

CONCEPT OF OPERATIONS EXERCISES HELP AVOID DESIGN ISSUES FOR DDG-1000 PROGRAM

The *Zumwalt* Class destroyer (DDG 1000) is a planned class of destroyers designed as multi-mission ships with a focus on land attack. The destroyer is being designed to require a smaller crew and be less expensive to operate than comparable warships.



DDG 1000 Design Concept

The DDG 1000 program has used 3D Computer Aided Design (CAD) modeling throughout its development to assist in the identification of [human systems integration \(HSI\)](#) issues early on by providing “fly throughs” of the design space well in advance of any construction. While this was useful up to a point, the HSI team identified the need for a low fidelity physical mock up to better evaluate design concepts with representative end-users. These “concept of operations exercises,” or COOPEXs, allow Sailors to participate in low fidelity prototype usability walkthroughs of ship and system designs to get early user inputs and to evaluate the design. The key concept was to use representative users, performing representative tasks.



DDG 1000 Bridge Mock-up

A full scale mock up of the proposed design of the entire ship's bridge was created in the Human Performance Laboratory at Naval Surface Warfare Center Dahlgren Division, and a COOPEX was conducted. Simulations of ship's motion and relationships to external objects were depicted via large screen displays positioned behind the bridge windows (providing a realistic environment). Active duty bridge officers were brought in to execute three scenarios: 1) harbor transit, 2) formation steaming, and 3) underway replenishment at sea (representative users, realistic scenarios). Data was collected to assess user needs for location of displays, content of displays, access to different areas of the bridge, communications requirements within and outside of the bridge team, work flow, seating requirements, etc. As a result of this COOPEX, 19 specific changes were made to the bridge design, including five which had structural impact. It is important to note that the evaluated design had previously undergone fleet review in the CAD models, indicating that CAD models are not sufficient to replace physical mock-ups.

COOPEX activities have provided an unprecedented level of insight into the relationship of ship designs and the associated impact on human activities or performance. Return has been realized in reduced technical and schedule risk (by identifying required design changes early enough to remedy technical issues and still integrate them into the total ship design), reduced acquisition cost by identifying design changes prior to approval of entry into the Engineering and Manufacturing Development phase (Milestone B) (and associated cost of late design changes), and the cost avoidance of rework associated to correct post initial operating capability fleet issues.

- **Cost Avoidance:** Cost avoidance for redesign and rework on the bridge layout and design alone is estimated at about \$22 million.
- **Human Performance and Manpower/Workload:** Mockups have provided the data necessary to validate the need for a third bridge watchstander under certain operational conditions, and the required skill set for that watchstander. This has a large impact on safety of operations and human performance.
- **Safety:** The exercise identified a number of structural members and elements that represented physical risks to the Sailor that were subsequently mitigated in the design.

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