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Using Additive Manufacturing to Mitigate the Risks of Limited Key Ship Components of the Zumwalt-Class Destroyer

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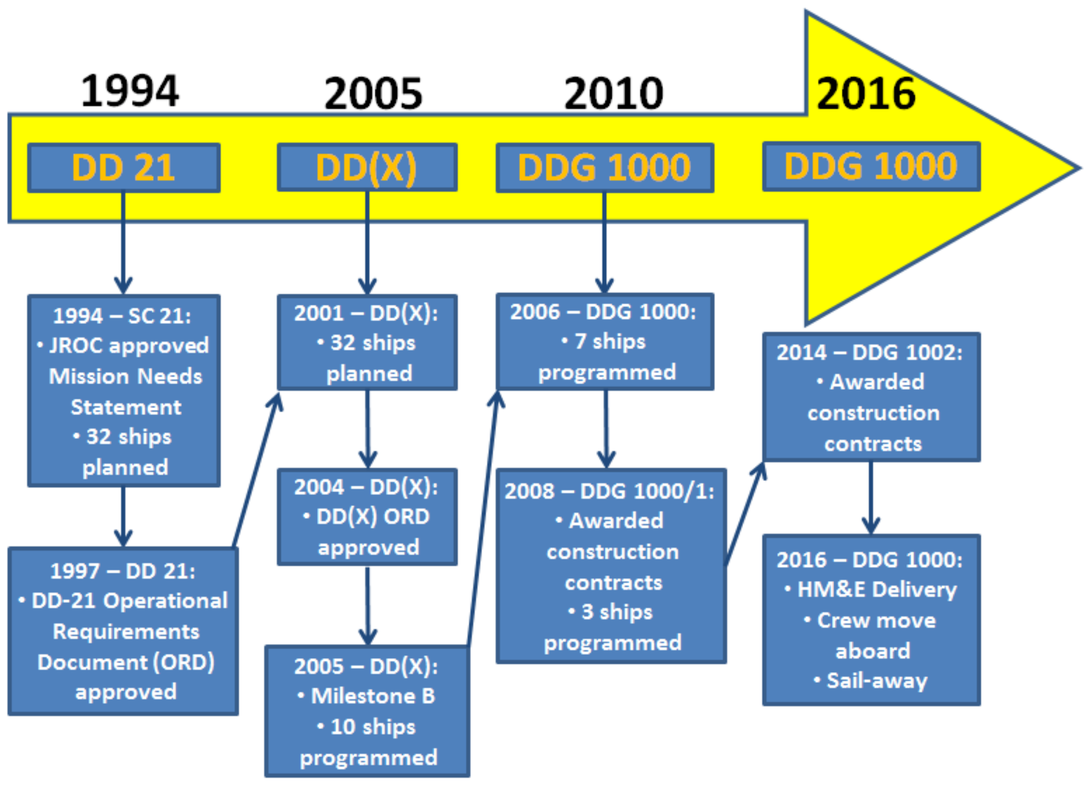
Abstract

The purpose of this project was to explore the benefits of using a combination of additive manufacturing (AM), Performance-Based Logistics (PBL), and Open Systems Architecture (OSA) to mitigate the risks of limited key ship components for the Zumwalt-class destroyer (DDG 1000) program. Specifically, this project was focused on current industry's capability for AM and the implementation of AM in the near future. Research was conducted in three phases. First, this research reviewed the problems and challenges within the defense industry. Next, this research reviewed the previous research on intellectual property (IP) concerns with AM (particularly, insourcing versus outsourcing) and the latest AM applications in the marketplace and defense industry. Finally, this research focused on DDG 1000 program documents, including the Acquisition Strategy (AS), the Life-Cycle Sustainment Plan (LCSP), and a Diminishing Manufacturing Sources and Material Shortages (DMSMS) analysis. By conducting a comparison of DDG 51 and DDG 1000 and analyzing an AM arrangement among Airbus, Systemanalyse and Programmentwicklung (SAP), and United Parcel Service (UPS), this research concludes that the government can use AM, with a properly structured PBL arrangement and OSA, to substantially mitigate risks, lower operation and support (O&S) costs, and effectively improve system readiness.



DDG 1000 Program History. Source: Program Executive Office (PEO) Ships (2016).

Methods

- First, we collected secondary data from articles, scholarly journals, and government research reports of PBL, IP rights concerns associated with AM, competition concerns associated with insourcing, and obsolescence management to gain insight into current strategy, process, and limitations in mitigating a limited supplier base.
- Next, this project researched the current capabilities and future impacts of AM within the commercial marketplace and defense industry, as well as the AM applications with the Department of Navy (DON).
- Then, we analyzed the Acquisition Strategy (AS) and Life-Cycle Sustainment Plan (LCSP) of DDG 1000 to see if the program has an adequate environment for implementing AM. We also analyzed the Navy Undersea Warfare Center (NUWC) Keyport's obsolescence analysis of DDG 1000's Improved Power Distribution Assembly (iPDA) circuit cards to present a new perspective on extending components' useful life and to mitigate the risk of a limited supplier base.
- This project then compared the operating environment between the DDG 51 and DDG 1000 class ships by identifying their similarities and differences. We ended with the analysis of a recent arrangement among Airbus, Systemanalyse and Programmentwicklung (SAP), and United Parcel Service (UPS) to investigate the possibility of a similar setup for DDG 1000.

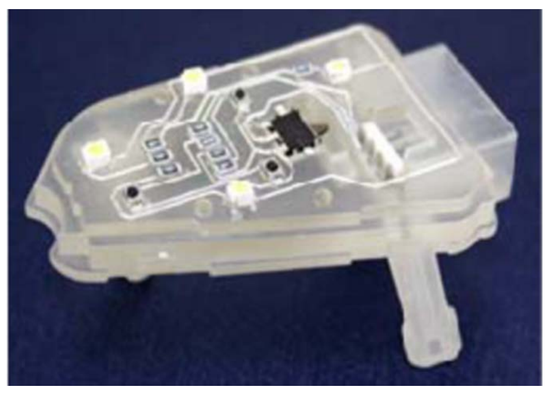
Results

- The DDG 1000 program can effectively mitigate the risks associated with limited supplier base for key Navy ship components by taking advantage of AM.
- AM makes Just-in-Time Manufacturing (JIM) for many critical components a reality and largely eliminates the need of lifetime buy, which enables the government to shift its focus from manufacturing in house to managing the support service.
- Coping with properly structured PBL contract and Open Systems Architecture Design, AM can also offer rapid design prototyping and system upgrading, making it easier to upkeep, update, and upgrade DDG 1000.

LEAP: The First Jet Engine with 3D-Printed Fuel Nozzles. Source: Kellner (2016)

First flight of a LEAP-Powered Airbus A320neo. Source: Kellner (2016).

The EBAM metal 3D printer at Lockheed Martin's manufacturing facility located in Littleton, CO.
Source: Grunewald (2016).



Fabrication of 3DCD Cruise Control Switch. Source:
Kim, et al., (2015).

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