NDIA 21320: HPCMP CREATE™ as an Early Example of a DoD “Software Factory”
This Presentation will address:

CREATE as an early example of the DoD “Software Factory” Concept:

- What is a “Software Factory?”
- Why is it important?
- The early CREATE Example
The Defense Science Board (DSB) defines a "Software Factory" as:

- A small software development team (5-15 members)
- Supported by an *highly automated* development infrastructure (development tools, computers, networks, storage devices, etc.)
- Focused on *continuous, iterative* product development using *Agile development practices*
Commercial Software Factory*

* Graphic from DSB Report, Feb 2018

Distribution A: Approved for Public release; distribution is unlimited.
Continuous, Iterative Software Development

Not this

DoD Software Process (Waterfall)
[Focus on end product]

1. Document requirements, plan, schedule, cost
2. Preliminary design review of system design
3. Write the software, measure progress using SLOC
4. User acceptance testing; measure defects found/solved

Release the product to users

(5-7 years)

But this

Commercial Software Process (Continuous Iterative Development)
[Focus on series of MVPs]

1. Create ranked feature list, system architecture
2. Set goals of 1st sprint to implement top features
3. Coding: team dynamically adjusts goals based on daily build/test & weekly evaluations
4. Revise code based on peer review and test findings. (Engage users in this process if possible.)
5. Develop parts of minimum viable product (MVP) that can be tested with users
6. Set goals for next sprint

Release MVP to users

Continuous Development Process (~6 week loop)

Nightly Build

After DSB Report, Feb 2018
Model 3: Incrementally Fielded Software Intensive Program
Why is this Important?

Software Drives ~60% DoD Program Risk (after DSB report)

* Graphic from DSB Report, Feb 2018

A hint of immortality!

F-35 Lightning II Block 3F est. (2017)

Airborne Software

SLOC in thousands

32,000
30,000
28,000
26,000
24,000
22,000
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0

F-16A Block 1 (1974)
F-16D Block 60 (1984)
P-3C (1996)
F-22 Raptor (1997)
F-35 Lightning II (2006)
F-35 Lightning II Block 2B (2016 AF IOC)
F-35 Lightning II Block 3F est. (2017)
The Commercial Case for Agile Development

A meta-survey* of 29 studies (of 300 analyzed) concluded the following return on investment:

- 29% lower cost
- 91% better schedule
- 50% better quality
- 400% better job satisfaction

* David Rico, “What is the ROI of Agile vs. Traditional Methods”
CREATE began to establish “Software Factories” in 2008

A Multi-Institutional, Multi-Organizational, Distributed Program

CREATE Software Factories

- Ships Project
  - Project Manager: HPCMP Lorton
  - NavyFOAM: NSWC, Carderock
- Integrated Hydro Design Environment
  - NSWC, Carderock
- Navy Enhanced Sierra Mechanics
  - NSWC, Carderock
- Rapid Ship Design Environment
  - NSWC, Carderock
- Air Vehicles Project
  - Project Manager: HPCMP, Lorton
  - Kestrel: 46th Test Wing, Eglin AFB
  - Quality Assurance: NAVAIR, Patuxent River
  - Helios: Army AFDD, Ames
- RF Antennas Project
  - Sensors Directorate, AFRL, WPAFB
  - SENTRI: Sensors Directorate, AFRL, WPAFB
- Meshing & Geometry Project
  - Project Manager: Navy NRL
- Ground Vehicles Project
  - Project Manager: Mercury ERDC
  - MAT TARDEC

CREATE Personnel Totals
- IPA: 5
- Gov’t: 79
- DOE: 2
- Contractors: 94
- Total*: 180

*Total includes IPA, Gov’t, DOE, Contractors, and Sub-contractors.
The CREATE Infrastructure

From the beginning CREATE embraced an extended view of the CREATE Product

DSRC Servers, incl Common Build Servers

DREN

HPC Portal

Core: CREATE executables

Help customers see this

Developers focus on this

Ensure that Customers see the “whole” product
The CREATE Approach to Agile Development

The CREATE Approach—"Disciplined Agile" based on Scrum

Our approach couples flexibility with accountability

Figure after info@matrix-soft.org
Software Factory Software Infrastructure*

Comparison of DSB Software Factory with HPCMP/CREATE Version of Software Factory

HPCMP/CREATE operating capabilities are highlighted in red

- Configuration management software (e.g., Puppet, Chef, Ansible) Git, SVN
- Continuous Integration (build and test) Systems (e.g., Travis CI for hosted service, Jenkins for open source application) Jenkins
- Scripts and code used to release software (e.g., Python scripts) Python, PERL,...
- Servers, network or other infrastructure that support release tools CREATE Server, Portal, and Continuous Build Server
- Software and tools to support developer self-service operations (NewRelic for application performance over time, diagnostic tools, monitoring) TotalView, Tau, Valgrind,...
- External test frameworks (e.g., Jersey Test Framework, Testplant/Eggplant) SCCI (Jenkins add-on), and Home Grown Tools
- External operational monitoring and log mining tools (e.g., Splunk, Elasticsearch + Logstash + Kibana (ELK) Stack) Splack,...
- Source code repositories (e.g., Github for hosted service, GitLab for open source application) Github, Redmine, SVN,...
- Issue tracking systems (e.g., JIRA, Trello, GitHub) JIRA, Github
- Container driven tools (e.g., Docker, Elastic Container Service (Amazon Web Services (AWS)), (Kubernetes) CREATE Server
- Requirements management (e.g., Doors, Blueprint) JIRA, Agile
- Infrastructure and cloud providers (e.g., AWS, Rackspace, Azure, RedHat OpenShift, Pivotal Cloud Foundry) DoD HPCMP provides cloud-like services—5 HPC computer centers with 11 High Performance Computers linked by a high speed network

*From DSB Report, Feb 2018, based on SEI DevOps

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A Software Factory Requires Quality Control

- Annual Releases
- Hierarchical Testing
- External, Knowledgeable Testing Group
- User Testing (Beta)

Based on HPCMP CREATE-AV testing practices

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The CREATE Goal for Iterative Development:

At least one new “version” every year

Annual releases demonstrate meaningful progress
CREATE Tools Impacting DoD Programs

DDG-1000
CVN-78 Class
So-Called “Valley of Death”
Ohio SSBN Replacement
LX(R)

Aerostar & Raven UAVs
F/A-18 E/F/G
E-2D

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

F-15 SA/DB-110
Strategic Airlift CP&A
A-10
B-52
Thank You!

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Back-up slides
CREATE Software Development Workflow for Distributed Teams

- **Balance flexible planning with milestone-based accountability.**

CREATE: Disciplined Adaptive Workflow Management based on Scrum (balance risk and value)

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

Development Environment Indicators

Notional Home Ground Chart for CREATE
*after* Boehm, Using Risk to Balance Agile and Plan Driven Methods, IEEE Computer Society, 2003

The attributes of CREATE environment favor an Agile Development approach
Example: Kestrel Software Architecture

[Diagram showing the architecture of Kestrel Software, including internal components such as Thermodynamics API, Prescribed Motion, and External Component Plug-ins like Fluid-Structure Interface and Auto FCS.]