A Vision for Ship Design and Analysis Tools

Mapping out a long-term strategy

BY NORBERT DOERRY

Vice Admiral Paul Sullivan, commander of the Naval Sea Systems Command, issued a memo on February 4, 2008 on ship design and analysis tool goals. With this memo, the United States Navy had, for the first time, clearly articulated its vision for how ship design tools and design methods should interact during the different stages of a ship acquisition. It includes:

a) Preference for tool development integrated with the leading edge architecture for prototyping systems (LEAPS) and the advanced ship and submarine evaluation tool (ASSET)

b) Recognition that design and analysis tool development efforts should include the collection or creation of experimental data to support verification, validation, and accreditation

c) Specific goals for design and analysis tools for pre-milestone A work:
- i) Enable the generation and analysis of hundreds of ship concepts to a rough order of magnitude (ROM) with a period of weeks or months
- ii) Be compatible with design of experiments, response surface, and set-based design methods
- iii) For ROM studies, accurately predict relative acquisition and lifecycle costs; the impact of emerging technologies and threats; the effect of emerging capabilities on the overall fleet architecture and the fleet capabilities; and the uncertainty of cost and performance predictions
- iv) Enable generating and analyze dozens of ship concepts to support analyses of alternatives within six months to include cost forecasts sufficient for developing program budgets and schedules; technology risks must be defined to a level to enable mitigation planning

d) Specific goals for design and analysis tools for preliminary and contract design:
- i) Enable informed decisions on subsystem tradeoffs
- ii) Reduce risk
- iii) Enable completion of a design iteration in 8 to 10 weeks
- iv) Have results equal to that achievable with physical modeling or prototyping

e) Specific goals for design and analysis tools for lifecycle support:
- i) Within hours, provide engineering analyses regarding the effects of damage, grounding, or other incidents
- ii) Facilitate modernization planning and design
- iii) Enable end-of-service life predictions
- iv) Measure effectiveness with respect to changing threats and tactics
- v) Support force structure studies.

These goals were re-affirmed by RDML Thomas Eccles, chief engineer and deputy commander for Naval Systems Engineering, Naval Sea Systems Command, in a memo dated September 29, 2010.

The impact of these memos on design tool development for ship design in the navy has been remarkable. ASSET has been re-architected to fully integrate with LEAPS. The computational research and engineering acquisition tools (CREATE) program embraced these memos in the development of the requirements for their ship design tool development. In support of the objectives cited earlier, CREATE-Ships is producing tools in the area of shock/damage response (NESM: navy-enhance sierra mechanics), hydrodynamics (IHDE: integrated hydrodynamics design environment; and NavyFOAM: navy field operation and manipulation), and rapid design and integration (RSDE: rapid ship design environment). CREATE is producing annual releases of these software programs to increase the number and complexity of use cases that can be analyzed.

The preference for tools development to more fully integrate with LEAPS has resulted in the latest LEAPS release (4.3), which includes the following:

- **LEAPS editor:** provides visualization and manual population/editing of the LEAPS database from

computer-aided design models, Microsoft Excel, and other tools

- **SHCP-L:** performs intact and damage stability analysis and provides 3D visualization of the results
- **ASAP Translator:** creates the input file to run ASAP-Lite (vulnerability assessment)
- **NCCM Translator:** creates the input file to run the navy common cost model (cost analysis)
- **LAMP Translator:** creates the input file to run LAMP (seakeeping analysis)
- **VERES Translator:** creates the input file to run VERES (seakeeping analysis)
- **SMP Translator:** creates the input file to run SMP (seakeeping analysis)
- **SWPE Translator:** creates the input file to run SWPE (resistance analysis)
- **TSD Translator:** creates the input file to run TSD (resistance analysis)
- **FKS Translator:** creates the input file to run FKS (resistance analysis).

The next release of LEAPS is anticipated to include an early manpower assessment tool (EMAT), which estimates manpower requirements based on preventative maintenance and watch standing requirements. EMAT populates manpower data back to ASSET when the estimation is complete. The LEAPS release also will incorporate intelligent ship arrangements, which uses the ASSET-generated LEAPS model as input, as well as a prepopulated constraints database to generate a 3D compartment arrangement of the entire ship.

Another outcome of these memos has been the development of a ship design process model. Early on, the navy recognized that to achieve the time goals outlined in VADM Sullivan's memo, a better understanding of the ship design process was needed. Steven Wynn described the creation of the ship design process model in the April 2011 issue of MT ("Design Process Improvement"). In addition to helping identify the priority of ship design tool development activities, this design process model is now being used alongside traditional planning processes in the planning for near-term ship design projects.

Much work still remains to accomplish the goals of these two memos. In an era of limited resources, the affordability, quality, and capability of our future fleet depend on ensuring that available funding for design and analysis tool development is wisely used to incrementally add capability in a manner consistent with a long-term vision. These memos have served well in providing that vision. **MT**

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