



Computational Research Engineering Acquisition Tools and Environments

A DoD Program to Aid Acquisition Engineering



Computational Research and Engineering Acquisition Tools and Environments (CREATE)

CREATE is a multi-phase program that started in 2008, to develop and deploy four (now five) computational engineering tool sets for acquisition engineers

- **Aircraft (AV) Design Tools:** Fixed-wing aircraft, rotorcraft, conceptual design, trade-space exploration and operational testing and transition
- **Ship Design Tools:** Shock/damage, hydrodynamics, early-stage design & trade-space exploration, and operational testing and transition
- **Radio Frequency (RF) Antenna Design and Integration Tools:** Conceptual design and detailed analysis tools relevant to virtually all DOD platforms
- **Ground Vehicles (GV) Tools:** End-to-end mobility solver, provide rapid, physics-based data for design and trade-space analysis
- **Meshing and Geometry (MG) Support:** The geometry and meshing project improves the ease, speed, flexibility, and quality of geometry and mesh generation, and enables the generation of CAD-neutral digital representations and product models of weapons systems & platforms and operational terrains and environments



CREATE
Computational Research and Engineering Acquisition Tools and Environments

CREATE-AV

Aircraft (AV) Design Tools

CREATE-SHIPS

Ship Design Tools

CREATE-RF

Radio Frequency (RF) Antenna Design and Integration Tools

CREATE-GV

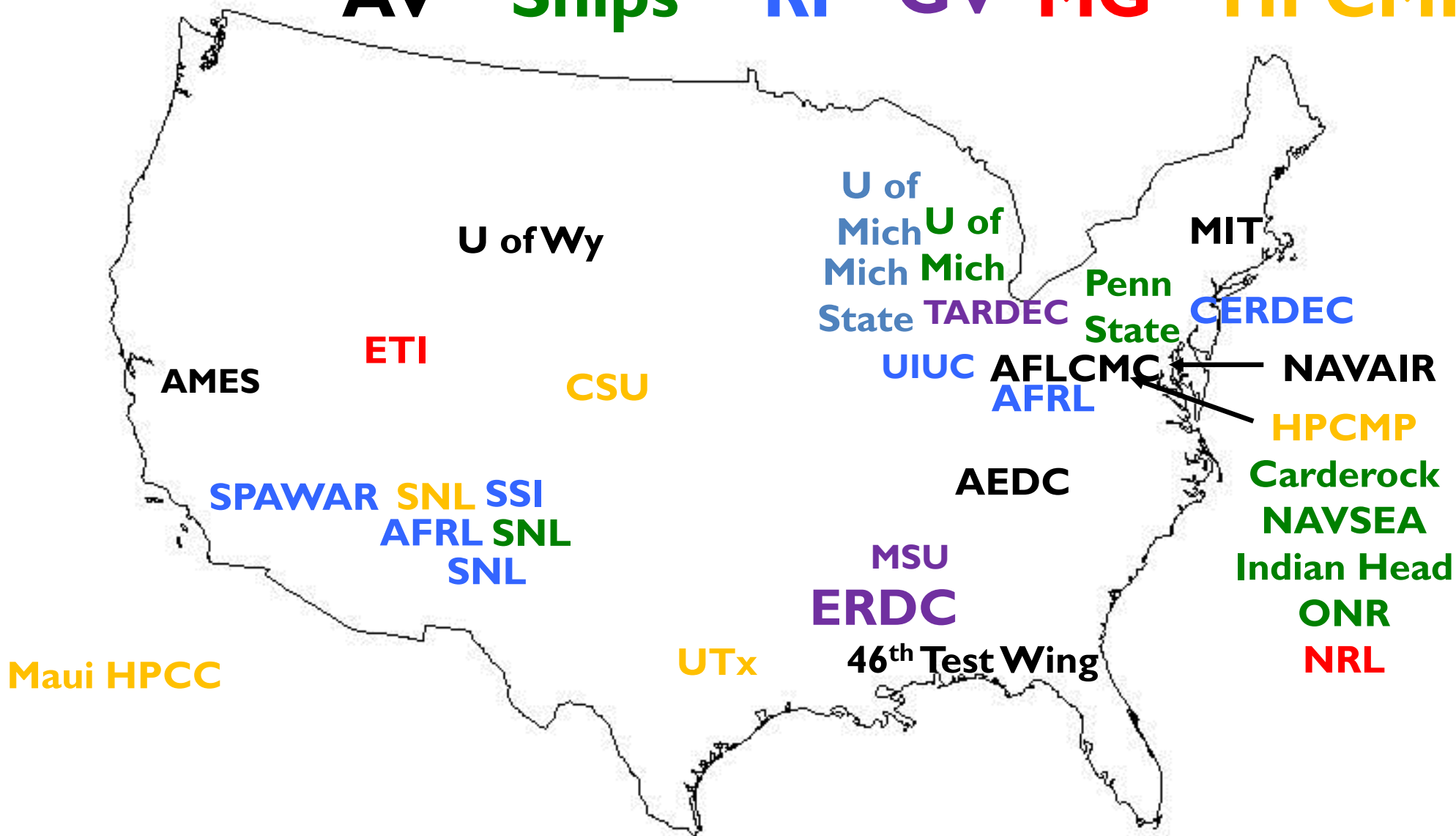
Ground Vehicle Design Tools

CREATE-MG

Meshing and Geometry (MG) Support

CREATE has 13 development teams ~30 distributed development groups

AV **Ships** **RF** **GV** **MG** **HPCMP**

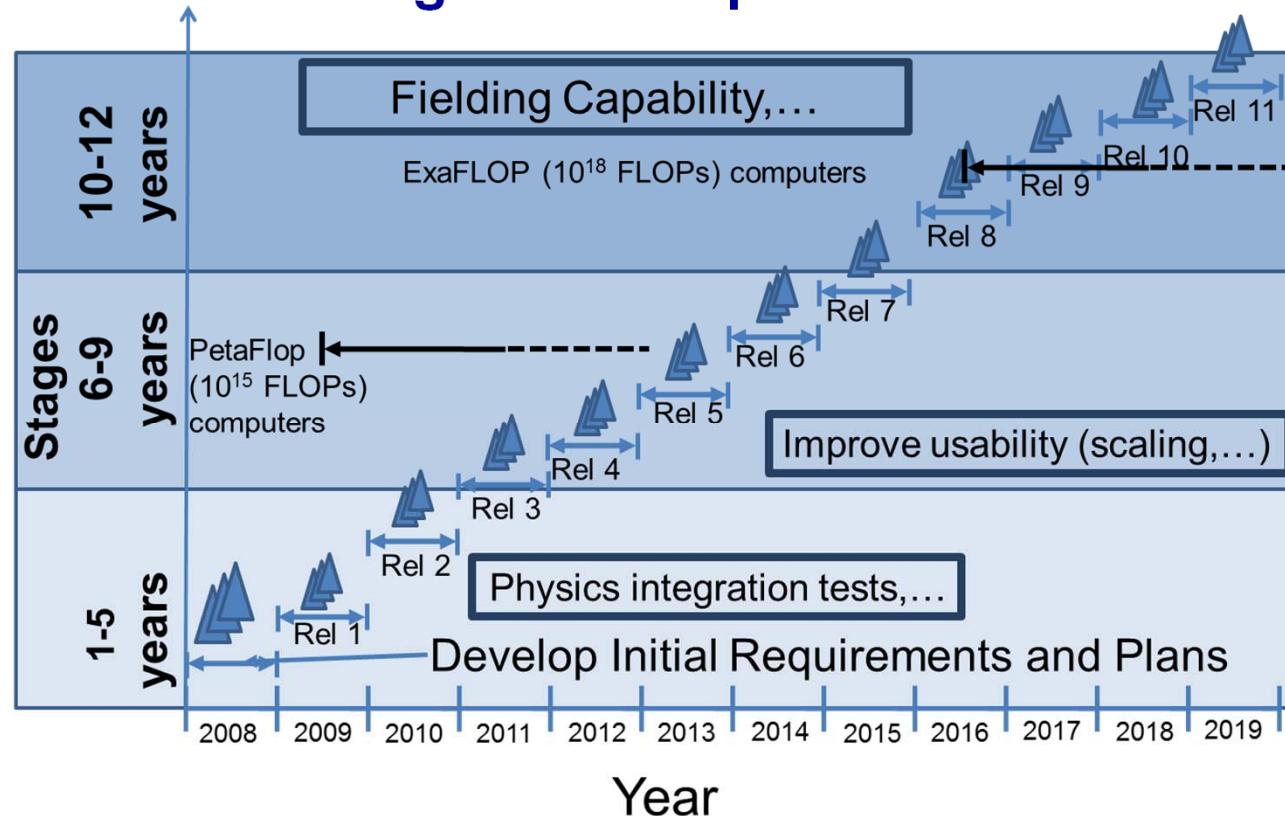


Build the Right Software, and Build it Right!

- **Software built by government-led teams of 5 to 10 staff**
 - Embedded in customer institutions
 - Oversight by customer institutions
- **Highly Disciplined, but agile Software Development Processes**
 - Strong emphasis on software quality
 - Supportive code development environment—virtual clusters, central servers and code repository, dedicated high performance computers...

Annual releases of each product following a roadmap

- Increased capability annually
- Extensive beta-tests of each release
- Rigorous V&V process
- Improved scalability for massively parallel computers
- Improved usability
- Responsive to evolving requirements
- Extensive documentation



CREATE Tools are now being used by over 110 DoD organizations to assess the performance of more than 70 DoD Weapon Systems



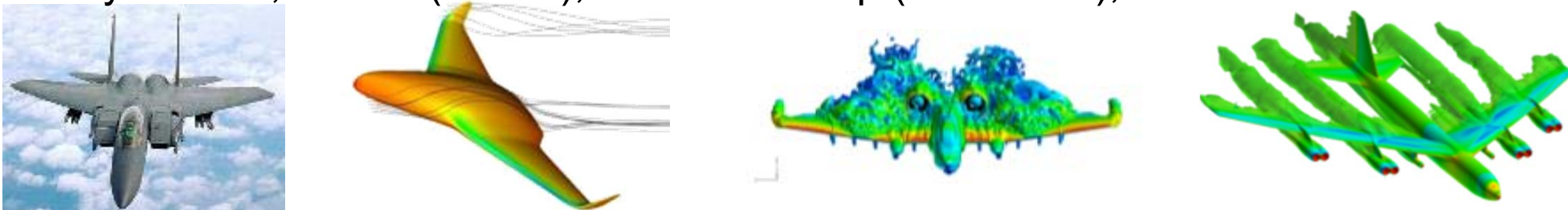
NAVSEA: DDG-1000 Destroyer, the CVN 78 and 79 Aircraft Carriers, and the Ohio Submarine Replacement and the LX(R) programs.



NAVAIR: Aerostar & Raven UAVs, F/A-18E, E-2D



Army: UH-60, CH-47 (ACRB), Guided Airdrop (RDECOM), V-22



AF LCMC: F-15 SA/DB-110, Strategic Airlift CP&A, A-10, B-52

Distribution A: Approved for Public release; distribution is unlimited.

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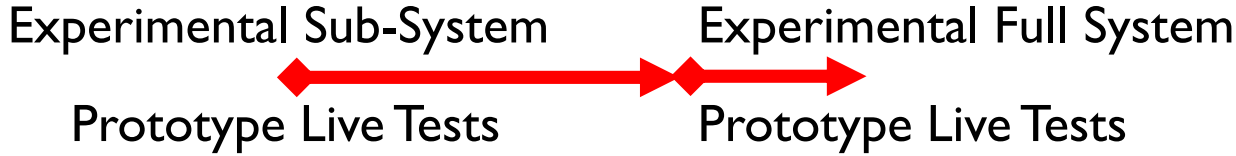
CREATE 6 Projects: 13 Multi-Physics Software Tools

- **Ships—CREATE-Ships**
 - Rapid Ship Design Environment (RSDE) - Rapid Design and Synthesis Capability
 - Navy Enhanced Sierra Mechanics (NESM) - Ship Shock & Shock Damage Assessment
 - NAVYFOAM - Ship Hydrodynamics — predicts hydrodynamic performance
 - Integrated Hydro Design Environment (IHDE) - Facilitates access to naval design tools
- **Air Vehicles—CREATE-AV**
 - DaVinci - Rapid conceptual design
 - Kestrel - High-fidelity, full-vehicle, multi-physics analysis tool for fixed-wing aircraft
 - Helios - High-fidelity, full-vehicle, multi-physics analysis tool for rotary-wing aircraft
- **RF Antenna—CREATE-RF**
 - SENTRI - Electromagnetics antenna design integrated with platforms
- **Ground Vehicles—CREATE-GV**
 - Mercury- High-fidelity, full-vehicle, multi-physics analysis tool for ground vehicles
 - MAT-Analysis Tool
 - GVI-Server interface to library
 - ES-Software library
- **Meshing and Geometry—CREATE-MG**
 - Capstone - Components for generating geometries and meshes needed for analysis
- **HPC Portal—Secure access to computers through a browser**

CREATE Tools Provide Access to “Test Data,” Decision Data Early in the Acquisition Process

Paradigm Shift

A new process:
Complement Live Testing with
Analysis of Virtual Prototypes



Concept Development			Engineering Development			Post Development	
Needs Analysis	Concept Exploration	Concept Definition	Advanced Development	Engineering Design	Integration & evaluation	Production	Operation & Support

Physics-based Computing Tests of **Virtual Prototypes** — Moves “Testing to the Left (and Right)”

Virtual Integrated Prototyping Environment



- Replaces “rule-of-thumb” extrapolations of existing designs:
 - with physics-based generation of design options for rapid trade-space exploration and physics-based analysis tools that assess the feasibility of the design options
- CREATE replaces “failure data from live tests” with “predictions of virtual prototype performance,” providing timely decision data that identifies design flaws and performance shortfalls early, allowing them to be fixed before metal is cut

Karem



AVX



Bell

Sikorsky/
Boeing

- JMR is the Army's science and technology effort for the Future Vertical Lift (FVL) program of record
 - FVL goal is to field speedy, long-range successors to the Army's helicopter fleets
- In June 2014, Army engineers used CREATE-AV Helios to help evaluate the full-vehicle aeromechanics designs from the four initial JMR industry partners
- The Bell and Sikorsky/Boeing designs were chosen to move forward to technology demonstration in 2017
- Government and US industry engineering teams are currently using Helios to model performance and interactional aerodynamics effects for both of these designs

CREATE Has Defined Core Software Engineering Practices for DoD Physics-based HPC Engineering Software Applications

Development Team

1. Lean (<10-15), close-knit development teams led by technical experts.
2. Transparency in development across CREATE projects.

Customer Focus

3. Oversight by senior stakeholder and user representatives.
4. Pilots to solicit customer reaction and feedback.
5. Frequent reporting to stakeholders.

Technical Maturity

6. Proven technologies and customer-defined use cases.
7. VVUQ in alignment with NRC (NAS/NAE) best practices for scientific codes.

Development Methods

8. Milestone-driven workflow management with agile flexible workflow execution and annual releases.
9. Configuration management.
10. Code builds based on tests.
11. Adequate code documentation.

Requirements Definition

12. Reliance on prototypes and use cases to define requirements.

CREATE Summary

- Developing and deploying tools with the desired new features for the DoD Air Vehicle, Ship, and RF acquisition engineering communities
- Acquisition engineering community interest and customer use growing exponentially
 - CREATE tools now in use by over 110 DoD acquisition engineering organizations (government, industry and academic)
- Continuing to contribute to the analysis and design of more than 80 important DoD systems
- Major progress in major challenges: user support, intellectual property, deployment capability, software engineering, ...
 - ⇒ On tract to achieve key goals → provide DoD acquisition engineering communities (government and industry) a new process to enable them to reduce risk, cost, time and rework and to improve system performance
- A key enabler of the DoD Engineered Resilient Systems and the AF Digital Thread & Digital Twin Programs and potentially a key enabler of the DoD T&E community Virtual Proving Ground Initiative.
- And developing CREATE tools for Ground Vehicles design and analysis

BLUF

- **CREATE is a set of physics-based HPC engineering tools to enable the DoD to develop innovative weapon systems.**
- **CREATE tools enable generation and analysis of virtual prototypes of DoD Air Vehicles, Ships, and RF antennas, and in the future, Ground Vehicles, and can accurately predict their performance.**
- **CREATE tools are:**
 - Government-developed, government-owned, and government-supported to enable the DoD to independently evaluate contractor deliverables.
 - Designed for a ~30 year+ life cycle.
 - Being adopted by DoD acquisition engineering communities (government and industry) and are beginning to have significant impact.
 - On the verge of being adopted by Defense Industry for commercial use.
- **CREATE Tools are enabling the DoD Engineered Resilient Systems and AF Digital Thread/Digital Twin Programs and can improve the effectiveness and efficiency of DoD T&E enterprises by enabling their Virtual Proving Ground (VPG) concept.**

116 DoD Organizations use CREATE Tools



HCPMP CREATE™ Ships: (38) Allion Corporation, Cardinal Engineering, DRS Corporation, DYNAFLOW Corp, **General Dynamics/Electric Boat Division**, Hi-Test Laboratory, **Northrop Grumman Corp Undersea Systems**, Classified Program NSWC Carderock Code 65, Classified Program NSWC Carderock Code 66, Naval Underwater Warfare Center, Sandia National Laboratories, Weidlinger & Associates, General Dynamics Land Systems, Hydromechanics Division Naval Surface Warfare Center Carderock Division, Bath Iron Works (shipyard), BMT-Syntek, Bollinger (shipyard), Booz Allen Hamilton, CSC (NAVSEA/PEO engineering contractor), DRS (NAVSEA/PEO engineering contractor), Gibbs and Cox (NAVSEA/PEO engineering contractor), **Hill (Newport News and Pascagoula shipyards)**, **Lockheed Martin**, NASSCO (shipyard), NAVFAC (Naval Facilities), **Northrop Grumman**, Office of Naval Intelligence, University of Michigan, US Army Corps of Engineers, US Coast Guard, MIT-Department of Naval Architecture, NSWC Carderock Division, Center for Innovative Ship Design, US Coast Guard and Coast Guard Academy, Texas A&M, Naval Postgraduate School, U. of Washington, Virginia Tech, Georgia Tech

HPCMP CREATE AV: (32) AFLCMC/EN, AFLCMC/XZ, AFAEDC, AFSEO, AF Edwards, AF Hill, AF Holloman, AFRL, NAVAIR/4.3, NAVAIR/4.10, NAVAIR/Carderock, Army/ADD (Moffett Field), Army/AED (Redstone Arsenal - Aviation), Army/SSDD (Redstone Arsenal - Missiles), Army Research Laboratory (ARL), Army/Nadick Soldier Systems Center), AF Academy (USAFA), AF Institute of Technology (AFIT), USNA, GaTech, BYU, NASA ARC, **Boeing Philadelphia/Mesa (Helicopters)**, **Boeing St Louis (Fixed-Wing)**, **Lockheed-Martin**, **Northrop-Grumman**, **Raytheon**, **Sikorsky**, **Bell Helicopters**, Textron, Karem Aircraft, Inc, Mercer Engineering, and Bihrl Applied Research Company

CREATE RF: (41) A&E Partnerships, Air Force Institute of Technology, ATK, **Ball Aerospace**, **Boeing**, Cobham Defense Electronics, **General Electric**, Georgia Tech Research Institute, **Harris Corporation**, **Lockheed-Martin**, MIT Lincoln Lab, **Pratt & Whitney**, **Raytheon**, **Leidos**, Rolls-Royce / Libertyworks, Signature Solutions, Inc., **Sikorsky Aircraft Corp.**, TechFlow, MITRE Corporation, The Ohio State University, **Northrop-Grumman**, University of Dayton Research Institute, Vencore, DoD Missile Defense Agency, Navy SPAWAR, Integrity Applications Inc (Pacific DS), Navy NAVAIR, U.S. Army Research Lab, Navy's Center of Excellence for Information Operations, AFRL Aerospace Systems Directorate, Aerospace Testing Alliance, NSWC-Carderock West Bethesda, Nation Air and Space Intelligence Center, Naval Research Lab, Army CERDEC, USAF AFMC AFLCMC/XZE, Naval Surface Warfare Center, Sotera, Michigan State University, NASA - Langley, NASA - Glenn

MG: (5+ CREATE AV, Ships and RF) Navy Research Lab (NRL)/ Low-Frequency Broadband (LFBB) Program, NRL/ Strategic Environmental Research and Development Program (SERDP), NRL/ Jet-noise reduction program, Engineering Research and Design Center(ERDC)-CREEL: Unattended Ground Sensors Programs, ERDC-ITL: Terrain Modeling