ANALYSIS OF THE OPPORTUNITIES OF INDUSTRY 4.0 IN THE AERONAUTICAL SECTOR

10th International Multi-Conference on Complexity, Informatics and Cybernetics: IMCIC 2019©
March 12TH–15TH 2019, Orlando, Florida, USA

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To cite this work:
Ines Guyon, Rachid Amine, Simon Tamayo, Frédéric Fontane. Analysis of the opportunities of industry 4.0 in the aeronautical sector. 10th International Multi-Conference on Complexity, Informatics and Cybernetics: IMCIC 2019, Mar 2019, Orlando, United States. hal-02063948

ABSTRACT

Introduced for the first time in Germany in 2011, **Industry 4.0 is a concept based on the fusion between the digital and physical worlds**, offering potential advantages in terms of flexibility, productivity, decreased expenses and improvement in quality. At the same time, the **aeronautics industry**, which has been making significant commercial progress in recent years, is perceived as a **sector structured by innumerable regulations with strong hierarchization of sub-contractors at all levels**. This hierarchization influences the economic dependence of these actors on their instructors, and these differences and difficulties represent an obstacle to the successful integration of digitalization in the aeronautical chain of production. **This article presents an overview of the challenges of Industry 4.0 alongside those of the aeronautical sector, proposing a critical analysis of the opportunities** offered by the former to the latter. Our work discusses the Fourth Industrial Revolution, a disruption based on the most important innovations of recent years, which will have a huge impact on the world we know today. It sheds light on the structure of the aeronautical sector and **the importance of the "ClockSpeed" factor**, due to the amount of technologies with different regeneration rates on board aircrafts. Finally, **our analysis highlights the limits of Industry 4.0 and why it is relevant to apply it to aeronautics**.

KEY TECHNOLOGICAL FEATURES OF INDUSTRY 4.0

- **Big Data and analytics:** decision-making in real time taking into account more data sources.
- **Autonomous robots:** more flexible, communicative and cooperative automated systems.
- **Simulation:** virtually model and optimize physical environments.
- **Cyber security:** protect interconnected systems.
- **Cloud computing:** enable flexible networks.
- **Industrial internet of things:** decentralize decision making and enable real-time traceability.
- **Horizontal and vertical integration:** develop cohesion between internal and external partners.
- **Additive manufacturing:** produce personalized, complex and light products.
- **Augmented Reality:** superimpose real and simulated objects, improving creation, manufacture and reparation procedures.

CONTEXT OF THE AERONAUTICAL INDUSTRY

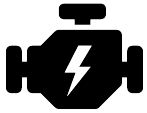
- Low **volumes**.
- **High-value** parts.
- **Complex** products (BOMs with thousands of components).
- **Supply chain** oriented by few **specific actors** leading to high dependency.
- **Low** levels of **automation**.
- **Costly human labor**.
- Long life span of products leading to **slow renewal of catalogues**.
- Significant **requirements in standards and security regulations**.

CHALLENGES OF THE AERONAUTICAL INDUSTRY

- **Reduce production costs**, while continuing to meet specific client needs in order to stay ahead of the competition.
- **Manufacture reliable, quality products** to achieve Zero Defect, minimize risks and meet the standards enforced by controllers represented by the EASA (European Aviation Safety Agency) and the FAA (Federal Aviation Administration).
- **Increase the pace of production** to meet the growing demands of airlines.
- **Manage the increasing complexity** of programs due to the increase in number of different integrated systems and the introduction of new elements (composite materials, additive manufacturing…) that also impact production costs.

SUPPLY CHAIN OF AERONAUTICS: A VERTICAL AND UNBALANCED NETWORK

Original Equipment Manufacturers



System / parts supplier
First-tier subcontractors

Specialized subcontractors
Second-tier subcontractors

Capacity subcontractors
Third and fourth-tier subcontractors

- 70% of companies in the industry run with under 250 employees.
- Smaller players are also largely economically dependent (lack of power balance between first-tier players and those below).
- Significant economic gap between different players.
- Subcontractors develop production in low-cost countries rather than focusing on digitalization or technological improvements.

CLOCKSPEED FACTOR: A BARRIER TO INDUSTRY 4.0

- The aeronautical industry is characterized by a high average lifespan of products
  - An airliner has an average life span of 30 years, so manufacturers produce aircrafts adapted to the evolution of the market while guaranteeing a constant standard of service and security throughout this time.
- An aircraft is made up of different modules with varying regeneration rates, known as Clockspeed[1], which defines the regeneration frequency (significant evolution, shortage) of a certain technology. In aeronautics, this factor can vary significantly:
  - For example, the **technological evolution of engines is very slow** (low ClockSpeed), whereas **semiconductor technologies are known to have short life spans** (fast ClockSpeed).

This desynchronization between technologies **significantly slows the overall increase in rate of production**, **limiting the possibility of implementing digitalization programs** throughout the aeronautical chain of production.

[1] C. H. Fine, "Industry clockspeed and competency chain design: an introductory essay,", In Automation in Automotive Industries. Springer 1999, pp. 6–10.

EXAMPLES OF INDUSTRY 4.0 IN THE AERONAUTIC INDUSTRY

- Big Data and analytics
  - BoostAerospace project (Airbus + primary first-tier suppliers) in which Supply Chain, Projects and PLM data were shared between 1 500 industrial and 11 000 identified users.
- Augmented reality
  - Airbus, alongside Accenture, won “Best Mobile Service or Solution for Enterprise[2]” for its wearable technology based on smart glasses for improving production and maintenance.
- Additive manufacturing
  - In 2018, STELIA presented a 1sq. meter fuselage demonstrator with 3D technology a small 3D printing revolution on a surface of this scale.
- Industrial internet of things
  - Airbus and Texas Instruments developed a set of smart tools which ensure drilling, fastening and the recording of measured data[3].

[2] Awarded in the Mobile World Congress, Barcelona, 2017.
[3] Industrial Internet Consortium & National Instruments, “Developing Smart Tools for the Airbus Factory of the Future,” Needham, USA, 2015.

LIMITS OF AERONAUTICS 4.0

- Digitalization must meet specific problems on a case-by-case basis
  - Digital integration in aeronautics is complex, as a result Industry 4.0 in the aeronautical sector is at its very beginnings.

- Cyber-security must be assured
  - The strategic position of the aeronautical industry in the major western economies make it a target for these types of attacks.

- Laws, standards and security regulations
  - Any changes in the production process means total compliance of the enforced regulations. The cumbersome nature of these regulations makes it difficult to change processes and results in a significantly challenging transition into an “all-digital” aerospace industry.

CONCLUSIONS

- The rise of Industry 4.0 requires greater flexibility and collaboration among its players in order to develop an agile reaction to its global vision.
- The aeronautical sector has its own specific characteristics, that entail a rather low level of automation due to low production volumes and significant hierarchal gaps between actors.
- Although subcontractors in higher tiers are supported directly by the top-management, this is rarely the case for those in lower tiers, who are economically dependent on the sector and rarely have investment potential, slowing down the implementation of digitalization within their own production systems.
- The desynchronization between on-board technologies with Clockspeed and strict security regulations create further obstacles in the aeronautical sector, blocking the path toward total integration of digitalization all along the chain of production.
- When the opportunities of Industry 4.0 are weighed up against its limits, it is clear that the integration of these new technologies is relevant. But this should be done on a case-by-case basis, taking care to disassociate the needs while ensuring compliance of all regulations without impacting the rate of production, and most importantly while ensuring flawless cyber-security.

THANK YOU VERY MUCH

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