IIoT

AI and the Digital Thread boost composites manufacturing

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The composites manufacturing industry has undergone a digital transformation during recent years while manufacturers across all sectors are now in the process of embracing the power of the Industrial Internet of Things (IIoT). This digital revolution is being driven by growing demands for composite parts and at the same time pressures for cost reduction. The scale of the digital change at composites part manufacturers has been truly remarkable. But IIoT is only part of the story.

Composites manufacturers are still learning how to make full use of the sophisticated capabilities and computing power that they now have at their fingertips. Artificial intelligence (AI) and the digital thread are the keys to unlocking the potential of Industrial IoT.

The dynamic nature of composites manufacturing environments makes human error a constant possibility. This is due to the vast number of variables in the production process and the limited time available to absorb information and make optimal decisions. Additionally, working with composites material raises some unique challenges, such as the time-sensitive nature of pre-preg raw material, the importance of tool maintenance, and adhering to rigorous quality standards.

For composites manufacturers to meet the increasing demands of their customers, they must introduce highly sophisticated tracking, traceability and audit capabilities. It is this which has driven the uptake of Industrial IoT technologies.

IIoT ensures all parts, kits, processes, machines, tools and personnel in a factory are constantly connected, and that their data is collected and stored in real time. When collected factory-wide, this information gives complete digital traceability: a digital thread that weaves from raw-material to end-product. However, simply storing the information is not enough. In order to deliver its full benefits, the data contained within the digital thread must be constantly analyzed, in real-time, so that useful insights, alerts and recommendations can be delivered to operational staff. But to achieve this, the support of AI software is required.

Once a factory is digitized and automated, real-time alerts ensure fast response to quality problems even before they occur. When AI software is applied to the digital thread, composite manufacturers have full control over their production processes ensuring that – even if the unexpected happens – they can react quickly, with minimal disruption to production schedules, cost and quality.

Sensors: recording the digital thread

Once a kit is created from given raw material, it inherits the parent-material properties automatically, and once tagged with sensor, it is automatically tracked on its own. All of these assets, such as raw material, new kits, finished good parts, tools and machine, are centrally and automatically tracked and, together with the use of sensors affixed to each asset, factories can eliminate the risk for human errors.

Using this technology allows production floor staff and managers alike to rely on system's alerts when an asset is about to reach a threshold as well as to receive optimized action recommendations and manufacturing decisions.

What makes up the digital thread?

In addition to improving quality and creating the digital thread, real-time tracking is becoming critical for production excellence. Constant tracking of critical factory assets, both on and off the production floor, is a cru cial part of using IIoT to effectively improve the factory's operations.

In the age of Industrial IoT (IIoT) and AI there's a smarter way to manage and optimize your manufacturing operations

Composite part manufactures have already recognized that manual processes are prone to human errors, meaning that operators' understanding of events on the production floor is usually limited to those which they can physically see and hear in hindsight. Moreover, lack of contextual information can result in production delays that impact the entire production floor, often leading to increased costs and reduced efficiency, raising the prospect of inferior quality products or missed delivery deadlines.

Consequently, many composites manufacturers have found that comprehensive asset tracking capabilities allow the elimination or improvement of many manual processes. However gaining full traceability generates massive amounts of data, which present the need for efficient data management and smart analysis.

Cloud computing meets manufacturing

When a sensor network has been widely deployed across a factory, it tracks events in unprecedented detail. Over time, this data delivers full traceability – the digital thread that maps the lifecycle of a product from raw material, through the manufacturing process and beyond to MRO (Maintenance, Repair and Operations). Managing this data presents challenges and when IIoT solutions are widely deployed across a production site, the datasets being collected are often unimaginably large.

Storing such quantities of data on-site could quickly cause capacity problems, leading to a need for major infrastructural investments. The high cost, and the need for ongoing maintenance of on-site data storage systems of the size required is impossible for most manufactures. With the cloud however, storage space is unlimited and when factories need more space, the system is instantly scalable.

Given the vast quantities of data that are now being gathered round-the-clock in composites factories, storing it in on-site servers is rarely an option. Instead, manufacturers have opted to store it off-site, though securely, in the cloud. A key benefit of the cloud is security while firms such as 'Microsoft Azure' and 'Amazon Web Services' are more than experts at protecting their customers' data. Contrary to popular assumptions, cloud computing is also low cost. Data storage facilities must be secure, they must be low cost, they must provide capacity for massive and ever-growing data-sets and, crucially, they must provide the immense computing power necessary to analyze substantial amounts of data in a useful and efficient fashion.

AI and the Digital Assistant

The application of AI-based software allows the full potential of IIoT to be unleashed. The AI-based software acts as a 'digital assistant' to factory staff, delivering the alerts and recommendations derived from the insights, and allowing managers and operators to enjoy the full benefits of IIoT. An AI-powered digital assistant can 'see', monitor and 'understand' hundreds or thousands of variables in real-time, using this information to make recommendations for human operators, or even act entirely autonomously on their behalf to optimize production. This represents a radical change in how factories are run, automating and optimizing the entire production process and making the factories 'smart'.

IIoT together with cloud computing and AI algorithms all come together today, to offer manufacturing managers a true digital assistant that can eliminate error-prone and inefficient manual processes. These digital assistants can communicate with factory floor workers on-the-go via mobile devices, giving every worker a contextual awareness that extends beyond their own human capabilities, and when needed - across the entire business. This contextual awareness can be applied to improve productivity in any stage of a composite manufacturing facility and across multiple sites.

Digital assistants collect data from factory floor sensors to provide complete visibility across inventory, work orders, machines and tools

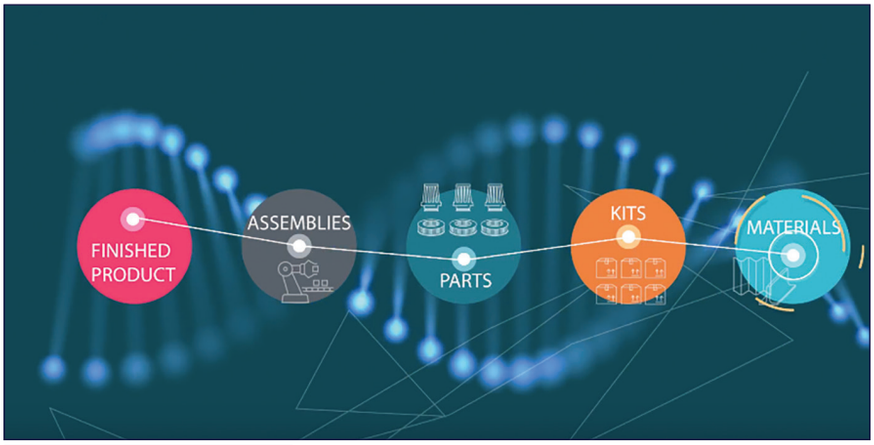
This raises the question of how best to implement IIoT technology in the digital factory. Three examples of implementation processes that are often used are optimized material selection, tool maintenance, and quality control.

Optimized material selection with the Digital Assistant

The method used to select freezer-stored carbon fiber raw material has a critical impact on efficiency. Among the many parameters considered, are raw material exposure time left (ETL), and roll length. Yet factory staff rarely have the time or ability to study all the variables, and at times, crucial information is often unavailable at hand, and therefore not taken into account. Understandibly, factory staff tend to grab the nearest raw material roll they find, trying to spend less time in the freezer and hoping to work quickly to improve productivity. This manual and random material selection process has large repercussions on waste and cost.

An IIoT/AI-based solution for selection of time-sensitive materials can be highly effective. It monitors every roll of raw material equipped with an RFID or BLE tag. Compatible readers placed around the production floor scan material rolls as they enter the manufacturing facility, allowing crucial information, such as ETL and roll length to be stored in a secure, off-site cloud. When an AI-powered digital assistant has access to all this information, it analyzes it instantly and uses it to select a material roll of optimum length and with the shortest ETL.

Workers responsible for removing rolls from the freezer can be equipped with hand-held mobile devices so that the digital assistant can 'communicate' with them, directing them to the optimal roll selection each time. By considering more information than a human mind could ever process and analyzing it in a way that the human mind is simply incapable of, this process has the ability to eliminate human errors.



For quality control and audit purposes the smart software logs a two-way digital thread from raw-material to end-product

Tool maintenance with the Digital Assistant

IIoT allows a tool maintenance management process which relies on tags and sensors affixed to the tools, to automate the monitoring, tracking and logging of a tool's use, while also scheduling maintenance sessions. The digital assistant takes it one step further. It understands the preventative maintenance requirements of each tool and, by monitoring the tool's autoclave duty cycles in real-time, optimizes tool utilization, optimally effecting future production planning.

Moving from 'time-based maintenance' to 'duty-cycle-based maintenance' is critical for the efficiency of operations, avoiding maintenance for tools to be scheduled earlier than necessary.

With the digital assistant, when a tool needs to undergo scheduled preventative maintenance, staff are alerted in time for them to be able to reschedule production plans accordingly, avoiding delays and bottlenecks. The digital assistant also updates other systems to hold up work orders that require the same tool avoiding congestions on the factory floor.

In highly regulated industries such as aerospace, manufactures find it necessary to provide audit reports at any given time. Accurate tool maintenance records allow the digital assistant to instantly generate reports, validating that the manufacturer has followed all necessary regulations and procedures.

Quality control with the Digital Assistant

When an AI-powered digital assistant is put in charge of quality control at a composite component facility, the outcomes are highly impressive. For example, if a batch of raw material is found out to be defective due to a freezer malfunction and the process is being handled manually, factory staff could be forced to trawl through paper trails to identify and retrieve all affected raw material units, WIP, kits and finished parts. Remaining exposure time will need to be manually recalculated, and kits will have to be individually inspected to ascertain their suitability for use.

This process can take many man-hours, so that waste due to elapsed exposure time will surely be high. The cost to the factory could ultimately be immense due to the reduction in production capacity during the several days it takes to contain the problem. The digital thread means all materials, kits and parts have been traced from the raw-material phase, through fabrication on the production floor, and on out to deployment in the field.

With the digital assistant in place, if a freezer malfunction is detected threatening to damage raw material or kits, the system instantly identifies all effected materials, kits and finished parts. For all raw materials, exposure time left is automatically recalculated, and staff are notified of the status of all materials and kits.
According to their status, materials and kits can be either discarded, or sent for quality inspection. Those flagged for expiration are marked for urgent completion. This means that a task which formerly took hours, now takes only minutes and is done automatically. It ensures no faulty parts leave the factory, and that production delays due to quality issues, are detected immediately and can be minimized and quickly controlled. The digital assistant is also able to offer 100% certainty that all affected kits and parts have been identified and located. In addition, software alerts are instantly prompted for parts that have already left the factory for shipment to customers. These are either stopped on route or customers are immediately notified, minimizing inconvenience and reputational damage for the manufacturer.

Closing the loop: IIoT, AI and the Digital Assistant

With the digital thread information at hand, providing two-way part traceability - from material to product and from product back to material - if the unexpected does happen, manufacturers will have full control over the production process, allowing them to react quickly with minimal disruptions to their production schedule and work orders' on-time, on-quality fulfilment.

Robust sensors, secure connected technology, and powerful, scalable cloud computing power are now widely available and affordable, and the need for artificial intelligence is clear. As the quality and cost demands made by OEMs become more onerous, and production volumes increase, the composites manufacturing process becomes ever more complex. It is necessary to augment factory floor staff with smart software that would allow them to make optimized decisions at any given time.

AI solutions should be implemented across the composite manufacturing process, they should be fully integrated with existing IIoT solutions, and they must be constantly reviewed and upgraded. Factories that do this will enjoy major rewards in terms of efficiency and quality control, allowing them to remain viable and competitive. □

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