Statistically Managing a Critical Logistics Schedule Using CMMI

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Northrop Grumman Integrated Systems
Agenda

- Presentation Overview
- Air Force Technical Order (AFTO) Form 22: Statistical Control of Schedule
- Implementing a Statistically Measurable Improvement
- Benefits
- Questions

CMMI® is registered in the U.S. Patent and Trademark Office.
Presentation Overview
The processes and products of Logistics Support are not typically considered prime candidates for statistical management techniques:

- In 2005 we achieved CMMI Level 5 in the SE/SW model.
- In 2006 we achieved CMMI Level 5 in the SE/SW/IPPD/SS model by expanding into other disciplines: Test & Evaluation, Avionics, Vehicle Engineering, and Logistics.

For further discussion on expansion of high maturity practices to other Engineering disciplines see Dr. Welch's presentation at 11am Thursday, 11/15.

In support of that expansion, the Logistics Directorate successfully applied Level 4 and 5 practices to manage a challenging scheduling requirement levied by the customer.
Air Force Technical Order (AFTO) Form 22: Statistical Control of Schedule
During the post-development phases of the Mission System life cycle, Technical Publications delivers and maintains Technical Manuals in support of Mission System deployment:

- Changes to Technical Manuals may be driven by:
  - Company proposed Improvements
    - Engineering Change Proposal (ECP)
  - Customer driven comments after delivery
    - AFTO 22
    - Air Force Technical Order (AFTO) Form 22 issued against fielded manuals owned by customer
Tightened Schedule Requirements for AFTO 22 Delivery:

- In 2004 (Production Contract) the Customer levied a schedule requirement to incorporate and deliver Routine AFTOs into Joint Integrated Maintenance Information System (JIMIS).

- In 2005 we transitioned to a Sustainment contract: Total System Support Responsibility (TSSR):
  - Award fees based on meeting various delivery/service milestones
  - As part of TSSR award fee, on-time delivery of incorporated AFTOs became more stringent
  - Delivery schedule of incorporated AFTOs was shortened by 57%
Team Goals – Technical Publications had two Quantitative Management objectives for incorporation of Routine AFTOs into JIMIS

- **1st Goal**: Establish and perform to a statistically stable schedule baseline: days-to-incorporate AFTOs (Voice of the Process)

- **2nd Goal**: Achieve a quantitative improvement to the schedule baseline that could satisfy customer’s 2005 award fee criteria (improve Voice of Process to satisfy Voice of the Customer)

- Increased efficiency in schedule must not adversely impact customer’s expectations of Technical Publications quality (a Blue rating of 0% - 0.5% defects)
Methodology for Implementing Statistical Quantitative Milestones

<table>
<thead>
<tr>
<th>IS Sector Phase</th>
<th>Milestone</th>
<th>Description</th>
<th>Suggested Tool</th>
<th>Status Complete/In Work</th>
<th>If In Work ECD</th>
<th>Comments or Slide Number</th>
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<tr>
<td>Identify</td>
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<td>Charter of Process Improvement including the Voice of the Customer (VOC)</td>
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<td>Input/Process/Output (IPO) Chart or Supplier/Input/Process/Output/Customer (SIPOC)</td>
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<td>Value Stream Map - Current State</td>
<td>VSM Presentation-VSM Templates</td>
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<td>Identify</td>
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<td>Measurement Analysis</td>
<td>Minitab and Interviewing Subject Matter Experts (SMEs)</td>
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<td>Stable Baseline Control Chart</td>
<td>Minitab</td>
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Implemented by a Process Management Team (PMT)
AFTO Disposition and Incorporation Process

**Process Definition**
Air Force Technical Order (AFTO) Form 22 is the method by which the government recommends changes/improvements to Technical Manuals. Northrop Grumman dispositions and incorporates the AFTOs issued by the government into Manuals.

**Sub-Processes Steps**
- NG at Warner Robins dispositions AFTO
- LKS Review & Approval of AFTO
- Processing Days in LKS
- Develop Data Changes in LSA Melbourne
- Incorporate AFTO into JIMIS
- Review Time in Pubs Tech Support
- Gov’t Review in Live Feed
- Released of Data (PDF, JIMIS TMD)
- Data Fielded for use

**Input**
- AFTO 22 submitted by JTF
- AFTO 22 Submitted by 116th ACW

**Output**
Tech Orders fielded for usage by the 116th ACW

**Customer**
116th ACW at Robins Air Force Base

**Applicable Procedures**
- I9-TDP-217 – AFTO Disposition and Incorporation Procedure

**Applicable Tools**
- JIMIS Database, AFTO Database (Access), Management tracking tool (Excel)
Value Stream Map – Current State 2004
AGS & BMS Tech Pubs – AFTO 22

LEGEND

T/T = Throughput Time
H = Hours
C/T = Cycle Time
M = Minutes
= Push
D = Days
= Inventory

JCC = JIMIS Conformance Checklist
AFTO = Air Force Technical Order
JTF = Joint Test Force

2004 Contractual Requirement of X days for AFTO Incorporation based on formal Tech Manual Delivery (TMD) of JIMIS

Release of Data
(PDF, TMD)

Govâ’/NG Data Fielded
For Usage

AFTO 22
Measurement Analysis

- Analysis conducted by the Process Management Team (PMT) reached the following conclusions about the measurement system:
  - Upon receipt, AFTOs are logged into database by one AFTO administrator exclusively
  - All process milestone dates are logged by one administrator and verified by the Tech Pubs Manager
  - Computations converting dates into days are executed automatically by equations embedded in the AFTO tracking database

- Conclusion: The metrics for AFTO schedule (days to incorporate in JIMIS) are repeatable, reproducible, and reliable, with negligible sources of variation.
1st Goal Accomplishments:

- Developed a statistical control chart from all closed AFTOs in 2004 AFTO database
- Analyzed and justified removal of special causes from data set
- Established Statistically Stable Baseline Schedule (Days-To-Incorporate AFTOs)
- Performed to Stable Baseline in 1st Quarter 2005
Schedule Activities 2004

I Chart of Award Fee Criteria

All Incorporated Routine AFTO’s All Complexities – 115 Data Points

- Contractually Excluded Categories
- Special Causes
Schedule 1st

Stable Baseline Established

2004 Schedule for AFTO Procedure

Special Causes Analyzed & Removal Justified:
All Incorporated Routine AFTO’s All Complexities – 109 Data Points
Performing to 1st Stable Baseline

1st Baseline: 2004 Data

Performing to 1st Baseline: 2005 Data
IMPLEMENTING A STATISTICALLY MEASURABLE IMPROVEMENT
2005 Goal: Reduce Upper Control Limit Below New Spec Limit

Although Stable, the process was not capable of achieving new customer requirement
Statistically Measured Improvement

2nd Goal Accomplishments:

- Completed Causal Analysis and Resolution activity to determine common cause of excessive variation in upper control limit
- Developed an Action Proposal Plan for Improvement
- Implemented Action Plan
- Gauged Improvements by Tracking New Data Points Against Baseline
- Refined Analysis: Improvement vs. Correction AFTO
- Deployed Two 2005 AFTO Baselines (Improvement & Correction)
- Performed to New Baselines
- Updated Value Stream Map to Reflect TSSR Award Fee Criteria and Stable Baseline Performance
Provided awareness training of the new schedule requirements - Series of email instructions and repeated face-to-face discussions to train/brief personnel in TSSR award fee criteria vs. Production Contractual requirements

**TOOLS:**
- Improved AFTO tracking database to "Red-light" AFTOs that exceeded planned days in critical phases of development

**PROCESS:**
- Inter-Directorate coordination to expedite revisions of wiring diagrams/schematic diagrams (WD/SD) impacted by AFTOs
  - Coordinated with Vehicle Engineering so updates of WD/SD associated with AFTOs would not adversely affect AFTO schedule
Improvements Against Baseline

Performing to 1st Baseline - Transitional period after Tech Pubs snapped 1st baseline around December 4 to January 2005

Baseline: 2004 Data

Starting in Feb. 2005: the partial implementation of process improvements resulted in improved performance
Implementation of Improvements

- Data confirmed that the process was performing within stable baseline limits

- Data indicated that process was not only below the UCL, but was under new spec limit (due to early improvement implementations)

- Since much of the improvement plan had been incorporated by February 2005, a new control chart based exclusively on 2005 data was run to analyze a tentative new baseline
New Chart of 2005 Post-Baseline Data

34% Improvement over original baseline UCL

41.8% Improvement over original baseline mean

- SD/WD
- Improvement AFTO
Refined Analysis: Improvement vs. Correction AFTO

- Due to wide range of the upper and lower limits in the 2004 process (1st baseline), differences in distribution between Correction and Improvement AFTOs were not a factor.

- In 2005, with tightened performance limits, the differences between the two types of AFTOs became more evident.

- Further statistical analysis of the data would confirm that Improvement AFTOs and Correction AFTOs should be charted separately (i.e. there were two populations of data).
Improvement vs. Corrective AFTO

- Using Minitab, 62 new data points from 2005 data were separated into two Subgroups:
  - Improvement Subgroup (38)
  - Correction Subgroup (24)

- Each of the two Subgroups were then divided (binned) into a Contingency table

- With data in a Contingency table, a Chi Square test could be conducted in Minitab
## Chi-Square Test

Expected counts are printed below observed counts
Chi-Square contributions are printed below expected counts

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<th>B</th>
<th>C</th>
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<td>2.839</td>
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<tr>
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<td>43</td>
<td>16</td>
<td>3</td>
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Chi-Sq = 9.338, DF = 2, P-Value = 0.009

Result: Only a 0.9 % chance these differences occurred by natural variation. There is 99.1% probability that there is a difference between Improvement and Correction distributions.

Two cells with expected counts less than five.
Two Baselines in 2005:

- Improvement AFTOs
  - UCL = 29% improvement
  - Mean = 31.7% improvement

- Correction AFTOs
  - UCL = 54% improvement
  - Mean = 62% improvement
Improvement & Correction AFTOs: Performing to Improved Baseline

Routine IMPROVEMENT AFTOs Incorporated Into JIMIS/Phoenix

- 2005 Improved Baseline
- Performing to Improved Baseline

Routine CORRECTION AFTOs Incorporated Into JIMIS/Phoenix

- 2005 Improved Baseline
- Performing to Improved Baseline

TSSR Award Fee Criteria

Number of AFTOs Ordered by NG Receive Date

Days to Incorporate AFTO
In 2006 a second goal to control & optimize LSA sub-process within AFTO 22 process was achieved.
BENEFITS
### Significant Accomplishments

**1\textsuperscript{st} Goal Accomplishment:**
- Technical Publications Established a Statistically Stable Baseline for AFTO Incorporation Schedule
- Demonstrated Performance to the Stable Baseline

**2\textsuperscript{nd} Goal Accomplishment:**
- Significantly Reduced the Process Performance Mean
- Significantly Reduced Excessive Variation in UCL of the Process
- Determined Need For Two Baselines:
  - Improvement AFTO Incorporation Schedule
  - Correction AFTO Incorporation Schedule

**Customer Expectations of “Blue Rated” Quality Have Been Maintained With Improved Schedule Efficiency:**
- From Sept 05 Night Eyes 
  - DCMA is pleased to report that for JIMIS-JIMIS quality, Phoenix has maintained exceptional quality levels, currently 0.0 percent defect rate, through three consecutive revisions.
The improved process assures continued success in meeting and exceeding the customer’s defined schedule days for Routine AFTO Incorporation

The improved Disposition & Incorporation of AFTOs process has a substantial impact on award fees
- The total AFTO Disposition & Incorporation activity in TSSR represents 2% of the annual award fee

The improved and statistically stable AFTO process ensures that Northrop Grumman will continue to meet the requirements of the customer and realize 100% of the Routine AFTO Award Fee activity
QUESTIONS?
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