



A European study
commissioned by
the Federation of
German Industries (BDI)
and conducted by
Roland Berger
Strategy Consultants

THE DIGITAL TRANSFORMATION OF INDUSTRY

**How important
is it?
Who are the
winners?
What must
be done now?**



SEIZE OPPORTUNITIES!



CHANGE STRUCTURES!



JOIN FORCES!

In brief

1

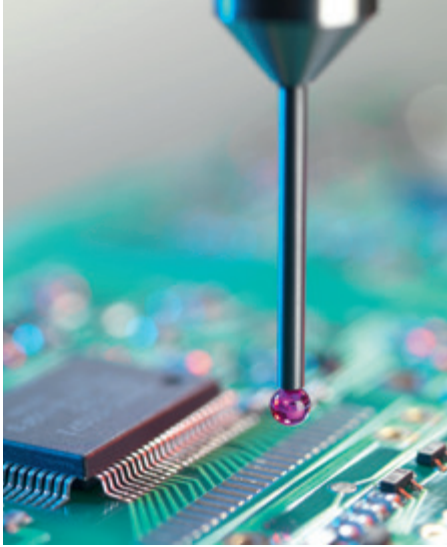
The digital transformation of industry is creating tremendous opportunities for Europe – and confronting it with huge challenges. The possibilities opened up by connected, more efficient production and new business models are highly promising, yet the risks are equally dramatic. By 2025, Europe could see its manufacturing industry add gross value worth 1.25 trillion euros – or suffer the loss of 605 billion euros in foregone value added.

2

The digital transformation of industry is also driving a radical structural transition in Europe's economies. New data, connectivity, automation and the digital customer interface are challenging existing value chains. Companies must take a long, hard look at their products and skill sets. And they have to improve their digital maturity if they are to recognize new opportunities, develop suitable offerings and get them to market quickly.

3

The digital transformation of industry demands concerted action within Europe. The regulatory framework must be harmonized, with a new weighting given to relevant issues. At the same time, a powerful, no-gaps information and communications infrastructure is needed if European industry is to remain competitive. As standards are shaping our digital future, companies and governments need to get engaged seriously in their global definition.



22 → **Electric performance:** How the digital transformation is affecting individual industries



26 → **Adjustment needed:** Why companies lag behind in the digital race



"Digital connectivity will continue to develop faster and faster. Today, you don't win the global competitive battle in the real world alone, but also in the digital one."

DIETER ZETSCHKE,
Chairman of the Board
of Management,
Daimler AG

32 → **Take-off:** How industry and governments must rise to the digital challenge

Contents

6 WHAT THE DIGITAL FUTURE HOLDS

8 WHAT IS AT STAKE

14 Why Europe must get involved in the standardization debate without delay

16 THE LOGIC OF DIGITIZATION

17 Four levers of transformation

19 The atomization of value chains

22 THE SITUATION OF GERMAN AND EUROPEAN INDUSTRY

24 Wave 1: The automotive and logistics industries are reaching a digital watershed

25 Wave 2: Medical technology, electrical engineering, mechanical and plant engineering and energy systems are experiencing a digital upheaval

25 Wave 3: Digital change will come later to the chemical and aerospace industries

26 GERMANY'S DIGITAL MATURITY

30 Huge shortfall in penetration

30 Urgent need for action

32 WHAT NEEDS TO BE DONE NOW

33 What companies must do

35 What governments must do

43 Target corridor

43 Time frame

46 SERVICE

46 Network

47 Imprint

50 Extras

What the digital future holds



Charles-Edouard Bouée
CEO
Roland Berger Strategy Consultants



Stefan Schaible
CEO Germany/Central Europe
Roland Berger Strategy Consultants

Our life has gone digital. For consumers, digitization – in the form of e-commerce, the mobile internet and social media, to name but three of many examples – has long since been part and parcel of everyday life. Now, the digital transformation is also permeating every link in the industrial value chain, from logistics through production to service provision. Germany's and Europe's industrial core stands on the threshold of fundamental change – change that promises fresh growth, prosperity for large parts of the population and greater resource productivity. Alternatively, that same change could see German and European industrial companies forfeit their global market leadership.

We understand the digital transformation as the seamless, end-to-end connectivity of all areas of the economy, and as the way in which the various players adapt to the new conditions that prevail in the digital economy. Decisions made in connected systems affect data exchange and analytics, the calculation and assessment of options, the initia-

tion of actions and their consequences. In line with Schumpeter's principle of creative destruction, these new tools will bring fundamental change to many established business models and value-added processes.

Commissioned by the BDI (the Federation of German Industries) and conducted by Roland Berger Strategy Consultants, this is the first study to explore the causes and effects of the digital transformation with regard to the "industrial heart" of Germany and Europe, by which we mean the automotive industry, logistics, mechanical and plant engineering, medical technology, electrical engineering, energy systems, the chemical industry and aerospace. To this end, we performed an extensive strategic analysis supported by workshops involving industry experts, received questionnaire responses from more than 300 key decision-makers at German companies, and interviewed 30 board members and chief technology officers at DAX-listed companies and leading medium-sized players. On this basis, we were for the first time able to measure the

overall effect of digitization on the German and European economy. The findings reveal the dramatic consequences of the changes currently in progress:

→ If Europe fails to turn the digital transformation to its own advantage, the potential losses for the EU-17 countries¹ add up to 605 billion euros by 2025 – equivalent to the loss of well over 10 percent of the continent's industrial base. This would push the EU's stated aim of increasing manufacturing's share of European GDP to 20 percent by 2020 way back out of reach.

→ For Germany alone, the positive scenario would add extra potential value totaling 425 billion euros by 2025. The corresponding figure for European industry as a whole would be 1.25 trillion euros over the next ten years.

In light of these high stakes, our study makes specific recommendations on what companies, their national associations and the governments in Germany and Europe can do to safeguard the future of Germany's industrial base and generate positive employment effects throughout Europe.

The key areas in which action is needed are these:

DIGITAL MATURITY. Top priority must be given to raising awareness among companies and mobilizing them, because many firms see digitization primarily as a way to boost efficiency. Yet the digital economy does more than merely oblige companies to optimize existing business models: It also promises new and hitherto untapped potential to add value. To identify and realize these opportunities, companies need to become more digitally mature. One aspect involves increasing their penetration of digital trends and possibilities. Another is to gain a better understanding of how the digital space is changing the rules of competition, as this will allow them to optimize existing business models and develop new ones. Third, firms must cultivate the ability to develop and multiply the resources they need in order to seize new opportunities in practice.

COMMON STANDARDS. The rules of the game in a given industry play a vital part if companies are to translate their specific capabilities into competitive advantages. That will

be the case even more so in the future. German and European companies must therefore move quickly to define these standards, working together to create suitable platforms for the sharing of ideas, knowledge and experience. German and European government organizations should support this process. The EU would, for example, do well to emulate the German government's National Electromobility Platform (NPE) program – a fine example of standard setting via effective collaboration between the state, the corporate sector and the unions.

POWERFUL INFRASTRUCTURE. A robust infrastructure forms the backbone of a connected economy. The success of the digital transformation hinges on no-gaps broadband networks and the guarantee of a high quality of service for mission-critical applications. Plant and machinery must be connected as extensively and securely as possible.

PAN-EUROPEAN COORDINATION. Success in the digital economy is equally dependent on cross-border collaboration. Investment programs such as the Juncker plan should focus rigorously on promoting the digital transformation. As part of a harmonized EU-wide approach, the aim is for a European economic alliance to encourage the development of clusters, cooperative ventures and syndicates or associations, bringing the skills and capabilities that are spread across Europe together in a virtual Digital Valley. This kind of European counterpart to Silicon Valley would interconnect all relevant developers and providers of digital solutions, from start-ups to global players, from garage firms to high-tech laboratories, thereby concentrating the stimulus needed to drive new developments and innovative business models.

Our thanks go to the BDI in general, and to Dieter Schweer, member of the Executive Board responsible for digital transformation, in particular for initiating and commissioning this study, and for their openness and cooperation. Special thanks also go to board members and decision-makers in German industry, as well as to EU Commissioner Günter Oettinger, who took the time for detailed interviews and discussions on the subject of digital transformation.

Berlin, February 2015

Charles-Edouard Bouée, Stefan Schaible

1) The EU-15 countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the UK) plus Norway and Turkey. (The other EU countries were excluded due to a lack of detailed industry data.)



**Faster, more synchronous,
more transparent:**

The European logistics industry stands to gain an extra 54 billion euros a year in value added by the digital transformation.

WHAT IS AT STAKE

For decades, Germany has ranked among the world's leading industrialized nations. Manufacturing accounts for more than 22 percent of its economic output (2013), compared with a figure of around 12 percent in the USA.²

Global corporations are the driving force behind Germany's manufacturing sector. They include automotive companies such as BMW, Daimler and Volkswagen and corporate groups such as Airbus, BASF, Bosch, Fresenius and Siemens (all of whose top managers we talked to in the course of this study) as well as an array of medium-sized firms that rightly receive widespread plaudits. The hidden champions in this segment – global leaders that often fly under the public radar – shape Germany's industrial landscape to a very considerable degree. In terms of sales revenue, more than 1,300 German medium-sized firms figure among the top three players in the world in their chosen niche markets. In other words, almost half of the world's roughly 2,700 "hidden global leaders" come from Germany.³

Other regions too are looking to strengthen their domestic manufacturing industries as part of a drive toward reindustrialization. After two decades of seeing production and jobs being transferred to emerging markets, the United States in particular is stepping up moves to return to the very top of the global industrial table. In Europe as well, the need to reinforce manufacturing is a key topic of debate. In 2012, the EU Commission formulated the ambitious goal of raising manufacturing's share of European economic output from 16 to 20 percent by 2020. Without digitization, however, reindustrialization is unthinkable.

Deep and direct integration in customers' processes and a vast store of manufacturing competency are two of German industry's main strengths. Both translate into specialized hardware and embedded software that enable the entire spectrum of corporate knowledge and experience to be put to good use in high-quality production. However, the digital transformation is shifting the ability to add value in manufacturing platforms and more standardized software solutions. At the same time, new players are threatening to replace incumbents at the interface to customers. This shift in the share of value added and disruptions to customer interfaces are creating a scenario that poses a lasting threat to the

2) UNCTADstat Database, United Nations Conference on Trade and Development

3) Investment Guide, Germany Trade & Invest

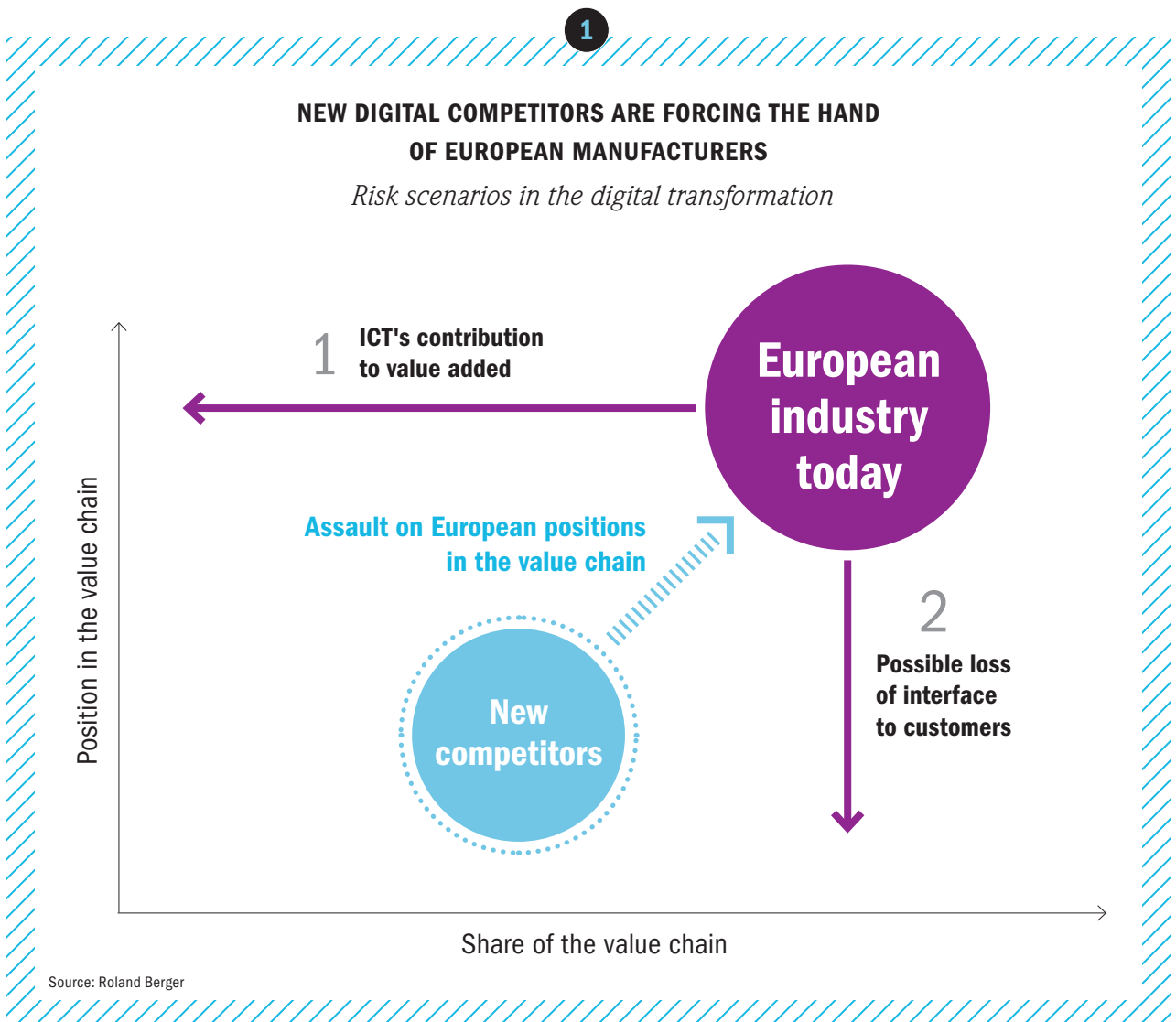
powerful position currently enjoyed by global market leaders from Germany and Europe.

If the manufacturing industry is indeed toppled from its leading position in value creation and allows other companies to take their place by controlling the interface to customers and applying superior digital expertise (Figure 1), this will lead to painful losses in value added and thinner margins:

POTENTIAL LOSSES IN GERMANY. Our negative scenario assumes a decline in industrial value added totaling 220 billion euros by 2025 in the eight sectors of industry analyzed

in Germany alone. The automotive and logistics industries would be especially hard hit, losing out on as much as 140 billion euros in gross value added.

POTENTIAL LOSSES IN EUROPE. If the European manufacturing sector misses out on the digital transformation, the sum of 605 billion could be at stake in the years ahead (Figure 2). This potential loss is calculated from the continuing increase in the share of gross value added accounted for by information and communications technology (ICT). In automotive engineering and logistics alone, this share is



slated to rise by 15 and 18 percentage points respectively between now and 2025. If European companies are unable to stake their claim in this fast-growing market with their own products and solutions, value will be added by new competitors instead.

These negative scenarios can be prevented from happening if Europe gains greater influence over the design of standards for the digital economy. Standards are necessary to ensure interoperability and generate economies of scale. However, unsuitable standards would put pressure on margins and jeopardize the competitive advantages enjoyed by German and European industry. This issue is of concern to the production knowledge that many manufacturers channel into their embedded software. Standards that are too narrow or too simple could undermine this advantage, for example by altering important conditions governing embedded programs such that high-quality individual solutions can no longer be developed.

It is also important to understand that a new standard – even one that favors the strengths of German and European companies – can open the door to the redistribution of global market shares. Armed with high-quality products based on the right standards, German industry is well placed to stand up to competition. On the other hand, today's global market leaders have so much further to fall than other players. Our companies must therefore prepare themselves for the full force of the digital transformation that is about to be unleashed. They must understand how important it is for the coming decades.

At the same time, changes at the customer interface can have a powerful influence on the development of companies' margins – witness our example from the mobile communications industry (Figure 3). Per device sold, Apple's proprietary software and hardware ecosystem today earns the company five times as much profit as Nokia realized when it led the market in 2005. By contrast, the margins of niche players such as HTC, who have no interface to the customer, are experiencing very negative development. Only mass producers such as Samsung are able, by virtue of the sheer scale of production, to offset the loss of a customer interface and thus continue to post positive margins, albeit much thinner ones than those of integrated premium providers.



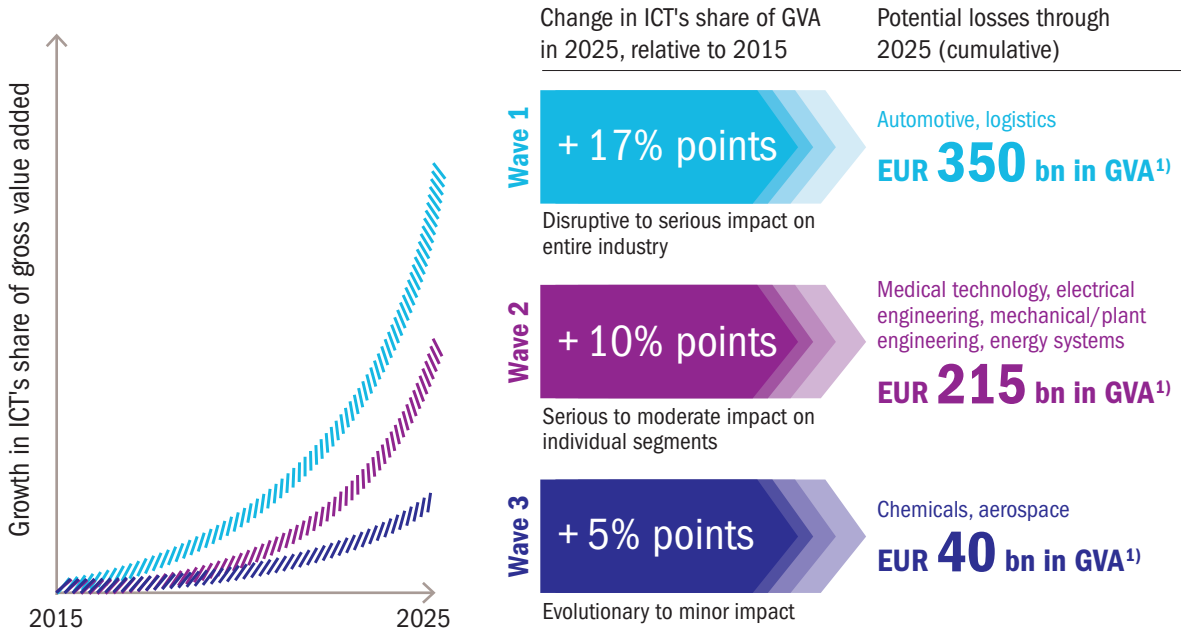
"The possibilities of the digital revolution must be put to good use. That involves designing, developing and manufacturing our products much more efficiently and much faster. In the aerospace industry, we are currently seeing a level of competition that we have never experienced before."

TOM ENDERS, CEO, Airbus Group

2

IF EUROPE MISSES OUT ON THE DIGITAL TRANSFORMATION, IT COULD FORFEIT 605 BILLION EUROS IN LOST VALUE ADDED

Potential losses arising from a shift in the shares of value added



Source: Roland Berger

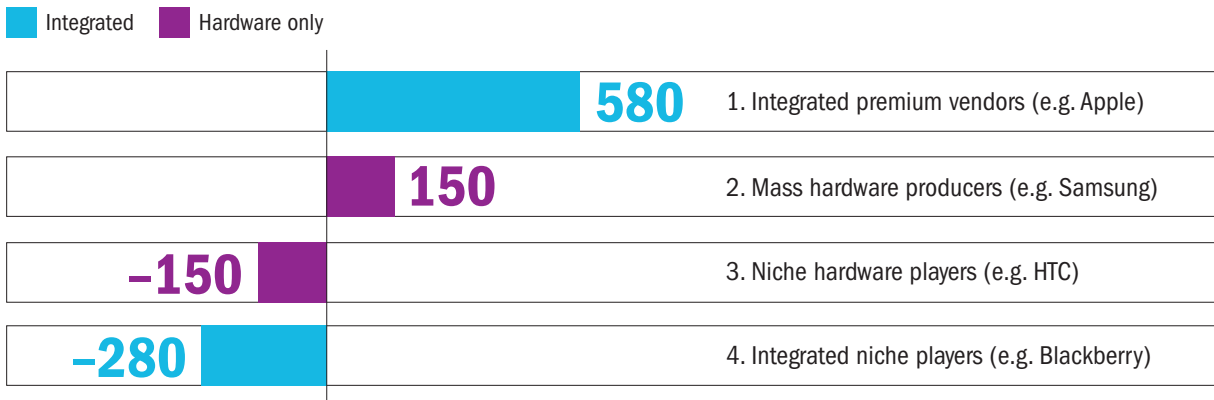
1) Gross value added foregone by the EU-17 countries if the increase in ICT's share of GVA is lost to international competitors

3

COMPANIES WITH NEITHER A CUSTOMER INTERFACE NOR LARGE-SCALE PRODUCTION ARE SEEING THEIR MARGINS COME UNDER HUGE PRESSURE

Profit margins in mobile communications

Margin per unit sold relative to the market leader in 2005 [percentage points]



Source: Roland Berger

A similar scenario is unfolding in the automotive arena, as OEMs fight to control the ever more important customer interface. Volkswagen, Fiat, Renault and other European manufacturers have thus joined the Open Automotive Alliance (OAA). This Google-led community is developing a shared platform for the connected car in order to be able to integrate navigation data and infotainment. Other manufacturers such as BMW are driving development emphatically but on their own initiative. The expectation is that those market players that only back incremental changes and fail to invest in digital platforms will come under pressure from – or even be edged out by – the new standards birthed by alliances such as the OAA, or by mobility service providers.

The importance attached to integrating automobiles in the digital ecosystem is likely to be critical. Will this question be as crucial to the purchase decisions of car buyers in the future as the question "iOS or Android" is for smartphone buyers today? How important will it be to them to have seamlessly integrated digital services? Where will the line be drawn between navigation and entertainment data on the one hand and user data that is of relevance to insurance and safety issues on the other? Will OEMs have to pay a commission to use a third-party customer interface, or might they even end up as little more than hardware suppliers?

These few questions and examples alone make it clear why a successful digital transformation is so important to industry: This transformation is what will enable industry players to realize significant cost benefits, tap additional revenue potential and develop new business models. It also reduces the time factor to a bare minimum: Smart factories can adapt their production to the whims of individual customers at short notice. Fully connected smart companies can organize countless supply chains in parallel and dynamically align their offerings to trends as they emerge in social media. Similarly, smart homes can organize the logistics of private dwellings and react in seconds to the changing wants and moods of their occupants.

Organizing the creation of value in dynamic networks completely changes the face of competition. Besides cutting the cost of existing business and pursuing vertical and horizontal integration, digitization now provides further ways to increase the value a company adds and thereby give it a competitive edge.



"The digitization of society gives us as a car maker the chance to make sure automobiles still have their place in cities in the future."

RUPERT STADLER, Chairman of the Board of Management, Audi AG

RACE FOR THE STANDARD

Why Europe must get involved in the standardization debate without delay

TRIUMPH OF THE OPEN MODEL. Standardization is pivotal to the ability of German and European manufacturing to compete in the future. We don't need to go as far back as the pitched battle over video recorder systems in the late 1970s: Recent developments in information and communications technology (ICT) are sufficient to underscore the tremendous importance of standards. While Cisco in particular built absolutely everything around the Internet Protocol in the 1990s, European equipment manufacturers stood by their proprietary – read: closed – network technology standards for corporate customers and telecom firms for the longest time. Although it was less flexible, the open model ultimately won the day, as standardization quite simply offered too many benefits. As a result, European ICT providers – companies posting revenues in the tens of billions – gradually saw their competitiveness erode, dissolved completely or were swallowed up by global rivals.

A WORLD APART. Flexible and connected production requires business ICT and factory equipment to be deeply integrated. Driven as a standard by US corporations, the Industrial Ethernet has already penetrated factories in the form of a wired network infrastructure. Yet even so, proprietary solutions – isolated silos and barely compatible architectures – can still be found in many industrial ICT installations. In such cases, business ICT systems (such as ERP software and CRM systems) are often linked to production ICT only via customized, vendor-specific interfaces. In most cases today, this block of production ICT systems, ranging from industrial control systems (such as ICS and SCADA) to sensors, actuators and production robots, constitutes a self-contained and often production-segment and provider-specific environment. Responsibility for these areas is typically split between the CIO and the CTO/COO, which does not exactly make it easy to integrate the various levels along the lines of Industry 4.0.

ECOSYSTEM AT RISK. As things stand, German and European mechanical engineering firms and providers of automation systems still rule the roost, in part because their products dominate the markets for these closed ecosystems. Yet US competitors are already seeking to break into these closed-loop solutions via the channel of standardization, in much the same way as the Internet Protocol swept away everything in its path in the 1990s. The launch of the Industrial Internet Consortium (IIC) in early 2014, largely at the behest of General Electric and Cisco, is indicative of these efforts.

NOTHING TO WORRY ABOUT? At first glance, complexity and the sheer multiplicity of production segments appear to present obstacles to a new standard. However, every historical precedent suggests that proprietary solutions will sooner or later be replaced by open standards – in individual segments and domains to begin with, and then throughout the market. The implication is clear: Market players must prepare themselves accordingly.

EUROPE'S RESPONSE. This raises the question of an appropriate response by German and European providers to the IIC initiative. It is vital to ensure that Europe speaks loudly, clearly and with one voice, and that excellent quality is allowed to remain a powerful differentiator in industrial production. For these reasons, now is the time for Europe's companies and governments to throw their full weight into the global standardization debate.

Penetrating this new dimension of competition is all the more important given that a successful digital transformation often not only changes existing processes within the organization, but also entails the creation of entirely new business models.

If Europe neglects digital skills and loses touch with the basic innovation of tomorrow, and if the ICT sector accounts for an ever smaller share of Europe's gross value added in the future, the consequences will be far-reaching indeed – both for the goal of further strengthening Europe's industry and making it fit for the future, but also for the impending digital transformation in other industries. That is why revitalizing the ICT sector in Europe is one of the keys to success. European companies must once again build up their own digital capabilities, from data gathering and processing through connectivity and automation to the development of their own business models at the digital customer interface. At the same time, these steps must be accompanied by activities

to strengthen public confidence in solutions for heavy data usage – solutions for big data, in other words.

Just how radically the changes brought by new technologies can affect established and apparently stable industries has already been shown by the European mobile communications industry. As recently as a decade ago, Alcatel, Nokia and Siemens were all regarded as global players with a bright future in ICT. Yet despite their dazzling prospects, heavy research spending and technological leadership, these stars of the European industry very soon plunged into oblivion. Take Nokia, for example: In the space of just a few years, the Nordic giant lost its position as a highly profitable global leader with a 30 percent market share and 265 million units sold per annum⁴ and, ultimately, pulled out of the market altogether. Snapped up by the world's biggest software group, the once-so-proud smartphone division of the Finnish company now goes by the name of Microsoft Mobile.

"We must and we will look very carefully at the opportunities and challenges presented to us by digitization. For BASF, the spectrum of possible models ranges from digital chemicals group to market leader for digital business models in chemicals."

UWE LIEBELT, President BASF 4.0, BASF SE

4) 2005 annual financial statements, Nokia



From smart factory to the autonomous vehicle:

If it vigorously tackles the challenge of digitization, the automotive industry can rake in an extra 35 billion euros in value added in 2025.

THE LOGIC OF DIGITIZATION

Maurice Lévy, CEO of the worldwide Publicis agency group, recently voiced his fear of "waking up one morning and having been 'uberred'." "Companies from completely different industries," he said, "can take away your regular business model overnight."

It is a fact that the possibilities opened up by digital media will bring dramatic change to our companies – to their strategies, processes, structures and products, but also to their cultures. In the future, people, machines and resources will communicate with each other directly and in real time. Rigid value chains will become dynamic value-added networks. Why? Because value will no longer be added sequentially and subject to time lags, but within a network of units that constantly communicate with each other, respond flexibly to each other and largely organize themselves (Figure 4).

The enablers of the digital transformation of industry include the internet of things, a high-quality broadband network and the increasing automation and autonomy of pro-

duction. These enablers facilitate new market positions and value propositions such as smart fabrics, fourth-party logistics (4PL) and predictive maintenance. All these technologies and propositions prepare the ground for disruptive developments and make them more likely to happen. Yet they are not doing so only in isolation, but as a combination. In many cases, value is added by connecting what used to be autonomous systems and joining up hitherto separate spheres. In effect, digitization is accelerating the process of evolution.

FOUR LEVERS OF TRANSFORMATION

To be able to assess the risk of being "uberred", companies must first understand the logic of digitization. The digital transformation takes effect via four levers (Figure 5):

DIGITAL DATA. Capturing, processing and analyzing digital data allows better predictions and decisions to be made.

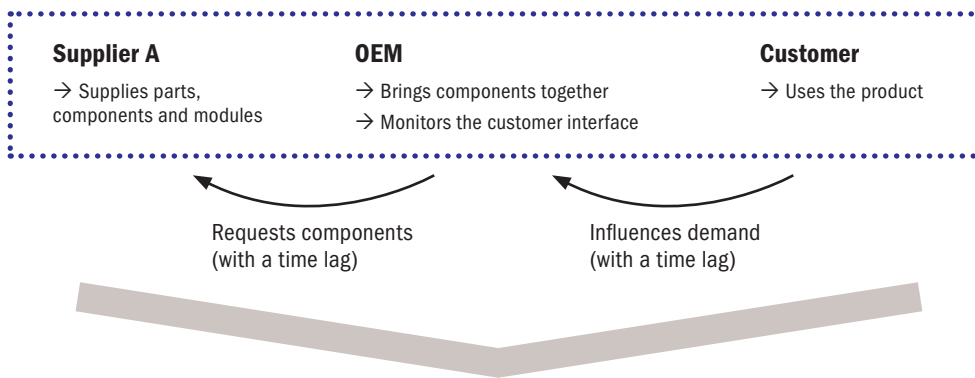
AUTOMATION. Combining traditional technologies with artificial intelligence is increasingly giving rise to systems that

4

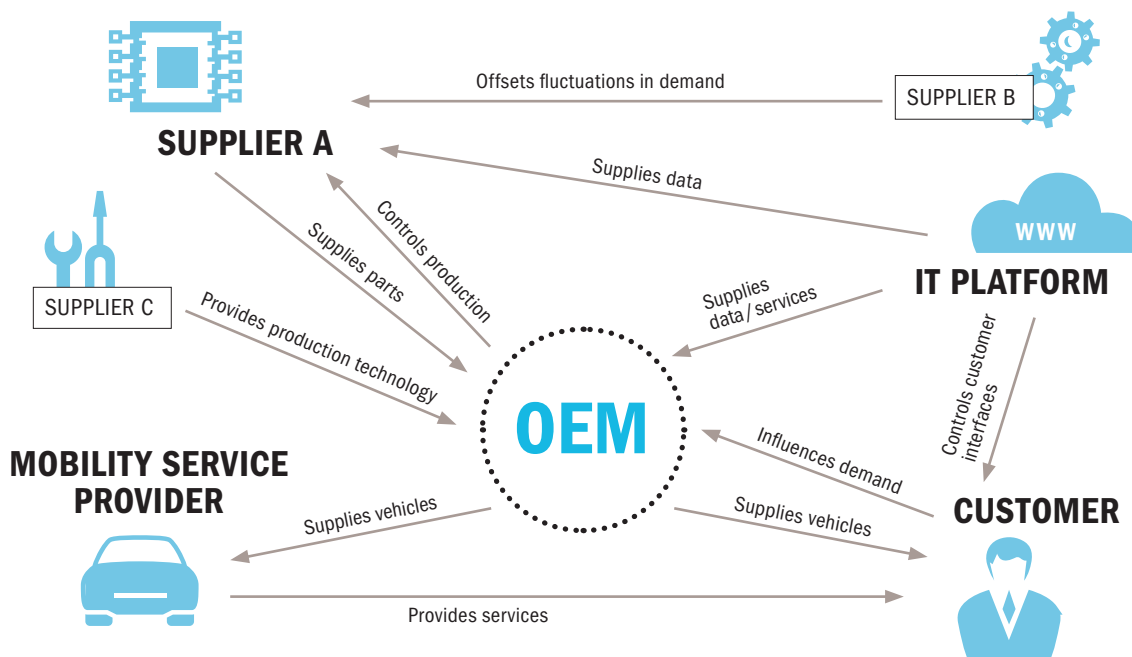
IN THE FUTURE, VALUE WILL BE ADDED ACROSS NETWORKS OF MANY CLOSELY CONNECTED PLAYERS WHO COMMUNICATE WITH EACH OTHER IN REAL TIME

Example: Impact of the digital transformation on the automotive industry

From rigid value chains...



... to dynamic value-added networks



Source: Roland Berger

work autonomously and organize themselves. This reduces error rates, adds speed and cuts operating costs.

CONNECTIVITY. Interconnecting the entire value chain via mobile or fixed-line high-bandwidth telecom networks synchronizes supply chains and shortens both production lead times and innovation cycles.

DIGITAL CUSTOMER ACCESS. The (mobile) internet gives new intermediaries direct access to customers to whom they can offer full transparency and new kinds of services.

The availability of digital data, the automation of production processes, the interconnection of value chains and the creation of digital customer interfaces is transforming business models and reorganizing entire industries. Just how far-reaching the transformation will be is exemplified by pioneering industries such as media (where print media and infrastructure providers have seen their importance wane, possibly to be followed soon by TV), the music industry (fully digital products and distribution channels), retail (online department stores and digital specialty retailers) and tourism (the demise of travel agencies and the ascendancy of aggregators). Signs of similarly disruptive changes are already appearing in the automotive and logistics sectors, too.

THE ATOMIZATION OF VALUE CHAINS

Given seamless connectivity, disruptors can break value chains down into their smallest elements and then, thanks to low transaction costs, reassemble them. However, this atomization will also lower or even eliminate the barriers to market entry. In some cases, it will even do away with the need for lots of fixed assets to handle production and logistics. Industry leaders who master complex processes and have built up a substantial capital stock cannot be certain of retaining their advantage in this highly volatile environment. That, too, is a lesson quickly learned from the example of mobile communications. Similar developments are already becoming apparent in the retail sector.

New players from other industries can leverage innovative business models to acquire a substantial level of value added. In the automotive industry, for example, it is not inconceivable that intermediaries could soon step into the value chain and take possession of the customer interface with

regard to insurance, car hire, the coordination of refueling stops and the production of very detailed travel information. It would also already be feasible for data aggregators to gain – and monetize – new insights into material wear and maintenance intervals. The competitive battle is often won not by the most convincing concept, but by the companies that are quickest to connect up their customer base. Metcalfe's law states that the benefits of a network increase in proportion to the square of the number of connected users, and this snowball effect lays the foundation for platform-based business models: The "winner takes all" logic of digital markets creates a situation in which even the player that finishes second may be no more than the first loser, despite being in possession of superior technology. This is precisely why, in a developing market, it is so important to occupy competitive positions early on and establish one's own standards.

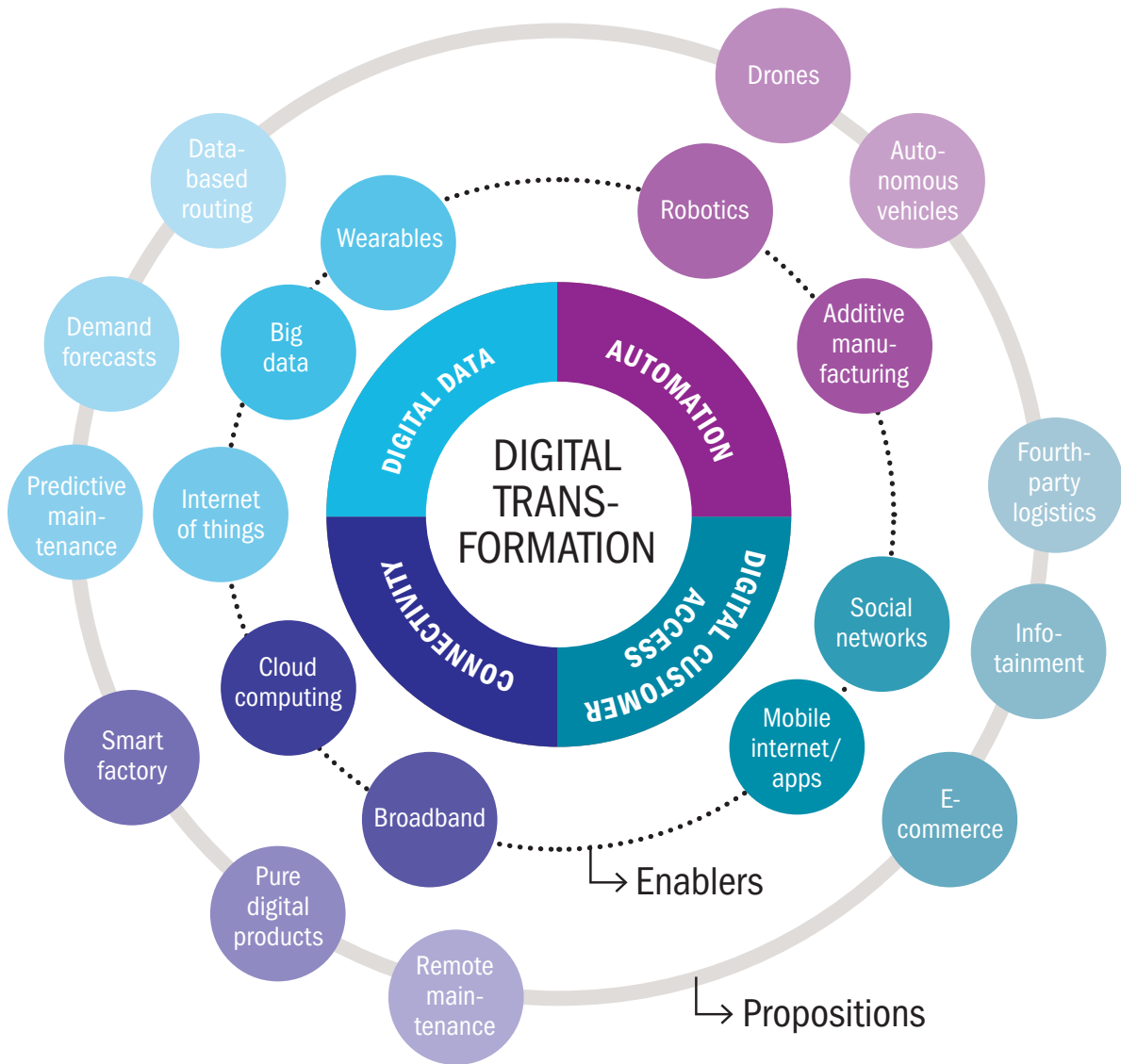
Internet companies from Silicon Valley have long since understood the writing on the wall. Google is a classic example: Founded in 1998, the data specialist has already developed its first industrial business models (Figure 6). These models may initially concentrate on the end customer, and many are still in the launch phase. What they already show, however, is that Google has long since discovered the value of manufacturing as a growth sector. All of its projects evidence a disruptive nature for incumbent firms. Based on data as its core competency and the access it enjoys to end customers, Google is completely redefining business models.

Entire value chains are thus running into digital disruptions as innovative companies start out from existing business models and move into adjacent areas. With the benefit of hindsight, each step seems to follow on logically from the one before. Amazon, for example, evolved in the space of a few years from an online bookseller to an internet department store to a provider of complex logistical services to a provider of cloud services to a tablet and smartphone provider to a video platform. It is scarcely possible to predict which industries could come into the firing line tomorrow.

The secret of success is to understand the rules of the digital game and occupy strategic checkpoints before others do so. On this score, pure online players often have the edge over traditional companies. Moreover, they are in a position to turn value chain inefficiencies to their own advantage. For the time

ESSENTIALLY, THE DIGITAL TRANSFORMATION TAKES EFFECT VIA FOUR LEVERS THAT ARE SUPPORTED BY NEW ENABLERS AND PROPOSITIONS

Drivers of digitization



Source: Roland Berger

being, German companies in particular are still managing to fight back thanks to an in-depth understanding of production processes and their close proximity to the customer interface. This advantage is already evaporating, however.

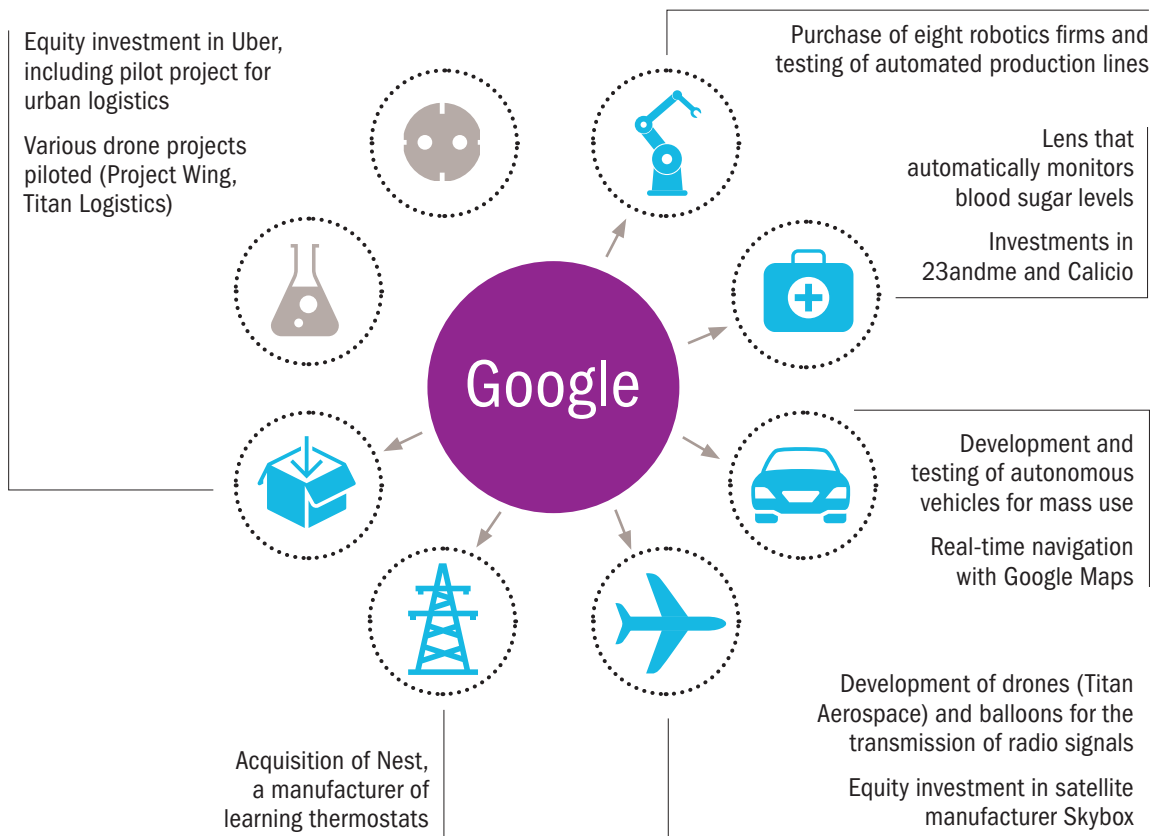
Europe's position is made even more difficult by the fact that, in the USA, Google experiences comparatively little reg-

ulation. In using its capabilities to gather data, analyze it and put it to good use, it can bank on a broad base of support from the business, scientific and political communities. As is so often the case, Europe is both less well organized and less patriotic. We must learn to carve a competitive advantage out of our decentralized nature and our diversity.

6

INTERNET FIRMS ARE DISCOVERING MANUFACTURING AS A GROWTH SECTOR

Google: Selected industrial projects and investments



Source: Roland Berger

**Enabling the digital
transformation:**

Electrical engineering can look forward to another 26 billion euros of gross value added a year.

THE SITUATION OF GERMAN AND EUROPEAN INDUSTRY

In Germany, many of the manufacturing industry's attempts to tackle the digital transformation concentrate on the subject of Industry 4.0. Frequently referred to as the "fourth industrial revolution", Industry 4.0 refers to the industrial-scale use of automation systems such as robotics with a focus on production processes, the emergence of cyber-physical systems and the interconnection of productive units within manufacturing environments. These changes are creating fully digital production networks that accelerate manufacturing and use production resources more efficiently. If that was all, Germany and its companies would certainly appear to be well placed for the digital race.

Yet this view fails to see the big picture, because the changes being wrought by the digital transformation go far beyond manufacturing alone. The four levers we have already touched on illustrate the extent of the transformation that is already underway:

DIGITAL DATA. Driven by the internet of things, sensors are increasingly being slotted into applications above and beyond their uses to date. This development is opening up new data sources not only in industrial machinery, but also at the interface to the customer – in vehicles, for example, and in portable computers (smartphones, tablets and wearables). Modern analytical technologies are allowing companies to crunch this data faster and in greater detail than ever before. Drawing on traffic and requirements data, today's logistics providers can adjust the routes for their transporta-

tion fleets in real time. Algorithms enable mechanical engineering firms to predict possible machine outages. Hundreds of data points help optimize numerous production workflows. The most important factors in this context are access to data and the ability to analyze it. A data monopoly of the kind Google has already achieved in many aspects of everyday life can quickly put other market players at a disadvantage.

AUTOMATION. The digital transformation is changing the function of machinery. Google, for example, has begun aggressively snapping up robotics companies in order to generate scale. It uses their products to gather more and more data which, in the next step, is translated into monetary gain. If Google succeeds in standardizing the operating systems and software used by its robotics products and combining them with the other services it provides (such as data analysis), the Californian giant will in future control key links in the value chain in every industry that uses robots.

CONNECTIVITY. For many market players, large segments of value creation effectively remain a black box to this day. The flow of goods in the logistical industry, for instance, is often anything but transparent. In production, coordinating requirements across company boundaries is frequently possible only subject to time delays. However, the increasing connectivity of what used to be separate systems is overcoming this lack of transparency and improving process efficiency. As a result, new applications such as car sharing and highly automated driving are emerging that would scarcely

have been conceivable without the connected car. Smart factories, too, are largely based on the interconnection of production systems facilitated by machine-to-machine (M2M) communications. All this, however, is possible only if an interoperable, universal communications standard is applied; and the formulation of such a standard has so far fallen at the hurdle of resistance within industries and an unwillingness to let go of proprietary systems.

DIGITAL CUSTOMER ACCESS. It is still unclear who is entitled to the data that accumulates during production in a smart factory. The user? The manufacturer? The IT service provider? There are sound arguments for all of these claims, and each would have far-reaching consequences for the control of production processes, the coordination of logistic flows and maintenance cycles as well as optimization on the shop floor. What if companies were to outsource the analysis of their production data to the digital platform provider? This provider would obtain superior data resources that would let it develop standards and value-added services. This in turn would create new dependencies: It could be, for example, that some specialized manufacturers would find themselves in the unfortunate situation that a standardized benchmark

inadequately reflects the benefits that set their products apart from mass-market manufacturers.

Although there will naturally still be a need for excellent engineers from Germany even in this scenario, their importance to the overall product will dwindle. Today's heavyweight industrial champions could very quickly find themselves relegated to the status of suppliers to digital platform providers, with all that this would entail for their vertical integration – and their margins.

The digital transformation will not hit every aspect of every industry at the same speed and with the same force. The extent of change in a given industry, and how fundamental that change is, will depend on the impact and scalability of digital innovations and on the ability to establish them. That said, no company can afford to rely on its value chain remaining unchanged, as our study of eight industries clearly shows for the first time. Three waves of digital transformation will sweep over these industries, the first of which will likely affect precisely those two industries whose gross value added is the highest (in relative terms) in Germany and Europe. These three waves will not all come at the same time. One thing is for sure, however: The digital transformation will affect the entire industrial landscape.

Wave 1: The automotive and logistics industries are reaching a digital watershed

Car makers and their supply industry are already in the process of transformation and have triggered large-scale programs, such as the in-vehicle introduction of the Internet Protocol (IP). Concrete outcomes were on show at last year's Consumer Electronics Show in Las Vegas. Examples included progress in highly automated and autonomous driving with vehicles from OEMs such as Audi, BMW and Mercedes. Critical questions remain:

- Who will control the digital communications interface to the driver and vehicle owner?
- To whom does the data generated in and in relation to the vehicle belong?
- Which software standards will become established in vehicles?
- How will automated cars change our understanding of individual mobility and our car purchasing behavior?
- How can vehicles be given effective protection against cyber-attacks?

The digitization of the **logistics industry** is already highly advanced. Even so, there is still room for much improvement in the organization of delivery networks. In logistics, digital scenarios revolve around questions such as:

- Will global automation standards become established for logistics in individual industries, or even across industries?
- Can providers of fourth-party logistics gain control of the customer interface?
- How can the delivery network be made even more agile and robust?

Wave 2: Medical technology, electrical engineering, mechanical and plant engineering and energy systems are experiencing a digital upheaval

Although new ways of contacting patients are at the center of the most important digital changes in healthcare, this area is so far poorly represented in Europe's **medical technology** industry. Even so, the narrower definition of medical technology examined in our study will still benefit from digital technologies. The greatest potential derives from diagnostic improvements arising from the analysis of (aggregated and anonymized) data.

Electrical engineering can benefit not only as a supplier of hardware and software for the internet of things. In the shape of digital power electronics, the industry also has in its hands one of the keys to the efficient use of energy. The biggest challenge is the standardization and virtualization of IT platforms in the context of factory control, because this is where IT risks will find their way into production.

While **mechanical and plant engineering** also uses Industry 4.0 for its own production purposes, it primarily sells it as a product for other industries. It nevertheless remains unclear when Industry 4.0 will be rolled out on a broad front, what role standards will play, and how attractive the option of retrofitting plant and machinery will be compared to greenfield strategies.

Smart grids and decentralized power generation are the digital transformation concepts that are bringing change to manufacturers of **energy systems**, in situations where smaller power generation plants and new grid structures are needed, for example. New opportunities to make power plants more efficient by analyzing performance data are also emerging. By no means least, decentralized power generation within a smart grid architecture creates heavy demands in terms of flexibility and security.

The circuits in smart power grids have to be switched within milliseconds, which in turn requires a high quality of service in the corresponding communications networks. Especially in mobile communications, this plays an important part in distinguishing between time-critical and non-time-critical traffic. For this reason, ongoing development in the direction of the "tactile internet" and next-generation systems (5G) is of paramount importance, not only in the energy sector.

Wave 3: Digital change will come later to the chemical and aerospace industries

The central role of process manufacturing means that automation has already reached a high level in the **chemical industry**. New digital technologies are yielding further evolutionary improvements, such as more effective development, more reliable delivery and smaller, more flexible production plants.

The main barriers to the use of digital technologies in the **aerospace industry** have nothing to do with technology: They are of a regulatory nature. More connectivity means more cyber-risks, a threat to which the aerospace sector is exceptionally sensitive. As a result, digital technologies will unfold their influence only gradually or in specific areas.



The digital transformation as a product and a service:
Mechanical and plant engineers have tremendous opportunities for digital growth and can pocket an extra 89 billion euros a year.

GERMANY'S DIGITAL MATURITY

The digital transformation as a whole is the subject of widespread debate, as are specific aspects such as Industry 4.0 and big data. Strangely, though, the strategic conclusions drawn and the concrete actions taken often lag behind the perceived significance of this topic among trade audiences and the general public. A survey of more than 300 top managers in German industry performed exclusively for this study confirms that, in this area, Germany and Europe have an awareness problem and a penetration problem.

According to the answers given by top managers and board members, a good half (55 percent) of respondent companies have so far concerned themselves intensively with the digital transformation. Given the huge importance of the topic, however, perhaps saying "only half" would be more appropriate. Moreover, companies seem to see cost-cutting as the most important aspect of digitization (43 percent of responses).

These findings are a pointer to the digital (im)maturity of German companies. Our indicator measures the ability of companies to derive benefits from the digital transformation, which requires skills and capabilities in four key areas:

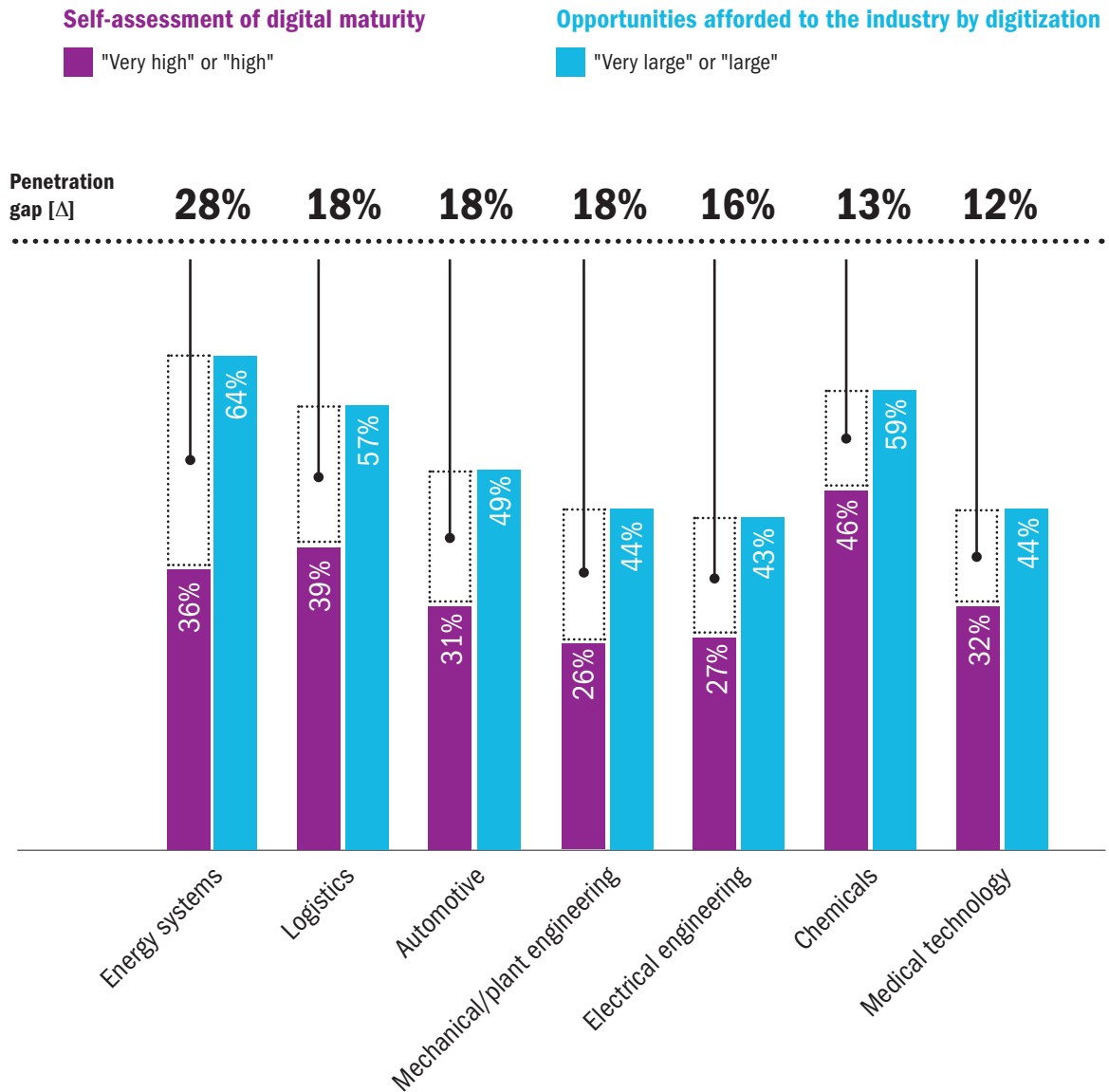
- Identifying and assessing current developments and trends in the digital economy
- Realizing potential efficiency gains in the existing business model
- Identifying disruptive changes in the company's own business model and, on this basis, defining new business models
- Initiating comprehensive change in the corporate culture in order to take the necessary implementation steps

Only about a third of German companies rate their own digital maturity as high or very high. On average, strong ratings are more prevalent among larger and more profitable companies: 62 percent of firms with EBIT margins upward of 15 percent affirm that they possess high or very high digital maturity levels. A breakdown of the responses by industry puts chemicals, logistics and energy systems out in front. By their own admission, many medium-sized electrical, mechanical and plant engineering companies are among the most digitally immature players. These companies thus see themselves as especially vulnerable to disruptive digital technologies.

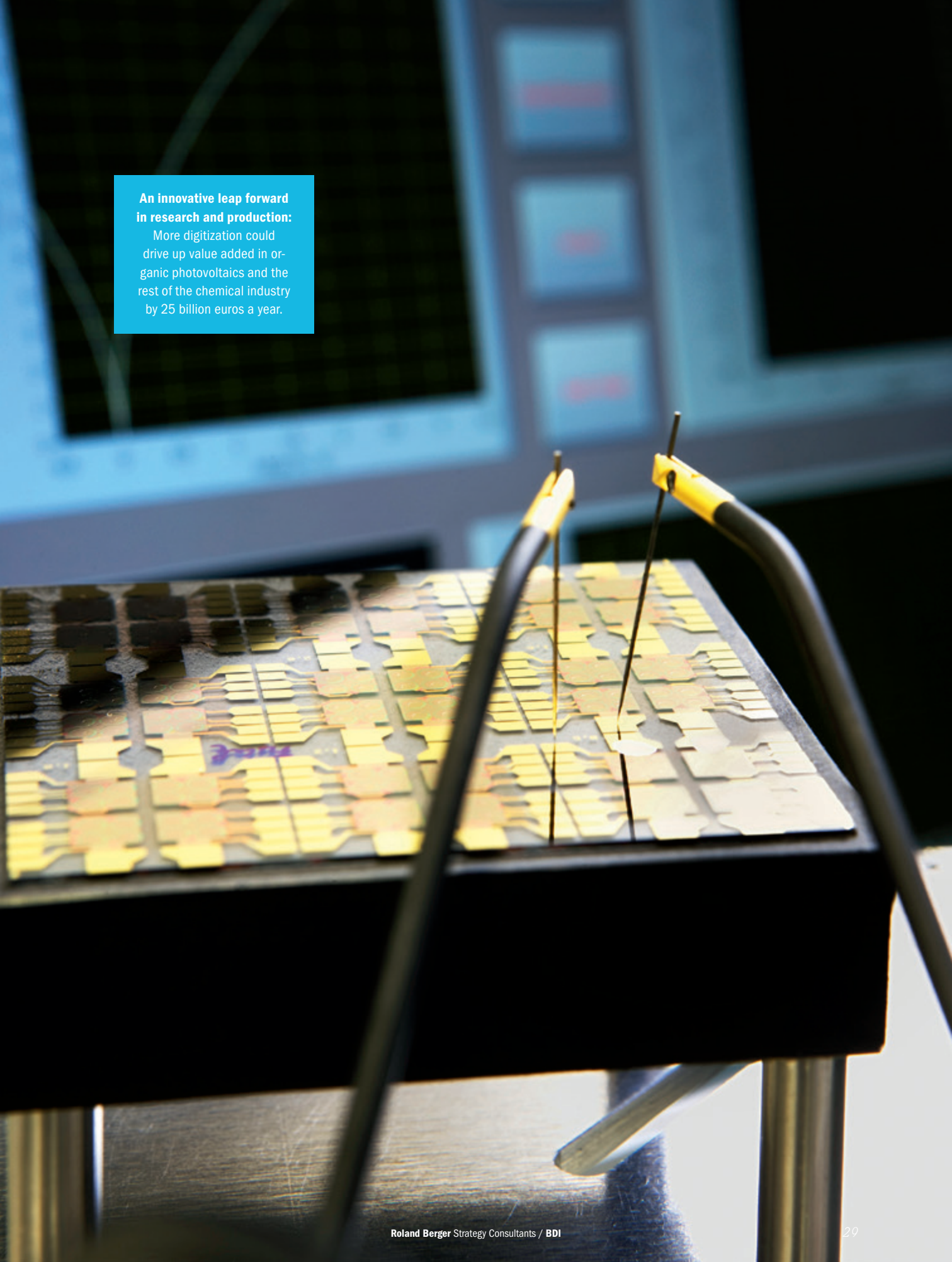
7

MOST INDUSTRIES ARE STILL FAILING TO EXPLOIT THE OPPORTUNITIES AFFORDED BY THE DIGITAL TRANSFORMATION

Penetration gaps in different industries¹⁾



1) Aerospace was excluded from cross-industry comparisons due to the non-representative number of responses
 Source: Roland Berger, survey of 300 top managers in German industry



**An innovative leap forward
in research and production:**

More digitization could
drive up value added in or-
ganic photovoltaics and the
rest of the chemical industry
by 25 billion euros a year.



"Basically, the political and business communities must give clear visibility to the digital transformation as a key future topic in Germany and Europe. Closer cooperation is urgently needed. Only then can political goals and business planning be reconciled to each other; and only then can a divergence between political statements of intent and the reality on the markets be prevented."

DIETER ZETSCHÉ, Chairman of the Board of Management, Daimler AG

HUGE SHORTFALL IN PENETRATION

The discrepancy between companies' digital maturity scores and the importance they attach to the digital transformation for their own industry is what we call the penetration gap (Figure 7). This gap is biggest among energy system firms, where fully 28 percentage points separate the degree of maturity from companies' assessment of opportunities. Logistics and the automotive, mechanical, plant and electrical engineering industries likewise exhibit differences in excess of 15 percentage points.

In their attempts to harness the digital transformation, many companies seem to lack a comprehensive focus (Figure 8). Rather than ramping up the development of new products and customer interfaces, the majority are aiming primarily to boost efficiency.

URGENT NEED FOR ACTION

Companies' self-assessment raises critical questions, but so too does the outlook with regard to government action. In a survey conducted jointly by Roland Berger Strategy Consultants and newspaper group Die Welt (Figure 9), only a little over 3 percent of decision-makers reckoned that Germany's federal government possesses sufficient competency and is providing necessary stimulus for the digital transformation. More than half of the respondents acknowledged that the government has understood the challenges but is still not providing the necessary stimulus.

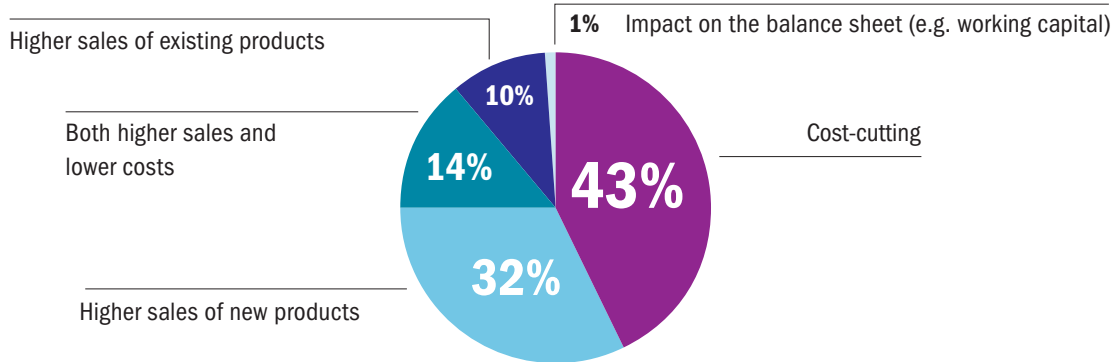
Around a third of the survey participants believe that federal government has not fully grasped the significance of digitization. Yet expectations in the corporate community are high: For example, the surveyed decision-makers called on the government to do more for the security and protection of data and to press ahead with expansion of the broadband infrastructure.

It would appear that neither businesses nor the political arena are adequately prepared for the challenges of the digital transformation.

8

MANY COMPANIES SEEM TO BE MISSING THE MAIN POINT OF THE DIGITAL TRANSFORMATION AND ARE FOCUSED ON COST-CUTTING

Objectives of the digital transformation

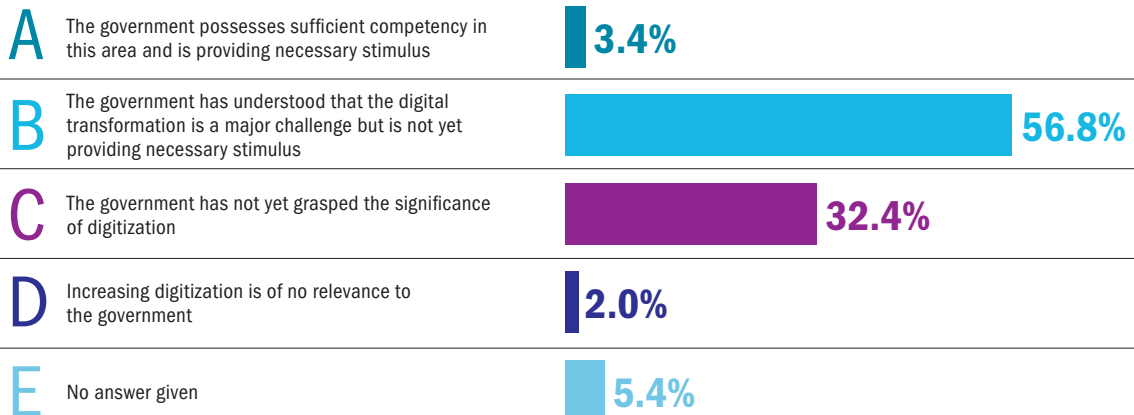


Source: Roland Berger, survey of 300 top managers in German industry

9

GERMANY'S TOP BUSINESS LEADERS BELIEVE THE GOVERNMENT IS ILL-PREPARED FOR THE DIGITAL TRANSFORMATION

Answers supplied by the Leaders' Parliament



Source: Roland Berger and the WELT Group, www.leaders-parliament.com



Boosting growth: Europe's aerospace sector can realize value-added potential worth 10 billion euros in 2025.

WHAT NEEDS TO BE DONE NOW

Europe's industrial companies must become more digitally mature if they are to take advantage of the opportunities afforded by the digital transformation. Company managers themselves must recognize and tackle the challenges, although industry associations, too, assume an important coordination function. Beyond that, industry must also cooperate (more) closely with the scientific community; and it needs a regulatory framework, carefully defined incentives and a no-gaps, high-performance information and communications infrastructure. To put these pivotal conditions in place, the government, businesses and scientific institutions must take concerted action. Especially in those industries that will be hit by the first wave of the digital transformation, it is vital to act quickly and resolutely – and to lose no more time. Players in the manufacturing industry must put their heads together, find robust solutions to their strategic questions and explore the possibilities for collaboration.

WHAT COMPANIES MUST DO

Europe's companies have a very good chance of benefiting from the digital transformation. To do so, however, they must put a series of conditions in place and up the tempo of change. Here are just a few of the most urgent imperatives:

Top management must focus its strategy on achieving digital maturity (Figure 10). Digitization is a job that belongs on the boss's desk. Top management should therefore concern itself with the opportunities arising from new developments, involving all levels of the company in this process.

Middle management now has the opportunity to prove that it can deal with new challenges and develop distinctive new business models.

Experts should foster a digital culture and pay more attention to the incremental and disruptive possibilities opened up by digital developments.

Technicians – including those in the IT departments – must be further enabled to the digital future. In many cases, they are the people who are trained to maintain and improve existing systems, and they should seize the opportunity to discover new ways forward.

Lastly, despite certain misgivings that are both justified and healthy, **customers and suppliers** should familiarize themselves with the opportunities afforded by the digital economy and learn to see them as potential assets.

In light of all these requirements, companies need a digital strategy and good communicators who can raise awareness of the opportunities inherent in these new developments.

The CEO himself or herself must explain how important digitization is to the business system in a language people can

THREE STEPS TO GET COMPANIES IN SHAPE FOR THE DIGITAL FUTURE

Digital transformation master plan

1

ANALYSIS OF THE INFLUENCE OF DIGITAL TECHNOLOGIES ON INDUSTRY

2

ANALYSIS OF DIGITAL MATURITY: WHERE IS THE COMPANY AT?

3

DEVELOPMENT OF AN IMPLEMENTATION ROADMAP

Questions

- What different future scenarios are conceivable?
- At what links is the value chain changing?
- Where are new, scalable platforms emerging?
- What are the key technologies?
- Which market players are affected (suppliers, competitors, customers)?
- etc.

- Where are new opportunities for and risks to our business emerging?
- Which of our products, customers and regions are affected?
- What (digital) capabilities can we draw on (personnel, partnerships)?
- Where is our digital business strategy anchored within the organization?
- Which products, process and infrastructures are at risk from cyber-attacks?
- etc.

- For which future scenarios do we need viable options now?
- What skills do we need to build up (data processing, automation, connectivity, customer interface)?
- With which market players should we join forces (strategic partnerships, "coopetition")?
- Which platforms/standardization processes should we play an active part in shaping?
- At what points should we exert political influence?
- How should we develop and improve our cyber-security?
- etc.

Outcome

Coming changes identified

Gaps in implementation and capabilities identified

Roadmap for digital transformation developed

Source: Roland Berger

understand. He or she must also calm people's fears, build up the appropriate skills and drive the transformation forward.

The chief strategist must analyze how digital disruptors think and see the company's home industry through their eyes.

The CFO must find a way to invest in the company's digital maturity without putting ongoing operations at risk.

The COO must rigorously commit to implementing the digital transformation, i.e. by adapting products, processes and business models, and must foster a digital culture within the company.

We put the investment amount needed for the digital transformation in the "industrial heart" of Germany at around 35 billion euros between now and 2025. That is a lot of money – roughly equivalent to the cost of the planned nationwide expansion of the broadband infrastructure by 2018. Bearing in mind that German companies have a capital stock of around 500 billion euros, however, it should be manageable. In Germany, more than half a billion euros will be invested in digitization for the first time in 2015. Of this sum, half will be spent on IT services, 125 million euros on setting up high-performance networks and about 80 million on new computer programs.⁵ To invest 35 billion euros over a ten-year period – 3.5 billion euros a year, in other words – the average rate of investment must increase by a factor of seven. Since digital markets often turn into monopolies, companies must move quickly, apply their strategies consistently and deliver operational excellence before other players get the chance to dominate the entire market for themselves in the role of first mover or fast follower.

WHAT GOVERNMENTS MUST DO

Europe's governments can play an important part in helping European industry to become more competitive. In many areas, companies on the old continent already lag a long way behind their US rivals, to some extent because the US has resolutely promoted many elements of the digital future. Bloomberg columnist Mark Buchanan, for example, points to the government subsidies that Apple has enjoyed for years:



"Acting as a systems architect, Europe has the capability to create its own secure backbone structure. The important thing now is to get EU-wide standards and laws established across industry divides in close collaboration with the authorities. That can only be done if we pull together. After all, Industry 4.0 is moving us toward intercompany and cross-border connectivity."

REINHARD PLOSS, Chief Executive Officer,
Infineon AG

5) Study entitled "Wirtschaft digitalisiert" ["Digitized economy"], BITKOM, 2013

"Every one of the most important technologies in Apple's smart products, including the iPhone and iPad, were developed elsewhere and largely thanks to state funding."⁶ We are not advocating that Europe follow suit and build up central structures: We are saying that companies and governments must find a European solution. A regulatory framework is needed that allows Europe's diversity and its industrial capabilities to be translated into competitive advantages. It is also important to coordinate European activities and speak with one voice when representing Europe's common interests on the international stage.

To these ends, governments should help Europe to pool its strengths and resources, improve the digital maturity of

its companies, prevent a form of standardization that undermines manufacturing skills, encourage investment in the digital economy, and create points of access and platforms that can be shared by companies, research institutions and other organizations.

Pooling strengths and resources

Germany has no lack of associations and platforms to discuss the digital transformation. Federal government, for example, has come up with several industry-wide strategies to promote digitization. A Smart Networking Strategy is currently being drawn up for the Digital Agenda, the focal point of

6) Mark Buchanan, "Who Created the iPhone, Apple or the Government?", Bloomberg View, June 19, 2013



"Many of the conditions in place in Europe are still far too fragmented. In the USA, you can go to market with a pilot test in California and very quickly roll out a business model for a vast market. In Europe, each country must be approached from scratch."

VOLKMAR DENNER, Chairman of the Board of Management, Robert Bosch GmbH

these efforts. The aim is to integrate cross-industry activities in an overall concept, the cornerstones of which were unveiled at the CeBIT trade show in spring 2014.

Federal government is also involved in Die neue Hightech-Strategie [The New High-Tech Strategy], Zukunftsprojekt Industrie 4.0 [Future Project Industry 4.0] and IKT 2020 [ICT 2020], while industry associations BITKOM, VDMA and ZVEI have joined forces to initiate Plattform Industrie 4.0 [Platform Industry 4.0]. These initiatives are flanked by a large number of public and private projects such as Allianz 4.0 BW (an Industry 4.0 alliance for the state of Baden-Württemberg), AUTONOMIK für Industrie 4.0 (an initiative to develop smart, autonomous tools and systems overseen by the Federal Ministry for Economic Affairs and Energy) and CyProS (a project focused on cyber-physical production systems backed by Wittenstein and the Federal Ministry of Education and Research). Further projects are in the pipeline, including Börse 2.0 [Stock Market 2.0] for start-up financing.

In Germany alone, the Federal Ministries for Economic Affairs and Energy, of the Interior, of Health, of Transport and Digital Infrastructure and of Education and Research – five ministries in all – are responsible for central technologies. At the EU level, a whole range of additional strategies and actions can be listed – first and foremost Horizon 2020, but also programs focused on specific areas. The latter include ITEA for software innovations and Artemis for cyber-physical systems.

Systematically bundling these initiatives and focusing them on a series of cross-industry objectives would appear necessary to make them more efficient and effective. Two important steps would be:

→ To define a shared vision, common objectives and the most important areas of action in a digital transformation charter for industry

→ To coordinate all ongoing and planned initiatives via a single project office

In terms of their mission, focus and resources, the Federal Ministry for Economic Affairs and Energy and the Federation of German Industries are best suited to assuming this coordination function at the national level and liaising with European institutions. They will need to be accompanied by potent partners in industry and research, such as the Fraunhofer Society, to ensure that actions are initiated with sufficient

speed and vigor. Industrial production accounts for a large proportion of the value added in the German economy, and many German companies are positioned as innovation and market leaders in key forward-looking industries. Accordingly, German companies should link up with European partners to drive the digital transformation.

The National IT Summit that the German government is currently developing and refocusing in line with the seven areas of action laid out in its Digital Agenda could play a pioneering role in bundling the country's digital activities. In the "digital economy and digital work" area, platforms for the innovative digitization of the economy and for Industry 4.0 are now in planning and will be coordinated by the Federal Ministry for Economic Affairs and Energy. Topics such as digital infrastructures, smart mobility and links between the German and European digital agendas will likewise receive closer attention in the future. Current efforts by the Fraunhofer Society, industry and the German government to create an Industrial Data Consortium are an important and proper approach to bundling and coordinating efforts and resources at least at the national level. Further steps must nevertheless follow.

Identifying and improving digital maturity

Companies themselves are primarily responsible for improving their own digital maturity. That said, achieving pan-European transparency about the capabilities of companies and scientific institutions in this area would be important not only to take stock of where individual industries and companies currently stand, but also for the purpose of political control. Compiling an atlas of Europe's digital maturity would lay a valuable foundation for the next steps in research, industrial and economic policy.

Protecting European interests in the context of standardization

In the USA, the Industrial Internet Consortium (IIC) initiated by industry itself is adopting a pragmatic approach to driving the definition of industry standards. At the very least, the government is providing sympathetic support. South Korea



Smart transition:

Energy systems can position themselves as the world's poster-boy industry, thanks to decentralized production plants and smart grids.

has set up the Ministry of Science, ICT and Future Planning, a government unit that is dedicated to digital topics. This ministry and the Korea Industrial Technology Association (KOITA) together represent the standardization interests of the country's domestic industry, which leads the world in smart home technology and is keen to establish a counterweight to the US-dominated IIC in this area. Meanwhile, the Chinese government is spending the equivalent of a good 700 million euros to widen the internet of things. Further details will be added to this project in the coming months as the new five-year plan takes shape.

Europe's strengths are the diversity of its players and solutions and its outstanding industrial skills. Standards that make too little provision for these strengths and that make it more difficult to apply production expertise in the form of embedded software, for example, would undermine the competitive strength of European industrial companies and threaten the future prospects of the entire economic area. The interests of European industry must therefore be spelled out clearly, and regulations that have a bearing on competition must be formulated in such a way that the opportunities arising from the digital transformation can be exploited.

Europe's political arena should support this process. The National Platform for Electromobility (NPE) is one example of how umbrella organizations, research institutes, companies and unions could bundle their interests. It would thus be welcomed if the EU Commissar for the Digital Economy and Society were to set up a European alliance for digital transformation. For example, companies and governments could define a coordinated, joint approach to dealing with the American IIC. European interests will only be protected in the long run if Europe presents a unified response to America's current dominance.

A coordinated European effort involving interaction with other regions, such as Asia, could also be a very interesting proposition. Endeavors to define standards would benefit from the size of the markets in the EU and, for instance, China, as well as from the technological leadership of some companies in either region. Alliances with Chinese and Japanese companies, platforms and political players in particular would be a suitable way to advance Europe's own positioning above and beyond the unilateral focus of the IIC.

Creating a balanced regulatory framework

Aside from general standards, the regulatory framework too must be aligned with the digital age throughout Europe.

SINGLE EUROPEAN MARKET. A harmonized, balanced and genuinely pan-European single digital market is needed in order to overcome current fragmentation. Such a market could slash costs and realize synergies through improved access to information, lower transaction costs, dematerialized consumption, a smaller environmental footprint and superior business and administrative models. Huge gains in efficiency could, for example, be realized by consolidating the telecommunications market. By way of comparison, Europe has 55 separate mobile networks, while the US has just five.

REVISED EUROPEAN REGULATORY FRAMEWORK. The EU's future legal framework must guarantee technology neutrality and support the use of the most efficient technologies. One aspect of this is to provide harmonized mobile broadband spectrums in line with European demand. To place investment on a secure footing, stable rules governing the use of frequencies must be established throughout Europe. It is also important to give due account to the peculiarities of internet companies in market analyses and competition procedures. The aim must be to give a greater weighting to dynamic competitive effects (innovations).

HARMONIZED DATA PROTECTION FOR THE EU. The current European Data Protection Directive dates back to 1995 and is in need of reform. It must be brought into line with conditions in the digital world, quite apart from the issue of considerable differences in national data protection laws. Any provider who sells cloud computing services throughout Europe, for example, has to know and comply with all these different regulations. Instead, a new, harmonized EU-wide data protection law is needed that should also apply to global players that operate in the single European market. It is therefore important to ratify the General Data Protection Regulation (GDPR) as quickly as possible. This legal framework must then also ensure that law enforcement no longer runs aground in the way it does today due to the lack of clearly defined competencies. The protection afforded to sensitive data must be aligned with different risks, albeit without causing innovation to grind to a standstill. Otherwise, the opportunities afforded by big data will be wasted.

REVIEW OF LAWS THAT ARE OF RELEVANCE TO THE DIGITAL TRANSFORMATION. The majority of all current laws and standards were drafted at a time when many digital technology applications were still inconceivable. That explains why highly automated driving, for example, is incompatible with prevailing laws. The legislator must keep up with technological progress and review all valid laws to determine whether they are suitable for the digital transformation.

ANTITRUST LAW WITH A GLOBAL ORIENTATION. The market for IT and electronic communications is global, so network effects play a crucial role. Other regions of the world are much more given to ex-post regulation than Europe is. In those regions, global IT and internet firms emerge that are not regulated until such time as they have reached a critical mass. Yet it is virtually impossible to build this kind of dominant market position from a European base. Although native European companies play in the same global market, they are bound by national antitrust laws. It is thus very difficult to achieve genuine economies of scale if large platforms are prohibited ex ante, instead of being reined in ex post where appropriate. On this score, the EU is vulnerable to players from other regions – witness the example of US video-on-demand provider Netflix in its competitive battle with Germany's TV channels. The latter were recently banned from creating their own platforms – the most recent of which was Germany's Gold⁷ – due to antitrust concerns.

STRICT PROCUREMENT LAW. When security-related public contracts are awarded, all providers should be obliged to declare in advance that they are not bound by law or contract to disclose confidential data to third parties (in a "no spy" clause). Just how important this criterion should be to public procurement processes is evident not only from the recent NSA affair, but from as far back as the Patriot Act in 2001.

A SECURE SPACE FOR DATA TRANSMISSION. Telephone and internet traffic within the Schengen area should not leave this area. A secure space for routing could curb the third-party surveillance of communications and strengthen Europe as a location for data. As things stand, it is almost

impossible for telecommunications players in Europe to know what route their e-mails and data packets take as they circumnavigate the globe, nor whether transit countries mirror or store their communications.

GUARANTEED SERVICE QUALITY IN NETWORKS. Industry 4.0, cloud services, innovations in the internet of things and in machine-to-machine (M2M) communications are not feasible without fast and secure data networks. Critical applications in plant and machinery need a guarantee of high-quality network connections at all times. Accordingly, it is vital to be able to continue offering a high quality of service. Net neutrality should be regulated at the European level and defined in such a way that network operators have adequate freedom and incentives, and that innovation is not hindered. The competitive opportunities for connected manufacturing and products in the future are huge. Europe must take advantage of them.

Triggering investment in the digital future

To date, Europe has invested far too little in the digital future. In the USA, venture capital equivalent to about 17.5 billion euros is channeled into this field every year – against a meager 3.5 billion for the whole of Europe. Nor is this figure linked to a shortage of capital: Around the globe, 170 trillion euros of free capital is looking for sound investment opportunities. To reinforce our digital future, we must therefore create the necessary conditions that make private investment in infrastructure and start-ups worthwhile. Suitable levers could be to stagger the licensing of internet services based on performance and security, or to grant tax breaks on venture capital.

Governments and industry also need to engage in a structured discussion about sharing the burden of investment within the framework of digital transformation. All relevant players should be involved in agreeing how huge pent-up demand for investment should be spread across providers, demanders and governments.

The public sector itself must likewise take action to work off the existing investment backlog in Europe's economy. Funds from investment programs should be used primarily to promote the digital transformation and exploit the resultant opportunities. For instance, we believe it is urgent for

7) Germany's Gold was a streaming portal planned by public broadcasters ARD and ZDF. The two networks abandoned the plan in September 2013 pursuant to strict specifications by Germany's Federal Cartel Office.

far more funds from the Juncker plan to be channeled into investments in the digital transformation. This money could be used to achieve progress in many important areas:

- The production of technical infrastructure for the digital economy (Europe-wide expansion of broadband networks)
- The promotion of digital start-ups
- The development of new instruments to mobilize private investment in the digital economy
- Research into and development of a European cloud with high security standards
- Changes to the educational offerings available to school-children and students and for employee development, with the aim of acquiring, improving and updating core capabilities for the digital future
- The promotion of flagship projects within the framework of the putative European economic alliance
- The promotion of big data applications by the scientific and corporate communities

Setting up a European business alliance and a virtual Digital Valley

Flagship projects must be realized as governments, the business community and scientific institutes move in concert toward the digital transformation. The resultant solutions can be made available selectively to interested parties. At the same time, they will lay the basis for standardization that is underpinned by pragmatic decisions rather than protracted negotiations. This approach could be part of a cross-industry European economic alliance that encourages clusters, cooperative ventures and syndicates/associations and supports both development of the required skills and positive networking effects. However, there is more at stake than wanting to rank as equals with the big US internet players and rivals from China, Korea and Taiwan: It is all about translating Europe's diversity into a competitive advantage.

Firms that have fallen behind in the opening round of the digital transformation can fight their way back to a place among the global leaders if they take resolute action. This feat could, for example, be facilitated by a European Digital Valley, a shared (virtual) platform for companies, founders and institutes. This kind of Digital Valley would be a good way

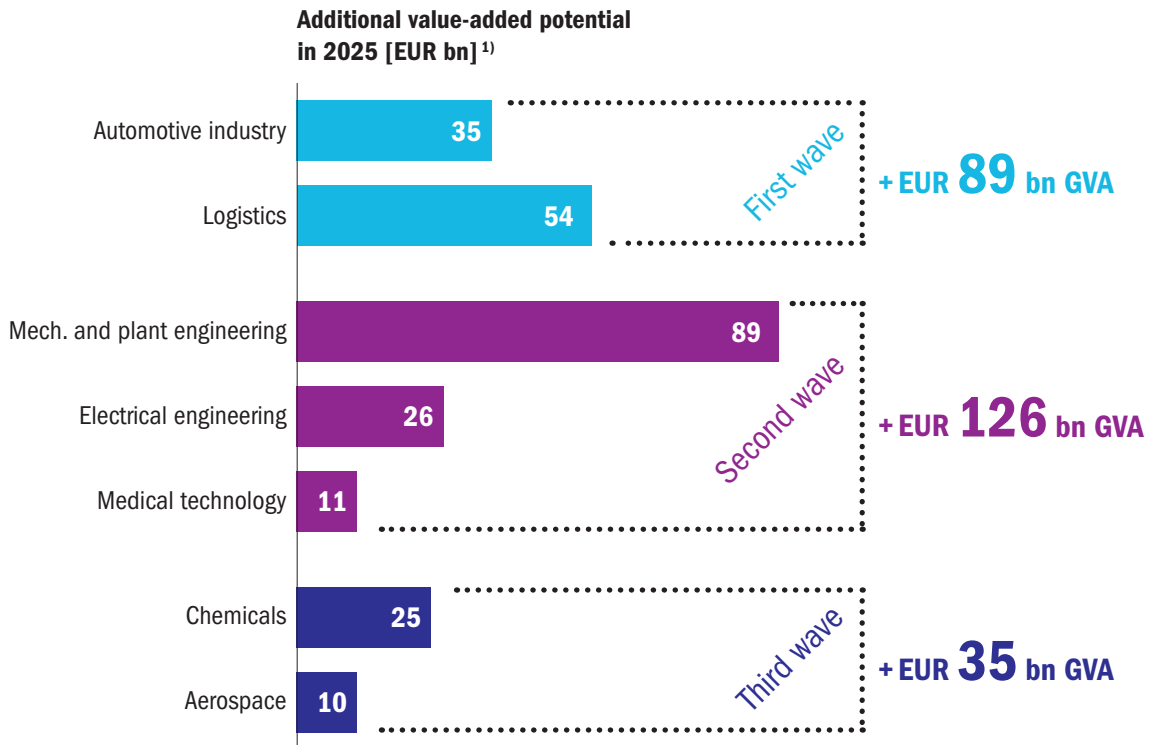


"Digitization will create new jobs, but it will also eliminate old ones – mostly unskilled ones. We have seen that in every structural transition to date. If the net balance is to add more jobs, we must concern ourselves with qualifications. Our goal must be to take people with us on our journey by providing them with training and development."

HENNING KAGERMANN, President,
acatech e.V.

THE DIGITAL TRANSFORMATION IS GIVING EUROPEAN INDUSTRY THE CHANCE TO ADD 250 BILLION EUROS OF EXTRA VALUE PER ANNUM

Overview of industries



1) Energy systems are subsumed under mechanical and plant engineering
Source: Roland Berger

to coordinate joint efforts to develop the digital economy in Germany and Europe. Scientific institutions should regularly measure and disclose the progress of these efforts to give industry itself, but also the government, a clear idea of the scope and force of the changes that are wanted. Right from the outset, however, national and European standardization organizations should also be involved. In dialog with international bodies, they should agree suitable norms in order to

preserve and build up the value that the digital transformation can add to industry in Europe.

Once this feat has been accomplished, an ecosystem built on a modern digital infrastructure and an independent storage and computing infrastructure must be in place – an ecosystem that lays the technological foundation for the digital economy. A common European innovation, growth and industrial policy is needed to develop and grow this ecosys-

tem, which must also be protected by a security standard that meets Europe's high expectations and could thus even constitute a competitive advantage.

Creating access

Big data, cloud computing and e-commerce: These and other digital technologies are influencing the whole of Europe's economy and society. Access to them must be advanced, damage and abuse must be prevented. It might sound tempting to cultivate a harmonized digital industry in Europe with EU subsidies, as was once done in aircraft construction. The cost would, however, be astronomical – and many times more complex than the successful example of Airbus. On top of these considerations, too much state intervention could stifle innovative capabilities in this rapidly-changing technological environment. It follows that the EU should, first and foremost, adjust conditions such that a European digital industry can develop itself, and that businesses are also free to source critical ICT skills with Transatlantic and Asian partners, without this putting them at a disadvantage. In particular, these conditions must include a single European market, a legal framework for partnerships with the USA and Asia, and strict procurement law.

TARGET CORRIDOR

The digital transformation presents huge opportunities to European industry. For the industries we have analyzed, we reckon that Germany alone could increase its gross value added by 85 billion euros per annum by 2025. This calculation is based on an expected gain in gross value added of between 20 percent and as much as 30 percent per industry. The annual value-added potential for European industry as a whole (EU-17⁸) totals roughly 250 billion euros in 2025 (Figure 11) – equivalent to cumulative value-added potential of 1.25 trillion euros over the next ten years thanks to the digital transformation.

8) The EU-15 countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the UK) plus Norway and Turkey. (The other EU countries were excluded due to a lack of detailed industry data.)

The joint efforts of governments and the business community must ultimately lead to the successful digitization of Germany and Europe. This should not be seen merely as a way to protect the economic strength of Europe's industry, but also as a significant opportunity for the digital industry and the economy as a whole to progress. One eye-catching figure highlights the vast importance of these efforts: As things stand, not one of Europe's internet companies ranks among the top 20 in the world (Figure 12). In a relatively short space of time, China has succeeded in establishing a number of companies in this table-topping segment, already accounting for 13 percent of the total market capitalization of all the top 20 internet players. We would do well to take this as our yardstick. Our aim must be to establish European champions who also make up 13 percent of the total value of the top 20 corporations.

If that is to happen, however, the public at large will likewise have to change its attitude to information technology and digital communications. The change has long since begun: Witness the discrepancy between the 1980s, when a public census that gathered a small quantity of anonymous data sparked off lengthy debates, and the naivety in evidence today in respect of search engines, electronic mailboxes and social networks. These data gatherers allow very large parts of the population to knowingly or unknowingly create personal profiles that can be analyzed, and that sometimes disclose more about people than even they know themselves. People need to develop a balanced understanding of the opportunities and risks inherent in digital technologies. A sober, well-reasoned assessment is needed in place of one-sided hysteria about data protection and blind electronic permissiveness.

TIME FRAME

Answers to the crucial questions about our digital future will not be found in a matter of weeks or months. The digital transformation is a lengthy and extremely dynamic process with no clear target in sight either for the companies concerned or for other players. The effort that this will take cannot be compared with landing on the moon: It is more like exploring a new continent without knowing where the journey

will take us, but at least with a clear idea of the chances and opportunities that this transformation will present to us.

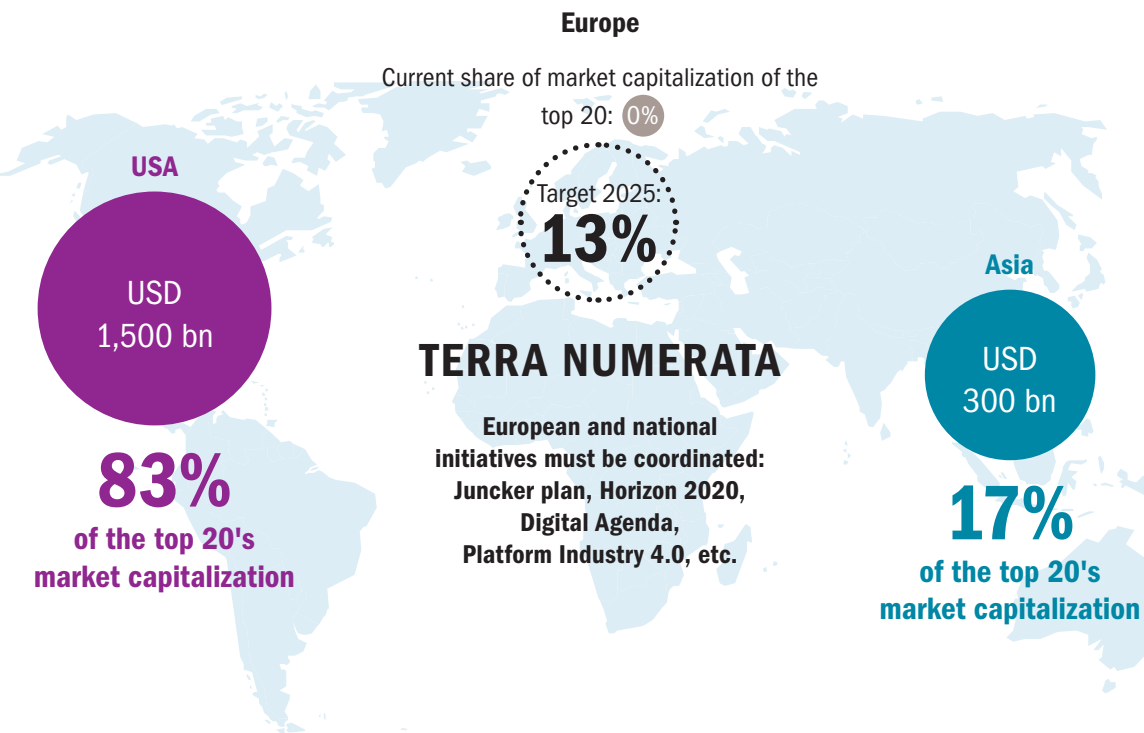
The road from the digitization of individual processes to the development of new, digitally driven business models is a long one, and the complexities of the digital transformation suggest the wisdom of repeated phases of thorough deliberation followed, in each case, by rapid action. The German and European economies are poised to embark on a radical structural transition that will keep us busy for a decade. Yet mastering this profound transition is imperative to safeguard the prosperity of coming generations.

One thing is certain: All our political, economic and social forces must work together if the goals of a far-reaching digital transformation outlined in this study are to be achieved. This is not about improving efficiency and the productivity of resources in German and European industry. The issue at stake is facilitating new business models that underpin growth and prosperity for Germany and its people, and establishing European standards that could shape the digital economy of tomorrow. If we succeed, digitization could become a basic innovation that yields as many benefits for Germany as the steam engine once did for Great Britain.

12

SQUEEZED IN BETWEEN TWO DOMINANT INTERNET WORLDS, EUROPE MUST STRENGTHEN ITS ICT INDUSTRY

Market capitalization of the top 20 internet firms [2014; USD bn; %]



Source: Roland Berger



Progress for patients:
Medical technology can look forward to annual growth of around 11 billion euros in value added thanks to the use of digital technologies.

Interviewees and study participants

Our thanks go to the following companies and organizations for their helpful discussions, inspiring ideas and valuable suggestions:

ACATECH – NATIONAL ACADEMY OF SCIENCE AND ENGINEERING E.V.

Prof. Dr. Dr. h.c. Henning Kagermann
President

AIRBUS GROUP

Dr. Tom Enders
CEO

ALSTOM DEUTSCHLAND AG

Alf Henryk Wulf
Chairman of the Board of Directors

AUDI AG

Professor Rupert Stadler
Chairman of the Board of Management

B. BRAUN MELSUNGEN AG

Prof. Dr. Heinz-Walter Grosse
Chairman of the Management Board

BASF SE

Uwe Liebelt
President BASF 4.0

BMW GROUP

Klaus Straub
CIO

DAIMLER AG

Dr. Dieter Zetsche
Chairman of the Board of Management

DEUTSCHE BAHN AG

Dr. Rüdiger Grube
Chairman and CEO

FESTO AG & CO. KG

Dr. Eberhard Veit
Chairman of the Management Board

FRESENIUS NETCARE GMBH

Klaus Kieren
Chairman

INFINEON AG

Dr. Reinhard Ploss
CEO

KIRCHHOFF GROUP

Arndt G. Kirchhoff
Managing Associate

KÜHNE & NAGEL INTERNATIONAL AG

Martin Kolbe
CIO

LINDE AG

Dr. Wolfgang Büchele
CEO

ROBERT BOSCH GMBH

Dr. Volkmar Denner
Chairman of the Board of Management

ROCHE DIAGNOSTICS GMBH

Henning Franke
Member of the Management Board

SCHULER AG

Stefan Klebert
CEO

SIEMENS AG

Prof. Dr. Siegfried Russwurm
CTO

TRUMPF GMBH & CO. KG

Dr. Stephan Fischer
Head of Software Development

VOITH GMBH

Dr. Hubert Lienhard
President and CEO

We would also like to express our sincere gratitude to the **300 TOP DECISION-MAKERS** in German industry who took part in the survey we conducted exclusively for this study. Their participation was instrumental in helping us comprehensively capture the mood with regard to the status of the digital transformation in Germany.

Published by

ROLAND BERGER
STRATEGY CONSULTANTS GMBH

Sederanger 1
80538 München
Germany
www.rolandberger.com

BUNDESVERBAND DER DEUTSCHEN
INDUSTRIE E.V. (BDI)

Breite Strasse 29
10178 Berlin
Germany
info@bdi.eu
www.bdi.eu

Study authors

PROFESSOR BJÖRN BLOCHING

Partner
bjoern.bloching@rolandberger.com

PHILIPP LEUTIGER

Partner
philipp.leutiger@rolandberger.com

PROFESSOR TORSTEN OLTMANN

Partner
torsten.oltmanns@rolandberger.com

CARSTEN ROSSBACH

Partner
carsten.rossbach@rolandberger.com

DR. THOMAS SCHLICK

Partner
thomas.schlick@rolandberger.com

GERRIT REMANE

Senior Consultant
gerrit.remane@rolandberger.com

PAUL QUICK

Consultant
paul.quick@rolandberger.com

OKSANA SHAFRANYUK

Senior Researcher
oksana.shafrazyuk@rolandberger.com

Roland Berger Strategy Consultants

Roland Berger Strategy Consultants, founded in 1967, is the only leading global consultancy of German heritage and European origin. With 2,400 employees working in 36 countries, we have successful operations in all major international markets. Our 50 offices are located in the key global business hubs.

Roland Berger advises major international industry and service companies as well as public institutions. Our services cover the entire range of management consulting from strategic advice to successful implementation: e.g. new leadership and business models; innovative processes and services; M&As, private equity and restructuring; and management support on large infrastructure projects.

Our firm is owned solely by a group of 220 Partners. We share the conviction that the firm's independence provides the basis for unbiased advice to our clients.

Everyone at Roland Berger Strategy Consultants is committed to our three core values:

- **ENTREPRENEURSHIP** – We follow an entrepreneurial approach and provide creative and pragmatic solutions.
- **EXCELLENCE** – We achieve excellent results and develop global best practices to ensure measurable and sustainable success.
- **EMPATHY** – We are insightful and responsible advisors and we contribute to the greater good.

At Roland Berger, we combine sound analyses with creative strategies that generate real and sustainable value for the client. We develop and consolidate our expertise in global Competence Centers that focus on specific industries and functional issues. We handpick interdisciplinary teams from these Competence Centers to develop the best solutions for our clients.

Roland Berger
Strategy Consultants

Bundesverband der Deutschen Industrie e.V. *(BDI – Federation of German Industries)*

The Federation of German Industries (BDI) is the umbrella organization of German industry and industry-related service providers. It speaks on behalf of 36 sector associations and 15 regional agencies, as well as representing over 100,000 enterprises with around eight million employees. Membership is voluntary.

THE VOICE OF GERMAN INDUSTRY. Industry is critical to the future competitiveness of our country. The Federation of German Industries communicates the interests of German industry and industry-related service providers to those in positions of political responsibility. It commands a wide network in Germany and Europe, in all key markets and in international organizations. The BDI provides information and economic policy advice on all topics of relevance to industry, as well as providing political support for the penetration of international markets. It thus helps enterprises to survive and thrive in global competition.

PLAYER IN THE DEMOCRATIC PROCESS. The BDI is a leading competence center for economic policy in Germany. As such, it engages in political discourse at an early stage, convinced that the best solutions for our common good can only be found in the competition for ideas. For this reason, the BDI is an indispensable civil player and an important force for the reform of social policy. The BDI advocates the social market economic model, which stands for free enterprise, unrestricted competition, equal opportunities and fair benefits. Drawing on the combined expertise of its companies and member associations, the BDI is committed to establishing a regulatory framework.

MEDIATOR BETWEEN THE BUSINESS COMMUNITY AND THE POLITICAL ARENA. The BDI measures its own performance in terms of the extent to which its positions are adopted in political reality. Its expertise substantiates its role as a hands-on advisor to the government. At the same time, the BDI explains and clarifies current political decisions to its member associations. The federation's credibility is rooted in a consistently objective and non-partisan line of argument. The BDI influences the democratic process in a transparent manner. It is also committed to actively shaping social policy in areas such as culture, education and immigration.

The BDI aims to strengthen Germany as an industrial location and foster favorable economic conditions to make this country increasingly attractive to industrial companies and industry-related service providers. It sees investing in education, research, innovation and jobs as the key to both stronger and better growth.



BDI

Bundesverband der
Deutschen Industrie e.V.

Terra Numerata™

Terra Numerata™ is a Roland Berger Strategy Consultants initiative to create a digital ecosystem in Europe. It comprises a platform or network of partnerships whose common goal is to help countries and companies successfully enter the digital age – and thus to help join up Europe's fragmented digital corporate landscape. Terra Numerata™ brings together three key components of digital business models that have fueled the success of similar platforms in Silicon Valley in the USA and in Shanghai or Shenzhen in China: innovators, venture capital and talent. Terra Numerata™ plans to help this talent pool raise funds and collaborate with businesses, universities and research organizations. At the same time, the platform is open to any incubators, investors, technology providers and other digital players that are interested in working together to drive innovation and develop digital business models. Under the aegis of Terra Numerata™, the various stakeholders in Europe – companies and governments, research organizations, start-ups, venture capital firms, and so on – are invited to join the discussion surrounding development of a digital ecosystem in Europe, and to join us in shaping the next steps forward.

Supplementary offerings

→ In-depth analyses of "The digital transformation of industry", featuring additional detailed investigations of the focal industries, can be downloaded from:
www.rolandberger.com
www.think-act.com
www.bdi.eu

Versions of this study and other publications optimized for mobile devices are available via the THINK ACT app. Once you have downloaded them, you can also read the tablet edition of our publications in offline mode.

To install the THINK ACT app, search for "Roland Berger" in the iTunes App Store or at Google Play.



STAY TUNED

www.twitter.com/RolandBerger

LIKE AND SHARE

www.facebook.com/RolandBergerStrategyConsultants

Further reading

Roland Berger Strategy Consultants publications are available at www.rolandberger.com/media and at www.think-act.com. Federation of German Industries publications in English are available at www.bdi.eu/bdi_english/publications.htm.



THINK ACT COO INSIGHTS

The magazine for Chief Operating Officers

Industry 4.0 creates a new and comprehensively interconnected system in production, opening up huge opportunities but also tremendous challenges for the manufacturing industry. In an exclusive interview with COO Insights, Harald Krüger, the BMW Group's CEO-designate, is clearly optimistic about what human-machine interaction will bring to automobile production. Roland Berger's own experts also highlight where the really lucrative 3D printing niches are springing up and look at how companies can defend themselves against the downside of connectivity: cyber-attacks from the internet. In this context, Chief Technology Officer Jean Botti talks about new security concepts at the Airbus Group. The latest issue of COO Insights features all these articles and lots of useful answers to the question of what helps companies succeed in Industry 4.0.



THINK ACT RETAIL BANKING – THE COMING REVOLUTION

Opportunities in the new multichannel world

Based on an extensive survey of 3,000 bank clients in Germany and Switzerland, this study, conducted jointly by Roland Berger Strategy Consultants and credit card company VISA, analyzes how interested clients currently are in banks' digital services and what they would like to see in terms of future online and mobile offerings. The core finding is that many clients have already taken the digital plunge, and that they are expecting more of digital solutions that are simple, safe and genuinely add value. In response, retail banks must systematically advance the digitization of their business models. Branch-based business will remain a key pillar, but must be flanked by an attractive array of online and mobile services (available in German only).



THINK ACT CYBER-SECURITY

Managing threat scenarios in manufacturing companies

The digitization of processes and products continues unabated as part of the fourth industrial revolution. Players from sectors as diverse as the automotive, consumer goods, chemicals and aerospace industry are increasingly reliant on digital processes to store and to share important data internally and with external suppliers. While this makes for faster and more efficient production processes, it does increase the risk of companies falling prey to online attacks. Data protection is therefore becoming an ever more complex, time consuming and costly business, with different parts of the value chain often coming under attack simultaneously. What companies should be doing is addressing the issue of cyber-security from an integrated perspective.



GLOBAL SHIFT IN POWER

How is German industry faring in the globalised world?

On behalf of the Federation of German Industries, research institute IW Consult in Cologne conducted a comprehensive study of power shifts in the global economy. In this investigation, Germany and its industrial players were not only compared to their main competitors. The authors also analyzed whether increasing foreign production of German companies strengthened or undermined Germany as a business location. To answer this question, the study looks beyond the traditional concept of gross trade flows, taking into consideration value added, i.e. the proportions of imports in exports, by drawing on sources such as recent OECD data.

CONTACT

We will be glad to answer your questions

Roland Berger Strategy Consultants

Susanne Horstmann

Press Spokesperson

susanne.horstmann@rolandberger.com

+49 89 9230-8349

BDI – Federation of German Industries

Dr. Jobst-Hinrich Wiskow

Head of Department Press and Public Relations

j.wiskow@bdi.eu

+49 30 2028-1565