NDIA #19693: Program Management in HPCMP-CREATE™ (A Family of Large-scale, Physics-based, System-of-Systems, Software Development Projects)

An Application of Risk-based Management Practices in Software Development


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Program Management in CREATE

If you were starting a new
- distributed,
  - physics-based,
    - system-of-systems
      - HPC-capable
DoD software development project

How would you manage it for long-term success?

…based on the CREATE experience
Program Management in CREATE

Why should you have confidence in the staying power of CREATE?
Start by Recognizing that Software Development is a Risky Enterprise

Gov’t Software: A Legacy of Risk Management Failure!
Examples of Failure Similar to CREATE

- DOE ASCI (Multi-Physics, HPC) < 50% Success

CREATE-Scale Project Cancelled
1. Creating and inventing new, innovative software technologies within the existing DoD program and project management structure.

2. Loss of credibility due to defects or insufficiently accurate models in the software that result in inaccurate results.

3. Building and managing software development teams that are embedded in, and part of, the DoD customer organizations.

4. Significant losses of core development staff and their corporate knowledge, due to severe funding reductions and other institutional turmoil.

5. Program coordination within the diverse management cultures especially security management—within different DoD organizations.

6. Requirements creep and relevancy over the project’s major development phases.

7. Rapidly changing computational and computer technologies especially rapidly changing computer architectures and environments.

8. Loss of DoD stakeholder and sponsor support due to frequent turnover of senior DoD personnel.

9. Loss of control of intellectual property rights in the absence of domestic copyright protection.

10. Supporting CREATE software users without impacting development.
CREATE Risk Management Principles
Addressing the Core Risks

- Develop a compelling, credible vision and endeavor to communicate it.
- Develop a long-term strategic plan and define the essential processes required to execute it.
- Recruit the right team leaders and strong, multidisciplinary teams.
- Balance the need for development team empowerment with the need for accountability.
- Recognize that program management must extend to the risks most outside its control: stable funding, stakeholder support and deployment to customers.
- Protect the development effort from institutional turmoil.
- Implement a rigorous verification and validation program.
The CREATE Approach: Principles to Practices to Mitigate Risk

"Principles" translated into shared "Practices", as opposed to "Processes", best fit the need for flexibility for CREATE operating within the three Armed Services

Notional Home Ground Chart for CREATE

Risk 1: Challenge of developing new, innovative software within the DoD Program Management structure

- Mitigating Practice: Strive for flexible execution with risk-mitigating milestones

CREATE Disciplined Agile

Hacker or Hero? Scrum CMMI Level II Practices Adaptive Methods Milestone/Risk Milestone/Plan Micro-managed Milestone

Agile Methods CMMI Software Methods

CMMI Process Improvement

*after* Boehm, “Getting Ready for Agile Methods with Care”, IEEE Software, 2002

CREATE Development Approach: A Disciplined Agile Workflow Management Approach based on Scrum
Risk 2: Loss of credibility
due to software defects or inaccuracies

Mitigating Practice: Implement a testing program compliant with National Research Council Guidelines; strive for continuous integration with automated regression tests for each commit, and test coverage measurements.

Regression testing after every commit

CREATE-RF Continuous Integration Platform

Discover problems before they are hard to fix
Risk 3: Difficulty building software teams under DoD constraints

- Mitigating Practice: *Identify a principal developer within customer organizations (in CREATE’s case, the Services)*
- Mitigating Practice: *Recruit lean (5-15 member) development teams lead by technical experts (typically from the DoD S&T community)*
Risk 4. Funding Reductions

- **Mitigating Practice:** Reach out to the customer with Pilot Projects that demonstrate value

  1. Identify Key Acquisition Processes (AP’s)
  2. Identify Products of AP’s
  3. Breakdown AP Workflows (WF’s)
  4. Identify HPC Insertion Points into WF’s
  5. Identify HPC Analysis Capabilities required to improve AP WF’s
  6. Prioritize and Group analysis capabilities
  7. Select Groups that represent greatest impacts to acquisition for HPC software development under CREATE-AV
  8. Build mechanisms for CREATE-AV software to impact targeted AP’s

This helps demonstrate value and promotes customer commitment.
Risk 5: Difficult program coordination in an environment of diverse management cultures—especially security-related

- Mitigating Practice: Establish browser access to CREATE software and support

- Secure access without downloading software

- 2-factor authentication
- Encryption in transit and at rest
- Separate subnet
- Single-sign-on
Risk 6: Requirements creep and product relevancy

Mitigating Practice. Express requirements as use-cases in language that customers and developers both understand.

CREATE-Capstone Foundational¹ Capability Requirements

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MG-00</td>
<td>Import Externally Generated Geometry (CAD, IGES, STEP)</td>
</tr>
<tr>
<td>MG-01</td>
<td>Create Parameterized Geometry</td>
</tr>
<tr>
<td>MG-02</td>
<td>Support Dependency-Based Associative Modeling</td>
</tr>
<tr>
<td>MG-03</td>
<td>Repair Externally Generated (eg CAD) Geometry</td>
</tr>
<tr>
<td>MG-04</td>
<td>Support De-featuresing and Idealization of Geometry</td>
</tr>
<tr>
<td>MG-05</td>
<td>Provide Robust Surface Meshing Algorithms</td>
</tr>
<tr>
<td>MG-06</td>
<td>Provide Robust Volume Meshing Algorithms</td>
</tr>
<tr>
<td>MG-07</td>
<td>Provide Geometry-based Mesh Generation and Adaption</td>
</tr>
<tr>
<td>MG-08</td>
<td>Support Multi-scale Models</td>
</tr>
<tr>
<td>MG-09</td>
<td>Support Legacy Component Integration</td>
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<tr>
<td>MG-10</td>
<td>Support Analysis Model Attribution</td>
</tr>
<tr>
<td>MG-11</td>
<td>Provide Accurate and Scalable Runtime Geometry</td>
</tr>
<tr>
<td>MG-12</td>
<td>Core Framework (Internal requirements to support all of the above)</td>
</tr>
</tbody>
</table>

MG-06 Use-Cases

- **MG-06-UC-01**: Unstructured all-tetrahedral volume meshing
- **MG-06-UC-02**: Unstructured hexahedral-dominated hybrid meshing
- **MG-06-UC-03**: Boundary Layer meshing with triangular wedge elements in the viscous region transitioning to tet. No interference from other BL.
- **MG-06-UC-04**: MG07-UC04 with complex geometries and multiple intersecting boundary layers
- **MG-06-UC-05**: Boundary layer meshing with hex, prism in the viscous region transitioning to hex/tet
- **MG-06-UC-06**: MG06-UC05 with complex geometries & multiple intersections
- **MG-06-UC-07**: Volume mesh handling for high order element (first approach)
- **MG-06-UC-08**: Matching volume meshes for periodic boundary condition
- **MG-06-UC-09**: Exterior volume meshing up to a given truncation boundary
- **MG-06-UC-12**: Support for strand-meshing paradigm

The focus is on shared understanding of requirements

¹ Established in 2008
Risk 7: Anticipating and responding to rapidly changing HPC environments

Mitigating Practice: Ensure that the CREATE program maintains an awareness of evolving state of the art in high performance computing

Example: CREATE Technology Partnerships with SNL

+ Exascale rising!
Risk 8: Loss of sponsor support due to frequent turnover of senior DoD personnel

• Mitigating Practice: Continually reach out to new senior- and middle-level members of the DoD acquisition engineering community.

Examples of Outreach:
• 3 BAAs or CRADAs
• 60+ CREATE Pilot Projects
• Dozens of training courses
• 100’s of technical articles (45+ in 2016 alone)
Risk 9: Loss of control of IP rights

• **Mitigating Practice:** Require a standard software distribution agreement (a license for use).

  - Recipient has no right to receive, use or examine any source code or design documentation relating to the Product, except as specifically authorized by approved collaborative development and source code agreements. HPCMP retains all right, title and interest in the Product and any portion thereof and in all copies, modifications and derivative works of the Product and portions thereof including, without limitation, all rights the Government may have to patent, copyright, trade secret, trademark and other proprietary or intellectual property rights. Recipient has no rights, by license or otherwise, to use, disclose or disseminate the Product, in whole or in part, except as otherwise expressly provided herein. Recipient may not use any name, mark or designation of the Product except for the express purposes in this Software User Agreement.
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• **Practice:** Acquire the necessary rights (DFARs) in contracts and licenses.
Risk 10: Supporting CREATE users without impacting product development

- Mitigating Practice: *Look for scalable self-help solutions, like Web Forums*
CREATE Program Management

What has made it work?

• Leadership beyond program management
• Balance between developer freedom and responsibility
• Embedded in CREATE’s primary customer organizations
• Customer-defined use-cases
• Frequent product releases
• Browser-based access and Customer Forums