Weldment Assembly vs 3D Printed Assembly Gap Analysis

Overview
3D printing is an emerging and novel technology that expands traditional manufacturing capabilities, but not enough is known about the structure-process-property. Lockheed Martin is interested in comparing structural and performance differences between 3D printed parts and welded assemblies. Through Rockwell Hardness, X-Ray Diffraction, and Scanning Electron Microscopy tests, the team will analyse the differences of the two manufacturing processes.

Objectives
Explore material properties and capabilities of 3D printing to help determine the feasibility of incorporating additive manufacturing practices into a standard manufacturing process at Lockheed Martin.

Approach
- Material Selection: 316L Stainless Steel
  - Weld Assemblies:
  - 3D Printed Samples:
    - Powder Fed: Directed Laser Deposition Process
    - Powder Bed: Powder bed fusion
- Testing Selection:
  - Rockwell Hardness Testing
    - Results in material Hardness
  - X-Ray Diffraction (XRD)
    - Shows phases present in material due to affects heat treatment
  - Scanning Electron Microscopy (SEM)
    - Microanalysis of solid materials to analyze microstructure and porosity

Outcomes
From the performed XRD tests, it is known that the same phases are present in both 3D printed samples as the welded assembly. The SEM test shows that there were elongated grains in the powder fed sample, which was caused by the direction of the raster of the laser beam. The elongated grains show there are anisotropic properties in the 3D prints. Finally, hardness testing resulted in higher hardness in both 3D samples.

The team hopes that this is a useful starting point for Lockheed Martin research and will provide the sponsor with a multifaceted set of results.