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STEP-NC: A MANUFACTURING LANGUAGE TOWARD SUSTAINABLE ADDITIVE MANUFACTURING

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ABSTRACT

Shopfloor information is important to the designer in this IR4.0 era. However, the machine language used in the CNC machine is still G&M code, which is a low-level language that restricts the information from flowing from CNC machines back to the designer. Hence, STEP-NC published by the ISO committee can overcome the limitations of the G&M code.

KEYWORD

STEP-NC, G&M code, ISO 14649, Machining language, Additive manufacturing.

INTRODUCTION

AM designers face significant challenges in understanding the sustainability value of AM products during the manufacturing stage. This is because the manufacturing language used at the manufacturing stage is Geometry & Miscellaneous code (G&M code), a low-level code that only provides the machine axes and machine status description. It does not include higher-level information such as manufacturing features, operations, product geometry, and sustainability data. Consequently, the data flow is unidirectional with no feedback, leading to a loss of manufacturing information during the process. Thus, the designers will require an additional system to obtain sustainable data from the shop floor to improve the design.

STEP-NC is a new standard for data transport between CAx systems and CNC machines. It addresses the inadequacies of the G&M Code by emphasizing machining processes rather than machine tool motion (Zhu et al., 2006). Hence, instead of telling the machine "How to do", the language lets the machine know "What to do". Figure 1 shows the difference between the G&M code and STEP-NC.

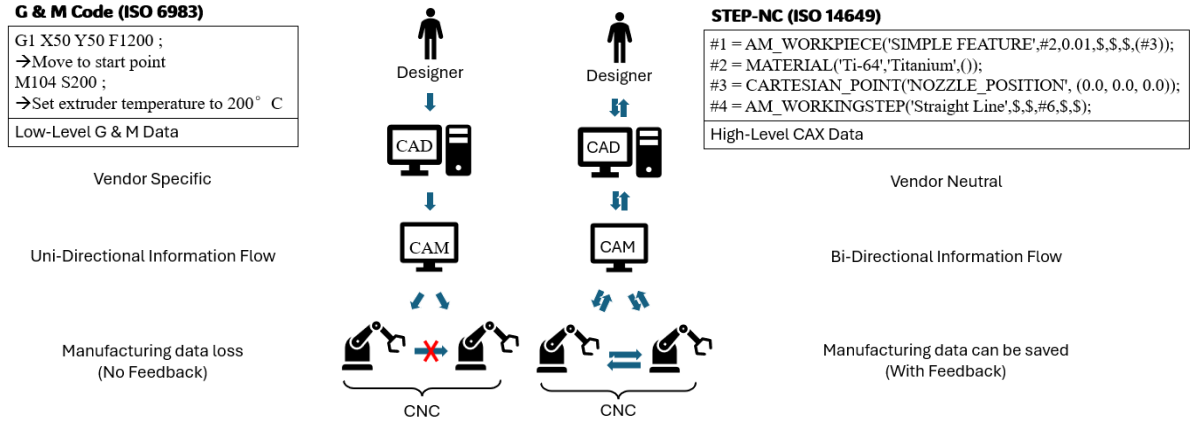

Figure 1: Difference between G&M code and STEP-NC

IMPORTANCE OF INTEROPERABILITY

Interoperability between manufacturing stages is critical for increasing efficiency, lowering costs, and improving coordination throughout the production process. It facilitates seamless data transmission between systems, reducing mistakes and rework while optimizing resource utilization. Manufacturers can speed up design iterations and production by optimizing

operations to reduce time to market and improve department collaboration. Additionally, interoperability can facilitate improved quality control and traceability, allowing for early detection of issues and easier compliance with regulatory and compliance standards.

Furthermore, interoperability is critical for implementing modern manufacturing technologies such as smart factories, IoT, and Industry 4.0. It enables real-time data exchange for predictive maintenance, process optimization, and supply chain collaboration. This integration also increases flexibility, making it easier to scale manufacturing, implement new technologies, and provide customized products. Interoperability promotes compliance in regulated businesses by guaranteeing uniform data exchange and environmental sustainability tracking, making it an essential component of successful and future-proof manufacturing systems.

HISTORY OF INTEROPERABILITY ISSUE

An example of a historical case related to manufacturing interoperability issues is the delays of the Airbus A380. Three delayed announcements resulted in the A380 development taking approximately 4 years longer than expected. The delay is mainly due to the wiring problem which the engineers found out the wiring for the A380 was too short during assembly. One of the main factors that cause this problem is the interoperability of software. Airbus engineers in France have used CATIA and CIRCE for three-dimensional computer modeling. However, the German engineers, on the other hand, were adept at using Computervision. According to the study, the failure to transfer the design files between various Airbus production facilities led to discrepancies in electrical wires. Therefore, it is important to standardize the manufacturing language so that anyone can solve problems on the spot at any manufacturing stage.

CHALLENGE OF STEP-NC IN ADDITIVE MANUFACTURING

STEP-NC for additive manufacturing was first published by ISO in 2020. Hence, it is still new and requires improvement to mature for industry use. More research on this standard is needed as the number of studies related to this criterion is still low. Researchers also face the issue of getting an example of the Part 21 file for AM, which makes the research more difficult.

Besides, the facilities, manufacturing capabilities, knowledge, and systems available in each local manufacturing venue can differ from those in other venues (Nassehi et al., 2006). These further limit the implementation of this language in the industry.

CONCLUSION

In conclusion, STEP-NC is a better manufacturing language in this IR4.0. However, for the additive manufacturing industry, changing directly from G-code to STEP-NC remains impractical due to the huge cost requirements for companies. So, researchers and engineers play an important role in making this technology more mature so that it can one day be used across all the manufacturing industries to improve green manufacturing.

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