

Topic: N152-109

## Sentient Science Corporation

Reliability Centered Additive Manufacturing Design Framework

Sentient Science is developing physics-based life predictions and inspection simulation software to provide a modeling framework to simultaneously optimize inspectability and reliability of Additive Manufacturing (AM) designs before they are finalized. Sentient Science is a technology leader in the field of life prediction simulation and prognostics and health management. Sentient Science's technology is leveraged to optimize the design of additive manufacturing parts in drive trains and structural components in military vehicles (ships, aircraft and land vehicles). Using this technology, AM parts achieve higher mechanical performance and better inspectability throughout the entire life-cycle. Sentient has more than 15 years of experience in microstructure modeling of different metallic alloys. Aerospace original equipment manufacturer (OEM) design teams leverage Sentient Science's modeling technology in redesign of existing parts or in new component design.

### Technology Category Alignment:

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**SYSCOM:** ONR

**Contract:** N68335-17-C-0156

 Corporate Brochure: [https://navystp.com/vtm/open\\_file?type=brochure&id=N68335-17-C-0156](https://navystp.com/vtm/open_file?type=brochure&id=N68335-17-C-0156)

**WHO**

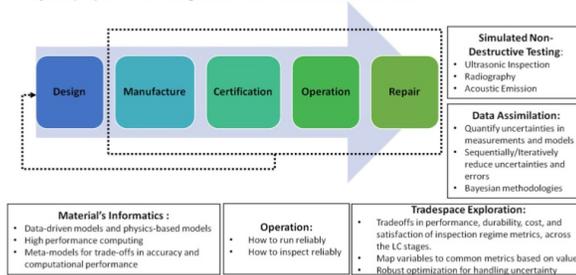
**SYSCOM:** ONR  
**Sponsoring Program:** Office of Naval Research Code 33

**Transition Target:** Future Naval Capability: Quality Metal Additive Manufacturing

**TPOC:**  
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**Other transition opportunities:** All Program offices will be interested if Sentient Science Corporation's approach can be leveraged to reduce weight and increase the performance of additive manufacturing (AM) parts. Sentient is engaged with leading Original Equipment Manufacturer (OEM) designers that are actively evaluating the design optimization capabilities provided by the current generation of DigitalClone Components, including industry leaders Boeing, Sikorsky Aircraft Corporation, Bell Helicopter, Rolls-Royce, Honeywell International, and Moog. These customers would likely be very interested in the Optimization module capability, as evidenced in letters of support from Boeing, Sikorsky, and Moog – and Sentient Science's partnership role assumed by Honeywell International

How is Reliability Assurance addressed throughout the Component Life-Cycle (LC) with the DigitalClone® Software Products?



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**WHAT**

**Operational Need and Improvement:** Sentient Science's DigitalClone Optimization module currently under development provides the baseline for a world-class design optimization tool. This will benefit the Navy and AM industry by providing a commercially-viable solution that enables simultaneous design optimization for both inspectability and reliability, a capability that ONR has indicated it finds lacking in the current market. As a result, the Navy will have access to a software solution that can be used by DoD and prime contractors during the design phase – allowing the Navy to implement procurement requirements that not only result in reliable products but also ones that can be more easily inspected by Navy field personnel.

**Specifications Required:** DigitalClone optimization tool will redesign the geometry of the part to:  
 - improve the inspectability of the part as defined by the Probability of Detection (POD)  
 - keep the mechanical performance the same or improve it

**Technology Developed:** The technology developed will be integrated into Sentient Science's DigitalClone technology suite, as a new module that will be called DigitalClone Optimization (DCO). The DCO module leverages innovative inspection simulation software and DigitalClone life expectancy technology to provide a capability for users to evaluate design options that enable simultaneous optimization for both reliability and inspectability, an industry first. Although DCO is expected to be primarily used by component designers, it is also highly likely to appeal to advanced operators (like the US Department of Defense) that have a vested interest in evaluating existing designs to determine whether improvements can be made that increase useful life and enhance the ability of inspectors to detect defects in the field.

**Warfighter Value:** In order to ensure the reliability of military weapon systems, especially during high loading environments (such as in the heat of the battle), stringent inspection requirements are occasionally established in critical structural components. Many times this inspections are not a trivial task, due to the complicated geometry or the detailed feature not designed for the proper inspection. Therefore, consideration of inspectability in the design process (before manufacturing the part) will noticeably make the inspection process more effective which ultimately reduces maintenance costs and ensures the reliability of our weapon systems.

**WHEN**

**Contract Number:** N68335-17-C-0156 **Ending on:** June 6, 2019

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Validate DCC stress and life analysis of AM samples	Low	DCC life prediction vs experimental fatigue testing	TRL-4	4th QTR FY18
Validate DCI inspection simulation module for AM samples	Low	DCI inspection prediction vs experimental inspection data	TRL-4	4th QTR FY18
Develop multi-objective optimization module (DCO)	Low	Propose a redesign of the geometry of the part, validated based on expert judgement	TRL-5	1st QTR FY19
Validate DCO module for AM samples	Low	Improvement of predicted inspection and life measures vs the experimental improvement for AM samples	TRL-5	3rd QTR FY19

**HOW**

**Projected Business Model:** Sentient's product is a physics-based software platform known as DigitalClone that uses microstructure-level analysis of the cumulative impacts of operating loads and conditions to forecast the life expectancy of mechanical components. The DigitalClone platform has a broad array of applications – to include design/process optimization, asset/fleet management, supplier comparisons, and sustainment planning. The set of modules that focus on additive manufacturing design/process optimization and analysis is called DigitalClone Optimization. To host the platform, Sentient has a partnership with Amazon Web Services (AWS) that ensures that the DigitalClone solution's infrastructure will meet even the most stringent cybersecurity requirements – such as those demanded by the U.S. government for DoD cloud-based solutions. The standard agreement with operators utilizing DigitalClone will be a 5-year (or longer) Long-term Agreement (LTA) that offers a fixed price annual subscription for access to DigitalClone.

**Company Objectives:** Sentient is interested in meeting with any Government Program office that is working on or with AM parts. Our initial target list includes both domestic and international existing customers that have ongoing AM initiatives and have already expressed some level of interest in our physics-based solutions:  
 OEM Designers: Sikorsky, Rolls-Royce, Bell Helicopter, Boeing, Airbus, Advanced Turbine Engine Company (ATEC)  
 Suppliers: Honeywell, Raytheon, General Electric  
 Operators: US Army/Navy/Air Force program offices, Defense Logistics Agency

**Potential Commercial Applications:** The five leading industries currently leveraging AM, that can benefit from Sentient's DigitalClone Optimization include Aerospace, Medical, Transportation, Energy, and Consumer Goods.