology for educational purposes, in which trainees can follow the actions trainers perform on their own devices. ARtillery Intelligence, a specialized consulting practice, estimates that mobile AR had more than one billion users worldwide in 2022 (Alsop, 2022). Beyond handheld devices, AR also extends to glasses to be worn like normal glasses just in front of the eyes.

Popular devices are «Google Glass» and Microsoft's HoloLens. After a PR disaster related to privacy and data protection issues following the launch of «Google Glass» in 2012 (Klein, Sørensen, Freitas, Pedron, & Elaluf-Calderwood, 2020; Nunes & Arruda Filho, 2018), Google re-released its AR headset as an «Enterprise Edition» targeted at workers on construction sites or factory floor (Statt, 2020). Mixed-reality devices, such as Microsoft's HoloLens, are in use, for instance, by the UK's National Health System NHS to support consultants reviewing COVID-19 patients via live streaming to the remainder of the medical team (Levy et al., 2021).

– As opposed to AR, **Virtual Reality** (VR) «kidnaps» the user into a hermetically closed view of a virtual space, often in three dimensions. Despite having been in use for quite some time in computer games, virtual escape rooms and other entertainment activities, VR attracted global attention when U.S. American platform corporation Facebook renamed itself in «Meta» in late 2021, proclaiming the future rise of «Metaverse» and releasing the collaborative VR platform «Horizon Worlds» on Oculus (Heath, 2021). CEO Mark Zuckerberg's vision of providing a full-fledged parallel universe, in which users navigate between games, live concerts, social gatherings and business events with a variety of personalized avatars, may still be at its infancy (Stern, 2021), but other companies have been successfully deploying VR in numerous business applications. Already in 2014, hotel chain Marriott introduced a VR simulator called «Teleporter» to let potential hotel guests digitally immerse into places like Hawaii or London (Fisher, 2014). The industrial design studio at British premium car manufacturer McLaren use VR headsets to switch between 2D and 3D models of their digital prototypes and accelerate the design process (Ekströmer, Wever, Andersson, & Jönsson, 2019), while shifting clinical training of medical students into the virtual space makes it more cost-effective, repeatable, and standardized (Pottle, 2019). In early 2024, US company Apple launched a VR headset called Vision Pro that might increase the appeal of AR and VR gadgets beyond gaming and niche applications.

There are numerous other device-driven, disruptive digital technologies that start gaining commercial traction beyond niche markets. For example, manufacturing companies invest into robotics and cobots, smart sensors and other Internet-of-Things (IoT) applications, while grid-based infrastructure providers, such as electricity and gas utilities, but also corporations operating in offshore wind farms or exploration and production (E&P) of oil and gas start deploying drones for unmanned inspections of their facilities (Javaid, Khan, Singh, Rab, & Suman, 2021). Beyond the short-term and medium-term horizon, quantum computing is likely to exceed the binary calculation capabilities of conventional computers and revolutionize processing power, especially in areas such as optimization, cybersecurity, and forecasting (Bova, Goldfarb, & Melko, 2021; Hidary & Hidary, 2021).

Algorithm-driven digital technologies

In contrast to device-driven digital technologies, potential applications of algorithm-driven technologies have been observed across almost all industry verticals. They range from corporate dashboards and the existing statistics and data analytics toolkit to completely new and disruptive technologies, in particular Machine Learning / Artificial Intelligence (AI), Blockchain and other Distributed Ledger Technologies (DLTs), and Robotic Process Automation (RPA). They have in common that they do not require the installation of a new hardware system but can largely rely on the existing IT infrastructure – although, of course, certain applications require a faster processing power and are typically computed on customized chips and cards.

Analogue to the previous section, it may prove helpful for a common understanding to clarify the terminology and exemplary use cases:

- **Artificial Intelligence** denotes a computational algorithm that imitates synaptic processes of a human being. Most generally, AI algorithms can be classified as either «Generative» or «Discriminative» (Gm, Gourisaria, Pandey, & Rautaray, 2020). ChatGPT by OpenAI or Llama by Meta belong to the category of Generative AI, because they create new content, for example text, images or computer code, whereas Discriminative AI typically is trained for classification and analysis of existing data. One of the most common methods of Discriminative AI is called Deep Learning, which is used, for example, for recognizing cancer cells in visual body scans like mammography (Kim et al., 2020) or detecting moving objects in autonomous driving (Muhammad, Ullah, Lloret, Ser, & Albuquerque, 2021). Random Forests are a statistical method for categorizing information, for example separating regular emails from spam, or predicting the purchasing behavior and preferences of individual customers on marketplaces such as Amazon (Al Amrani, Lazaar, & El Kadiri, 2018). AI can also be used for language recognition, in which the algorithm improves its performance incrementally by a method called Reinforcement Learning (Sharma & Kaushik, 2017). Business processes can benefit from AI all along the corporate value chain, ranging from logistics and optimization to forecasting, cybersecurity and end-user communication. Even in HR (human resource) management, AI can contribute to improve, for example, the selection process of new employees, or develop personalized learning journeys (Tambe, Cappelli, & Yakubovich, 2019). The comparison with conventional statistical methods reveals why AI has been successful in business applications: Statistics aims at aggregating information from a large body of observations into simpler yet meaningful and interpretable indicators, for example the mean income or carbon footprint of a population, or the relationship between the percentage of vaccinated persons in a region and the respective rate of occurrences of a disease. By contrast, AI allows for a reversal of that simplification: Given the processing power of computers, predictions on certain actions can move from the abstract and statistically aggregated «customer segment» back to a differentiated prediction for each individual within the customer segment. AI can accomplish data mining at a pace and precision which is unprecedented and would require an immense human effort to be rivalled.

However, the technology comes with two important caveats: First, it requires enormous amounts of clean and well-structured data to produce meaningful results, following the classical «Garbage in – Garbage Out» problem in data processing (Lew & Schumacher Jr, 2020). Second, there is still a trade-off between its predictive power and causality. Especially in Deep Learning the algorithm's selection and decision mechanisms are not transparent, because they occur in so-called Hidden (intermediate) Layers. Methods such as Heat Maps are used to better understand the algorithm's internal «reasoning», but especially in clinical medicine and life sciences a new «interpretability gap» may occur (Ghassemi, Oakden-Rayner, & Beam, 2021).

Lastly, it is necessary to mention that anything described in this book as «Artificial Intelligence» should rather be called «Machine Learning». Marvin Minsky, one of the hosts of the famous Dartmouth Conference in 1956, which became the birthplace for the phrase «Artificial Intelligence», defined in 1970 an Artificial Intelligence as «a machine with the general intelligence of an average human being, a machine that will be able to read Shakespeare and grease a car.» (Borchers, 2006) In comparison, the wording «Machine Learning» has a more modest ambition than a computer fully imitating a human being: A Machine Learning algorithm specializes in one relatively narrow task, for example, playing Chess or Go, and learns how to excel in this task. Practically all AI applications that currently exist in the world should hence rather be called «Machine Learning.» For the sake of simplicity and convention, this book reverts to the wording of «Artificial Intelligence», even though it actually means Machine Learning.

- Originally, **Blockchain** was invented as a distributed ledger to facilitate peer-to-peer transactions in the cryptocurrency Bitcoin – without any intermediaries such as banks or financial brokers. Since then, numerous other Distributed Ledger Technologies (DLTs) and so-called «Tokens» have been developed and released in Initial Coin Offerings (ICOs). Most importantly, DLTs like Ethereum have extended its functionality from a cryptocurrency-based financial instrument into a multi-purpose toolkit for automatically executed and recorded Decentralized Applications (DApps) and Smart Contracts, which are used in gaming, lotteries, trading and prediction markets, and many others (Mohanta, Panda, & Jena, 2018).

While Blockchain and DLTs have not (yet) revolutionized financial markets, as many market observers predicted in the first peak of Bitcoin-mania in 2015/16 (Tapscott & Tapscott, 2016), it proves particularly successful in three emerging niche markets and use cases: First, Decentralized Finance (DeFi) builds upon the initial idea of Blockchain as a means for peer-to-peer financial transactions. With the promise especially to individuals who have no access to a commercial bank account, a thriving FinTech startup ecosystem has emerged that offers services in lending and borrowing, pooling, bonds, portfolio management and investments. In 2021, the total value of DAO (Decentralized Autonomous Organizations) treasuries, which are community-owned and a democratized decision-making process in their governance structures, increased to $16 billion (Slavin & Werbach, 2022). The second Blockchain application that is worth mentioning is Non-Fungible Tokens (NFTs). These tokens assign an asset a unique NFT, which then can be used in various digital processes and transactions. One example is digital artwork, which by and large evaded the conventional art market, a unique ownership by becoming part of a public ledger, typically Ethereum, thereby creating an artificial scarcity for an easily reproducible good (Rehman, Zainab, Imran, & Bawany, 2021). Platforms such as Foundation, SuperRare or NiftyGateway act as gatekeepers and allow for auctioning and trading of the NFTs.

Beyond the strategic positioning in newly emerging niche markets, one of the reasons for the success of DeFi and NFTs can be found in the quest to empower individuals – small-scale investors, people without access to banks, or artists. They are typically run on public chains, and anyone with a crypto wallet can participate.

By contrast, the third successful application of Blockchain technology follows a different logic: If many parties interact in the handling of a complex service, a Blockchain solution may enhance transparency and efficiency in the operation. The most prominent example for this type of use case was a consortium called TradeLens, founded by global logistics corporation Maersk with the support of IT company IBM, and halted in late 2022. With the objective of «digitizing global supply chains,» TradeLens acted as an ecosystem that was supposed to connect all major stakeholders involved in the handling of goods, ranging from ocean carriers and freight forwarders to port authorities and governmental customs agencies, and as a platform to share documents and data (White, 2018). In comparison to most applications in DeFi and NFTs, it did not have its own currency or token system, and it was an exclusive «members only» club that grants permissions to join based on a combination of an applicant's role and its data types. From its official launch in August 2018 until December 2019, the consortium already attracted more than 175 unique organizations, and by December 2022 TradeLens claimed to have processed more than 70 million containers, published 36 million documents, and tracked 3.7 billion events (TradeLens, 2022). As a reason for the discontinuation of the venture, the founders Maersk and IBM state that «unfortunately, such a level of cooperation and support has not been possible to achieve at this point in time.» (ibid.)[2] A similar consortium-based approach is pursued by German car manufacturers and OEMs in collaboration with research institutions and telecommunication companies in the Catena-X Automotive Network, founded in May 2021 (Reed, 2021). In this book, case 9 on Chargeurs describes in greater detail how Blockchain can serve as a platform for data exchange.

– The name **Robotic Process Automation** (RPA) of the last disruptive digital technology presented in this short overview may be misleading. «Robots» in the context of RPA are not mechatronic artefacts with three-dimensional extensions and certain humanoid features. Rather, the terminology is meant in a metaphorical way: RPA's robots imitate actions that humans perform working with a computer. Preferred actions that RPA robots can execute are typically repetitive tasks that humans can do in around five to twenty minutes, but which do not require sophisticated intellectual input or reasoning skills, for example processing invoices, or transfer of data from a website to a spreadsheet application or database (Kroll, Bujak, Darius, Enders, & Esser, 2016). If the task is sufficiently standardized with a fixed sequence of individual steps, RPA can deal with these routine jobs much faster and more reliably than human beings who are prone to errors. RPA software by the leading providers, such as UIPath, BluePrism or Automation Anywhere, allows users to either define and program each step in a simple flow chart, or «show» the robot the steps to take in live action and record it. Most of the RPA applications are still rule-based, but advances in RPA are being made in the integration of AI tools, for example in the integration of algorithms that are capable of recognizing letters and numbers in handwritten notes (Alberth & Mattern, 2017). As opposed to most other disruptive digital technologies presented here, technical hurdles to implement RPA in back-office processes are minimal, and investment is modest. In one of this book's best practice cases, Turkish mobile phone operator Turkcell decided to develop internally its proprietary RPA system, rather than renting the robots of a commercial supply company.

[2] In 2023, a personal conversation with the head of IT at a Spanish port authority revealed that one of the reasons for the discontinuation might have been the fact that the information on the containers and transactions was not properly maintained and updated, and hence was not 100 percent reliable.

All six digital technologies would deserve a more detailed analysis of the competitive environment, growth forecast, innovation pipeline, etc. The grey literature, especially from commercial and academic industry observers and consulting practices with an interest to sell their services to business clients, provides regular and numerous technology and market updates, though, which can readily substitute further notes and comments of the authors. Instead, the focus is on the international survey conducted as a precursor to the qualitative research of this book.

Results of the international industry survey

The aim of the survey was to explore how the above-mentioned digital technologies are used in actual businesses – in terms of the frequency of deployment, and their main purpose. In addition, the authors' intention was to identify the interviewees' expectations by ranking selected digital technologies with respect to future business importance for their areas of responsibility. The survey was complemented by similar surveys among participants of selected executive education programs conducted by ESMT lecturers in the years 2020 and 2021.

The combined size of the sample was around[3] 655 respondents, counting all valid responses. In the surveys that were conducted in late 2020 and early 2021 the authors added «Data Analytics» as a benchmark that allows for a comparison with an already established business practice. A sub-sample of around 60 respondents from international executive education trainings provided their answers. This sub-sample may not adequately represent the broader population of businesses, but might provide some orientation about the use of data analytics in a comparable setting with respondents from higher management.

The first question concerned the frequency of usage of the above-mentioned digital technologies in a respondent's area of responsibility. Respondents could choose between three categories, «Frequently», «Rarely» and «Not at all».

Figure 2 shows the results, ranked by the digital technology with the highest percentage value in the category «Frequently». Artificial Intelligence ranks first, with more than a third of all respondents using this technology frequently. Virtual Reality, Robotic Process Automation and Blockchain are frequently used by around a quarter of the respondents, Additive Manufacturing and Augmented Reality by less than 20 percent.

On aggregate across all digital technologies, 46 percent of respondents do not use the selected technologies at all, and another 30 percent use them rarely. The results imply that less than a quarter of the respondents use these technologies frequently, while almost two thirds of the sub-sample use data analytics frequently.

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[3] Some questions were not answered by all respondents.

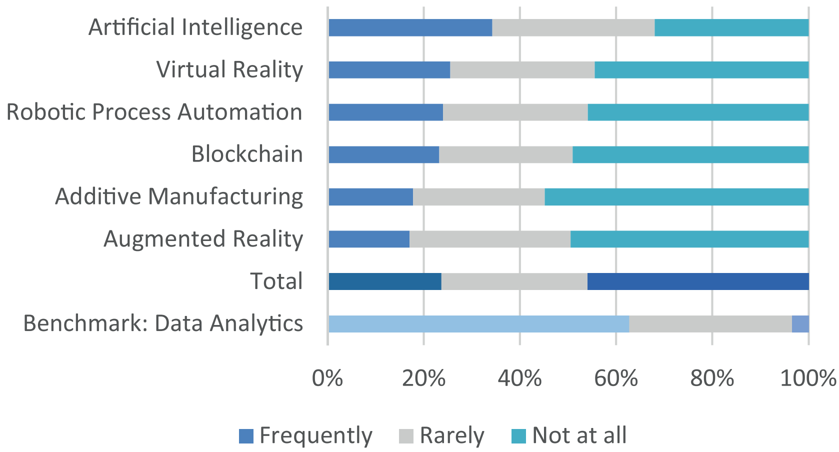

Figure 2: Frequency of use of digital technologies and data analytics.
Source: Own survey, n=655, Benchmark n=60.

The second question of the survey concerned the relevant use cases. In the next section on organizational enablers the authors will discuss use cases in greater detail, but in principle use cases can be divided into two categories: On the one hand, back-end solutions are typically introduced to achieve efficiency gains, optimize, or automate processes, and ultimately cut costs. On the other hand, digital technologies can be used to enter new markets, provide innovative products and services to B2B or B2C customers, introduce new business models that may turn into future pillars of growth for an organization, and ultimately generate additional revenues.

Hence, respondents could choose between three categories: «Process Optimization», «Revenue Generation» and «Other». On aggregate, around 43 percent of the answers were related to Process Optimization, 35 percent to Revenue Generation, and 22 percent to Other. Anecdotal evidence about the category «Other» suggests that survey respondents understand, for example, that this group was in the process of setting up data lakes, doing the groundwork of digitization.

Artificial Intelligence, Robotic Process Automation and Virtual /Augmented Reality were rather used for process optimization, whereas Blockchain and Additive Manufacturing had higher percentages in revenue generation.

On aggregate, use cases in the back office had a 10-percent margin compared to new business models with additional revenue generation. These findings suggest that a large part of the digital transformation of companies is still related to revamping the existing IT legacy systems and optimize internal processes. The comparison with data analytics showed that process optimization with almost 55 percent of the responses was the main driver for internal use cases, too.

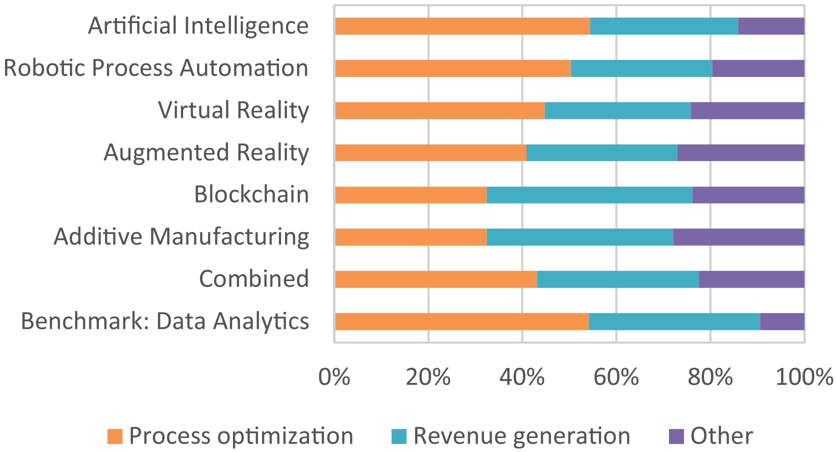

Figure 3: Use cases of digital technologies and data analytics.
Source: Own survey, n=655, Benchmark n=60.

For the third question, respondents had to rank selected digital technologies according to the future business importance for their areas of responsibility.

Aggregated across ranks 1 to 3, Artificial Intelligence was considered the most important technology with around 31 percent of the responses. Robotic Process Automation was ranked second, but with only around half the score of AI, followed closely by Additive Manufacturing, Blockchain and Augmented Reality. Virtual Reality was the least relevant digital technology with respect to future business importance.

Of course, preferences regarding the implementation of digital technologies varies across industry sectors. In a survey by PwC, a consulting practice, among around 50 operations and supply chain officers, AI scored highest among the disruptive technologies comparable to this book's survey, followed by Blockchain, Robotics/RPA and Augmented Reality adopted by 18, 16 and 14 percent of the respondents, respectively. However, the two top-scoring technologies that were applied within their supply chain operations were cloud-based data platforms as well as Internet of Things and connected devices with more than 50 percent adoption rates (Waco, 2023).

A survey of around 500 C-suite executives and senior leaders in financial services companies, conducted by consulting practice Broadridge, suggests similar preferences with respect to the digital technologies discussed in the case studies of this book: When asked about their firms' plans to increase their investments over the next two years, AI led again with an average of 21 percent increase, closely followed by Blockchain/DLTs with 20 percent. RPA was expected to experience a 14 percent increase of investments, whereas metaverse/VR and AR would see only one percent increase (Soto Sanchez, 2024).

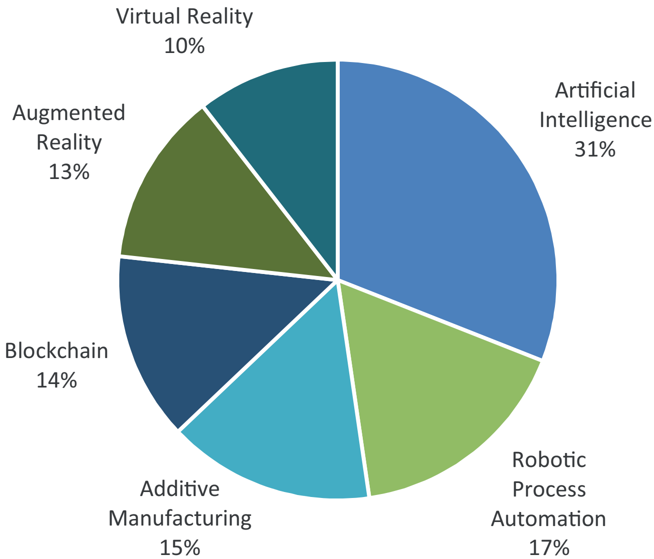

Figure 4: Future business importance of digital technologies.
Source: Own survey, n=655.

Across various industries, the survey results consistently demonstrate the significance of AI, with subsequent emphasis on the technologies of Blockchain and RPA. Triggered by OpenAI's ChatGPT in late 2022, the global momentum of Large Language Models and GenAI has most likely consolidated the leading position of AI and machine learning in the preference set of disruptive digital technologies (Writer, 2024).

The three most important findings of the quantitative analysis can be summarized as follows:

Artificial Intelligence is by far the most important digital technology in future business applications;

Robotic Process Automation and Blockchain also remain relevant across various industries, ranging from supply chain and operations to financial services;

Evidence from more than 600 upper management executives suggests that most digital technologies are primarily used for process optimization rather than revenue generation.

Organizational Enablers

Digital technologies are the essential prerequisite of digital transformation. For each of those technologies, leaders, and department heads must decide how to implement them – with external expertise, acquisitions and joint ventures, internal training of the existing workforce, or via consortia, platforms and industry collaborations.

Who should take over these tasks? Is it the IT department, or the personal responsibility of the Chief Information Officer of a company? Should it be the newly appointed Chief Digital Officer since many companies are establishing this role in the C-suite? Is the top-down approach sufficient to change the corporate culture of a company? Or should the deployment of digital technologies be initiated as a grassroots movement, mushrooming all over the departments according to the actual needs of a team?

Many non-«digital native» corporations struggle to master the digital transformation of their organizations. They depend on legacy IT systems, which often cannot be easily replaced by up-to-date software due to company-specific customization and cannot be transferred easily to any new software or platform due to interrupting continuous operations. Data is compartmentalized, incompatible with other internal databases because of differing interfaces and programming tools, without any stakeholders or experts from other departments having access or even information about its existence.

In some cases, only very few internal IT specialists can curate and oversee the complexity of the software, the so-called «Last Man/Woman Standing» phenomenon. In other cases, the lock-in of being the last customer on an expiring solution with an external service provider induces a dependency and correspondingly high costs. Information is messy, that means, labelling and tagging are inconsistent over time and, for example, geographical regions, which implies that humans can decipher patterns within a dataset, but machine algorithms would not be able to use the inputs efficiently, the so-called «garbage in – garbage out» phenomenon, which was already mentioned in the introductory notes on Artificial Intelligence.

Under these conditions, digital transformation becomes a threat rather than an opportunity. Korotov and Sack (2019) call this «Digital Anxiety.» Executives hesitate to tackle the challenge, but they are aware that their future competitive advantage will depend on the intelligent use of data. Ultimately, corporate survival hinges upon a successful digitalization of their businesses.

A matrix of models for organizational implementation

But how can this transformation be implemented from an organizational point of view? Which resources should companies deploy? Should they team up with external consultants to accelerate the adoption process, hire IT experts or students, or build up and rely on their internal expertise as a source of longer-term competitive differentiation?

The following framework sketches four alternative pathways that companies can choose. In its dimensions, it is based on Christoph Räthke's Corporate Entrepreneurship Matrix (Burger, Räthke, Schmitz, & Weinmann, 2021). In this conceptual framework, the vertical axis depicts whether a digital innovation project solely relies on internal resources, such as the IT or the R&D department or integrates capabilities from outside the organization. By contrast, the horizontal axis differentiates according to novelty regarding the existing skillset of the firm. Starting on the left side, the degree of innovativeness is low and close to existing use cases – only with a digital twist. Often, these digitalization projects are launched to increase process efficiency and cut costs in the back office. Moving further to the right, the degree of disruption increases: New business models and use cases may lead to yet undiscovered digital pillars of future growth, but they face the trade-off of high uncertainty about their chances of success, the necessity of transformational leadership, with a mind-shift towards experimentation, a culture of psychological safety to accept failures, and – more generally – a learning organization that is willing to depart from existing paradigms.

Prototypical examples for each of the four quadrants will be explained in the following sections.

Model I: Nucleus

The top-left quadrant shows the nucleus model, coming closest to the conventional understanding of the IT department's role in facilitating the introduction of a new software solution or digital technology. Triggered bottom-up by business units or middle management, a local pain point is identified that can be resolved by deploying a digitally enhanced solution. Sometimes internal domain experts and IT representatives collaborate in dedicated teams to find appropriate technologies, in other cases the business unit hires students or postdocs from universities, IT specialists or engineers from the job market, always with the objective of replacing a locally established system with a more efficient solution.

For example, the procurement department of energy midstream company Uniper, headquartered in the German city of Düsseldorf with a workforce of around 12,000 employees, established a Center of Excellence (CoE) to promote using RPA in 2016, which corresponds to the nucleus in the terminology of the matrix in Figure 5. Even though the procurement department initiated the process, the CoE started operating as a «federated model» with «a group of business areas, called 'pioneers', namely, from procurement, accounting and back office operations.» (Seaton, 2019) In addition, Uniper standardized processes, for example an

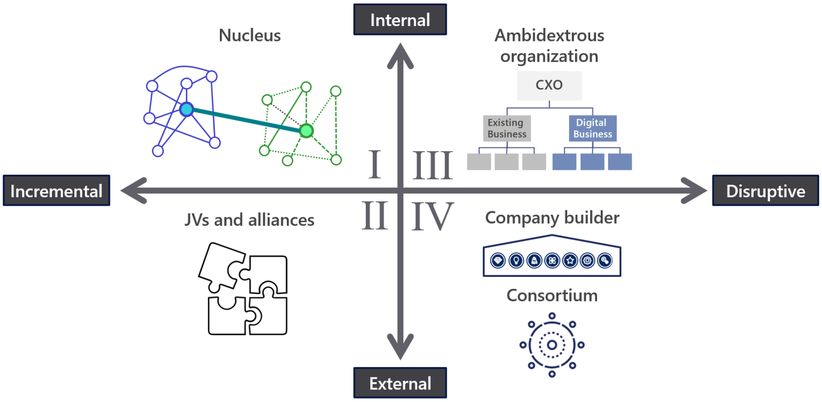

Figure 5: Four models of organizational implementation in the Corporate Entrepreneurship Matrix.
Source: Adapted from Räthke et al. (2021).

assessment for business teams how to identify the most suitable candidates for future automation. The Center of Excellence did not only coordinate the implementation of the robots, but it also took an active role in propagating the technology across departmental units and silos. Until 2019, it provided in-house RPA trainings for around 180 Uniper employees (ibid.). One of the lessons learned in the Uniper RPA rollout, though, was the continued importance of the IT department as an internal key partner in charge of security, support, and infrastructure.

In the book, best practice cases (1) to (4) provide individual narratives how data analytics, RPA and AI were implemented following the rationale of the nucleus model.

Model II: JVs and alliances

Setting up an internal unit like Uniper's Center of Excellence may lead to a trickle-down effect and fundamental cultural changes of the existing workforce. However, if a company does not perceive the need for a specific in-house expertise, because it may not be considered part of the desired, strategically defined core competencies, and a solution must be found quickly – then the bottom-left quadrant of the matrix with Model II «JVs and alliances» applies. External partners can be established players in the market with complementary resources and capabilities, such as IBM for Maersk in setting up the TradeLens platform, but also DeepTech startups concentrating on niche applications that are of value to larger companies.

These collaborations can materialize as projects with clearly defined objectives, milestones, and deliverables, with a start, an ending date and a piecewise transfer of knowledge and technological training from the startup to the contractor. But they might also be implemented as a solution with continuous renewal of the business relation, for example via monthly or annual subscription fees, or an output-based or pay-per-use model.

For example, Swiss-based startup ITficient offers its expertise to create digital twins of physical components as well as predictive maintenance services to companies such as sensor manufacturer Phoenix Contact, Kaeser Kompressoren, one of the world's leading manufacturers and providers of compressed air products and services, or Austrian electricity utility Verbund. In the case of Verbund, ITficient developed a digital twin of the Rabenstein hydropower plant in the Austrian province of Styria: «All data is managed, analyzed and visualized by ITficient. A dashboard provides a complete overview of Rabenstein turbine in real time, including the data from sensors and virtual sensors as well as the remaining service life.» (Gebhardt & Alberts, 2019) For Verbund as a utility, the strategic objective was not only the reduction of downtimes due to predictive maintenance, but also the real-time optimization of plant utilization in balance with intermittent renewable energies, such as wind or solar power (ibid.).

Best practice case (6) of machine-translation services startup Lengoo describes the benefits of these partnerships from the perspective of the startup, whereas case (7) contains a dialogue of representatives of both partners, Allianz as an incumbent and Peregrine Technologies as the startup.

Model III: Ambidextrous organization

The third quadrant depicts a prototypical solution to how an organization can organize disruptive innovations internally. Building on prior works by March (1991), American scholars Tushman and O'Reilly introduced the concept of the ambidextrous organization in their seminal article in the California Management Review (1996). In their definition, organizational ambidexterity is the capability of a firm to simultaneously «explore», that is, finding new pillars of growth, and «exploit», which means securing revenue streams of the existing business lines. Based on a sample of 35 firms, they identified ambidextrous organizations as the most successful innovators, «where the breakthrough efforts were organized as structurally independent units, each having its own processes, structures, and cultures but integrated into the existing senior management hierarchy.» (O'Reilly & Tushman, 2004) In practical terms, this implies that the organizational setup to implement disruptive digital business models should separate between «explore» and «exploit» business units, so that the existing corporate processes, structures, and cultures do not «contaminate» the new organization. However, the support of top management ensures that the «explore» businesses have access to existing resources, such as «cash, talent, expertise, customers, and so on» (ibid.).

The idea of the ambidextrous organization came into existence before the current wave of digital transformation hit corporations. For disruptive digital business models, though, the hypothesis of two functionally and culturally separated entities for exploration and exploitation business lines seems even more relevant, because digital business models may require different skillsets than traditional operations. Moreover, the gap between the existing workforce and a new generation of «Digital Natives» may require a cultural split to become attractive for young talents.

One recent example illustrates how organizations can successfully implement ambidexterity in their day-to-day practice: Klöckner & Co is a producer-independent steel and metal trading company, present in more than ten countries with a six-digit customer base. Founded in 1906 in the city of Duisburg, right in the center of the West German Ruhr area with industrial heavy-weights such as ThyssenKrupp and a long tradition of coalmining. In 2014, the company's CEO decided to launch a steel-trading platform – in a first step for its own customers, but with the idea of evolving into the leading European marketplace. Instead of establishing the new digital unit on their compounds in Duisburg, the CEO Gisbert Rühl opts for the emerging startup hub Berlin: «The digital hub was envisaged to be 'far enough from Klöckner to act independently, yet close enough to leverage expertise as well as access to customers and suppliers'.» (Korotov & Sack, 2019, p. 5) The new subsidiary was called kloeckner.i and became a major success story for the company, with around 140 employees at the end of 2022 (kloeckner.i, 2022).

In the book, Brazilian business school Saint Paul chose the path of an ambidextrous organization when implementing its AI functionality, as well as the Schweizer Kantonalbank with its Innofactory. The two corporate narratives can be found in case studies 5 and 10, respectively.

Model IV: Company builder / Consortium

In the global village surrounded by a flat world, innovation has moved from hermetic, secretive R&D departments to Hackathons, Open Innovation platforms, crowdfunding, and crowdsourcing. Accelerators accommodate entrepreneurs and equip them with the skills and a network of mentors to let their visions materialize, makers experiment with digital technologies in fab labs and co-working spaces. Tapping into the larger innovation ecosystem and its workforce has never been easier than today, especially in hip and cosmopolitan hubs like London, New York, Shanghai or Bangalore.

In those locations, organizations can establish company builders or accelerators that attract millennials and founders, data experts, geeks, and nerds. One example for this strategy is German Hidden Champion Viessmann, a family-owned manufacturer of boilers for heating systems with a workforce of around 12,000 employees. Its headquarters are in a small town in rural

Western Germany, far away from any urban agglomeration. Max Viessmann, the 30-something family heir and CEO, realized that his company had to move towards Smart Home and digital solutions. In Berlin, he set up a company builder called WattX, a joint workshop for other high-end manufacturing companies called Maschinenraum (Schlenk, 2016), in addition to two Venture Capital funds, one of which is located in Munich, the capital of the Southern state of Bavaria .

Another path to digital disruption is via consortia. Many Blockchain applications follow the dynamics of platform economics, with the «winner-takes-it-all» tendencies. Setting up an independent Blockchain platform as a stand-alone product may suffer from a lack of traffic and lengthy financial investments before any reasonable financial returns arrive, whereas participation in an existing network with a proven IT solution and sufficient traction may be a less risky alternative for many companies. However, complex governance mechanisms of a multi-party platform may prevent rapid implementation, as best practice case (8) on Uniper's permissioned Blockchain solution reports.

In the previous section on Technological Enablers, TradeLens and the Catena-X Automotive Network have served as introductory examples. They will be complemented in the subsequent case studies by best practice case (9), which provides in-depth insights into how Hidden Champion Chargeurs established a Blockchain platform for luxury materials.

Scope of the book

The overarching objective of this book is to provide a hands-on toolkit for executives to leverage digital innovations amidst a societal and economic context of volatility, uncertainty, complexity and ambiguity – the so-called VUCA world (Taskan, Junça-Silva, & Caetano, 2022). Digital transformation is a highly dynamic process, which got even further accelerated by COVID-19 and the global lockdowns during the first waves of the Pandemic, forcing companies as well as individuals to switch to digital solutions much faster than previously anticipated. Suddenly, human interaction in many parts of the world was reduced to communicating in minuscule tiles with peers, colleagues and friends, hardly being able to decipher mimics and gestures. Documents and spreadsheets eventually started to get shared via cloud solutions, and companies had to adapt to a remote, dispersed and digitalized style of co-working.

This extrinsic shock proved to be highly disruptive. However, many organizational changes were reversed at the end of the Pandemic, with even the tech companies, such as Zoom, encouraging their workforce to at least partially return to their offices (Mahdawi, 2023). Organizational setups prove to be more resilient than anticipated during the lockdowns.

Digital innovations face a similar challenge of resistance to change. Often, they originate from intrapreneurs, rebels and «Pirates in the Navy»

(Viki & Pohl, 2022), leading to clusters and pockets of excellence, but small improvements in the larger scheme. The cover image of this book depicts that motive.[4]

The major intention of this book is to capture the qualitative insights of successfully implementing disruptive digital technologies in day-to-day practices. The subsequent case studies serve for leaders and executives as a source of inspirational input how to embark on a digital transformation journey in their respective business units or teams. They contain qualitative interviews with corporate executives, entrepreneurs and academics who were willing to share their experiences with the authors of this book, and were recorded, transcribed and edited for publication.

The authors have chosen the format of individual storytelling rather than quantitative analysis for the best-practice cases, because they can represent the complexities of implementing disruptive technologies in an organization – in a way that managers can learn most from the experience. In particular, stakeholder management and innovation narratives are more difficult to be captured by figures and numbers but require a subtle understanding of the corporate context, as well as the human need for stories (Shiller, 2019).

Of course, this book's insights do not take all failed innovation initiatives into account. Rather, they are characterized by a positive selection bias (Collier & Mahoney, 1996), because they only depict successful examples of change. However, they entail important insights into the practical logic how change initiatives may succeed, and therefore have important managerial implications.

Digital transformation encompasses multiple dimensions, and many taxonomies for consistent categorizations have been introduced in scholarly literature. In this book, the selection of questions closely follows the theoretical framework of Bumann and Peter (2019), which is based on a meta-analysis of digital transformation frameworks and not only focuses on technologies, but also on organizational aspects, such as culture, strategy, the employees' willingness to change, and the role of customers as active drivers of the transformation. The concept will be presented in greater detail at the beginning of Part 3.

It would be beyond the scope of this volume to cover all algorithm-based and device-based digital technologies that were presented in the section on technological enablers. In order to identify the most important technologies that drive digital transformation, the authors used the survey results and selected

[4] It is a visualization of changes of a given, complex geometrical structure morphing incrementally into a novel pattern, based on Nobel Laureate Sir Roger Penrose's seminal tiles (Penrose, 1974). The pattern was published by Welberry (2019) in the scientific context of quasicrystals and modifies two sets of ν_i, ϕ_i parameters with an incremental deformation pattern. The color-coding of the illustrator's interpretation is intended to suggest that some change initiatives fail, while others are carried further and become engrained in the corporate structure of organizations.

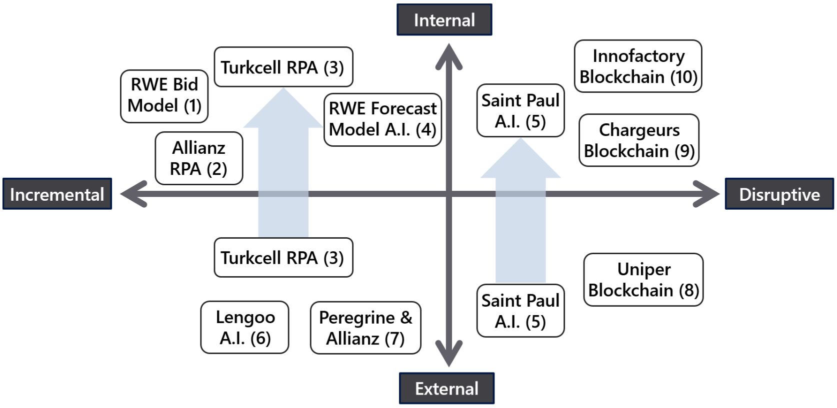

Figure 6: Positioning of case studies within the Corporate Entrepreneurship Matrix.
Source: Adapted from Räthke et al. (2021).

the interviews for this book based on the shortlist of the most relevant sector-indifferent technologies. These are – in order of hurdles of implementation – Robotic Process Automation, Artificial Intelligence, and Blockchain. Figure 6 provides a positioning of the respective case studies within the Corporate Entrepreneurship Matrix.

For the following four chapters of Part 2, the authors suggest moving gradually from the first quadrant of the matrix, with case studies (1), (2), (3) and (4) on the *nucleus* type of organizational dissemination to case studies (5), (6) and (7), which depict joint ventures and Saint Paul's case on an ambidextrous organization, whereas cases (8), (9) and (10) exemplify attempts to initiate more disruptive transformations.

Part 3 of the book distills the main findings from the interviews and corporate narratives. For readers with a limited amount of time, the authors suggest concentrating on the narratives of the best practice cases that are most relevant to them at the beginning of chapter 6, and then jumping directly into the analysis of future developments at the end of Part 3.