European Commission

Digital Transformation Monitor

Industry 4.0 in Aeronautics: IoT applications

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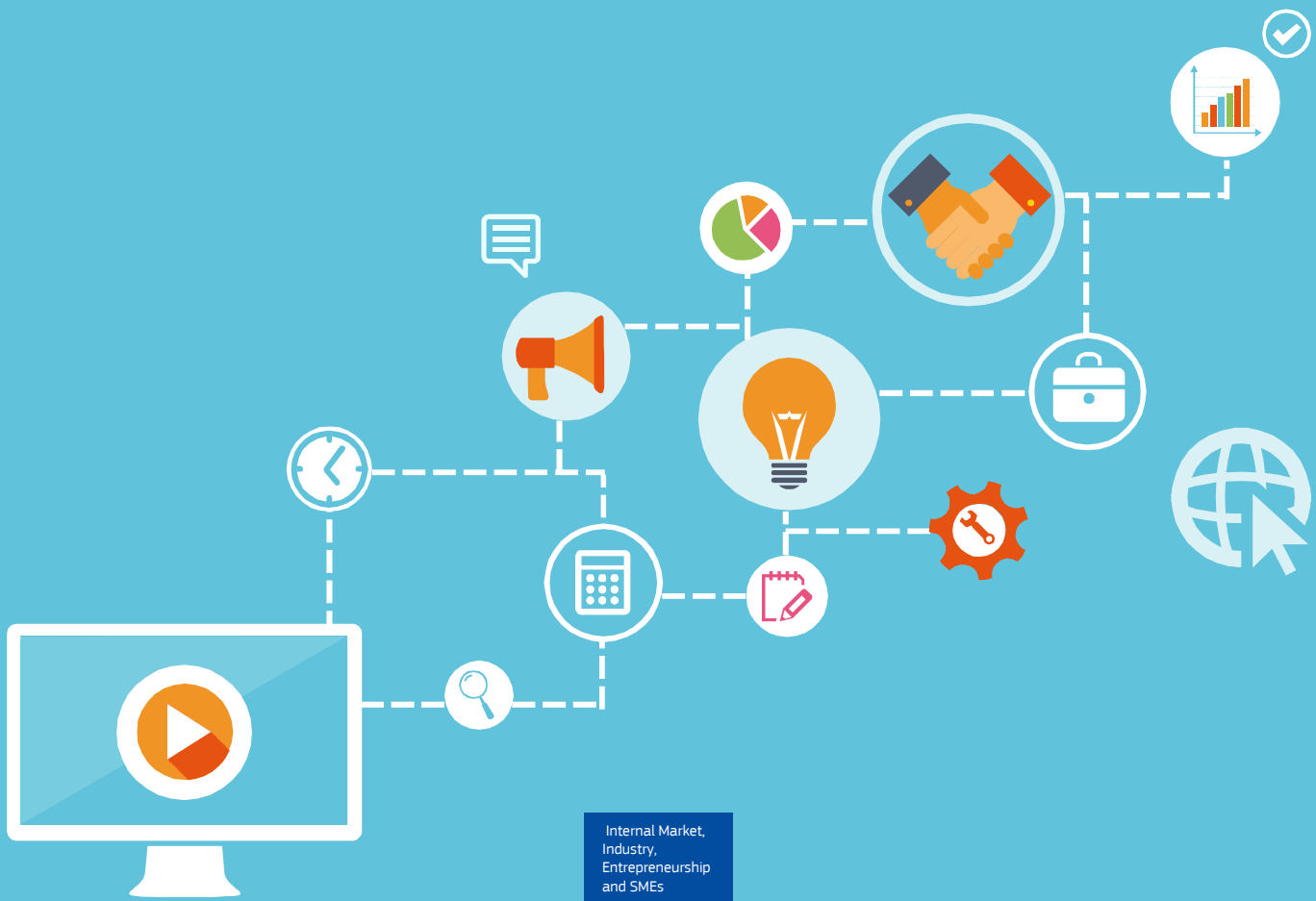

Internal Market, Industry, Entrepreneurship and SMEs

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Industry 4.0 in Aeronautics: IoT applications

The deployment of connected objects is transforming the aeronautics industry. This affects the manufacturing process with new tools and services that generate a drop in production costs. It also enables the development of new business models centered on a service approach. The European industry has to invest both in technology and skills to sustain its position in a global market.

1

A radical transformation

The Internet of Things is a key enabler of the Industry 4.0 trend. The digital transformation of the industry will bring radical transformation to manufacturing processes and to product and services offerings.

The Industry 4.0 revolution

The 'Industry 4.0' trend is seen as a transforming force that will modify not only production infrastructures, but also the development of products and services and even the customer relationship.

The trend is building on an array of digital technologies: the Internet of Things, Big Data, Artificial Intelligence, and of digital practices: cooperation, mobility, open innovation.

IoT as a key enabler of the smart factory

The "Smart Factory" is a key element of the Industry 4.0 trend. It brings promises of lower production costs and increased efficiency.

New tools for manufacturing

A part of the "Smart Factory" development is the introduction of new technologies, bringing new opportunities in manufacturing.

This is the case of increased use of automation and robotics, or the use of new tools such as augmented reality or 3D printing.

These new technologies are especially suited to responding to the demands for precision manufacturing of the aerospace domain. They also help to strengthen the respect of safety regulations of the domain.

Connected objects as a cornerstone of the transformation

However, beyond these new tools, the major transformation brought by the "Smart Factory" movement lies in the increased connection and integration of different ICT-enabled components in a single networked system.

This will enable a significant increase in manufacturing efficiency through the analysis of production data. It will also lower production costs through increased flexibility and digital integration in the supply chain.

The aerospace industry, relying on a large network of suppliers will highly benefit from this increase in flexibility.

Connected products and new services

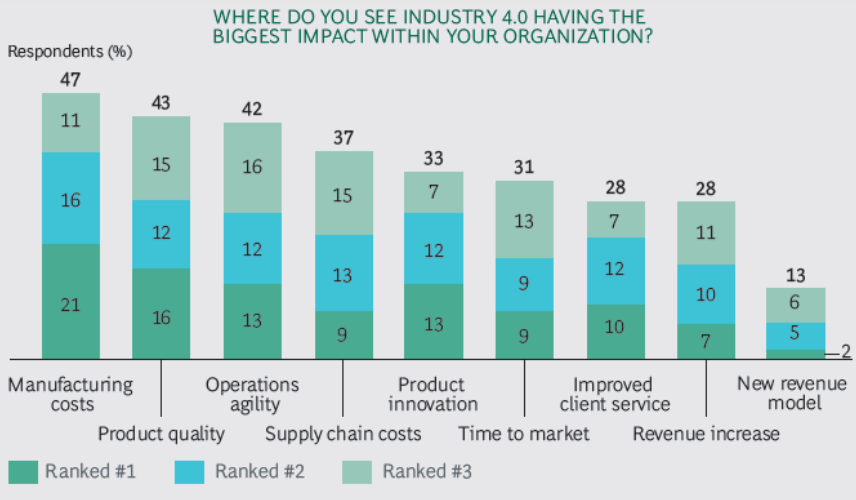
The development of the Industry 4.0 also implies the development of connected products, which will transform business models and bring new revenue opportunity.

This applies to manufacturing tools but can also apply to components of the aircraft in itself, increasingly considered as a cyber physical system.

The various parts of an aircraft, from the engines to the hull and the cabin are now fitted with electronics and sensors able to monitor in real time the behaviour of the plane. They also enable to remotely and effortlessly check for potential issues and maintenance needs.

Adding connectivity to these enables the emergence of new services through the connectivity itself (remote control and monitoring applications) or through the data generated by the devices.

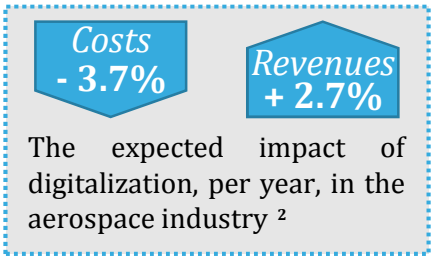
Figure 1: Promises of Industry 4.0[1]



Source: BCG's 2016 Value from Industry 4.0 survey.
Note: Because of rounding, not all numbers add up to the totals shown.

Source: BCG

These new services are expected to bring additional revenue opportunities to the industry.



The expected impact of digitalization, per year, in the aerospace industry [2]

2

Opportunities opened up by IoT solutions

The connected factory

The use of IoT technologies in aeronautics manufacturing provides increased labour efficiency by providing contextual information to human workers. Increased connectivity also enables tighter integration of the value chain

Precision manufacturing

Developing an airplane is a complex process and involves several thousands of steps which operators must follow, with many checks in place to ensure quality.

Contrary to other industries, such as the automotive industry, the use of automation and robotics is low. Most of the assembly process of an aircraft, as well as a significant part of manufacturing of the component is done by human workers.

The key toward "Smart Factory" in the Aeronautics manufacturing is thus in supporting human workers with digital enhanced tools that increase their productivity.

IoT enhanced tools

By connecting the worker and their tools to an IoT platform, manufacturing accelerates as critical information flows seamlessly across the assembly line.

Airbus[3] is applying the Internet of Things technology not only to its products, but also to the tools its employees use in the manufacturing process.

Hence, an Airbus employee on the factory floor who can use a tablet or smart glasses to scan an airplane's metal skin can determine what size bolt is needed in a given hole, and the rotation force necessary to install it. That information can be spontaneously sent to a robotic tool, which completes the task

The smart factory (internally called 'Factory of the Future') aims to streamline many thousands of steps in the assembly of an airplane – it involves up to 400,000 bolts and screws alone, using 1,100 different tools. The main interest is that with those tools being connected, the process is much quicker and it is even more reliable than if the bolts were being tightened manually.

Location tracking

Another major challenge of the smart factory is to deploy technologies able to keep track of manufacturing equipment locations in real time with precision and across the factory floor and value chain.

The challenge is not only to identify where every tool is on the factory floor but also to keep track of operator usage data and behaviour.

This enables increased operator safety and production security (by validating that only authorized and trained employees are using specific equipment).

There are tight regulations regarding aircraft construction, requiring constant oversight and regular audits and quality checks.

The use of automated tracking technologies can help reduce the burden of regulation compliance and significantly speed up the manufacturing process while increasing quality.

Additionally, one objective is also eventually to identify optimization opportunities in workflows by applying data analytics to the location data.

The Industrial Internet Consortium (IIC)[4] recently launched the setup of a joint industrial test bed gathering Bosch, Tech Mahindra, Cisco and National Instruments. Aircraft construction is a prime target for such technologies.

New services transforming the industry

The integration of IoT into the aeronautics industry will provide considerable benefits as new services enable optimization of airline operations and asset management.

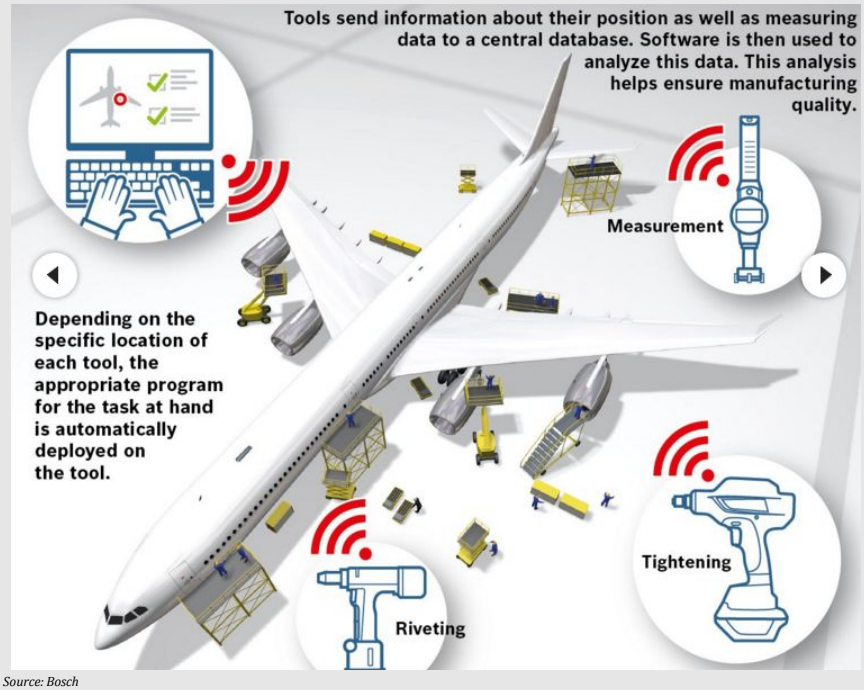
The new services target the main point of the industry, from maintenance and fuel cost to optimization of traffic.

Preventive maintenance

The development of preventive maintenance services will help reduce aircraft downtime and increase the safety of the industry.

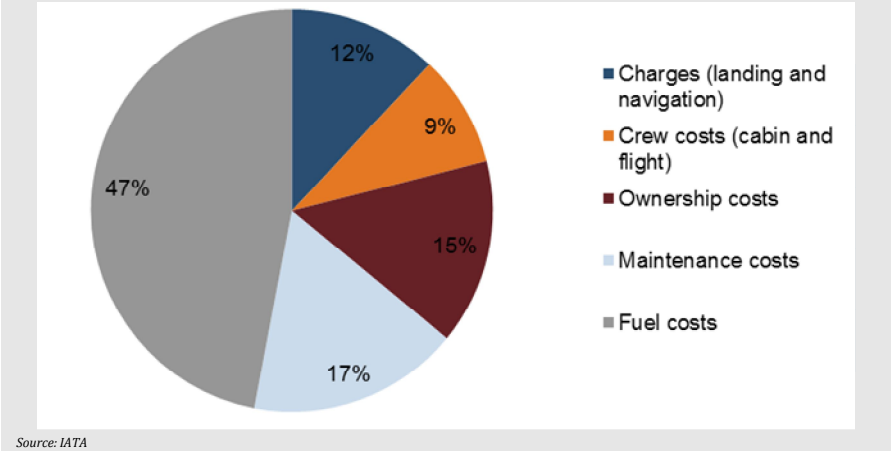
Aircraft on ground (AOG) time is a critical cost factor for the airline industry. It can cause major disruption and damage an airline's reputation.

Figure 2: Tracking tools on the assembly line



Source: Bosch

Figure 3: Direct costs of an airline company



Source: IATA

Large numbers of sensors are now deployed in the aircraft. They monitor in real time critical performance parameters and thanks to the IoT, the data can be transmitted in near real time. It helps ground staff to analyse the data rapidly, detect any issue and quickly take corrective action. Overall it reduces both the time and the cost of maintenance.

$1,250,000 each day
Cost of a grounded A380 Airbus [5]

Increased fuel efficiency

Applied to engine performance, data analytics and predictive maintenance can result in important gains in fuel efficiency.

Pratt & Whitney's Geared Turbo Fan engine is equipped with more than 5000 sensors that constantly monitor key indicators and enable a precise modelling of the engine behaviour.

Data analytics enable the real time prediction of fuel demand in order to adjust thrust levels.

This results in 10-15%[6] reduced fuel consumption as well as environmental benefits through reduced emissions and engine noise.

Optimization services

Connected objects enable the development of entirely new lines of services dedicated to using the data collected to optimize airline operations.

GE Aviation and Accenture have formed a joint venture company called Taleris[7], to provide airlines around the world with intelligent operations services. The objective is to predict, prevent and recover from operational disruptions.

This platform allows GE to provide a new business line, centered on the aircraft fleet optimization service.

3 Impacts on value chains and business models

The transformation of the production processes, and the emergence of new services is having strong impacts on the structuration of the ecosystem. It offers new business models and opportunities for the aeronautics actors. But they imply significant reorganization and evolution of business practices.

Evolution of the value chain

The Internet of Things is leading toward a more flexible and connected value chain, with stronger emphasis on R&D, and service offerings. The ability to provide connections inside the value chain is emerging as a new key role for the ecosystem.

Value shift away from manufacturing

For the aerospace manufacturing industry value is shifting as a result of the flexibility and efficiency gains offered by smart factory technologies.

Developments in the smart factory are leading to gains in production costs as defects are eliminated and automation reduces the human-resource intensity of production tasks.

Value is thus shifting toward research and development and design tasks, on the one hand, and to after-sales services on the other.

These shifts are impacting players, enabling the development of smaller-scale units focusing on design and engineering of products on the one hand, and the emergence of platforms and ecosystems on the other hand.

New roles on data exchanges

The Industy 4.0 trend relies to a significant extent on the increasing integration of IoT data and IT systems between the actors of the value chain. This opens up a position for actors focusing on data exchange and analysis platforms.

The aeronautics industry relies already on a complex network of suppliers focusing on specific technologies. But the development of the IoT and Industry 4.0 is requiring stronger integration of their IT infrastructure.

Data exchange and interoperability between manufacturing systems is one of the key challenges and a new position in the value chain open for those providing it. The control they achieve on data access can in turn enable them to provide key optimization services for the industry.

Products as a Service business model

The development of connected products is enabling the transformation of the business model into a service offering. Key parts of the airplane are no longer owned by the airlines but rather rented as a Service.

The first step in the movement toward servitization is often to try to bundle additional services with existing products. Producers can thus count on recurring revenues, while the consumer only pays for its actual usage of the product.

Rolls Royce motors[8] "power by the hour" business model and "Total Care" service are well representative of a transition toward "product as a service" offering with service revenues four times superior to original product cost.

The data gathered from the motors has enabled Rolls Royce to take engagement[9] on fuel consumption reduction with airlines, generating new service revenue opportunities[10].

These reductions can create a significant economic sector. According to GE[11], each reduction of 1% in fuel consumption by Airlines would amount to an economy of 30 billion USD over 15 years.

This also implies additional evolutions in the business relationships. It increases the role of customer relationship, shifts a one off CAPEX investment into OPEX costs and enables continuous improvements and support.

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4 Challenges

To take advantage of the digital transformation, actors have to rapidly adapt their organization to new practices and develop new skills.

Accordingly, companies need to invest consequently in new technologies but also need to consider several critical questions about the adaptation of their organization to this phenomenal change.,

New skills and organization required

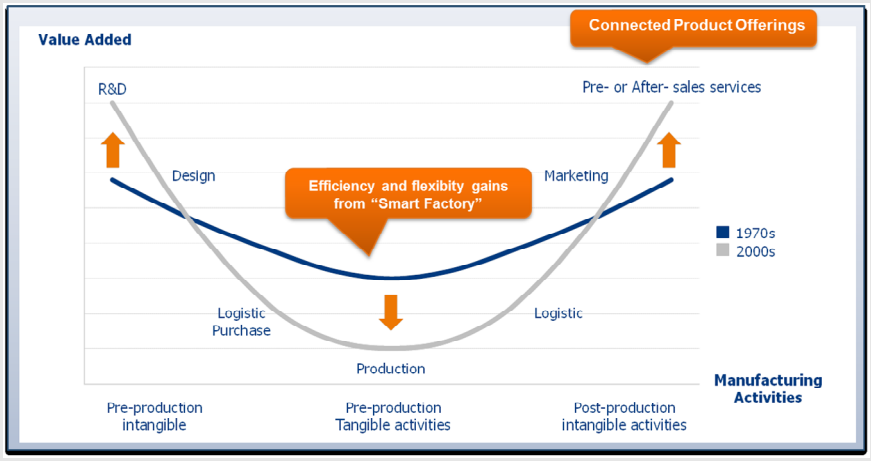
To support their transformation, the aerospace industry companies need to rapidly develop the qualifications of their employees in software and data sciences.

The lack of qualified employees is named as Number One concern, in a 2016 survey of BCG of the manufacturing industry[12].

They also need to consider evolutions toward services in their business models, and how it will impact their organization. More focus on customer care, the set-up of new service offerings, continuous improvements and lasting relationships.

Finally to fully take advantage of the transformation, the industry needs to develop mechanisms ensuring that every actor in the supply chain, including SMEs, are integrated in the process.

Figure 5: Distribution of the value added, by manufacturing activity[11]



Source: Ambrosetti, Bruegel and OECD

Investing to sustain productivity

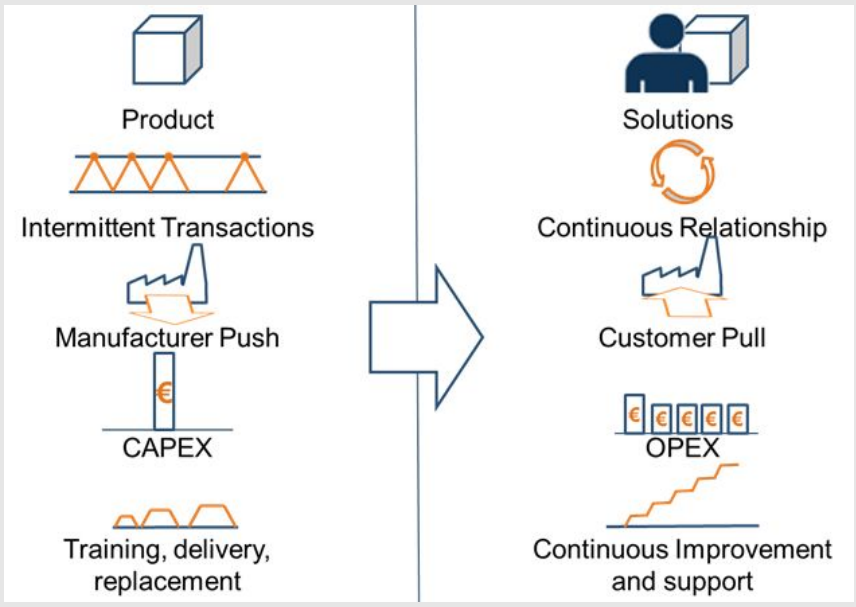
The potential benefits of connected objects and industry 4.0 are well understood by the industry leaders.

However, the capacity to invest in time in new technologies and adapt to changing production needs remain critical in order for the European industry to remain competitive in a globalized economy. A voluntary approach is needed.

There is a high aversion to risk and a global attitude of caution in regard to ICT technologies in the industry. They are often considered as potential hazards in terms of security and with high upfront costs and deployment times.

Supporting, initiatives that promote both investment in technology but also changes in business practices can have an important structuring role.

Figure 6 : Effects of servitization on customer relationships[13]



Source: IDATE DigiWorld, The Industrial Internet, May 2017

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About the Digital Transformation Monitor

The Digital Transformation Monitor aims to foster the knowledge base on the state of play and evolution of digital transformation in Europe. The site provides a monitoring mechanism to examine key trends in digital transformation. It offers a unique insight into statistics and initiatives to support digital transformation, as well as reports on key industrial and technological opportunities, challenges and policy initiatives related to digital transformation.

Web page: https://ec.europa.eu/growth/tools-databases/dem/

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