U.S. Air Force Software Engineering Efficiency and Productivity for Information Operations

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U.S. Air Force
Agenda

- Introduction
- U.S. Air Force AFSC Way
- CMMI vs Agile
- Efficiency Study
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  - Definitions
  - Tracking
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Introduction

Software Engineer Problems

- https://www.youtube.com/watch?v=BKorP55Aqvg

Why are we here?
“Speed is GOOD”
The term “Speed,” in the AFSC Way Lexicon, is meant to be synonymous with efficient processes that promote throughput paced to a Road to... goal.
U.S. Air Force AFSC Way

- Important Definitions
- Road To...
- Networks
- Gates/DBR
- Release Points
- Visual Displays
- Standard Work (Scripting)
- Tools/Tech Data
- Touch Time
A sequence of activities in a project plan which must be completed by a specific time for the project to be completed on its need date.
Little’s Law

At steady state, all production systems have an average throughput, work-in-progress (WIP), and flowtime.

The fundamental relationship between all three is determined by Little’s Law: \( WIP = \text{throughput} \times \text{flowtime} \).

Little’s Law Demonstrated in a Simple Production System

- **Input:** 1 unit/4 days [Throughput]
- **Work-in-Progress (WIP):** 6 units
- **Flowtime:** Each unit spends 24 days in the machine
- **Output:** 1 unit/4 days [Throughput]

\[ WIP = \text{throughput} \times \text{flowtime} \]

6 units = \( \frac{1 \text{ unit}}{4 \text{ days}} \times 24 \text{ days} \)
What led the Air Force to using the AFSC Way?

U.S. Air Force Blows $1 Billion on Failed ERP Project

By Robert N. Charette
Posted 15 Nov 2012 | 16:38 GMT

The U.S. Department of Defense latest strategy for putting lipstick on a pig, when faced with a major project debacle, has been to say, “Well, it’s not a total waste because the effort creates an opportunity to harvest technologies and lessons learned.” I expect to see the same lipstick strategy, maybe in a new shade, from the U.S. Air Force regarding its Expeditionary Combat Support System (ECSS), which it finally decided to scrap after blowing through a billion dollars over seven years of development to produce a system which it admits as having no “significant military capability,” Defense World reported late last week.
CMMI vs. Agile

CMMI (Capability Maturity Model Integration)

Characteristics of the Maturity Levels:

- **Initial (Level 1)**: Processes unpredictable, poorly controlled and reactive.
- **Managed (Level 2)**: Processes characterized for projects, and is often reactive.
- **Defined (Level 3)**: Processes characterized for the organization and is predictable. (Projects tailor their processes to fit their organization’s standards.)
- **Quantitatively Managed (Level 4)**: Processes measured and controlled.
- **Optimizing (Level 5)**: Focused on process improvement.

Agile (12 Principles for Project Management)

- **Stage 1: VISION**
  - Description: The goals for the product and it’s alignment with the company’s strategy
  - Owner: Product Owner
  - Frequency: At least annually

- **Stage 2: PRODUCT ROADMAP**
  - Description: Holistic view of product features that create the product vision
  - Owner: Product Owner
  - Frequency: At least biannually

- **Stage 3: RELEASE PLANNING**
  - Highest Priority Features Launch
  - High Priority Features Launch

- **Stage 4: SPRINT PLANNING**
  - Description: Establish specific iteration goals and tasks
  - Owner: Product Owner and Development Team
  - Frequency: At the start of each sprint

- **Stage 5: DAILY SCRUM**
  - Frequency: Daily

- **Stage 6: SPRINT REVIEW**
  - Description: Demonstration of working product
  - Owner: Product Owner and Development Team
  - Frequency: At the end of each sprint

- **Stage 7: SPRINT RETROSPECTIVE**
  - Description: Team reflection of environment and processes to optimize efficiency
  - Owner: Scrum Team
  - Frequency: At each sprint

CLASSIFICATION: UNCLASSIFIED
CMMI vs. Agile

- Air Force uses CMMI as evaluation standard for software
- Agile is used as the process
CMMI vs. Agile

Large scale
- Risk adverse
- Mission critical
- Management oversight

Small Scale
- Single team
- Volatile requirements
- Software only environment

Reference: CMMI or Agile: Why Not Embrace Both! By Hillel Glazer, Jeff Dalton, David Anderson, Mike Konrad, Sandy Shrum
Efficiency Study

“100% relative efficiency is attained by any Decision Making Unit only when comparisons with other relevant DMUs do not provide evidence of inefficiency in the use of any input or output. As noted in the preface, this definition may be altered, expanded (or even replaced) when knowledge of 100% efficiency is available.” - 45SWI38-203

Most Efficient Organization (MEO)
Efficiency Study

Tinker AFB is CMMI level 3.
Hill AFB is CMMI level 5.
Warner Robins AFB is CMMI level 5.

“Located at Hill Air Force Base, the Software Maintenance Group (SMXG) offers a wide variety of skills to complete your project on time and under budget. Our talented professionals are ready to help you succeed. Browse our website or download our brochure and discover how we can assist you with your latest project.”

- SMXG Chief
Efficiency Study

TPS MAINTENANCE

CV%, SV%, ACT-SCHED COMPLETION

PRODUCTIVITY

Primary Workloads

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
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<tbody>
<tr>
<td>B-2 Test Program Set Development</td>
<td>Development of 285 TPSs; scheduled to be completed in 2002.</td>
</tr>
<tr>
<td>B-1B TPS Maintenance and Rehost</td>
<td>Ongoing maintenance and rehost of over 600 TPSs in support of OC-ALC and the B-1B Operating Base.</td>
</tr>
<tr>
<td>Jet Engine Testing, Trending, &amp; Support</td>
<td>Twelve jet engines; includes engine accessories (electronics), an over-growing workload, and support of Jet Engine overhaul process. Direct support is provided to Air Force installations worldwide.</td>
</tr>
<tr>
<td>Avionics TPS Development, Rehost, and Maintenance</td>
<td>Multiple weapon systems; continue to support and provide new solutions for the OC-ALC avionics repair organization.</td>
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13 May 2016
Efficiency Study

- Tinker AFB looks at Return on Investment (ROI).
- Earned Value Management (EVM) looks at efficiency in terms of 1. cost, and 2. schedule.
Efficiency Study

- Tinker AFB 76th SMXG process flow was simulated to show inefficiencies and bottle necks

<table>
<thead>
<tr>
<th>Simple</th>
<th>Tech Design 45 Days</th>
<th>Hardware 34 Days</th>
<th>Design Review 1 Day</th>
<th>Integration 120 Days</th>
<th>Implementation 45 Days</th>
<th>Manufacturing 95 Days</th>
<th>V and V 1 Day</th>
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Efficiency Study

Flowday Goal Avg: 538
Negotiated Flowday Avg: 734

Total Requirement:
B-2: 164 TPAs
B-1: 36 TPAs

Future Requirement:
B-2: 65 TPAs (Jun 14)
B-1: 24 TPAs (Feb)
C-130: 5 TPAs (Jan 14)

As of: 31-Aug-15
Efficiency Study

Overall Flowday Goal: 383
PY15 Planned Inductions: 45
PY15 Planned Completions: 33
PY16 Planned Inductions: 48
PY16 Planned Completions: 49
Total Requirement:
0-2: 232 TPS
3-1: 281 TPS

As of: 31-Aug-15

Road to 383 days
Productivity Study

- IBM uses a computer software tool from CAST to compare their code to industry best practices to ensure it is efficient and does not waste lines of code.
- Productivity rates are measured in function points per month or other time step.
- Quality is factored into this rate by checking for the defects and removal efficiency. Of the defects that are not removed, there is a further breakdown of high severity and low severity.
- Problem is finding ways to include time overruns and wasted time.
- Biggest downfall to productivity is paperwork and admin.
- Complexity is a factor that can normalize the productivity charts while removing some of the Lines of Code issues.
- Introducing an idea of burden percentage to normalize cost for productivity.
Productivity Study

- Air Force uses lines of code for productivity studies
- Technical Packages of Software (TPS) are divided into Simple, Average, Complex, and Very Complex.
- Number of Flowdays are:
  - Simple -> 211
  - Average -> 296
  - Complex -> 383
  - Very Complex -> 443
Productivity

- One Way Analysis of Variance (ANOVA) tests showed that complexity factors were not good ways to differentiate the different TPS’s.
- Best workers were put on Very Complex projects and were able to finish faster than Simple projects
- Only Average and Complex TPS had any differentiation
Conclusion

- Efficiency is dependent on Most Efficient Organization
- Productivity depends more on quality of programmer than on complexity
- Air Force uses efficiency and productivity in the Agile and CMMI constructs as measurements of success
Questions