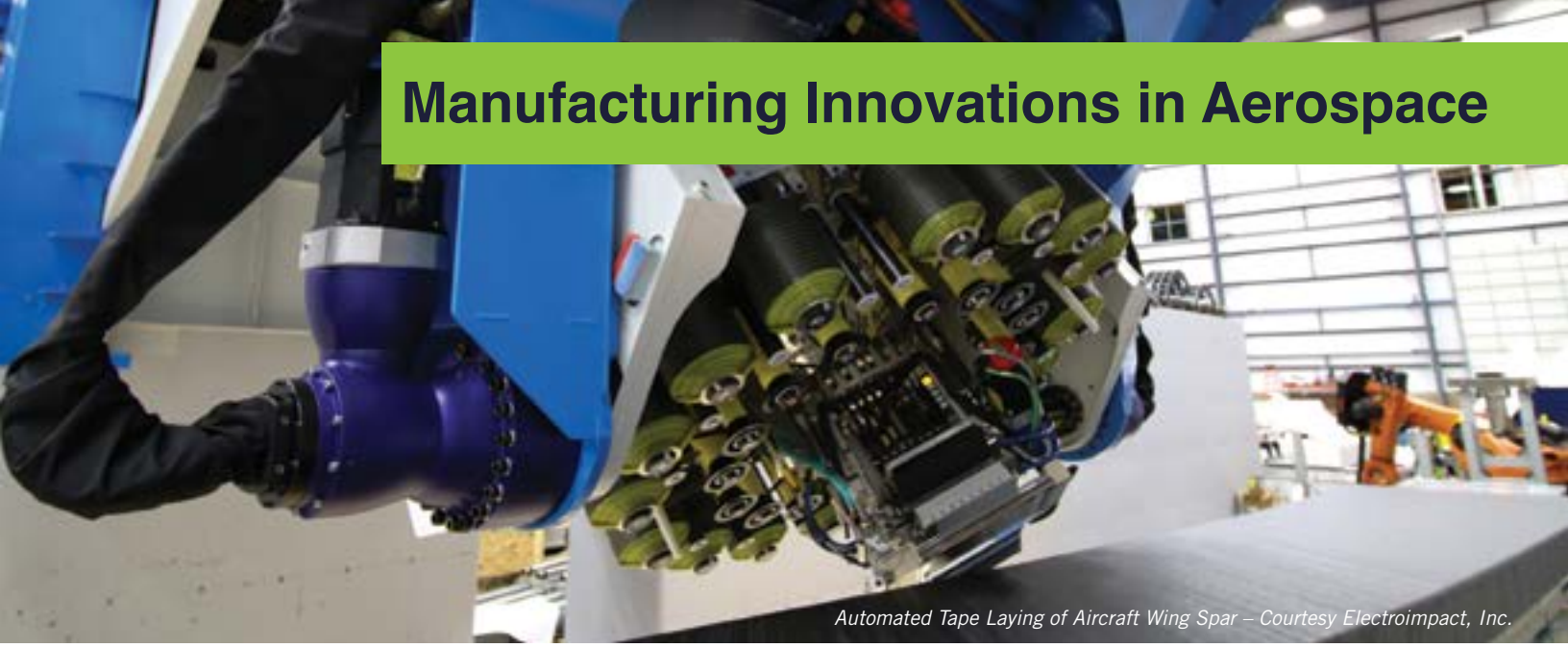
Manufacturing Innovations in Aerospace



Automated Tape Laying of Aircraft Wing Spar – Courtesy Electroimpact, Inc.

It was not long ago that the primary focus in aerospace system design was performance – achieve the best performance with the best material using the best manufacturing method. Commercial and defense aviation are now very focused on cost reduction and manufacturing efficiency. Some performance can be sacrificed if the cost can be reduced.

This cost-benefit evaluation will be increasingly enabled by technology that computes, predicts, and validates performance with the aid of virtual simulations (computer enabled, such as performing finite element-based simulations of structural tests). Key technologies at the forefront of manufacturing costs will also be highlighted.

Additive Manufacturing

There is a lot of attention on additive manufacturing in the aerospace industry today. Additive manufacturing covers the manufacturing methods that can create a part from a material with little waste. The first real use of additive manufacturing was in aerospace where engineers laid-up fiber-reinforced laminated structural parts in the 1960s.

Traditional manufacturing with metals includes machining, casting, forging, and molding which can produce waste, require significant energy, and often needs expensive tooling. Additive manufacturing methods can create metal and plastic parts without tooling by either directly depositing or fusing the material just where it is needed. When parts and assemblies are designed taking advantage of the unique capabilities of additive manufacturing, companies can produce systems that can reduce weight, improve performance, reduce costs, and significantly streamline their supply chains.

The aeroengine industry is taking a leadership role in applying additive manufacturing to their systems and are showing dramatic business benefits from the use of this technology. However, much remains to be done in establishing thorough and rigorous pathways for certification and ensuring repeatability and part performance over the service lifetime. These are research topics currently being discussed and pursued by some academic institutions.

Automation

Additive manufacturing is an automated process but there are other automation methods that are making an impact in the aerospace market. Composites make up a significant percentage of modern airplane systems and the manufacturing of these structures is done largely with automated fiber placement (AFP) and automated tape laying (ATL) systems. These replace the hand lay-up methods that were used in the past to create laminated composite structures.

Automated systems for joining, fastening, and assembly operations are also becoming more mainstream. The aerospace industry is learning from the automotive industry about using more robots and mechanical systems to automate the manufacturing process. This not only improves efficiency but can have benefits on quality by making the process more repeatable and robust.

Again, certification of AFP and ATL structural components, understanding the manufacturing "signature" of the AFP and ATL methods which are process and machine specific will require much research to be done in the future. Combining advances in vision-based automation and the accuracy and repeatability of production via AFP and ATL methods, leads to several new areas for innovation in manufacturing of large aerostructures.

Digitalization

An emerging trend is the digitalization of the design, manufacturing, and operation of systems. The idea is that digital design feeds the manufacturing system, the manufacturing system records all steps digitally, and the completed system is continuously monitored for performance.

Another term used is the digital twin which means the physical system has

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a digital twin that has the complete history of the system from raw material to end of service. This can have a significant effect on the entire product lifecycle that can reduce design, manufacturing, inspection, quality control, and maintenance costs of a system.

For example, with the data being collected and stored throughout the lifecycle of the system, maintenance can be carried out when needed rather than on fixed schedules. Time consuming inspection processes can be replaced with in-line sensing of the manufacturing operation. This can also lead to constant improvement of the manufacturing process by using analytics to determine where and how the manufacturing process can be improved and made more efficient.

Pathways will yield new innovations

In the same way that the assembly line first implemented by Henry Ford revolutionized manufacturing for a century and more, and the introduction of the wind tunnel led to significant innovation in airplane design, we are in the midst of an industrial revolution that will yield dramatic improvements in the way parts, assemblies, and systems are manufactured and produced.

This will have an impact across many industries but probably the most impact in the aerospace industry that still relies on significant human labor. The technologies of additive manufacturing, automation, and digitalization will lower the costs of aerospace systems, change the skill sets needed for the future manufacturing workforce, and produce more fuel efficient and better performing systems through a pathway that will yield new and innovative designs thought impossible a few years ago.

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$6 billion. As Hyperloop routes are constructed globally, over the next 20 years, a conservative estimate of $180 billion will be spent on Hyperloop PODs.

Janicki Industries recognizes this unique generational opportunity and is partnering with Hyperloop One and Pacific Hyperloop to advance the PNW region competitively as the first region to connect via Hyperloop.

Closing the case for the economic gain, job creation and community benefits requires collaboration with all innovators in the aerospace sector. Pacific Hyperloop is engaged with interested parties to form a joint venture in accelerating regional Hyperloop implementation. The PNW region must secure the first-mover advantage to continue the global leadership as the net exporter of transportation technology.

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Manufacturing Innovations

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It is an exciting time in the industry but also disruptive to skilled labor, supply chains, design and engineering groups, and procurement. Our educational institutions need to be at the forefront of producing the technical talent for the new manufacturing environment, leading the research projects that will produce the knowledge base for future manufacturing innovation and certification, and retraining those individuals who will be displaced.

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Drones

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Why Washington? Sure, there is plenty of competition from outside the US, especially from Chinese companies, one of whom, DJI, has a 70 percent market share in the "pro-sumer" UAS market space where commercial operators use a consumer UAS in their business. Additionally, "custom drone" designs or major parts thereof, can be rapidly produced with 3D printers and piece parts are readily available from global and US sources, often leading companies to assemble or manufacture UAS components in house.

However, the sheer growth of this market merits the attention of Washington companies manufacturing everything from connectors to composites, contracting imaging services, autonomous software, sensors, avionics, payloads, launch and recovery hardware and that meet the all-important data analysis and management needs the industry generates.

To no one's surprise, Boeing subsidiary, Insitu, is focusing more on commercial UAS market opportunities. Amazon's well known UAS delivery efforts and Microsoft's own work and investments in airspace software activities reflect great interest in the UAS realm as well. And there are a whole host of smaller, innovative companies that conceive, develop, test, manufacture or otherwise provide products and services for the UAS market today. Concurrently, our major universities, community colleges and even K-12 schools are engaged in UAS or robotics education efforts, including those for the ground and maritime environments.

As Russell Wilson of the Seattle Seahawks would say, "Why not us?" The seeds of innovation are right here in Washington, in our companies, clusters, trade associations and our educational institutions. Now is the time to take advantage of those seeds to help the state become a preeminent leader in the UAS segment of the aerospace industry.