Enabling Design for Energy Efficient Additive Manufacturing

By Hari Prashanth Narayan Nagarajan

Candidate for Master of Science in Industrial Engineering

Major Professor: Dr. Karl R. Haapala

Abstract

Manufacturing exists as a stronghold for continuous growth and development of economies, a trend that is likely to continue as the demand for commodities and products grow. However, manufacturing activities pose a significant demand on the environment (e.g., using resources), which can be accounted for and reduced through the application of sustainable manufacturing principles to analyze and improve the performance of manufacturing systems. Additive manufacturing is a rapidly emerging alternative to conventional manufacturing, including subtractive processes, often attributed to its claim for sustainable product development, e.g., reduced cost, reduced energy and material use, and the distributed production of tailored consumer products. However, these claims remain unsubstantiated for high volume production since benefits are product-specific and vary extensively. Hence, to ensure industrial efficiency with the growth of additive manufacturing, informed design and manufacturing decision making tools integrated with life cycle product and process data are required. Thus, the purpose of this research is to enable energy efficient design for additive manufacturing through 1) cradle-to-gate characterization of the environmental performance of additive manufacturing processes to identify the key contributors to environmental impacts, 2) characterization and modeling of additive manufacturing process time, energy use, and production cost, and 3) development and demonstration of a design decision support tool for evaluation of additively manufactured products and additive manufacturing processes. This research develops an overarching approach to additive manufacturing sustainability assessment and demonstrates that informed decision making for additive manufacturing can support sustainable product development.

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Oregon State University OSU College of Engineering

School of Mechanical, Industrial, and Manufacturing Engineering