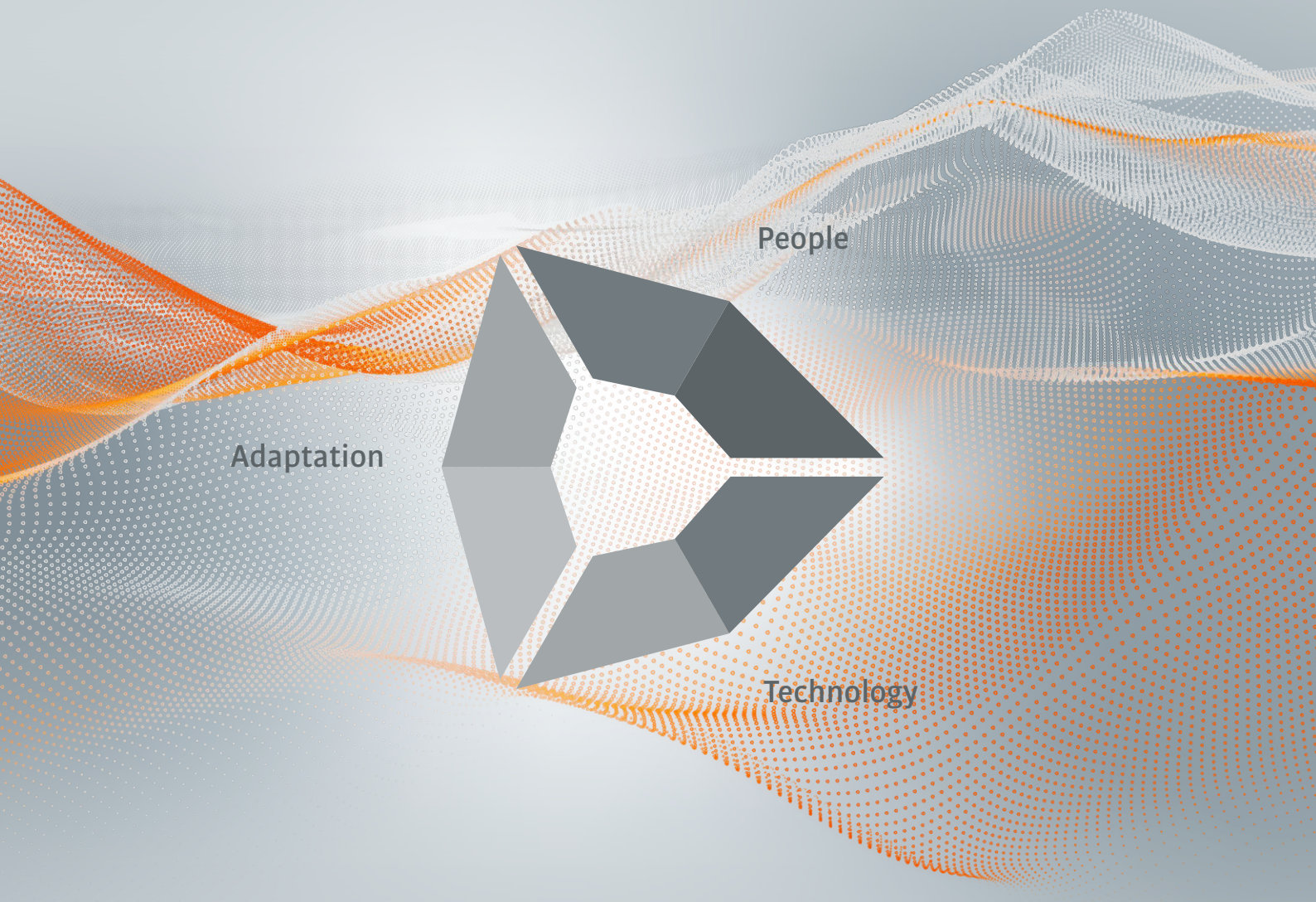
KUKA

# Shaping future production landscapes

_setting the course for
tomorrow's world of production

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# Management summary
## Contents at a glance

**Focusing on rapid adaptability:**

It is foreseeable that a world in which everything is networked will be determined by the ability to adapt. In the future, production must therefore be able to gear its technical infrastructure quickly and flexibly to meet new market requirements. **Page 4**

**Being aware of future indicators:**

In the field of innovation management, the analysis of megatrends has become an established method of predicting future developments. Not all companies will be affected to the same extent. However, all future-oriented companies should analyze and take advantage of the megatrends that are relevant to their markets. **Page 5**

**Three key factors in mastering the transformation:**

In order to meet future production requirements, companies will have to base their decisions on these three key factors that will be crucial for the future of production. **Page 11**

**Key factor ‘people’:**

Companies wishing to prevail in the future will have to focus on maximizing flexibility and efficiency as well as improving the working conditions for production personnel. Among other things, technologies that are intuitive to operate will be required in order to motivate employees and boost their productivity. **Page 12**

**Key factor ‘technology’:**

Readily accessible and adaptable technologies are the driving force behind agile production systems that can respond rapidly to capacity and customization requirements. **Page 12**

**Key factor ‘adaptation’:**

Whether or not manufacturing companies can keep up with the pace of technological transformation depends primarily on their ability to recognize opportunities and requirements at an early stage and to adapt their structures, processes and solutions quickly and flexibly. **Page 13**

# Realignment
## Setting the course for the production of the future

"The world is changing at an ever faster pace. Do decision-makers have any influence at all on this? Probably not. But they can certainly influence how their production facilities are geared towards the future. Let us look five years ahead: What central key factors do you expect to be of decisive importance for production?"

**Prof. Dr.-Ing. Dirk Jacob**
Production Automation and Robotics

One thing is certain: the very first ripples of the megatrends announced by futurologists were enough to shake entire branches of industry to their very foundations. Digitalization, in particular, is steamrolling its way through the entire field of industrial production. Transformation towards a globally networked and integrated economy is making itself felt in all sectors. We are therefore at a juncture in which it is apparent that the mechanisms we use to act and the way we manufacture are undergoing fundamental change.

Established practices are being replaced at an ever-increasing rate. New and old technologies coexist in parallel, overlap and accumulate. The choice of options available to companies today is exploding exponentially. The future scenarios for companies are becoming ever more complex, while the time to respond to market developments is simultaneously becoming ever shorter.

Most companies are currently focusing on using new technologies to make selected processes more flexible or to increase output. Flexibility and efficiency are key building blocks in the production environments of the future. However, companies need to take a step further and consider how holistic and sustainable solutions can be implemented to gear production environments towards dynamic market changes.

This White Paper presents three key factors that must be considered if you want to future-proof your production environment. In times of great change, those who act early enough can open up new production possibilities.

# Focusing on versatility
## Questioning established decision-making parameters

Faster, bigger, cheaper – this credo has been considered irrefutable in industry for over a century. Stronger throughput performance and faster conveyors helped to make production a little more efficient each year. Over the decades, this approach ensured relatively continuous improvement in cost-effectiveness on the basis of economies of scale.

Robust and flexible: KS PULSE transports body components quickly and safely through the production stations.

The first approach to ensuring continued success is often the automation of processes. There are still sectors and production processes with great potential for increasing efficiency through intelligent automation processes. For this reason, it is always worth checking what positive cost effects this key measure can trigger in your own company.

But is this enough to continue improving production processes in the future? Even when the quantity and quality of machines and systems have been optimized and all potential effects of scale have been exploited to the full?

### Gearing production to the dynamic ground rules of the market

It is to be expected that highly efficient, intelligent automation solutions will play a pivotal role in future production environments. Anyone failing to exploit this potential in time will almost certainly be quickly squeezed out of the market. Furthermore, new ground rules that are considerably more dynamic apply in the digital world. In order to stand out from the competition, one thing is more important than anything else: companies must have production facilities that can adapt quickly to changing general conditions. It makes no difference whether these arise from disruptive new business models, technological development, the trend towards customization or attractive jobs in times of demographic change.

### Focusing on the versatility of the company

In the future, companies must be able to adapt not only their technical infrastructure and supply chain quickly to new market conditions, but also their business models, the nature of their customer relationships, their customer support services and the availability of essential resources – in the worst case, all at once and under enormous time pressure. Companies that have already integrated a continuous learning and change process into their day-to-day operations and are therefore characterized by a high degree of versatility are at a clear advantage in these change processes.

### Overcoming a one-dimensional focus on efficiency

In order to identify the key factors that are relevant for the successful production of the future, decision-makers need to realize that the one-dimensional focus on the conventional factor of ‘efficiency’ will not bear sustainable fruit. This is because no matter how efficient a company is, it needs to remain open to change, regularly review operations and take a critical look at standpoints that have always gone unchallenged.

This, in turn, requires a holistic approach that takes into account the complexity of the world in the aftermath of the fourth industrial revolution. Successful companies will be able to respond to technical innovations, societal developments and global factors such as climate change and scarcity of resources to an unprecedented extent and faster than ever before.

Therefore, the art of mastering the future does not consist in referring to the Gartner hype cycle[1] to forecast precisely which of the specified technologies will change the world in the years to come. Rather, it consists in making well-considered decisions in production facilities now, thereby laying the foundations that will enable them to adapt flexibly and quickly to the expected changes.

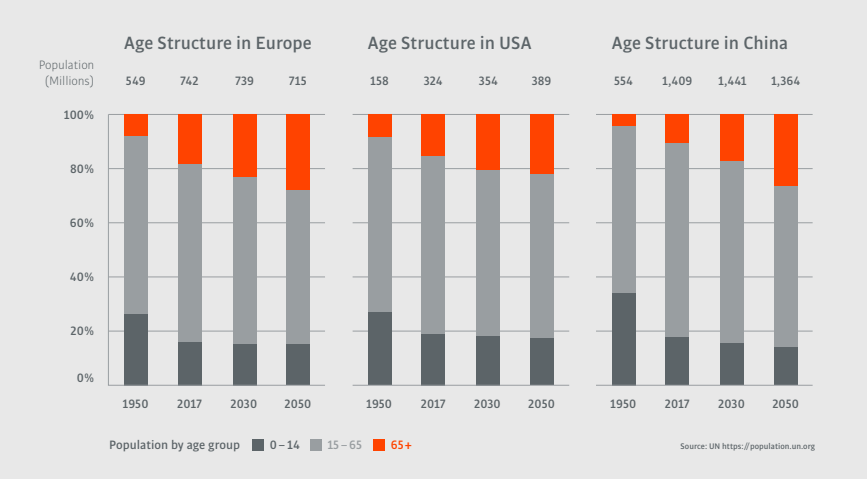
[1] www.gartner.com/smarterwithgartner/gartner-top-10-strategic-technology-trends-for-2019

# Analyzing megatrends
## Deriving strategies for the future early on

Exact predictions of the future are simply not possible. Nevertheless, in the field of innovation management, the analysis of megatrends has become an established tool for predicting future developments. Megatrends enable prognoses that can be used to derive reliable forecasts of market developments and the resulting requirements for your own company. It is therefore worth considering the constraints of economic evolution as guideposts and designing a versatile manufacturing infrastructure for the future on the basis of the key factors that are relevant for production.

"Not every company will be affected to the same extent by the megatrends, but every company needs to address them. Only those who make timely use of technologies with the potential to adapt to changing requirements will survive on the market in the long term."

**Prof. Dr.-Ing. Dirk Jacob**
Production Automation and Robotics




## The megatrend of demographic change – the workforce of the future requires holistic production systems

Since humans are indispensable as the driving force in production, companies will have to master two tasks in the future. The first of these is to promote the health, skills and motivation of the existing workforce. The other is to facilitate the integration of young employees into complex production processes. Here companies must position themselves as attractive employers – with holistic production systems. Intelligent automation solutions have a valuable contribution to make in creating an appealing working environment and preventing personnel shortages.

## Ready for plan B: countering demographic change with robotics and automation

If the average age of people working in production increases, it will become all the more important to automate strenuous, hazardous or harmful tasks completely or to provide long-term relief with robots assisting human employees by means of direct interaction. Robotics and automation can take on repetitive tasks in particular, thereby alleviating the shortage of skilled labor in many production processes. One major opportunity for the application of collaborative robot systems is using them to perform ergonomically unfavorable tasks – for example to reduce heavy physical strain and to increase quality by means of precise process control.

## The megatrend of digitalization – multiplication of possibilities

The collection, analysis and saving of data in real time are rapidly changing industrial processes. Digital twin, cloud and big data are increasingly determining the life cycle of products – from development and manufacturing through to maintenance. Companies need to recognize the fact that the megatrend ‘digitalization’ has triggered the greatest evolutionary leap forward in decades – and this impact is increasingly affecting production.

## Digitalization – a socio-technical transformation process

Digitalization must not be reduced to a merely technical phenomenon. It is a socio-technical transformation process that will change our society in virtually all areas of life, resulting in a whole new level of complexity. Companies with a vision for the future are drawing two important conclusions from the megatrend of digitalization:

**1. Ecosystem-based action:**
In an age of digitalization, only companies that see themselves belonging to different ecosystems [2] and embrace a global community will be successful. Such a community offers internal and external connectivity, multiplies interfaces to relevant developers, suppliers and innovators. It helps to intensively maintain and benefit from a global, cross-sector network.

**2. Fusion of humans and technology:**
Only companies that see humans and machines as partners whose respective strengths complement one another are in a position to recognize technological potential and leverage it to the full. [3] In order to ensure a fusion of human abilities and technology, however, companies must increasingly invest in the integration of efficient human-machine interfaces.

## End-to-end data flow and networked processes

Industrial digitalization is influencing plants, systems and processes. By providing a wide range of networked information about the status of individual components as well as the overall production process, the Industrial Internet of Things (IIoT) optimizes productivity. Employees acquire a better overview of the production process and can respond more quickly.

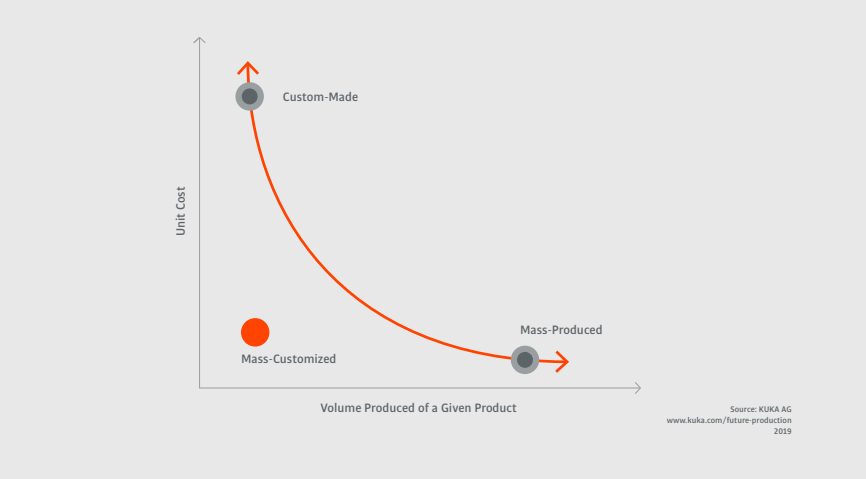
In order to ensure integrated digitalization of manufacturing cells and production lines, however, decision-makers must turn to future-proof suppliers with the required core competencies from both the digital world and the world of mechanical and systems engineering. This is because the production of the future requires automation solutions that provide companies with an ecosystem in which micro-services and big-data analyses can be used to analyze and ensure a sustainable increase in manufacturing efficiency, quality and availability.


## The megatrend of customization – rediscovering the individual

The new variety of life philosophies is resulting in greater individualization, which in turn is fundamentally changing consumer behavior. Driven by rapid technological transformation and global networking, the megatrend of customization is affecting the requirements on manufacturing companies worldwide.

The trend is making one thing clear: the more deeply users' personal identities are anchored in products, the more intensively they identify with the products. Consequently, products must give users the feeling that they were made specially for them. However, personalized production is characterized by changes in special features. Customer clusters are broken up and individual customer requests must be implemented in product design and production. The optimal batch size in customized production, assuming products are perfectly adapted to customer requirements, is 1. The challenge will be to implement this ideal in the context of high-yield industrial production.

[2] www.zukunftsinstitut.de/artikel/hands-on-digital
[3] www.zukunftsinstitut.de/artikel/hands-on-digital




## Successfully and cost-effectively implementing a batch size of 1

In most industries, batch size 1 production at anything approaching series-production costs is virtually impossible at present. The objective in customized mass production is to maintain overall plant effectiveness. The challenge here is hindering performance and quality from declining in comparison with series production.

In order to be able to satisfy this trend towards customized products, companies must integrate intelligent automation solutions into their production. These will enable extremely versatile production which can be networked throughout the entire process chain. The digitalization of production will make this possible. On this basis, the system can automatically be converted to changing product types – without wait times and without production downtime. It will thus be possible to implement the manufacturing of customized series in the context of industrial mass production – with an attractive return on investment and a short time to market.

## One key to success: highly flexible human-robot collaboration

IIoT and the production of tomorrow will create the basis for manufacturing high-quality one-off products with the profitability of series production. Traditional manufacturing is being replaced by highly flexible factories in which humans are optimally assisted at the heart of production by machines and robots. As repositories of knowledge, humans will be relieved of strenuous and undesirable physical work in the long term.

The HRC-capable LBR iiwa works hand-in-hand with humans and, as a result, is revolutionizing industrial production and manufacturing.

## The megatrend of resource scarcity – dawn of a new economic philosophy

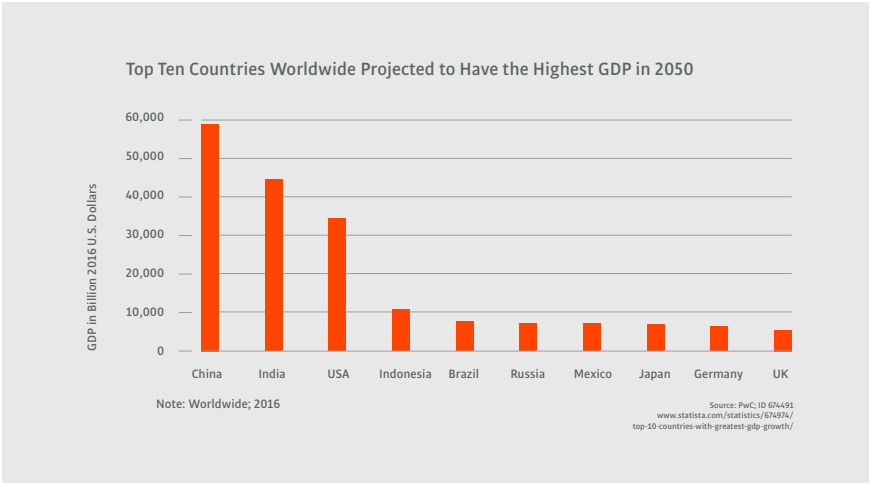
The shortage of minerals, metals and fossil raw materials is already driving home to us the fact that our current consumer behavior is at its limits. The shortage of resources is making raw materials more expensive, necessitating long-term changes to production processes and leading to a reappraisal of the values of global societies. From normative regulations such as legislation on plastics and emission limits to new ethical customer preferences – the scarcity of resources is permanently changing the way companies think and act.

## Maximizing energy and resource efficiency in production

Production costs in the industrial manufacturing sector generally comprise both the costs for equipment, materials and energy and also personnel costs. The actual breakdown of costs varies greatly from one sector to another. For many manufacturing industries, however, material costs represent a major cost block. The reduction of material usage and the search for cheaper, alternative raw materials are thus of central economic importance.

Companies that want to prevail in the production of the future will have to integrate flexible technologies that use resources efficiently. This will be enabled by the use of intelligent automation solutions that optimally serve all production processes precisely and efficiently, and thus with a minimized impact on resources.

The fact that linear resource extraction models are increasingly being replaced by regenerative recycling models also supports this. The flow of goods is becoming ever more transparent – from extraction of the raw materials to production, assembly, distribution and use of the products, not forgetting disposal and reuse. Digitalized production also enables continuous documentation of the social, economical and ecological use of resources. This is the only way of establishing a sustainable economic system that is ethical and viable in times of limited resources.

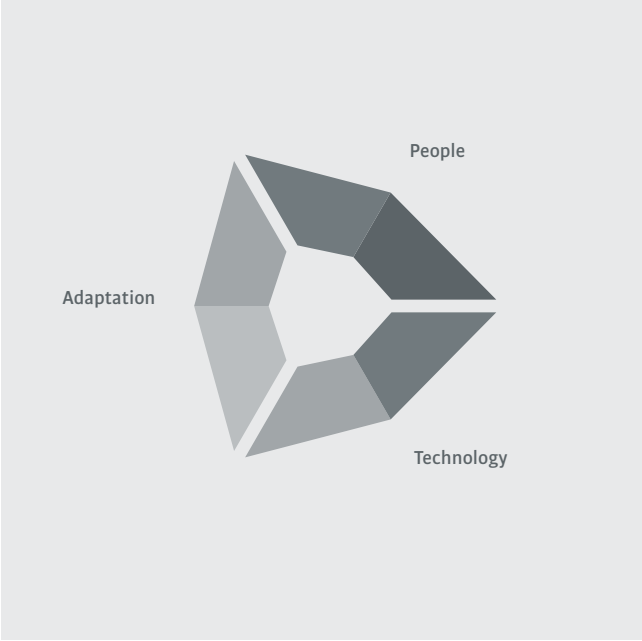



## The megatrend of shifting economic power – understanding the consequences of volatile market fluctuation

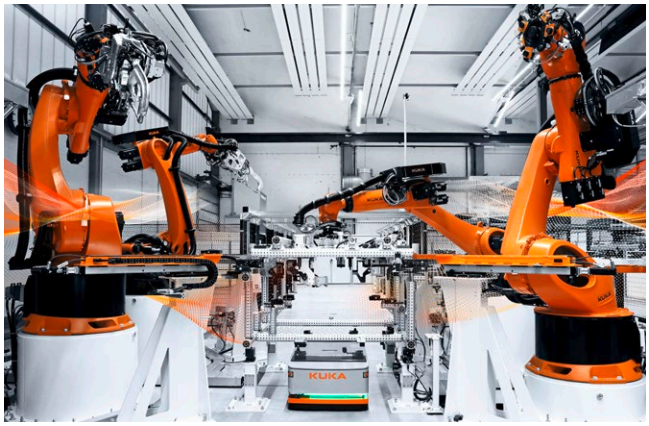
The production of the future must adopt a more global outlook – with globally networked production locations and supply chains. The shifting and distribution of economic power over more countries and regions goes hand in hand with new customer requirements and new rules for production. In order to cater to specific regional customer requirements in an economical and timely manner, global production locations are often indispensable – if for no other reason than to eliminate long transport times and high customs duties. Group standards must be introduced and monitored globally. Moreover, they should be highly adaptable to specific regional, economic, technical and cultural circumstances.

# Redesigning production processes
## Three key factors that are relevant for production

The megatrends are overarching indicators of the global challenges facing companies today and in the future. They provide clear indications of the issues that the business sector will have to translate into concrete strategies for the future. What key factors are already deciding future success?




The intelligent linking of the key factors ‘people’, ‘technology’ and ‘adaptation’ is paving the way for the future production landscape.



## Key factor 1: People

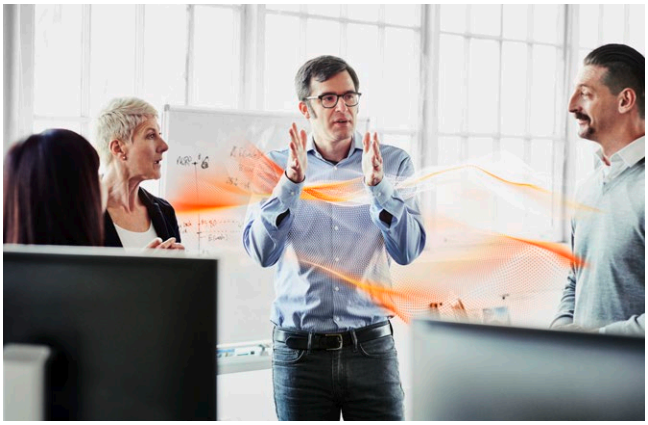
The key factor ‘people’ will play a central role in tomorrow’s technology-based production because of their flexibility and creativity: as creative elements, as knowledge repositories, as production workers and as consumers. After all, it is people who are creating these new opportunities of flexible production. One thing that will be important for the production environments of the future: with intelligent production technologies, we can significantly enhance the capabilities of our production employees and they themselves can become even more efficient. Smart technologies support people and open up new ways of working and exploring new applications, thereby enabling more efficient manufacturing with higher quality and improved ergonomics. Technical assistance systems, such as ‘cobots’, augmented and virtual reality, are increasingly becoming everyday factory assistants.

However, the positive effects of flexible and networked machinery and systems can only be tapped in their entirety if the interface between man and machine enables us to understand and use complex technologies intuitively. Interfaces – whether for programming, commissioning, operation, analysis or servicing – must become as simple and self-explanatory for people as operating a smartphone.

## Key factor 2: Technology

The key factor ‘technology’ constitutes the basis for sustainable production environments. Ground-breaking, flexible production technologies, such as robotic manufacturing lines, matrix production and mobile platforms, are creating a wide range of new production applications. They create a fundamental basis, enabling companies to provide an agile and effective response to different capacity requirements, customization requests and the consumer trends of their customers. On the one hand, increased use of these adaptable production machines, such as CNC machines, 3D printers or robotic systems, can help companies react to new production requirements. On the other hand, it is not until operational technology (OT) is combined with information technology (IT) that the existing boundaries of production systems are radically pushed back. Put simply, OT “is hardware and software that detects or causes a change through the direct monitoring and/or control of physical devices, processes and events in the enterprise.” [4] In conjunction with IT-driven developments, such as artificial intelligence, big data and cloud platforms, they are transforming the entire supply chain to form a new, interactive, global network. This will open up unimaginable potential in the production environments of tomorrow. It is with good reason that this disruptive technological quantum leap is also being referred to as the fourth industrial revolution.

[4] https://www.gartner.com/it-glossary/operational-technology-ot



### Key factor 3: Adaptation

The key factor ‘adaptation’ describes the ability to adjust existing processes, systems and applications quickly and systematically to permanently changing requirements and market developments. This is a factor without which economic success is inconceivable in a continuously changing world.

Open interfaces, ecosystems and high-performance development kits for third-party suppliers are the key to disruptive product innovations. This level of unobstructed access to success is only possible, however, with production system providers who offer their customers platform-independent interfaces that enable different, manufacturer-independent applications to be networked. Companies that wish to position themselves in the production environment of the future must therefore work with a flexible, adaptive innovation culture that leaves all paths open to them – from the development of their own innovations to the purchase of new, pioneering technologies. The environment in which future-oriented companies operate is greater than the sum of its parts. This is because the more complex a system is, the more open and varied the perspectives must be.

Furthermore, companies should make use of suppliers whose automation solutions are coupled to adaptive smart services enabling quick and easy adaptation to new requirements. Consulting expertise, for example, identifies the greatest potential of existing systems and achieves rapid measurable results with minimal adaptation of the processes.

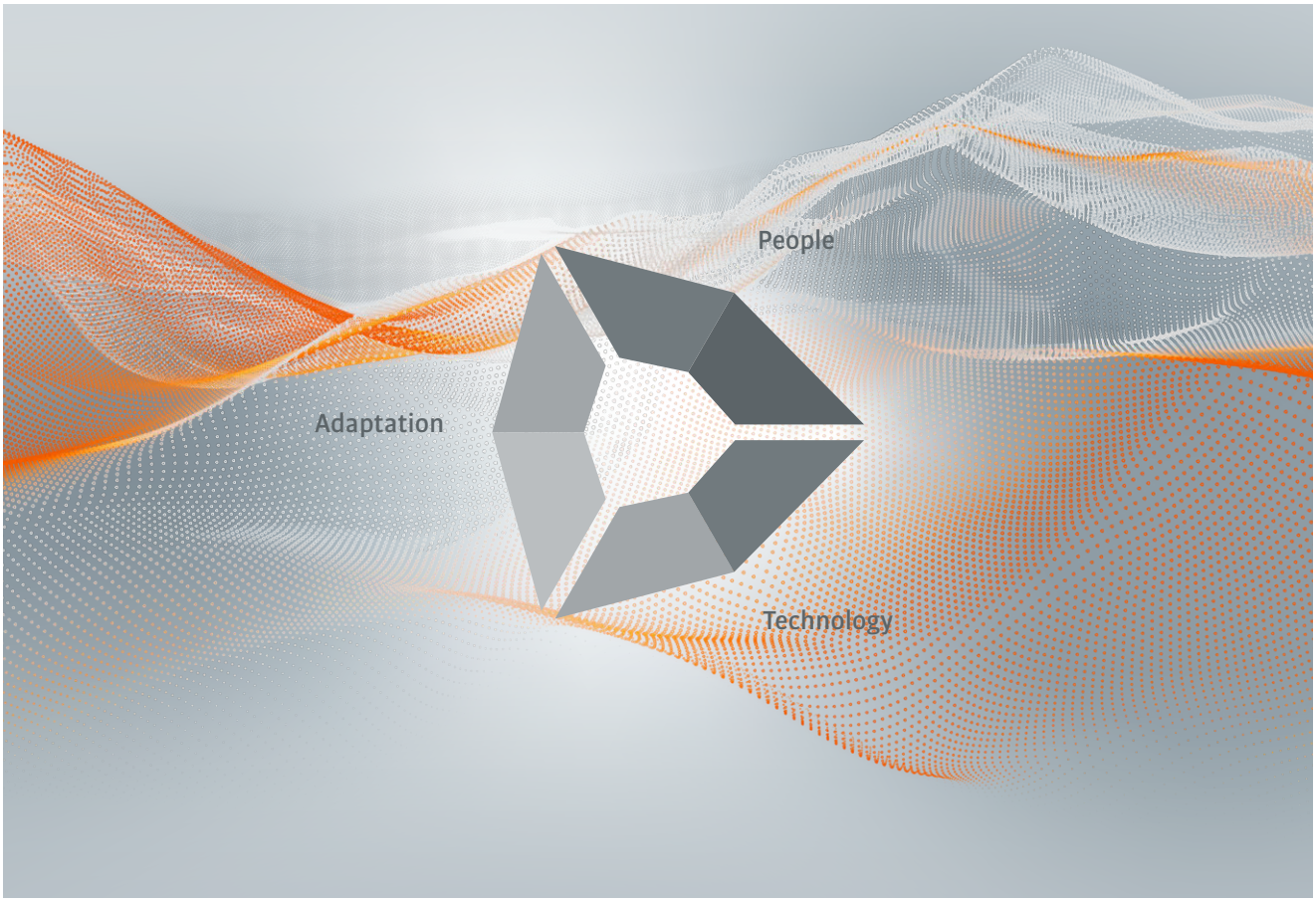
In order to stay up to date in times of volatile markets, continuously changing demand parameters and resource efficiency, entrepreneurs should also invest in production facilities with open interfaces and standards as well as correspondingly large developer communities. System programmers, robot programmers, system houses and integrators, and also the users’ production experts can get together and connect. These communities provide the necessary understanding for the growing diversity and complexity of technology and enable quicker results in higher quality. The chosen automation provider should thus have community marketplaces in their repertoire that open up the existing internal system for new technologies and create attractive new opportunities for keeping pace with the fast-moving world of production – including economically profitable solutions that are immediately available.

When selecting production equipment with the required open interfaces and integrated networking, the issue of safety and security must be taken into consideration. It is important to address both the safety of the production process and the security of the software and to integrate corresponding concepts for safe operation of the systems.

Only through the intensive collaboration of many different participants is it possible to push back the boundaries of infrastructure with new technologies and open them up to a larger circle of users through better user interfaces. In this way, robots can be expanded with plug-ins for specific applications or user and motion modes endowing them with new abilities.

The key factor ‘adaptation’ is the basis for keeping the production technologies of companies up to date – but only in conjunction with the key factors ‘people’ and ‘technology’.

# New formula for success
## Using the DNA of future production environments




The combination of the three key factors ‘people’, ‘technology’ and ‘adaptation’ forms the basis of future production environments. Together, they provide the formula for success that can empower companies to design sustainable production worlds. Only by using all three factors in a targeted manner is it possible to set up a secure, flexible infrastructure that will be able to meet the requirements of the future in terms of dynamic performance and flexibility.

When selecting an automation solution supplier, it is essential to find the right combination of the three key factors for your own production. The important thing here is to make use of this combination of factors and not to consider each of the three key factors in isolation.

Ultimately, setting the course for tomorrow’s world of production is like a definitive equation: if just one of the three key factors is missing, companies will no longer be able to reap the sum total of the future-proof benefits. Success results primarily from the threefold combination of ‘people’, ‘technology’ and ‘adaptation’. Companies should therefore take early advantage of this trio – because every decision taken determines the freedom of companies to shape the future.

# Practical guide
## Seven tips for an individual strategy

**1.**
Facilitate technology development for internal and external developer communities. Create the basis for this by using open standards, exchange platforms and modular languages.
**» Key factor ‘adaptation’**

**2.**
Use controllers and devices with intuitive user interfaces. The goal is to develop a user interface that enables production employees to configure and operate systems, irrespective of their abilities or generation.
**» Key factor ‘people’**

**3.**
Use production technologies that are based on open interfaces and come with an ecosystem of suppliers – for example, a marketplace in which a development community offers tailored solutions.
**» Key factor ‘adaptation’**

**4.**
Use assistance systems and human-robot collaboration to relieve employees of physically strenuous or monotonous tasks. Longer-lasting health and greater satisfaction in the workplace are the best way of retaining experts in your production system for as long as possible.
**» Key factor ‘people’**

**5.**
Make sure that new employees with different qualifications can operate your systems. Promote knowledge transfer between experienced colleagues and new employees.
**» Key factor ‘people’**

**6.**
Make your processes and technologies more flexible in order to enable customers to configure and customize products and solutions.
**» Key factor ‘technology’**

**7.**
Create modular processes and systems that can be adapted easily to the different circumstances of production sites around the globe (e.g. technical standards, legal regulations).
**» Key factor ‘adaptation’**

# Look out for upcoming White Papers...

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