

Modernizing Life Science Manufacturing:

How analytics, IoT and the cloud are rewriting drug production



Manufacturing is one of the most challenging environments in the pharmaceutical industry. Companies must quickly, efficiently and consistently execute complex processes in compliance with evolving regulations. Any missteps in these processes can lead to shortages or compromised safety of drug therapies which are critical to patient's lives. Today, enhanced data collection through connected IoT devices, data analytics and machine learning in the cloud are giving companies near real-time insights into their plants, equipping them to manage these pressures and modernize their manufacturing pipelines.

Therapeutic manufacturers are recognizing the efficiency-enhancing potential of data analytics at a time when pricing pressures and portfolio shifts are forcing them to rethink their operations. Having built their manufacturing footprints in the era of blockbuster pills and capsules, leading pharmaceutical

companies now see biotherapeutics, cell and gene therapies and other emerging drug modalities as critical to their future. However, these new modalities are considerably more complex and costly to make than traditional pharmaceutical products and require the mastery of new technologies, processes and supply chain requirements.

Incremental improvements in manufacturing margins at all plants, whether they make pills or biotherapeutics, are more important than ever. In some cases, manufacturing is now a way to gain a clear competitive advantage, from improving yields to decreasing production time, and can have a significant impact on the bottom line.

In light of the pressure to make therapeutics better, faster and cheaper, forward-thinking companies are seeing this as an opportunity to use new data analytics and the cloud to modernize their manufacturing operations and supply chain. To do so, manufacturers



need a partner, such as AWS, that has tailored its cloud offering to the pressures and requirements of good manufacturing practice (GMP) environments.

THE VALUE OF AUTOMATED AND CONTINUOUS COMPLIANCE IN THE CLOUD

Manufacturers that run their regulated GxP workloads on the AWS Cloud are realizing a range of unique benefits, including enhanced traceability and trackability of what's occurring in their IT environment, near real-time testing and enhanced speed of setup.

The pharmaceutical company Merck is one of many companies that run regulated workloads on the AWS Cloud, benefiting from the automated and continuous compliance this provides. Utilizing AWS CloudTrail, Merck has the capability to log every change to its system, enabling it to provide auditors with details of all revisions. Similarly, AWS Config is used to show auditors how its environment was configured on any day in the past, improving on the point-in-time approach to compliance that was common in the industry¹.

Similarly, Moderna Therapeutics runs day-to-day drug manufacturing GxP workloads in the AWS Cloud to maximize cost savings and agility. From Moderna's inception in 2010, the company embraced a cloud-first strategy². Traditionally, a biotech would establish an on-premises infrastructure when it needed to run regulated workloads. Moderna believed running GxP workloads using SAP on the AWS Cloud could be done more quickly and at less cost than setting up on-premise hardware. That belief has been validated by Moderna's ability to construct a 200,000-square-

foot GMP facility whose supply chain and processes are driven by a GxP cloud IT environment. The AWS Cloud-based system enables a fully integrated ecosystem of applications.

"For us, it doesn't make sense to see any company going into the old way of doing things, with the agility, flexibility and the integration that you can bring using AWS and SAP," Marcello Damiani, Chief Digital Officer at Moderna, said. "It's been flexible enough to allow us to build in a very fast fashion³."

Companies including Merck and Moderna are using the cloud to enable a new level of manufacturing agility and compliance to enhance their operational performance. By working with industry members and regulatory consultancy Lachman Consultant Services, AWS [created a white paper](#) to outline how the AWS Cloud platform can be used in a manner that is consistent with GxP compliance guidelines, creating valuable information to guide companies interested in adopting the cloud for regulated life science workloads.

UNLOCKING THE VALUE OF EXISTING MANUFACTURING DATA WITH ANALYTICS AND MACHINE LEARNING

Seeing an opportunity to significantly lower costs while increasing output reliability and quality, some manufacturers are integrating data analytics into existing production environments to gain insights into process parameters that determine critical quality metrics, enabling them to identify and resolve issues faster. The capability to glean fresh insights from existing data is made possible by the ability for manufacturers to store and analyze vast amounts of information in an efficient manner in the AWS Cloud.

1 AWS re:Invent 2016: Continuous Compliance in the AWS Cloud (LFS302). (2016).

2 Damiani, M. & Johnson, D. Moderna Therapeutics Case Study – Amazon Web Services (AWS). Amazon Web Services, Inc. Available at: <https://aws.amazon.com/solutions/case-studies/moderna-therapeutics/>. (Accessed: 7th August 2018)

3 [Whitepaper] AWS and SAP: How and Why Companies Run Regulated Workloads in the Cloud. Available at: <https://pages.questexweb.com/AWSandSAP-December2017-Registration.html?source=meta>. (Accessed: 29th June 2018)



Faced with an uptick in the discard rate of certain vaccines, Merck gathered all the data generated at one of its manufacturing sites into a data lake in the cloud. Pooling minute-by-minute temperature readings, batch process control records and other site data into the data lake enabled Merck to analyze the site holistically for the first time⁴.

Once Merck visualized data from every batch produced by the plant, it identified a correlation between yield and fermentation performance traits that suggested a root cause of its problem. The process took 15 billion calculations and 5.5 billion batch-to-batch comparisons, a level of computing beyond the reach of their on-premises IT systems. The on-demand scalability and compute power of the AWS Cloud allowed Merck to improve the manufacturing production output for its drug product.

Similarly, San Francisco-based Bigfinite is using the AWS Cloud and machine learning

to store and analyze the disparate sources of data generated by biopharma manufacturers. Previously, these data sources largely sat siloed in legacy applications, limiting companies' ability to glean insights from them.

Bigfinite built an analytics platform that pulls in data from multiple manufacturing data sources like connected production equipment, Manufacturing Execution Systems (MES), Quality Management Systems (QMS) and ERPs, and analyzes it using machine learning, artificial intelligence and neural networks. Using the AWS Cloud for these tasks allows bigfinite to provide a GxP-compliance-ready environment that can capture, store, interpret, analyze and model disparate data sources at large scales to help optimize manufacturing processes.

This machine learning-powered approach is delivering benefits to manufacturers today. A multinational company used Bigfinite's platform in one of its European plants, where 50 reactors mix compounds in parallel and subsequently release

⁴ AWS re:Invent 2014 | (HLS201) Using AWS and Data Science to Analyze Vaccine Yield. (2014).

volatile organic compounds (VOCs)⁵. The release of VOCs is controlled and highly regulated and the manufacturer exceeded the limit several times a year, leading to fines, environmental damage and significant energy use to cool the facility's furnaces.

Using the Bigfinite platform to monitor the reactors, the manufacturer stabilized its VOC emissions within three months. In the first two months, the platform learned to analyze the raw data for insights into how to better organize the production processes. These changes were implemented in the third month, resulting in VOC emissions staying below the limit and the cooling system's energy use falling by 17%.

As with Merck's vaccine manufacturing breakthrough, these improvements were achieved using existing, underused data. The company already had the answers. It just needed the analytical power and ability to combine multiple disparate data sources in one place to find them. They did it in the AWS Cloud.

THE CLOUD-ENABLED FUTURE OF MANUFACTURING

In the years to come, manufacturers' ability to uncover insights from new and existing data will increase sharply, bringing with it the potential for efficiency gains and resolution of intractable challenges.

The inevitable increase in the availability of data and, by extension, answers will occur as companies connect more pieces of manufacturing equipment to the internet. These IoT devices are already improving the day-to-day operation of production plants while providing new streams of information to flow into cloud based data lakes for analysis.

Drugmakers are using machine learning and data from IoT sensors to predict when equipment is at risk of failure, thereby averting costly and time-consuming unplanned shutdowns. Novo Nordisk is among the companies using these technologies to enable predictive maintenance, for example by monitoring the vibration of bearings to assess the risk of equipment failure.

"These tools are so accurate that you can know whether [the issue is with] a ball in the bearing, or the edge of the bearing or if it's the oil that has been polluted in the bearing," Kasper Malthe Larsen, Chief Technology Architect at Novo Nordisk, said at an event co-hosted by Bigfinite⁶.

A different example comes from Moderna, which is piloting the use of AWS IoT buttons—similar to Amazon's Dash shopping buttons—in the ordering of materials. Instead of filing a Kanban card, workers on the production line press a button to place a material order in SAP, simplifying the process and minimizing administrative burden.

Such deployments of IoT devices stand to improve the efficiency and quality of manufacturing plants, but also create new security risks. AWS IoT mitigates these risks through the built-in authentication and authorization of devices, encryption of data and access control to device data. The AWS system monitors IoT devices continuously and sends out alerts when abnormal behavior is detected.

With confidence in the security of their systems, manufacturers will generate more and more data, expanding the analyzable pool far beyond what they

⁵ Gubau, P. bigfinite case study - Amazon Web Services (AWS). Amazon Web Services, Inc. Available at: <https://aws.amazon.com/solutions/case-studies/bigfinite/>. (Accessed: 7th August 2018)

⁶ Webinar - Condition-based monitoring - addressing the untapped cost saving potential in pharma manufacturing. NNE Available at: <https://www.nne.com/techtalk/webinar-condition-based-monitoring/>. (Accessed: 29th June 2018)



currently gather for compliance purposes. While this data boom is creating new opportunities for insight it will increasingly and exponentially place a strain on traditional on-premise storage and analytics capabilities. The realized value of the data will rest on manufacturers' ability to efficiently probe it for actionable insight, something that is impossible to do manually at these scales.

Expanding the use of cloud-based artificial intelligence and machine learning can help to resolve these problems by enabling companies to more quickly sift answers from vast datasets. Tools such as Amazon SageMaker, can equip manufacturers to rapidly spot patterns within vast stores of data to help glean insights hidden from humans by the sheer scale of the information repositories. These services combine easy-to-deploy machine learning models and access to scalable computing capacity with the goal of unlocking insights from data assets that lead to more efficient production plants.

In light of changes to drug portfolios and commercial pressures, such manufacturing efficiency gains are no longer just nice to have. Increasingly, efficient, modernized production plants are needed to thrive in the competitive drug market. Manufacturers that recognize this fact and deploy scalable, cloud-based systems today can profit from the ongoing boom in production data, securing themselves a competitive advantage for years to come. ●

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