SUCCESS STORY 5527.001

Tool utilized to match specific parts with a desirable additive method

Knowledge graph developed as basis for machine learning

SIMBA Chain Additive with Knowledge (AWK)

PROBLEM

Critical repair parts and consistent metadata must be available to keep Department of Defense (DoD) weapon systems capable for mission execution and to ensure warfighter safety. If a part is not available in the supply system, it becomes backordered. At this time the availability of 3D models and technical and testing data become critical to developing an additive manufacturing (AM) solution for the asset, i.e., vehicle, ship, aircraft, or missile. A validation and verification process enabled by advanced technologies will ensure proper system performance and safety.

OBJECTIVE

The goals of the project were summarized according to three main objectives. The first of these was matching a part to a viable additive method for part production. The next was leveraging machine learning to associate parts to the AM process and specific 3D printer(s). Lastly, the tool was designed to assess if parts previously manufactured via traditional techniques remain viable if produced using additive methods.

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to:

VALUE CHAIN

ASTM PROCESS CATEGORY
N/A

EQUIPMENT
N/A

MATERIAL
N/A

TECHNICAL APPROACH

SIMBA Chain and the University of Notre Dame developed an Ontology Design Pattern (ODP) to model and reason material transformations. Given 3D files and basic metadata, such as material type, size, quality, and process, SIMBA Chain, Inc. (SIMBA) leveraged its Additive with Knowledge (AWK) tool to match a specific part to a viable additive method for part production using a unique fusion of Knowledge Engineering (KE) and machine learning (ML) to associate parts to the additive process and specific 3D printers. The tool is also to assess if parts previously manufactured via traditional techniques are viable if generated through additive methods.

ACCOMPLISHMENTS

The primary results of this project included the production of a tested ontology, instantiated knowledge graph, and continuous integration and continuous delivery (CI/CD) pipeline for improvements of the ontology. The ontology, which is the culmination of existing work and new design patterns, was tested, iterated, and open to future attempts at machine learning. The ontology was designed to represent real-world constraints on part(s) manufacturability. The knowledge graph, instantiated using Army part and printer data, was validated against a set of conditions using Shapes Constraint Language (SHACL) . This knowledge graph – upon inclusion of more part and printer data – would be the basis for machine learning efforts if a full recommender system were built. The results of this project established the feasibility of knowledge engineering within the AM domain. This project resulted in the successful construction and implementation of the Advanced Manufacturing for Maintenance Operations (AMMO) ontology that serves as a foundation for a future graph ML-based recommender system.

PROJECT END DATE

September 2022

DELIVERABLES

- Data Management and Technology Control Plan and Planned Project Deliverables List
- Collect target part data and produce schema for Ontology Design Pattern
- Final report

FUNDING

$250,000 total project budget

PROJECT PARTICIPANTS

Project Principal:
SIMBA Chain Engineering

Other Project Participants:
NCDMM/America Makes
University of Notre Dame

Public Participants:
U.S. Department of Defense