2024 ASME IMECE Conference

Assessing the Feasibility and Potential Benefits of Converting to Model Based Definition for a Small Manufacturer

Martin L. Tanaka & Carson B. Pardue

College of Engineering and Technology, Western Carolina University, Cullowhee, NC, USA

Industry 4.0 is changing the way that products are designed and manufactured. It leverages the extensive amount of information that is now available to develop products more quickly, improve production efficiency, and decrease response time to changing market demands. Key elements (underlined) of Industry 4.0 include the following. Using the model based definition (MBD) approach to improve communication of technical information throughout the product lifecycle. The industrial internet of things (IIoT) to create an interconnected network that collects manufacturing process data directly from industrial machines. The big data generated when multiple sensors on multiple machines upload their status. New approaches to process big data like artificial intelligence (AI) that generates knowledge beyond traditional calculations. Cloud-based computing which enables access to data generated in multiple locations worldwide. Protecting sensitive information uploaded to the cloud requires cybersecurity. While this list is not comprehensive, it outlines many of the major elements of Industry 4.0.

In this research, the feasibility and potential benefits of converting to MBD are examined in a case study with a local company. When using MBD, the 3D digital model becomes the authoritative source of all product information, and this single data format can be used throughout the product's lifecycle. This approach is in sharp contrast to the traditional method for engineering design communication. Traditionally, the 2D drawing was considered the master document. It was originally drawn on paper and represented a contract between the purchaser of a component and its manufacturer. As computer aided drafting (CAD) and later computer aided design (also CAD) systems were developed, parametric modeling began to take hold. These tools enabled engineers to design components in 3D and quickly generate 2D drawings from the 3D models. Yet even though the 3D models existed, 2D drawings were (and still are) considered the authoritative document. While it is sometimes possible to import 3D models, computer numerical control (CNC) machines for manufacturing, coordinate measuring machines (CMM) used for inspection, and component suppliers such as mold makers, metal stampers, and finishers still rely on data provided on 2D drawings to recreate information for their computer systems. The goal of MBD is to have a single data file that can be used by everyone and eliminate the need to transfer information from system to system and via paper drawings.

Working with a product design and manufacturing company close to the university, we sought to determine if converting to MBD could be used to eliminate the need for 2D drawings. The company provided researchers access to actual product documents. Multiple parts of various sizes and complexities were converted to MBD. The initial study focused on the quality systems portion of the company where inspections were being performed using 2D drawings. An institutional review board (IRB) approved study was conducted to determine the time needed to complete a quality inspection using MBD and the results were compared to 2D drawings.

All participants had a lower average inspection time using MBD than 2D drawings. This was surprising because participants had experience inspecting with 2D drawings (some more than 10 years) and performing an inspection using MBD was new. While the trend is promising, differences in inspection time caused by variability in part complexity and a low number of test subjects did not yield statistically significant results prior to grouping. However, when the more experienced quality inspectors were grouped together, MBD was shown to be significantly faster than the traditional approach. It could be postulated that additional experience and training could enable all quality inspectors to perform their jobs faster using MBD. In addition, the adoption of MBD would eliminate steps in the current process from part design through final inspection. This could lead to additional cost savings, reduction of data translation errors, and improved time to market.