

CASE STUDY: DIGITAL FACTORY STRATEGIES AT F3

ENGINEERING

BACKGROUND

F3 Engineering, a leading aerospace manufacturer, specializes in the production of commercial aircraft components. As the aerospace industry grew more competitive, the company faces mounting pressure to increase efficiency, reduce lead times, and meet stringent quality standards while managing complex supply chains. Accomplishing this with the tight skilled labor market requires a focused approach. To maintain its market leadership and address these challenges, F3 embarked on a **Digital Factory Transformation** initiative in 2021.

The aerospace sector, known for its precision and safety-critical requirements, presents unique challenges for manufacturers. F3's primary goal was to create a more agile, efficient, and data-driven production environment to keep up with rapid technological advancements and evolving customer expectations.

The production lot sizes also present a significant challenge, as needs can range from 1 pc to 100 pc orders. The setup times to manufacture, assemble, and test the components are a significant cost factor that typically amortization methods drive costs up.

OBJECTIVES

THE OBJECTIVES OF F3'S DIGITAL FACTORY TRANSFORMATION WERE:

- 1. REDUCE PRODUCTION LEAD TIMES:** Improve production efficiency to reduce the time it takes to manufacture aerospace components.
- 2. ENHANCE PRODUCT QUALITY AND TRACEABILITY:** Implement advanced monitoring systems to ensure that every component meets the rigorous safety and quality standards required in aerospace manufacturing.
- 3. INCREASE AGILITY AND CUSTOMIZATION:** Adapt production lines quickly to meet different customer needs and design specifications.
- 4. SUSTAINABILITY AND WASTE REDUCTION:** Minimize resource usage and waste through optimized production processes.
- 5. SUPPLY CHAIN INTEGRATION:** Integrate and digitize the supply chain to improve supplier collaboration and reduce disruptions.

DIGITAL FACTORY STRATEGY IMPLEMENTATION

F3'S DIGITAL TRANSFORMATION WAS BUILT AROUND SIX KEY TECHNOLOGICAL PILLARS:

1. DIGITAL TECHNOLOGY:

F3 implemented Digital across its production processes as first step. Everyone working on production has access to the small high-fidelity information available at all workstations. F3 invested in transforming its traditional 2d drawings into high-fidelity 3d models that can follow the components through the manufacturing, quality, and assembly stages. While this is a significant investment, the digital basics, as I call them, allow all departments to work using the same information.

The use of digital-enabled F3 to implement process improvements using the great tools that are available in the market.

2. WORK PROCESS IMPROVEMENT FOCUS:

One of the cornerstones of F3's digital strategy was adopting Work Process Improvement Focus. By utilizing the process improvement triangle (Process discovery, Process optimization, and Process implementation), F3 has significantly streamlined its manufacturing floor operations, producing ready-to-ship components in 2/3 of the time it normally takes.

This methodology was particularly beneficial in producing small-batch, customized assemblies for specific aircraft models.

3. MODERNIZE EQUIPMENT

Now, to take full advantage of digital and process improvements, F3 has invested in modern manufacturing systems equipment. Coming out of COVID, manpower shortages are exaggerated. How can output be increased when manpower is constrained? Using the basic technology that has been a multiplier for skilled craftsmen. However, buying a great piece of equipment does not help all that much unless there is technical expertise, training, and BUY in of the employee base,

4. CONTINUOUS TRAINING AND COACHING

The training provides the basics of what is trying to be accomplished. The coaching brings it home. While operators are working, they are asked what they are doing; no stopwatches or time studies. Simply engage with the operators and ask them to repeat what they are doing and to try it another way. Then asking operators to try it their way and time it, informally, then try it a new way and time it. The quality is still there, and the process time drops 20 to 50% in most cases! Yes, there needs to be expertise at each position and put aside ingrained practices to see a different outcome.

5. PREDICTIVE ANALYTICS: TAKE ERP DATA AND INCREASE LOT SIZES

AI-powered analytics tools were integrated into F3’s digital infrastructure to process large amounts of data generated by its past sales and production history. These tools used **machine learning** algorithms to identify trends and optimize production schedules.

“Let AI analyze your historical data. The results may surprise you in a good way. I didn’t realize how many times the customer ordered this part, or I didn’t realize how much time it took to make these items; are these the actual costs of these parts? Yes, many ERP systems claim to do this, but how well do they do all three? Using an AI to analyze may surprise you and change your preconceived notions. Look at the data in new ways and insights may be more meaningful to your production business.”

-Odilo Vazquez

6. DIGITAL SUPPLY CHAIN INTEGRATION

F3’s supply chain was integrated into a digital platform that provided real-time visibility into supplier operations. By sharing data and forecasts with suppliers, the company improved procurement efficiency, reduced material waste, and shortened lead times. The digital supply chain management system allowed F3 to track every component’s lifecycle, from raw material sourcing to the delivery of finished parts, ensuring compliance with stringent aerospace regulations.

CHALLENGES FACED

WHILE F3 EXPERIENCED SIGNIFICANT SUCCESS IN ITS DIGITAL FACTORY TRANSFORMATION, IT ENCOUNTERED SEVERAL CHALLENGES ALONG THE WAY:

1. LEGACY SYSTEM INTEGRATION:

F3 faced difficulties integrating its digital tools with legacy systems. Some older equipment and software were incompatible with newer process improvements, requiring investment in upgrades and additional customization to ensure smooth interoperability.

2. SKILL GAP:

The shift to a digital factory required a workforce skilled in areas like data analytics, AI, and advanced manufacturing technologies. F3 invested heavily in employee training and upskilling to bridge the talent gap, but the transition required time and resources.

3. CYBERSECURITY RISKS:

With the increased reliance on interconnected systems and data exchange, F3 faced heightened cybersecurity risks. Protecting sensitive production data and ensuring the integrity of aerospace designs became a top priority. The company invested in cybersecurity measures, including encryption, intrusion detection systems, and secure data-sharing protocols to mitigate these risks.

OUTCOMES AND RESULTS

F3's digital factory strategy resulted in several key improvements across its operations:

- **REDUCED PRODUCTION LEAD TIMES:** Through the adoption of additive manufacturing and AI-driven production planning, F3 reduced its lead times by 20%. This allowed the company to meet customer demand for rapid customization and delivery.
- **PREDICTIVE ANALYTICS: TAKE ERP DATA AND INCREASE LOT SIZES IMPROVED PRODUCTION QUALITY:** F3's real-time monitoring systems and AI-based quality control algorithms reduced defect rates by 15%, ensuring compliance with strict aerospace standards and enhancing product reliability.
- **INCREASED OPERATIONAL EFFICIENCY:** Use process improvements. **The introduction of predictive maintenance and IoT connectivity improved equipment uptime and reduced unplanned downtime by 25% while also optimizing resource usage.**
- **SUPPLY CHAIN RESILIENCE:** The digital integration of the supply chain allowed for better collaboration with suppliers, reducing material shortages and improving procurement times. This helped F3 maintain production continuity during global supply chain disruptions.

LESSONS LEARNED

F3'S DIGITAL FACTORY JOURNEY PROVIDED VALUABLE LESSONS FOR OTHER AEROSPACE MANUFACTURERS:

1. **INCREMENTAL IMPLEMENTATION MINIMIZES RISK:** Implementing digital technologies in phases, rather than all at once, allowed F3 to manage risks and refine its strategy based on initial results.
2. **INVEST IN WORKFORCE DEVELOPMENT:** Digital transformation requires a highly skilled workforce. Investing in training and continuous development is essential to ensure the success of new digital initiatives.
3. **CYBERSECURITY CANNOT BE OVERLOOKED:** As connectivity increases, so does the risk of cyberattacks. Robust cybersecurity measures must be integrated into the digital factory from the outset.

CONCLUSION

F3 Engineering's digital factory strategy transformed its manufacturing operations, making the company more agile, efficient, and responsive to customer needs. By embracing advanced technologies such as additive manufacturing, digital, and AI, F3 significantly improved its production capabilities while maintaining the high safety and quality standards required in the aerospace industry. This case study underscores the importance of a well-planned digital transformation strategy for aerospace manufacturers looking to stay competitive in a rapidly evolving market.