

V4i

Virtual Verification Validation & Visualization

Manufacturing Type Certification Project

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Project Team Members

- Team:
 - Rolls-Royce (prime)
 - University of Notre Dame
 - ICTT System Sciences
 - Johnson & Johnson
 - Sentient Science



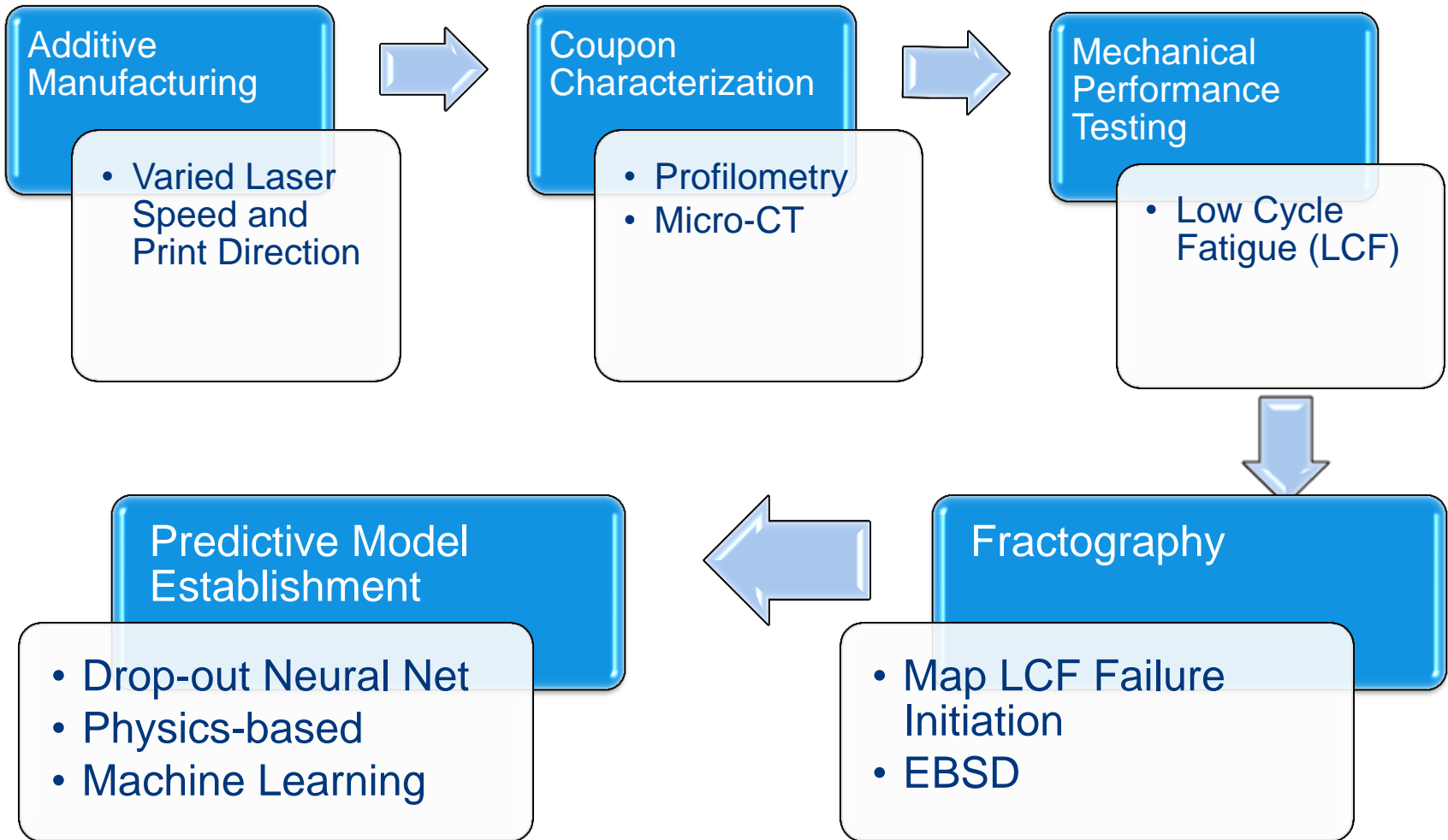
3D PRINTING CENTER OF EXCELLENCE



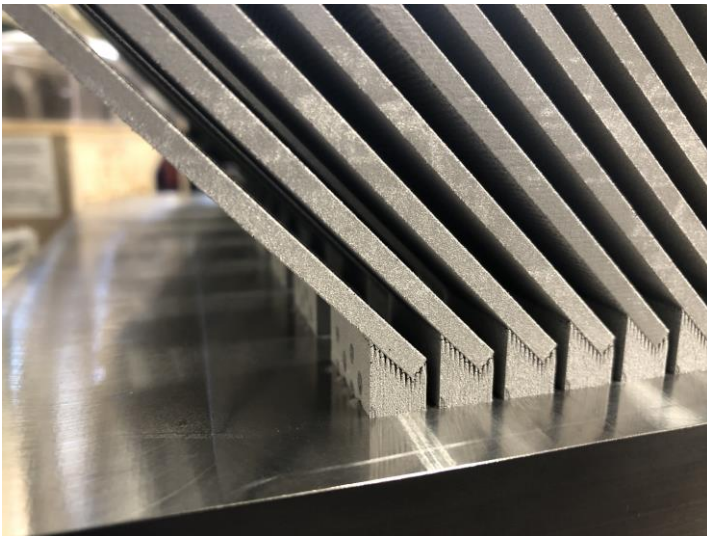
Manufacturing Type Certification - Benefits

- The goal of this project is to develop software modeling tool(s) that will predict mechanical material properties of printed components that may contain structural defects.
- The modeling tool will reduce the amount of physical testing and printing of multiple iterations of components by
 1. Reducing the need for exhaustive mechanical performance testing
 2. Assessing the empirical impact of defects on the subsequent mechanical performance properties possibly widening or restricting the acceptance criteria of AM components with known defects
- The V4I Framework ecosystem goals of this project are to demonstrate 1) Scaling up to more models and model users; 2) Managing models over their life cycle; 3) Increasing model use of what has already been learned; 4) Packaging general VVUQ principles as actionable assets; 5) Preparing for a more building-block model world; and 6) Use of the unifying Model Wrapper across diverse models.

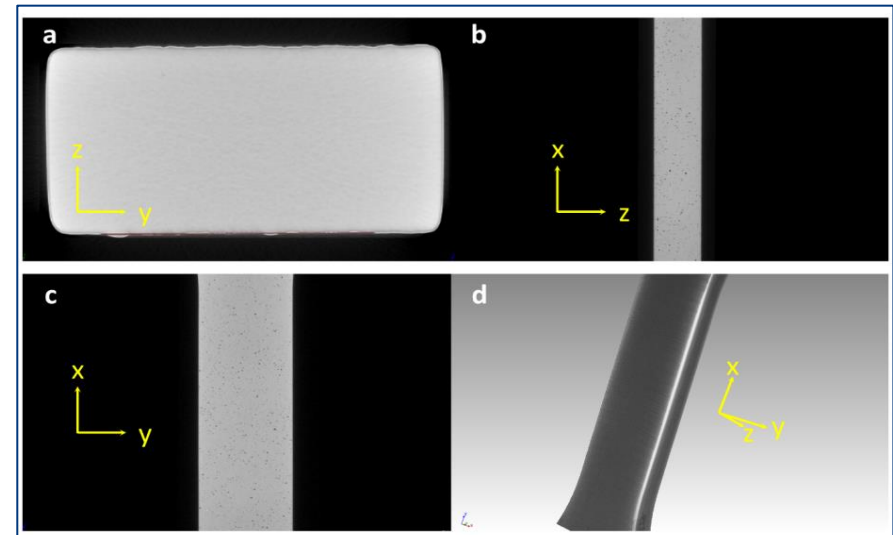
Project Deliverables (Manufacturing Model)



Coupon Printing & Inspection



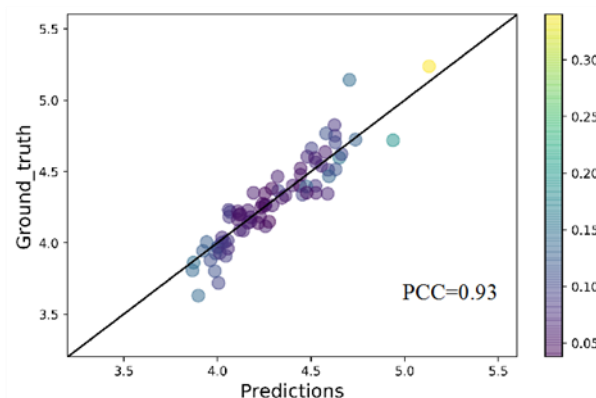
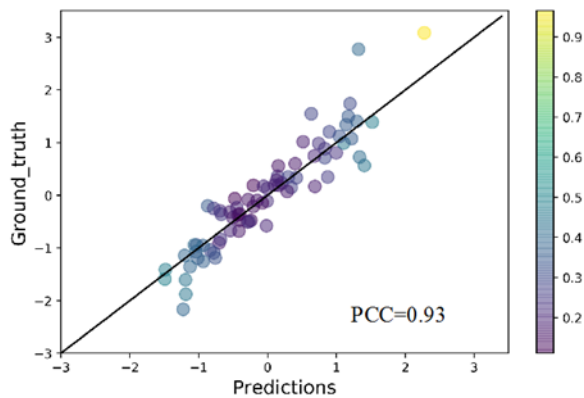
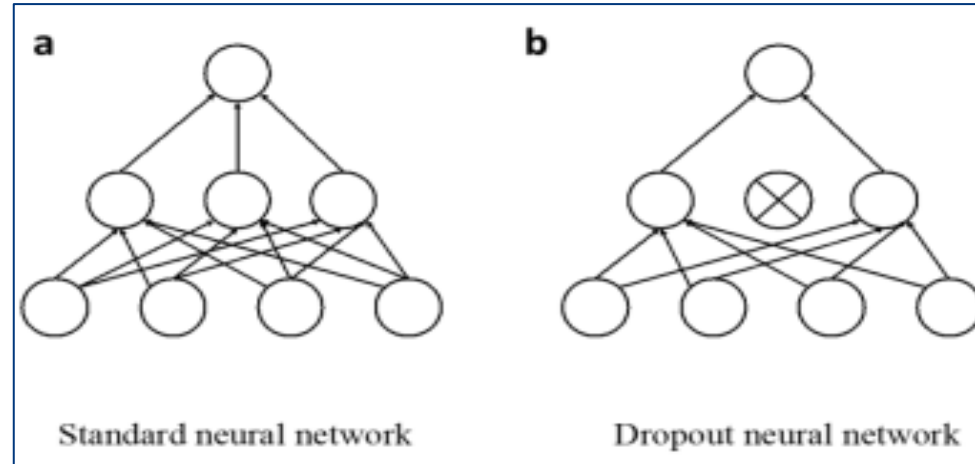
Samples were printed vertically & at 45degrees at varied laser speeds to induce defects



Micro-CT scans identified internal defects, while Surface Profilometry identified surface defects

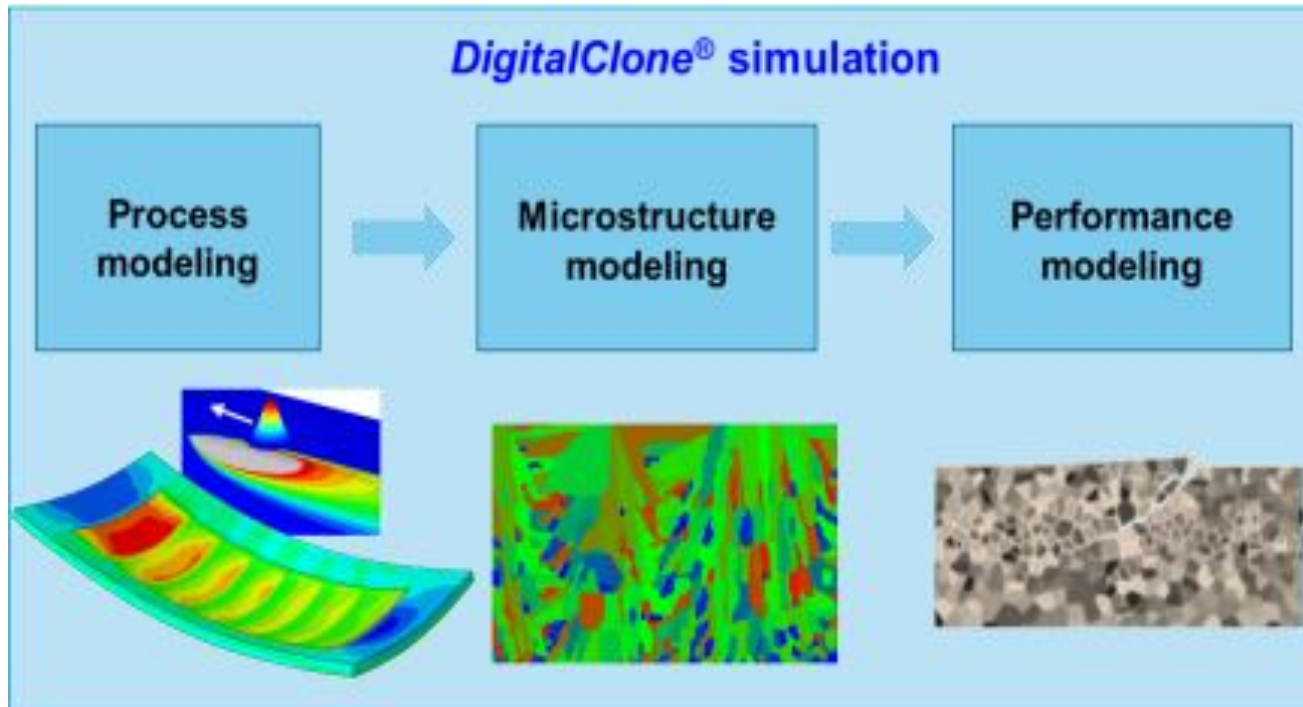
Drop-out Neural Net (DONN)

Drop-out neural network can be used as a surrogate model in regression or classification tasks and at the same time capture model uncertainty



A unified DONN was trained by adding surface descriptors as inputs using all data from both sets to predict logN of all samples.

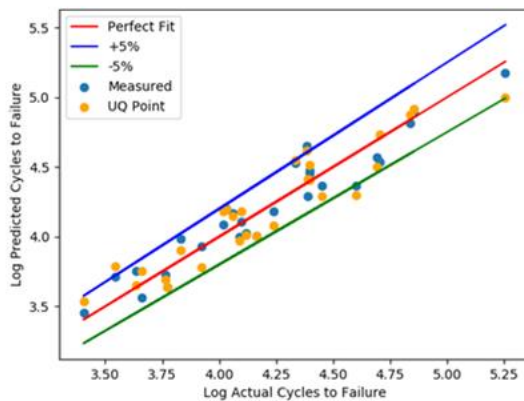
Physics-Based: DigitalClone for AM



Sentient uses its DC-AM model uniquely for Ti 6-4 alloy system made using the laser powder bed fusion process and apply this model to elucidate the relationship of process-microstructure-performance for this specific alloy system.

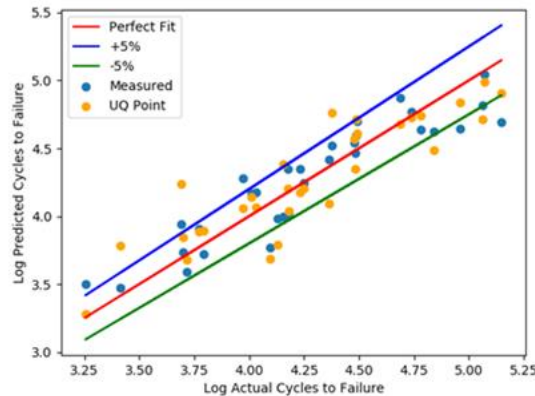
Python Machine Learning Model

UQ of input training data for Ridge



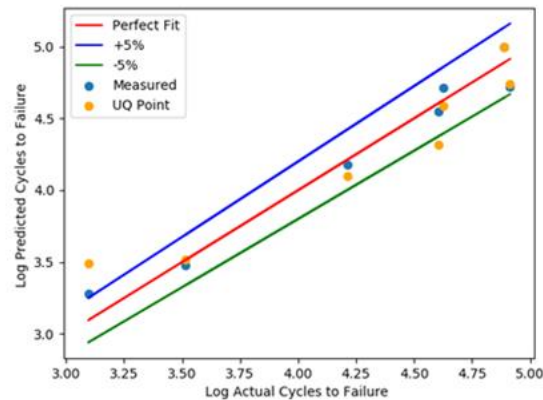
a)

UQ of input training data for Ridge



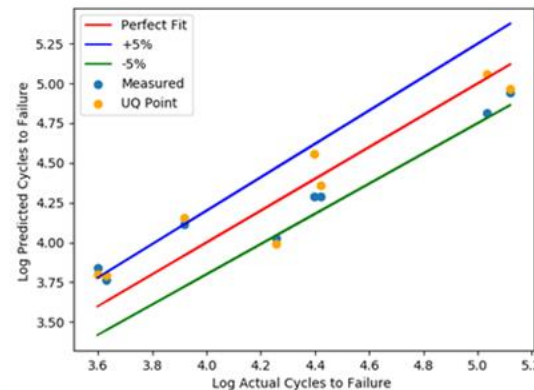
b)

Final Ridge Results of Data Withheld from Training Set



c)

Final Ridge Results of Data Withheld from Training Set

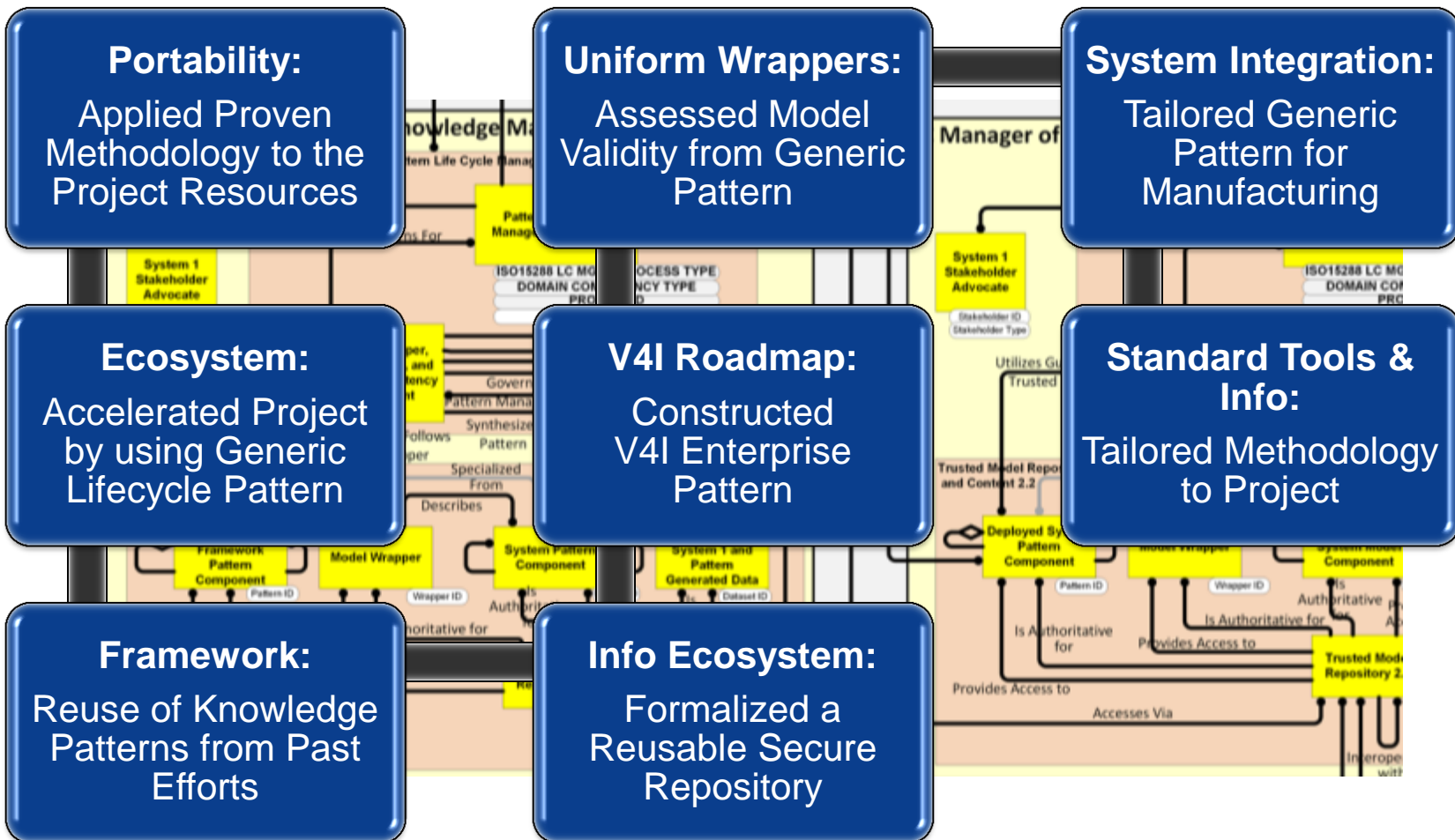


d)

The results of this work demonstrated that the ridge model was the best model out of all the fifteen model configurations examined.

Ridge function model results for machined LCF tests specimens for model development data and model test data respectively in the as machined condition (a and c) and as-built condition (b and d).

Project Deliverables (V4I Systems Framework)





Advanced Assurance in Manufacturing