Critical Review: Impact of Smart Manufacturing to Energy Savings

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Introduction

Smart Manufacturing is the broad category of manufacturing with a goal of optimizing and advancing the manufacturing process. The National Institute of Standards and Technology (NIST) defines Smart Manufacturing as systems that are “fully-integrated, collaborative manufacturing systems that respond in real time to meet changing demands and conditions in the factory, in the supply network, and in customer needs.” [1]

What makes Smart manufacturing “Smart”?

Traditional Manufacturing

- Has systems independent of each other.
- Built in a vertical fashion centering on the product line.
- System is unaware of surroundings.
- Isolated optimized cells perform same task.
- Cells are unable to respond to dynamic changes in production.

Smart Manufacturing

- Built in a horizontal manner extending across the facility from business to maintenance.
- Subsystems communicate with one another, allowing adaptive responses to changes in manufacturing.
- Communication networks can extend beyond the manufacturing floor to other departments to allow for greater flexibility.

[2]

Levels of Smart manufacturing

Hierarchy of Control

Level 0 – Manual Control

- A control system that manually actuated and only has ON/OFF states.

Level 1 – Reactive Control

- The feedback from a sensor or system on sensors actuates the system in either an ON or OFF state.

Level 2 – Programmable Control

- Programmed instructions can take multiple conditions and inputs into account to actuate the system in either an ON or OFF state.

Level 3 – Variable Control

- The system has conditions other than ON or OFF and can operate in an in-between state.

Level 4 – Intelligent/Anticipation Control

- Considers variables outside the operating system to make intelligent decisions.

[2]

Cyber-Physical System Levels

Level 1 – Correction

- Proper feedback data is necessary and relies on a sensor network.

Level 2 – Presentation

- The important portions of information must be filtered from the noise for more complex applications such as monitoring system health.

Level 3 – Machine Network

- At this stage, the system is connected beyond the singular operation and is able to compare performance with other similar machines.

Level 4 – Data Analysis

- Information has been collected and processed, and at this stage it is displayed concisely to the operator for decision-making.

Level 5 – Data Collection

- Rather than an operator performing the decision making, the system is self-adjusting and self-configuring with minimal supervisory control.

[3]

Pillars of Smart Manufacturing

Automated Solutions

- Collaborative robots – Robot-to-robot or robot-to-human interaction that extends the system complexity beyond that of an isolated system.
- Mass Communication – Fleets of robots communicating with each other or other parts of the facility system to improve efficiency.

Internet of Things (IoT)

- Integrating sensors into existing equipment to read and analyze data to make informed decisions.
- Tuning the manufacturing process from the data gathered from sensors in the equipment.

Augmented Reality

- Introduces a layer of digital feedback to the user to convey more information.
- Simulation – Dangerous functional equipment can be simulated.
- Real-Time Feedback – Live sensor data can be overlaid to assist a user while the machine is running.

Additive Manufacturing

- Using machines such as 3d printers that “print” layers of filament to make a part.
- Much simpler to prototype parts by 3d printing them.
- Printing test models with a 3d printer is much cheaper compared to forging or casting.
- Much cheaper and easier to manufacture complex shapes.
- 3d printers are also much easier and safer to use than most traditional fabrication equipment.

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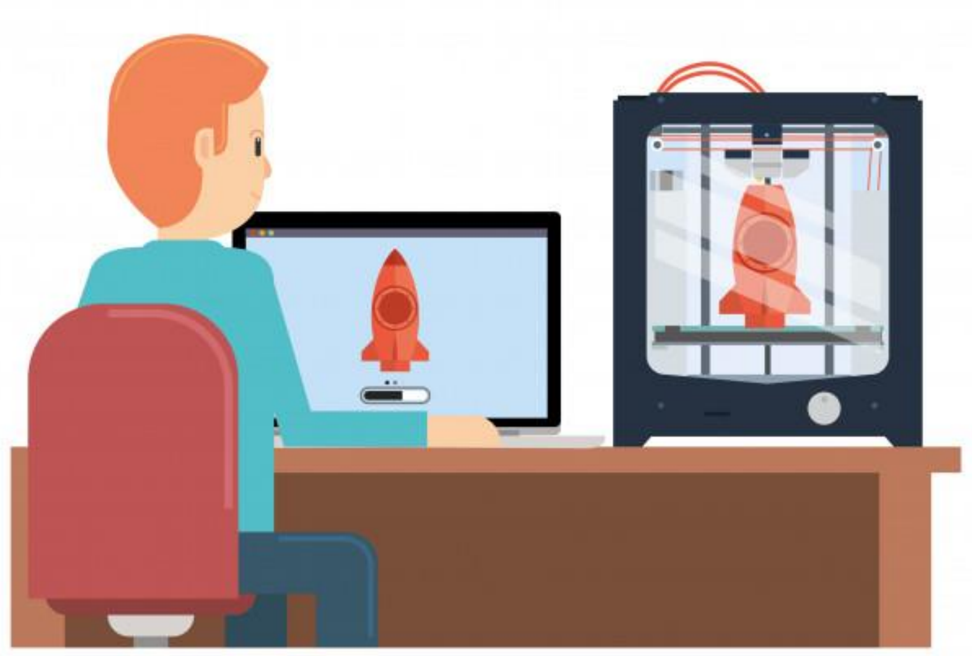

Implementation

- Using “Lights-out” factories that continue to work without lights or heat greatly reduce overall cost and allow reallocation of human resources to higher priority tasks.
- Replacing old motors and pumps with ones that are connected to a smart system and can yield in energy savings by optimizing and varying their output.
- Integrating the Siemens COMOS program to show live data simulations to allow the user to make informed decisions that will induce energy savings. The COMOS program will also allow for tighter control over the work space resulting in the application of predictive maintenance. [5]
- Incorporating 3d printers to prototype parts instead of casting or forging them.
- Building a large communication network to sustain entire manufacturing sites, allowing for greater customization and allocation of resources.

Conclusion

Smart Manufacturing yields many benefits compared to traditional manufacturing. Factories are able to achieve higher efficiency ratings by using the connections made from each manufacturing step and optimizing each of them for the upmost efficiency. In the long run, converting traditional manufacturing techniques to incorporate smart technologies will potentially save companies millions in which they could then invest into further developing their company.

References

[1] https://www.nist.gov/topics/smart-manufacturing

[2] E. A. Rogers, “How Smart Manufacturing Saves Money,” ACEEE, pp. 1–11, 2015.

[3] J. Lee, B. Bagheri, and H. A. Kao, “A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems,” SME, vol. 3, no. October 2017, pp. 18–23, 2015.

[4] M. Rüßmann et al., “Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries,” Bus. Inf. Syst. Eng., vol. 6, no. 4, pp. 239–242, 2015.

[5] Siemens, “COMOS.” Siemens, 2008.

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