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Zero-Defect Manufacturing Utilizing Autonomation in Aerospace

December 1, 2022


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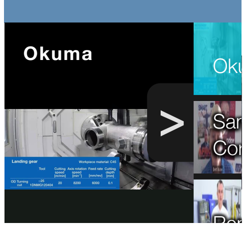

Autonomation (or Jidoka) is described as automation with a human touch [1]. Autonomation refers to automation of those tasks that are mundane or important from a safety or quality point of view but still requires human attention [2]. The idea is to minimize operator intervention and improve zero-defect manufacturing (ZDM) [1]. ZDM is a robust tool used in total quality management (TQM) to mitigate quality risks. When autonomation is implemented, a problem is automatically detected, discontinues the manufacturing process, and signals to the operator to initiate containment. Containment involves reestablishing the process and implementing rapid problem solving [2]. This supports preventive actions, a quality or safety issue. Containment also improves throughput with less human involvement.

Autonomation vs. Automation

Famed consultant Shigeo Shingo indicated that there are 23 stages of a fully manual process compared to a fully automated process [3]. A fully automated aerospace manufacturing process must detect and correct its own operating nonconformances. As a result, this is not always cost effective [4]. However, automation benefits are achieved with autonomation to reduce the cost of poor quality. Hence, Jidoka is one of the main tenets of the Toyota Production System (TPS) [5]. Its principal emphasis is on the leadership function. Autonomation permits the machine to cease operations if it detects an anomaly. This averts production of defective products and reduces over production (waste). TPS is derived from a four-step process: automation; use of technology to enable machines; aerospace manufacturing procedures; and repeatable processes and mundane tasks without human involvement.

Autonomation Today

Apart from the manufacturing facility, Jidoka principles are used on many modern lean six sigma applications [9]. For example, when logging into a CNC machine, if an operator repeatedly enters the wrong part number, the machine will not initiate the program. In another instance, if a circuit overloads, the electrical safety breaker will trip to mitigate a fire. In yet another example, a forklift will provide a warning and become inoperable if the load exceeds the limit. Lastly, pneumatic torque wrenches have sensors to signal a lack of proper torque. In the above cases, even though an automatic sensing and protective action occurs, a human must operate machinery to ensure necessary compliance, maintenance, and corrective action.

The Role of Digitization in Autonomation

Indeed, Makhija Wickramasinghe [4] indicated that digitization has a vital role in manufacturing operations. Where ZDM methods focus on effective aerospace manufacturing processes, digitization supports conveying key performance indicators (KPIs) accurately and expeditiously. Digitization improves lean culture as its role has become even more critical in a global aerospace manufacturing environment. Manufacturing processes require specificity, simultaneous operations, and standardization in all processes. As a result, data needs to be communicated consistently and accurately. In this manner, stakeholders, including customers, are provided with metric trends in real time. Digitization in autonomation achieves enhanced production, quality, safety, and responsiveness.

Conclusion

Significant tactics, strategies, and activities are initiatives to construct ZDM processes. ZDM is the standard for built-in quality [7]. The objective of this article is to clarify how ZDM is utilized for autonomation in aerospace standardization. Additionally, ZDM provides a framework to improve conformance, reliability, and repeatability in aerospace manufacturing systems [5].

Finally, multifunctional manufacturing processes are comprised of ZDM, which is inherently a complex process because of the simultaneous operations needed to accomplish zero defects. The application of the ZDM philosophy, together with autonomation, presents significant challenges and opportunities for the implementation of new processes that contribute to innovative manufacturing production processes. An emphasis must be on developing fully integrated, operative solutions, employing many quality systems, digitization, data analytics, and industry standards such as AS9100, ISO 9001, and Advanced Product Quality Planning.

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James W. Schlusemann Elected President of SME

SME has elected long-time member James W. Schlusemann, LSME, as its 2023 president. The organization announced the 2022 election results and installed its new officers, directors, and council representatives during a ceremony at the SME Fall Gala, held Nov. 6 in Atlanta. The new terms begin in January 2023.

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