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Thought leadership from Atos

Your business technologists. **Powering progress**

New business trends and operational parameters

The keys to the future: connection and real-time intelligence

The Factory 4.0 powered by technological innovation

Developing a roadmap for change

Smart Factory

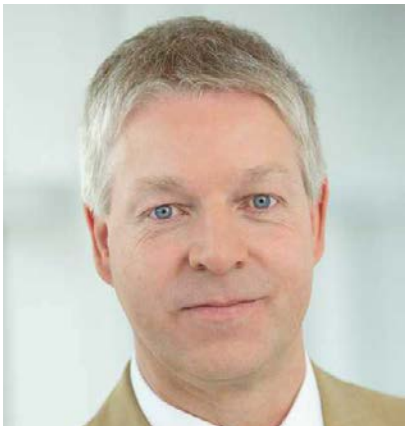
Connecting data, machines, people and processes – delivering the next generation of manufacturing

Atos

Contents

Foreword

"At Atos we strive as much to look forward as it is to deliver in the present. Sharing our vision of the Factory of the Future is our unique approach to help our manufacturing clients navigate their way through these challenging and promising times, and stay one step ahead of the game".



Swen Rehders
EVP Global Head of MRT Market, Atos

Manufacturing has made huge progress in recent years: automation levels have increased in all manufacturing sub-sectors and third party suppliers now have better vertical skills, geographical coverage and greater scalability. The number of products and product variants has exploded. Globalized capability has become the foundation of cost reduction.

Our Ascent initiatives are designed to share with our partners and customers advance innovation and thought leadership on emerging trends that will shape our world in the near future, and impact businesses.

This Ascent magazine explores one specific area in which Atos is proud to have a unique DNA and track record: the factory.

Technology enables new business models and new methods of production execution; it also opens new scenarios and opportunities. The human life and expectations are in constant change on political, economic, environmental and societal levels. This will have a major impact on almost every organization and every person across the globe. Factories will be a key part of this change – and are going to transform significantly.

Delivered by both our market and technology experts across the globe, as well as by our readings and client discussions, this thought leadership paper outlines all these new trends that are about to shape our business over the next decade.

German and US governments dedicate important budgets to help their industries to develop and implement new strategies. After the first industrial revolution in the 18th century with the mechanization of manual work, the second revolution involving mass production techniques in the early 20th century, and the third revolution brought by electronic and computer systems in the past decades, we are now at dawn of the 'fourth industrial revolution'.

Today we hear about Industry 4.0, led by the convergence of the physical world and the virtual world (cyberspace) in the form of Cyber-Physical Systems (CPS).

At Atos we want to follow this and to play a key role in these developments, for and aside our manufacturing clients.

We are happy to share our vision in this paper. We hope you will find with it the ideal guide to provoke thought and debate in your company, and be prepared for the world in the next decade. Welcome to the Factory 4.0.

New business trends and operational parameters in manufacturing

Customer Centricity and Smart Products

Increasingly, customers and the market expect more from manufacturers and the factories that are the center of their delivery model: more connection, more adaptability, more responsiveness.

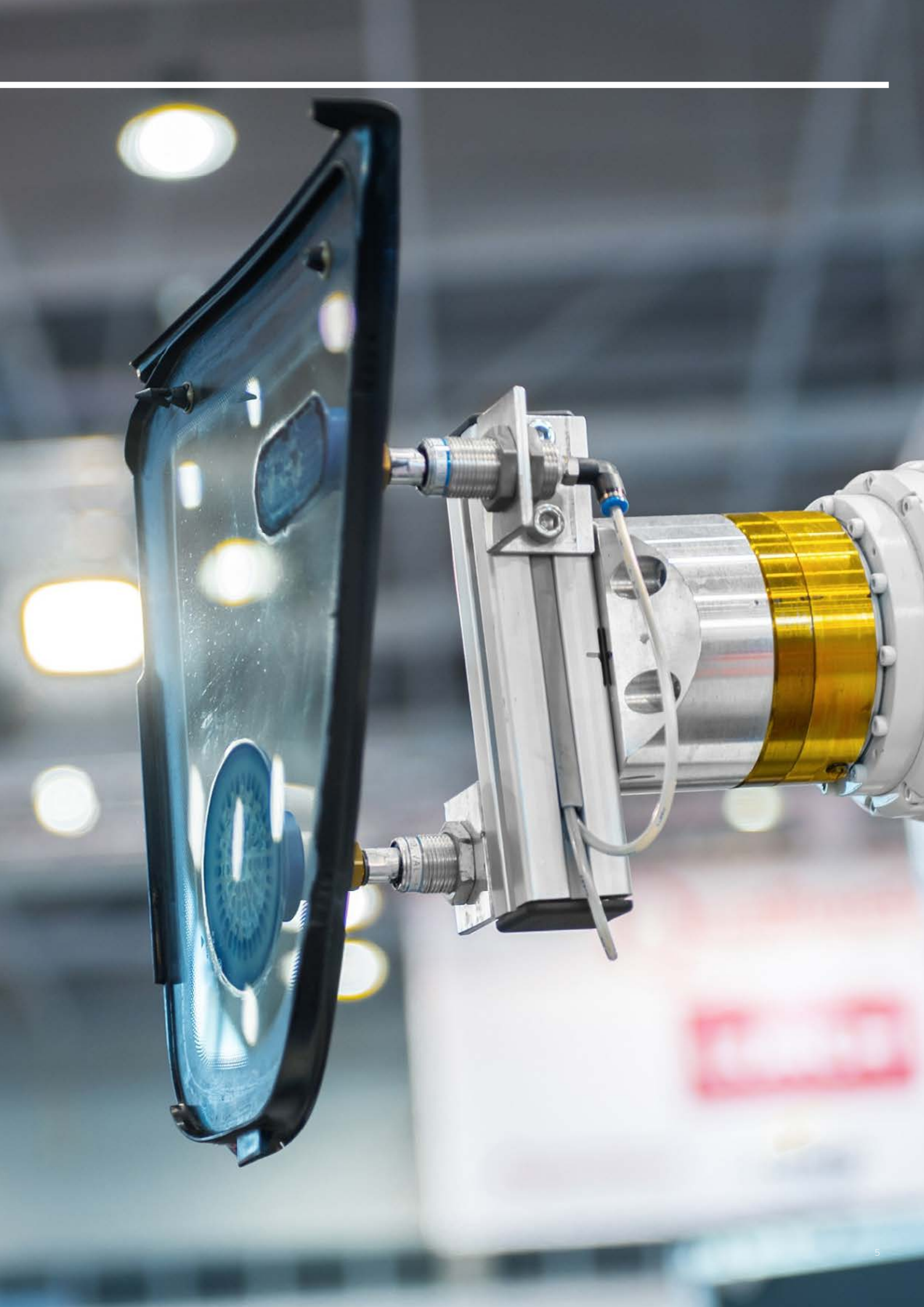
Today's factories must enable the manufacturer to deliver in a world where radically shortening production cycles and a high degree of product variation and personalization are fast becoming prerequisites. Customers want more models and variants, specific to their individual usage profile and requirements, now. Customers have zero tolerance for quality issues and will immediately go to the competition if these are encountered.

Factories must increasingly become more customer-centric, delivering products that do more and meet better individual needs, while driving new user experiences. Production environments must be balanced to support a production model that delivers intelligent and appropriate customization on basic uniform product design: this is the key to driving the 'mass customization' reality.

This requires accelerated time-to-market through execution accuracy and agility, more efficient and accurate processes and supply, to ensure quality levels and speed up delivery.

Through new levels of communication at every level across the factory and the manufacturing value chain, manufacturers will be able to collaborate better and more effectively; they will also be able to respond to competitive pressures, shortening product lifecycles, and rising demand for product and service personalization.

Digital, smart sensors are increasingly part of the factory ecosystem. Production components such as machines, robots and test elements are all equipped with sensors. Within factories, this means traceability and more – (and more accurate) data, which supports better procedures and more efficient production, all of which enables manufacturers to reach new conclusions and make business processes better. In the market it enables enriched experiences, usage data gathering, design evolution and new revenue streams from on-demand/Pay as you go offers, such as Michelin's plan to charge fleets for 'tire rental' services based on mileage. This presents important opportunities to new businesses.



New operational parameters

To achieve their potential to meet customer and market needs and compete in today's global, dynamic landscape, manufacturers need new operational scenarios to be considered, modeled and put in place:

Convergence of information technology (IT) and operational technology (OT) enable cyber physical systems (CPS)

The autonomous and independent behavior of manufacturing units leveraging the use of relevant information is a cornerstone of the smart factory. A central feature is here to have real-time data available to connect the virtual world with the real world, the opportunity to permanently create a virtual image of reality updated by real time data. This opens possibilities for entirely new business models based on the convergence of physical devices and IT – cyber-physical systems (CPS). CPS, are defined as 'systems of collaborating computational elements controlling physical entities'. Essentially, through CPS, physical entities can be controlled fully through IT – and device functionality is not defined solely by physicality but also software. Currently used throughout industry in aerospace, automotive, infrastructure, energy, transport and other areas, CPS are increasingly critical to manufacturers and the factory ecosystem.

They will affect, increasingly, the way factories are constructed and run in the future, and play an ever-bigger part in the ways that smart products, connected machines and augmented operators work together. These CPS platforms will be the basis to connect the individual 'internets' with each other – the internet of people with the internet of things and the internet of services.

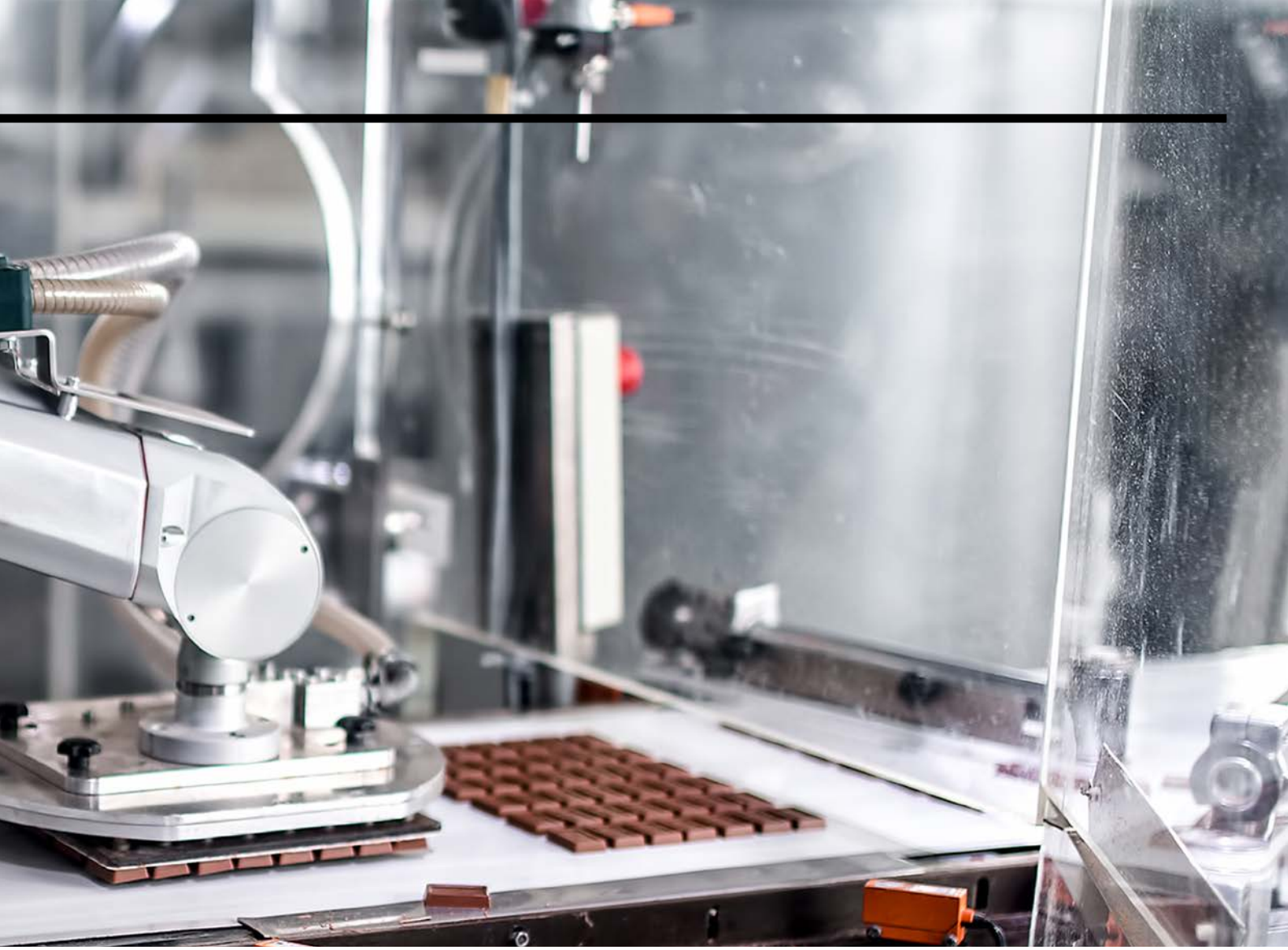
Gaining end-to-end visibility – across plants and disciplines

Manufacturers need to be able to visualize increasingly complex production scenarios. For maximum flexibility, dispersed plants need to be controlled or at least overseen from a single, central vantage point. This requires unified governance and line of sight over every aspect of strategy and operations. Each individual plant should be looking to contribute to the health and performance of the body (system?) as a whole. Factories must be harmonized with the business, so that they can be monitored, measured and managed in the same way. Uninhibited information flow leads to holistic, efficient resource management across all plants. To deliver this, Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) must work together, giving central coordinators a clear picture of plant activity and capacity.

More open relationships must be enabled and encouraged between departments to drive information flows and collaborative working more freely across design, engineering and production planning, and marketing, sales and customer service teams. The factory of the future must be centrally coordinated and governed, but able to work independently across hierarchies at need. This combination will enable it to respond more rapidly to change and incorporate new learnings and ideas on how to improve products and processes more effectively and from across the entire organization.

Factories must stop being seen as a box, and be viewed as open, cooperative environments. Greater co-operation along the value chain leads to better-quality products, fewer iterations, and faster time to market, and thus competitive advantage.

This requires new concepts of



production planning (informed by pervasive intelligence and computing) that can be populated, implemented and adjusted according to need. A central organizing function and integration is also needed, to enable this more coordinated production.

Deploying 'anywhere' design and manufacture

Global production and value chains need to be leveraged for success. This means that products need to be reproducible across the entire factory ecosystem, with factories able to 'make' anything the organization needs to make – anywhere. This means the ability to resource flexibly – for instance, re-routing orders, depending on local constraints and demands.

Putting in place joined up operations is key to accelerating product lifecycles, real-time product evolution and perfect alignment of business and IT

By supporting R&D, sales and production to collaborate (and giving them the IT and systems to do so), manufacturers can reduce the number of iterations in products, and proactively meet requirements in product development. 'IDC Manufacturing Insights' has issued in a survey about Operations Technology Predictions a major need for product mass configuration, identifying the need to move away from a make-to stock (MTS) manufacturing approach and mass production, and embrace more of a make-to-order (MTO) or engineering-to-order (ETO) approach to meet specific customer needs. The final goal is to achieve make-to individual (MTI) production and mass customization.

Embedding intelligence is key to real-time awareness and agility

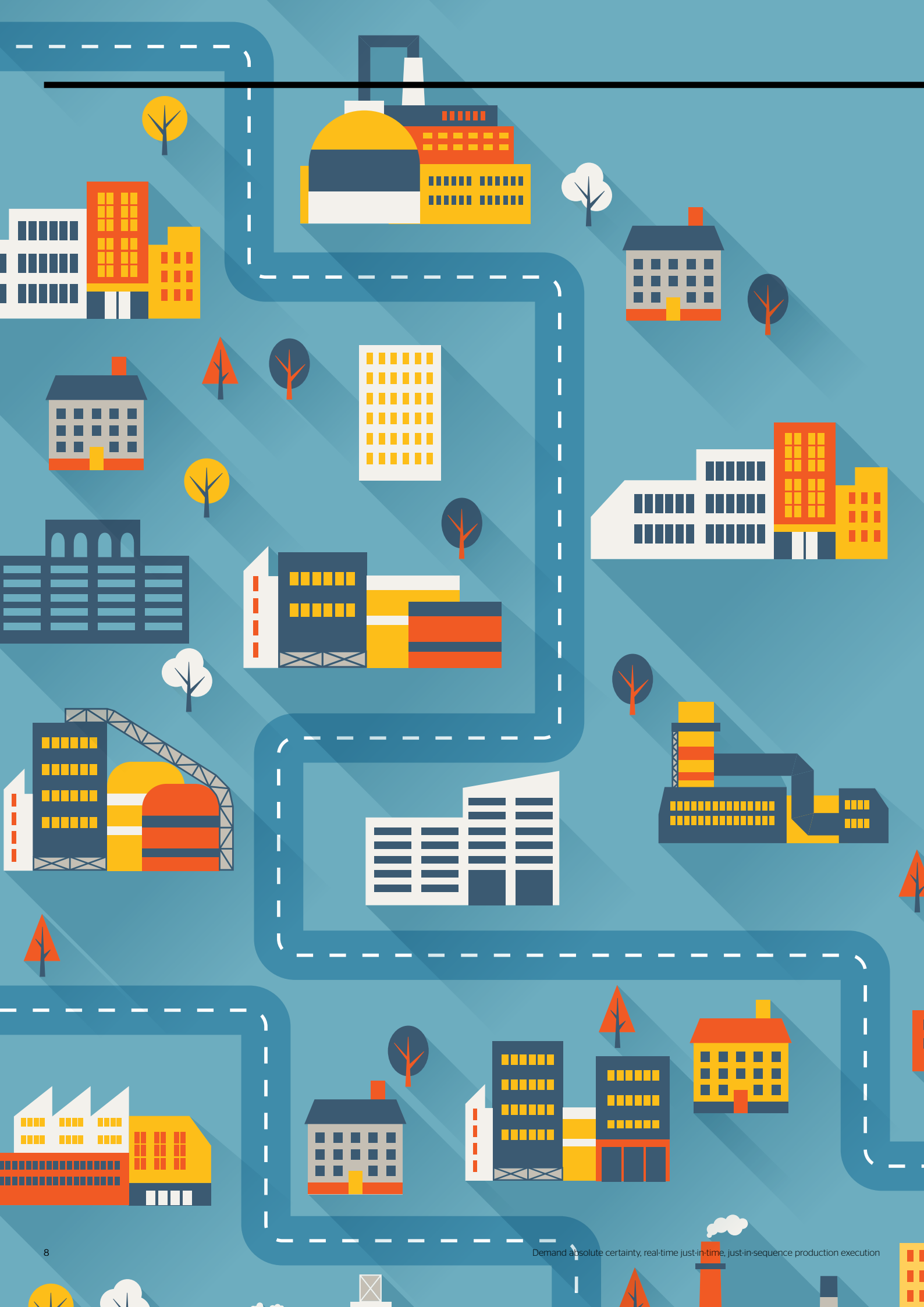
Putting in place the real-time intelligence and sensors at every level of the factory and production cycle, manufacturers can see everything that's going on throughout production lines and increase their ability to take immediate actions to produce more output and higher quality, and thus support operational and business agility.

Achieving real-time decision support, guiding product development and steering operations requires the availability of reliable, efficient and constant data streams, made possible through advanced IT. Naturally, it also demands that manufacturers have the ability to combine and analyze the high volumes of complex data being delivered through multiple, dynamically interrelated sources.

This includes the data coming in via increasingly 'social machines' – connected cyber-physical systems that deliver greater connectivity between machines and operations and planning functions to achieve real-time decision support, guide product development and steer operations. Factories thus need to support an operating model based on computing being embedded at every point – and it's the key to real-time planning and mapping of production, and to the evolution of products. This approach is the best way to turn your data into intelligence, and then into value. This point is also described more in detail in the next pages.

Becoming ready for disruption

Speed, accuracy and precision in every area of execution is essential in order to become more adaptable to change.



The keys to the future: connection and real-time intelligence

Across the new factory ecosystem, we will see these operational scenarios described above having a considerable effect. They will bring a radical change in the way that factories and in turn manufacturers work, delivering the next evolution of smarter and connected manufacturing.

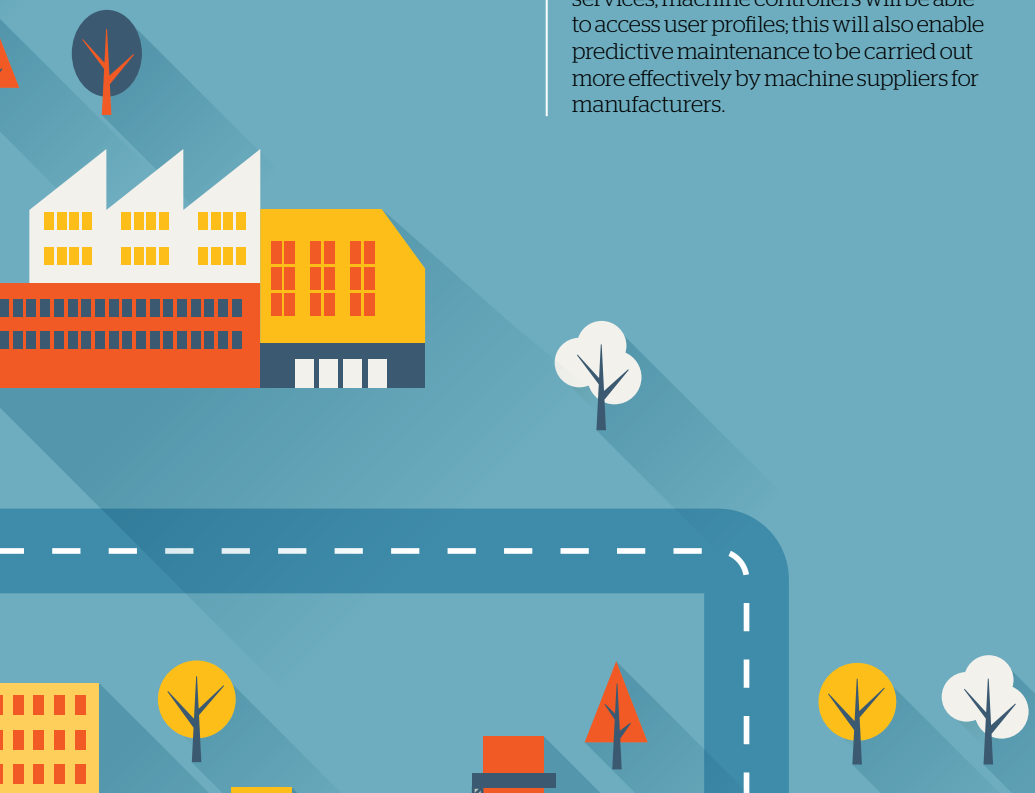
Connected machines & applications

Manufacturing machines and equipment will be connected, and able to talk to each other and share information in real time, ensuring that each can access all necessary data to be prepared for what's coming next.

The next generation, smart factory will automatically re-route work, pre-empting bottlenecks and identifying areas of underused capacity, customize production, enable predictive maintenance, and operate continuously and at unprecedented levels of efficiency. Machine information from outside specific plants will be accessible, enabling remote control of manufacturing units and services; machine controllers will be able to access user profiles; this will also enable predictive maintenance to be carried out more effectively by machine suppliers for manufacturers.

We will move towards the merger of minds and machines, thanks to electronic sensors that allow them to see, hear, feel. These machines will increasingly become not only more 'intelligent' or 'smart'. They will be brilliant, self-aware, predictive, reactive, self-healing, self-improving, and social.

We are already seeing technology, in some areas, being able to outperform humans in complex tasks. In 2011, IBM's 'Watson' computer won against the best human player in Jeopardy. Since 2012 Watson has been preparing to take the entrance test for admittance into the prestigious University of Tokyo; its development team believes it will succeed before 2021. Today, we can imagine that the new generation of machines, the machine learning models based on Neocortex, will become as important as all of today's non-brain like software.



Connected people

Despite the increasing intelligence of machines, people will remain the heart of the factory: humans will retain the fundamental control and decision-making function. Human-centric plant strategies will enable a flexible and proactive production environment. Intelligent, self-aware machines will liberate operators to focus on optimizing production and planning. As well as this, cross-functional communications will be enabled along the entire value chain, from design through engineering, production, sales and service – and work will thus aggregate around 'communities of practice' or 'communities of interest' – not just within functional silos.

It is predicted that, in the next 5 years, a middle-class worker will have 10 devices connected to the network. Internet and mobility, as well as personal and professional worlds, will converge, any time, at any place, for anybody and in any device. The tablet that did not exist five years ago has already become the device of choice for a whole generation. Permanent access to applications, live information feeds and automatic alerts from the machines to mobile devices, meanwhile, will allow operators, managers and engineers to move around more – safe in the knowledge that they will always have access to the latest status information, and be able to make decisions and trigger new actions from wherever they are.

Touch and voice entry become the norm, and people now expect to be able to switch or swipe information from one device and from one person to another. In a world where people no longer work fixed hours, from a fixed PC in a fixed location – manufacturers need to understand and enable their people's dynamic and continually changing 'digital mesh'. Younger workers will be able to communicate easily in the ways that they are used to – through social channels and open networks, with everyone contributing and without hierarchy. This will not only make manufacturing more attractive to upcoming generations; it will speed up continuous improvement through incorporating contributions more easily and effectively.

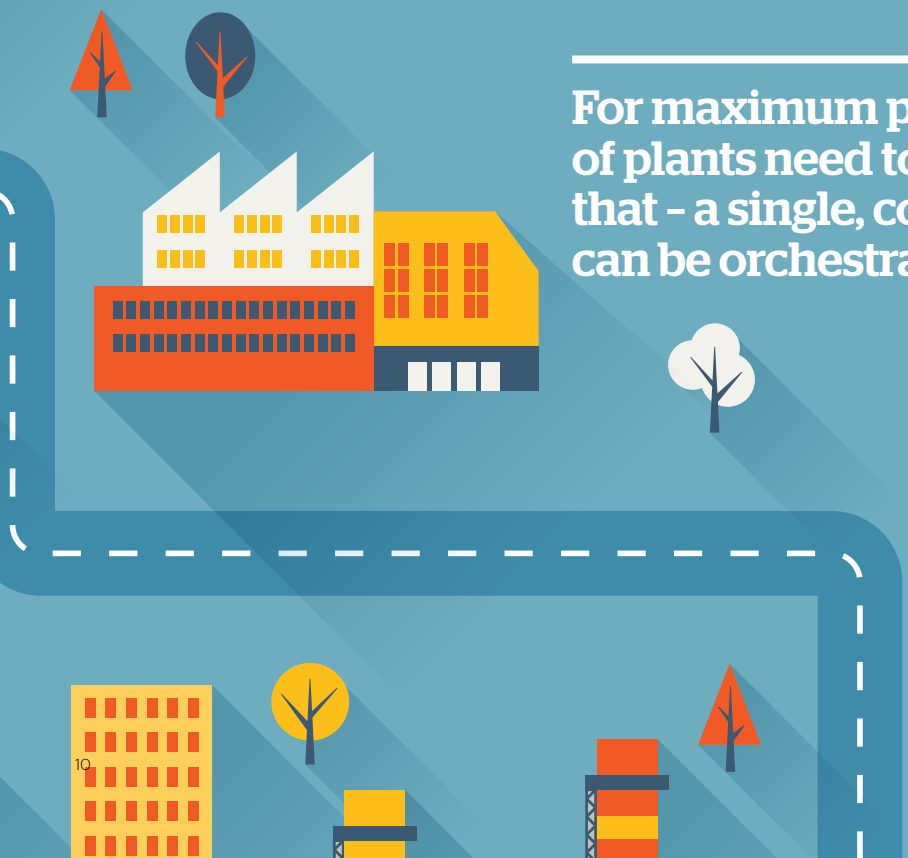
A last point we would like to point out here, is where digital and electronic components merge with textiles to create "smart clothing", a futuristic form of clothing that can function as an active device. The idea of joining textiles and electronics has already become a reality, starting in sports and leisure as well as in military environments. Smart Fabrics and wearable technology is a real way forward, making worker's life more convenient, efficient, secure by providing interactive and communicative clothing suitable for the plant floor.

Connected Plants

For maximum plant efficiency, networks of plants need to be treated as exactly that – a single, connected entity that can be orchestrated as one. Facilities are no longer fixed and silo-driven but flowing with intelligence, adaptability and the ability to dynamically reconfigure.

Manufacturing will decouple from specific plants; software and activities will decouple from specific hardware. Future planning models will be much more dynamic and flexible, making best use of machines and global capacity, responding to demand and opportunities.

Each contributing facility should be benchmarked against central standards; they must be comparable with each other (you must be able to directly compare the performance and processes of one factory with those in another) and learn from each other. Factories will increasingly be part of a network of factories, a single fluid, self-managing and constantly interacting asset; in some ways, we can imagine the new generation of factories as 'living'.
They will bring together machines and minds and advanced analytics to make better decisions; use ubiquitous sensors to see, hear, understand; generate and understand prodigious amounts of data.



For maximum plant efficiency, networks of plants need to be treated as exactly that – a single, connected entity that can be orchestrated as one.

The Factory 4.0 powered by technological innovation

Key Technology enablers

There has never been a bigger force for change than technology. The new factory ecosystem is linking up with a range of technological enablers to create the conditions for a 'perfect storm'. These are the keys to delivering the 'connection' vision set out above, and integrating it into business strategy and operations successfully. At the highest level they include such technologies as:

- **M2M communication** – embedded sensors in machines and products
- **Network ubiquity** – to drive intelligence everywhere
- **Mobility everywhere** – to get information to the point of need
- **Open standards** – to enable integration
- **Big data and analytics** – to combine and understand vast pools of data in real time
- **Mature and secure cloud** – to balance central and local data
- **Social technologies** – to drive collaboration
- **Augmented Reality** – adding complementary information to real situations
- **3D printing** – enabling Make-To-Individual manufacturing to become a reality.

A word on 3D printing and Manufacturing on-demand: We are increasingly in a manufacturing world in which there is a requirement and expectation of more rapid bespoke production, both in or to deliver the rapid prototyping of more products and variants, and to support specialist products and obsolete parts globally and locally.

This is where 3D printing comes into its own as a viable way to rapidly, cost-effectively deliver components or complete products and decrease the holding and transporting stock (and obsolescence concerns).

In 2013, the entire world began to become aware of the potential of 3D printing. The possibilities of these technologies are almost as limitless as the imagination, and will have a strategic impact across the whole manufacturing industry. In the coming years 3D printing technologies will be seen as a viable alternative to current manufacturing processes.

The role of Big Data and Analytics

Connected machines and data inevitably produce vast quantities of data. Factories can harness this to drive all sorts of new insight and efficiencies, creating intelligence everywhere.

It is estimated that 3.5 zettabytes (3.5x1021) of unique information will be generated in 2014 – more than in the whole of the previous 5000 years of human history. By 2020, industrial data will make up 50% of all digital information.

Key enabling technologies include data-capture solutions; big-data analytics software; scalable, cost-efficient cloud-based storage and processing facilities; and sophisticated reporting tools.

'Big data' and sophisticated analytics are increasingly accessible via specialist cloud-based services. This in turn drives responsive real-time decision-making and predictive actions. This will be used for both customer and operations data, to personalize products and improve production efficiency.

Operational efficiency will be ensured through proactive, preventative maintenance and real-time planning. Thousands of embedded sensors will relay real-time information, and identify emerging problems, so that they can be fixed preemptively. Intelligent, dynamic production line planning will allow jobs to be rapidly rerouted, so productivity is maintained when bottlenecks do occur.

Real-time, customizable dashboards are making reporting more intuitive and efficient all the time. These user-friendly tools provide at-a-glance status updates and alerts to managers whether in the control room, at head office, or on the shop floor.

All of these changes, if correctly integrated, will result in unprecedented gains in terms of cost, efficiency and productivity.

Further considerations to bear in mind

As new operational and technological scenarios begin to shape strategy and enable factories to meet new customer centric needs for new models, more variants, other organizational requirements and impacts will open up. These must be borne in mind to maintain efficiency and support business direction:

CIO Governance:

CIOs will require new governance models and support structures in order to maintain effective information flow, technological support and product development processes. New supply chain and production models – depending on efficient resource use, collaborative working, and strong global IT governance and compliance.

Information security:

Manufacturing faces often distributed shop floor IT architectures with high requirements on availability and integrity and with a runtime of up to 20 years and 24/7 environment where service slots for patches are not possible. Companies have to ensure connection of the industrial controls network (ICS) to the internet with appropriate protection mechanisms and prevent the misuse of office IT to get access to the ICS network.

In future we will see increasing security requirements through relocation of shop floor control activities in the cloud and machine-to-machine communication. Internal attackers or external attacks that can penetrate to the ICS network, can induce damage to the production facilities.

Consequently, safety and security cannot simply be broken down into functional components but should instead be approached as a process with proactive behavior with sufficient monitoring of risk indicators.

Compliance:

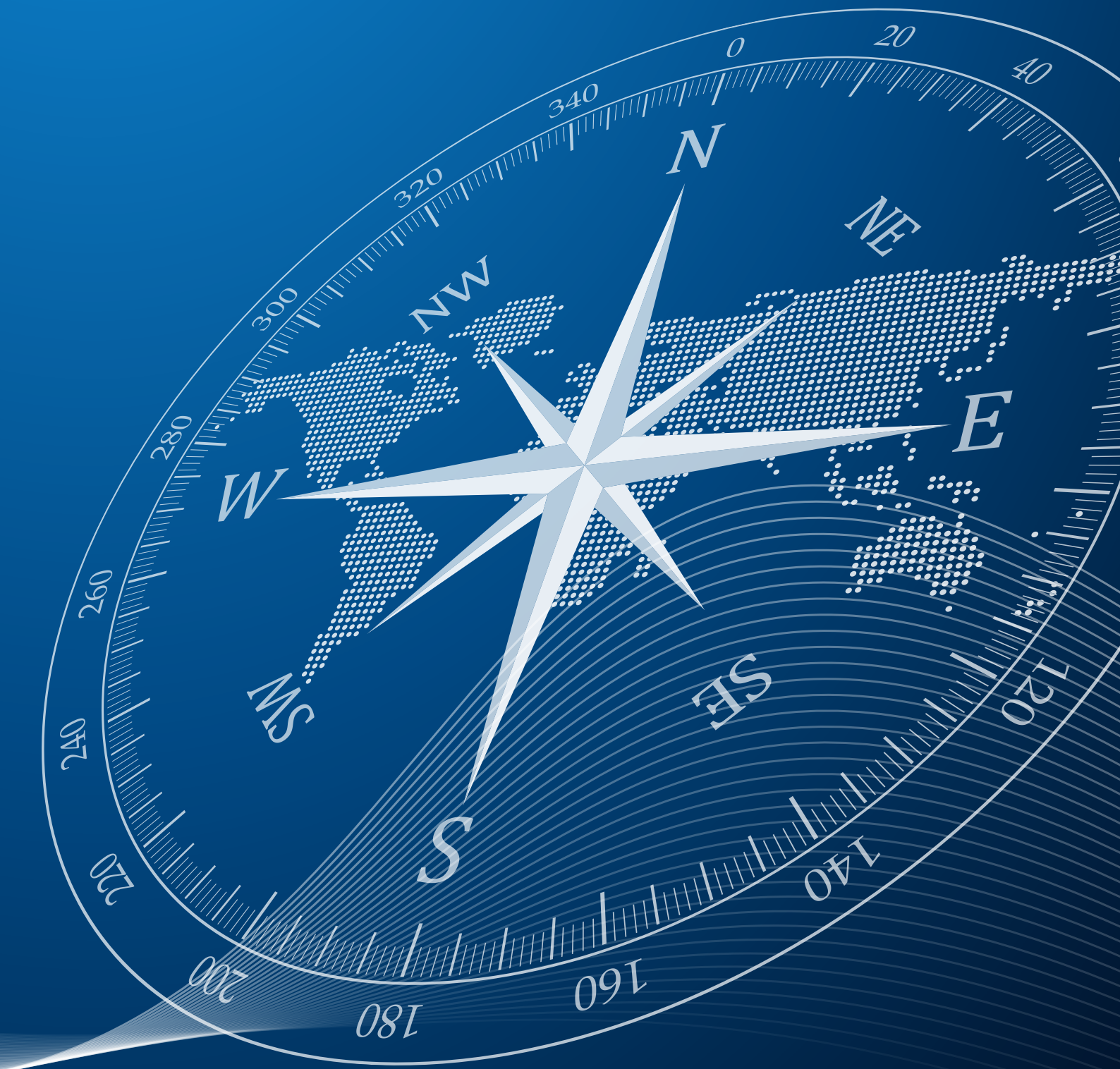
National and international compliance must be navigated as data is moved between sites in different territories with different regulatory frameworks – without slowing down the business or impeding operational effectiveness.

Sustainability:

Sustainability is becoming key to the manufacturing agenda – and will be on the top 5 topics on the agenda of 60% of CEOs by 2015. Linking environmental and operational excellence means aligning with international responsibility charters, to develop innovative and sustainable solutions. Factors such as fabrication directly to the end customer, new sustainable materials and products and a move away from 'planned obsolescence' towards built-in re-use, re-manufacturing and recycling will all contribute to a more sustainable and effective manufacturing business

Workers' roles:

The future of manufacturing is people-centric and this has never been more critical to success. For the first time in history, we have 4 generations of workers working together, with very different education, styles and aspirations. Some roles may disappear or fundamentally change, but skills and knowledge will intensify in importance. Automation, faster decision-making and rapid production will mean that all workers must become, and remain, expert workers. In this context, supporting a new people scenario and realigning roles will be more fundamental than ever. Considerable organizational and cultural work will be needed to engage and motivate traditional workers by aligning traditional expertise with the needs of the changing production environment, and attract younger employees used to a more open collaborative way of working.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Developing a roadmap for change

Organizations face so many opportunities and challenges that often, identifying where and how to begin is the biggest obstacle. The answer is clear roadmapping of the journey, from where they are now to where they need to be. This is vital if successful transformation is to be achieved. Key steps include:

1 Begin with a clear transformational goal

The starting point of the journey must be to decide what the destination is. Beyond the new requirements that are already visible (the need to become more customer-centric, and to accelerate time to market, for example), manufacturers must also cater for the many unknowns. Customers' priorities can change overnight, and it only takes a surprise move from a new entrant to disrupt a whole market. It is crucial then that manufacturers build adaptability into their technology strategy and wider planning for factory and production evolution. This makes consultancy and analysis of ambitions a crucial part of the first step.

2 Prioritize cultural & organizational issues

Connecting machines, applications and products only works if people and the organization are also connected. Organizational fluidity and dynamism will need to be central objectives of any initiative. This means considering the people elements first – for example, how the company will motivate managers and employees to think beyond their current roles. Once the workforce is on board, the company can begin to look at how it will align processes and IT systems to support its employees in new ways of working – and work out the complicated ways in which IT changes will affect other systems.

3 Make innovation a central process

To compete, factory ecosystems must play an active part in innovation rather than being involved only in the execution phase. This will involve putting in place the people and processes to involve plants with the wider business and encourage and discover new ideas.

4 Overcome silos

Many companies (and their factory ecosystems) have operational, technological and organizational barriers in place. These are less suitable for today's faster, more dynamic and complex manufacturing environment. Manufacturers should look to adopt ways of working that avoid boundaries of hierarchy, functions and roles – and drive collaboration, communication, and information sharing everywhere.

5 Transform in the medium term

Don't look too far ahead; instead, aim for a transformation over the next 3-5 years. Following development of the vision, manufacturers can start planning pilots, beginning with concrete steps such as improvements to PLM and MES capabilities.

6 Act holistically

Manufacturers will have to manage their network of production facilities as a unique virtual factory that consolidates the number of different manufacturing plants in terms of resources, processes, and products. They will also have to gain greater level of real time visibility across the global network of operations and more centrally managed supervision and coordination of execution activities.

7 Offload complexity

Remote hosting of technology platforms could help achieve centralized visibility, and provide the scalability needed to cope with data from multiple plants and areas of operation. Factories also need good filtering and reporting tools to drive relevant and timely intelligence back out to local planners and operators. Specialist cloud-based services may be a practical option for large-scale data processing and analytics, while managed business process services could help companies take advantage of new revenue models based around connected products.

8 Keep refining the strategy

Once the building blocks are in place, the priority should be to create a defined, clear vision and strategy to aim for; the steps you take towards this horizon can be evolved, as new opportunities and challenge emerge. This means continuous reassessment of tactical responses towards a clear goal, and looking outwards to see how other manufacturers and other industries are adapting and innovating.

Conclusion

The speed of change occurring in the factory ecosystem is unprecedented. In this environment, where the 'future is happening now', the only safe strategy is to be ready for anything. In this new manufacturing revolution the customer is in the driving seat, steering the direction manufacturers must go through their demands. Manufacturers will have to constantly deliver customers higher-level ambitions, while driving even more organizational efficiency and productivity benefits.

Effective factory managers will be those capable of rapidly adapting and scaling their activities, assets and infrastructures to exploit evolution in technology and become more responsive to changing global markets, and closer to customers.

The four IT pillars – cloud computing, social business, mobility, and Big Data analytics – are emerging as viable technology enablers for more flexibility and speed on the plant floor. Accelerated flexibility at a plant level will depend on smarter, real-time intelligence and data capture at every stage and level of the factory and production cycle.

The global plant floor – where personalized, made-to-individual products and services can be designed anywhere, produced anywhere, and sold anywhere – is emerging as the operations model that will allow companies to fulfill customer-specific requirements from multiple emerging and global markets. To run their global plant floor effectively, manufacturers will operate a network of specialized production facilities that blend into a single virtual plant. Centralized coordination will be based on real-time.

On the technical side, innovation will continue to raise new standards. We are now at the start of new revolutions, in biotechnology, 3D printing, robotics, nanotechnology and artificial intelligence. They will continue to transform our lives – as well as the factory ecosystem.

The greater long-term benefit will be the ability to run autonomic or self-healing processes. When the Internet of assets reaches maturity, the interconnected devices of the global plant floor will be able to react autonomously to a broad range of events. They will request each other to perform actions to avoid the bottlenecks of plant operators who would be otherwise overwhelmed by the necessity to quickly make thousands of decisions to maintain system performance.

Alongside this, the manufacturing sector will have to attract younger skilled workers, realign roles and create an inspiring environment for each generation of workers. Smart assistance systems release workers from having to perform routine tasks, enabling them to focus on creative, value-added activities. In view of the impending shortage of skilled workers, this will allow older workers to extend their working lives and remain productive for longer.

The smart factories that are already beginning to appear employ a completely new approach to production. Smart products are uniquely identifiable, may be located at all times and know their own history, current status and alternative routes to achieving their target state. The embedded manufacturing systems are vertically networked with business processes within factories and enterprises and horizontally connected to dispersed value networks that can be managed in real time – from the moment an order is placed right through to outbound logistics.

This increasingly interconnected, autonomous and adaptable smart factory can then take the next step – to become the truly intelligent, connected next-generation factory that all thriving manufacturers will rely upon, and drive competitive advantage through, in the near future.

About Atos

Atos SE (Societas Europaea) is an international information technology services company with 2013 annual revenue of €8.6 billion and 76,300 employees in 52 countries. Serving a global client base, it delivers IT services in 3 domains, Consulting & Technology Services, Systems Integration and Managed Services & BPO, and transactional services through Worldline. With its deep technology expertise and industry knowledge, it works with clients across the following market sectors: Manufacturing, Retail & Services; Public sector, Healthcare & Transports; Financial Services; Telco, Media & Utilities.

Atos is focused on business technology that powers progress and helps organizations to create their firm of the future. It is the Worldwide Information Technology Partner for the Olympic & Paralympic Games and is quoted on the NYSE Euronext Paris market. Atos operates under the brands Atos, Atos Consulting & Technology Services, Worldline and Atos Worldgrid.

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