Software System Acquisition Lifecycle Management Improvement

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Bottom-Line, Up Front (BLUF) Summary

Army programs having:

- a comprehensive *measurement strategy*,
- a supporting *measurement framework* aligned to software measures, and
- a mature acquisition team communication process,

typically delivered quality capability, on time and on budget.

The Problem

Programs often report satisfactory status for months before declaring a breach. Sometimes everyone – PM, PEO and Sec. for Acquisition – already suspects the program is troubled but they don't know why.

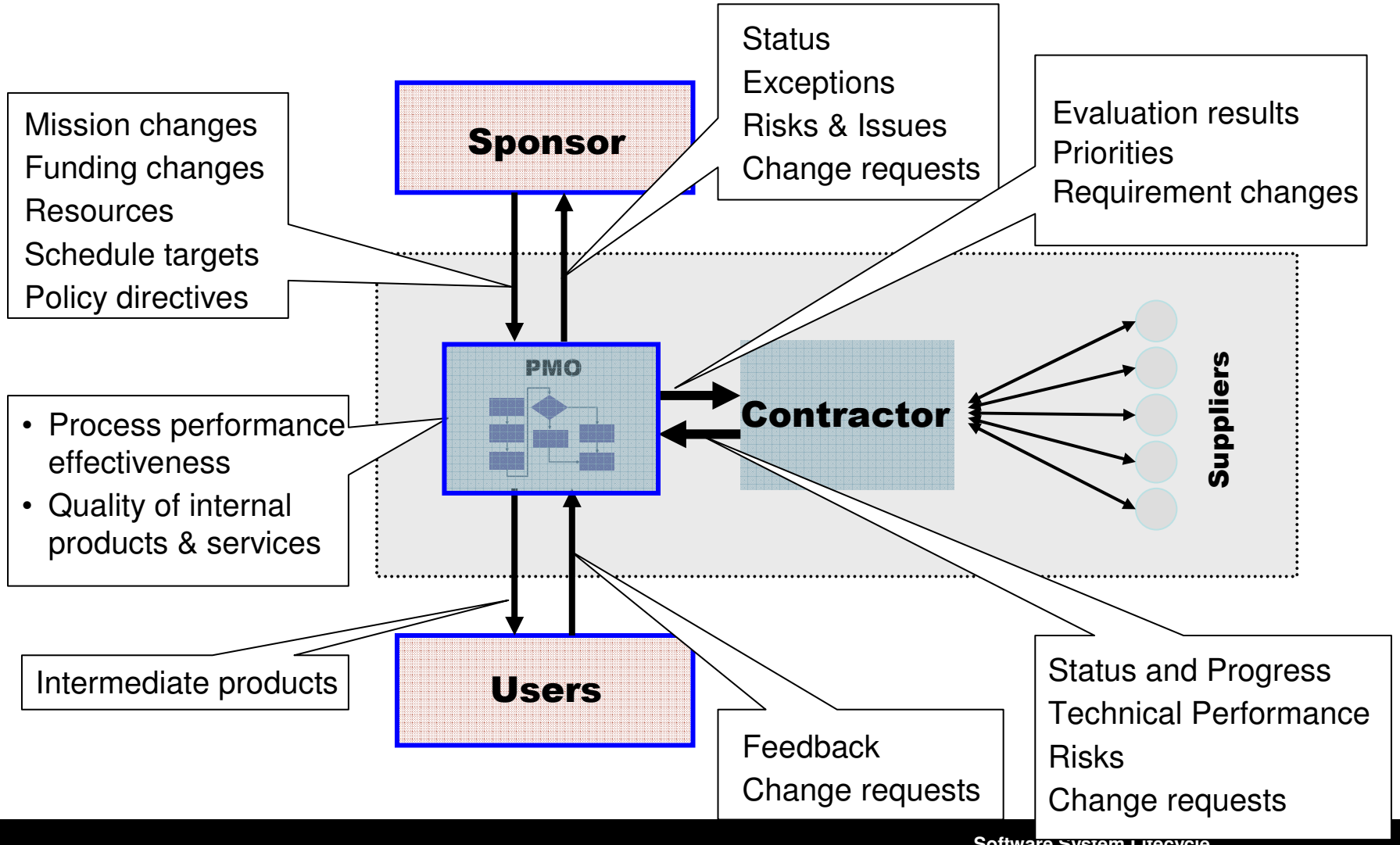
Can we make these troubled programs visible? (Senior Management)

How valuable is the "Probability of Success Report" P(S)?

If we do identify specific risks, what actions can be taken for recovery?

- Let's not devise a measurement system without thinking how it serves the program office.

Broader Outlook is Needed



Topics

ASSIP and Measurement Initiative

Systemic Findings

Chronic Problems – “old news”

A Measurement Framework

Supporting Best Practices and Lessons Learned

Improvement Recommendations

Acquisition is not getting better

The Army continues to field world class capability, of which over 80% of respective functionality is enabled by software *

However system delivery is often plagued (over the decades) with schedule, cost, quality issues. These issues, and measurement, have become a prime-time topic. Examples are:

GAO 06-393:

- "If DOD continues to move programs through development without requisite technology, design, and production knowledge [metrics] , costs and schedules will increase, which will reduce the quantity delivered to the warfighter. This practice will also continue to reduce DOD's buying power, as less capability will be provided for the money invested."

GCN:

- "Based on our discussions with individual [companies], three factors determine" the success of a software development program, Andrew said. "A manageable environment, disciplined processes and metrics, metrics, metrics."
- GAO found that industry metrics fell into seven categories: requirements, cost, schedule, quality, size, tests and defects.

Software re-work: GAO 04-383 reported $8 Billion expended, GAO 06-393 now reports $12 Billion expenditure, a 50% increase!

* 2000 Defense Science Board Report

Army Strategic Software Improvement Program (ASSIP)

The Army Acquisition Executive/Assistant Secretary of the Army for Acquisition, Logistics and Technology ASA(ALT) chartered the Army Strategic Software Improvement Program (ASSIP) in 2004 in partnership with the SEI.

- Understand the extent of the software problem and provide recommendations for process change
- Institutionalize best practices, lessons learned and process improvements
- Meet the scope and complexity conditions warranted by SoS acquisitions and network-centric warfare

ASSIP Measurement Task

ASSIP sponsored effort focused on Army acquisition program measurement practices.

Objectives:

- Characterize the current state of program measurement,
- Identify programs with exceptional practices and
- Document effective measurement practices
- Analyze sources of acquisition program risks attributable to software effort
- Make recommendations based on best practices

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Measurement Pattern of Success

Successful programs have an integrated, balanced measurement approach tied to core software measures

Core software measurement provides insight into team or component level program performance.

Program Office Functions

Oversight	Control	Planning
Communications Funding vs Need Track to Schedule Progress to Plan Spend to Plan Risk **Risk Drivers** Product Quality Process Quality Relationships Team Performance Learning	**Decisions** Change Request Evaluate Performance Evaluate Product Select Vendor Risk **Action** Incentive Payments Change Orders Award Fee Establish Contract	Team Performance Estimate Effort Estimate Duration Estimate Progress Allocate Resources Schedule Create EVMS Mitigate Risk

Linkage to PM Duties (Relevant!)

Core Software Measures

Cost
Schedule
Performance
Defects
Requirements

But Others Have Measurement Problems

Limited Process Measurement:

- Many program offices document or train very few work processes.
- Fewer have documented processes related to Control and Planning.
- Fewer still document *internal work processes*

  e.g., RFP generation

  — Acquisition Readiness Level (SIS acquisition management)

Little Measurement Education:

- Successful measurement programs were observed to have at least one person with specific training in measurement practice.
- Available measurement expertise provide better opportunity for 'actionable intelligence' that the program manager used in decision making and control

  e.g., data present, a little more effort to make decisions with…

Use of Measurement Has Been Too Narrow

Oversight of the supplier is the primary use

- Most of that work provides communications to all stakeholders.

Earned Value is the primary mechanism.

- EVMS is a valuable senior level summary; however,
- at PMO level it does not provide diagnosis or response time needed. .

Measurement is less used in Program Control and PMO Planning functions.

Software Measurement and respective risk prioritization is rare

- Lack of software and measurement education and experience is a contributor.
- Consequently, contribution of software to the program is undervalued

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Chronic Problems – 'Old News'

These problems have been seen before, and have been reported for decades. They often point to core, systemic issues.

- Test Cycles that take too long
- Risk Management that does not result in shared risk
- Lack of Quality Assurance so process problems are invisible
- Missing and "TBD" Interoperability Requirements

Test Cycles (and Force Deployment)

Multiple force deployment experiences of the past decade suggests that every program can expect to deploy a partial product on short notice. Some products have a test cycle exceeding 12 months.

Force Deployment Drives:

- Frequent Integration
  - Integration requires product testing and validation. These activities *provide a great deal of measurement*
- Product behavior in use provides valuable feedback
  - Partial products provide field supported validation; **HOWEVER**, the product development team must *know how the product behaves in use.*

Risk Management

Successful programs know and manage their top risks, and can readily represent effective risk mitigation.

- *Effective programs use core SW measures to accomplish this.*

Communicating Risk, horizontally and vertically, is vital.

- Typical charts used: **Red-yellow-green** grid, and **"Risk burn-down"**

Often Missing, Monitoring:

- Trigger Events (what)
- Time to program level recognition (Houston, we have a problem..)

Problem:

- Some program offices still describe their 'risk' as "cost and schedule," but these are only an impact of a risk-event and not truly a "risk".
- Hint: Training issue - these are typically impacted by a risk…

Missing Quality Assurance

Program offices generally do not have an understanding of Quality Assurance (QA). Little evidence of working QA functions in PMOs.

QA provides a PMO with evidence that its defined processes are working or not working. If not, there are several possible reasons.

- The process is broken
- People are not trained
- Someone chose to bypass the process because of other motives.

QA findings represent potential risks to the program.

- The PM can ask about these potential risks for potential mitigation

Quality assurance need not be exhaustive. For efficiency, it is possible to sample.

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Measurement Framework

Army PMOs that were successful in development and the use of measurement demonstrated some similar characteristics that we have called a framework for measurement.

We divide this framework into four categories: Organization, Infrastructure, Expertise and Accountability.

Organization Structures,

Measurement Infrastructure,

Education, and

Expertise.

Organization Structures

Each level/unit of the organization has unique concerns and is responsible for different decisions and actions.

PMO Units:

- *Work broken to manageable units and assigned to an organizational unit*
- Optimized horizontal/vertical communications among organizations vital to program performance management. All attend PM reviews!

PMOs

- Monitor internal performance of development teams and granular level of risk.
- Monitor external changes and risk (measure protects from Requirements creep!)
- Communications to PEO & Army Sr. Staff: Probability of Success P(s) report

PEOs and above

- Program level risk review, how are SW risks represented (not now in P(s) explicitly)?
- Assure clear performance objectives and review PMO measurement practice
- Provide appropriate resources to PMO e.g., education

Measurement Infrastructure

An effective measurement system will eventually require some supporting services. Perhaps PM's can share this burden across the PEO?

Examples: Data Storage

- Data consolidated for higher level reporting
  - Allow for expedient traceability
- Facilitate sorting and filtering for problem solving and evaluation
  - Few programs have the necessary resources.

And, Charting / Reporting

- Only the most basic charts and reports can be produced with a spreadsheet – better tools are needed.
- Some programs had turned to Army Software Engineering Center organizations for a portion of their measurement infrastructure needs.
- Other programs had requested the suppliers provide extra charts, even when the data had been generated by the program office.

Integrate with Work Processes and Procedures

Measurement Education – a story

Training/Education:

- Employee attended a Masters program in Software Engineering taking a course in software measurement.
- The first measurement indicators supported requirements and requirements change management.
- The program was able to realize much better performance and significant cost savings as a consequence of the resulting improvements.
- Plus, the causes of problems were illuminated, and proper mitigation techniques were known and could be employed effectively and efficiently.

Quote:

"We were surprised how useful and effective even this simple measurement was. I'll never operate without metrics again."

Measurement Expertise

Effective PMOs had a small number (1-2) of trained staff

Role

- Defined measurement procedure, data collection, data storage and reporting procedures.
- Design measurement indicators, charts, tables and graphs.
- Align measures to mission and process improvement goals

Expertise provided

- Facilitator
- Data representation
- Statistics and measurement

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Best Practice$_1$

Accountability

Each indicator was assigned to an individual. If the indicator suggested something might need investigation, that individual tracked the source data and related events in preparation for staff meetings.

- e.g., a system engineer was responsible for analysis of provided technical progress, risk and product quality measures
- These staff meetings were highly effective

Several things can happen to cause a concern that has to be analyzed

- Verify then trust, measure or reporting system can change or have bad data
- There can be an actual problem
- There might have been a single event and recovery is in progress
  - Variance is within the 'noise level'

Best Practice$_2$

Domain Expert Support

During the validation process, the domain expert partnered with measurement experts to determine the most effective, efficient, and relevant measures to collect, analyze and report.

- This was not a one-time process; periodic assessments were necessary to ensure relevance.

e.g., have a communications expert assist data interpretation

Re-validate Measures/Risks across Project Phases

Measurement indicators*, the data collection, analysis and reporting processes required adjustments within project phases and particularly when a program went through a major milestone transition.

- Measures of progress and risk are certainly different when transitioning from RFP work to design work.

* Indicator: A chart, table or graph that communicates an important measurement story.

Best Practice$_3$

Partnerships – SEC/SED Relationship

Several PMs recognized the benefit of utilizing expertise from the local Software Engineering Center/Directorate.

- Some programs have used SEC/SED expertise and infrastructure to help establish their own measurement program.
- Others have used software engineers to support systems engineering work.

SEC/SED organizations have reached higher levels of process maturity (CMM/CMMI).

- These organizations are already in the habit of providing sound measurement data to many Program Managers.
- These groups are able to provide PMs with a high level of confidence and predictability in product delivery.

Leading Indicator Definition

Indicator:

A chart, table or graph that communicates an important measurement story.

Leading Indicator:

An indicator that conveys a potential program risk and suggests a potential for action.

Specifically, indicators that show:

a trend that misses its target, or
a technical or program risk, or
a problem that must be resolved.

Good Potential Leading Indicators

Are component teams achieving expected performance?

- Milestone slip, Resource availability, Quality performance, Defect queue, Change queue

Is program identifying and managing risk?

- Risk discovery and escalation, Risk burn-down, Significant risks

Is program managing communications and relationships?

- Action item performance, Relationships

Are external stakeholders participating?

- Requirements development, Review participation
- GFE/GFI, etc. delays create havoc with schedule and cause managers to re-assign people to other tasks.

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Summary Recommendations 1

Extend the Army's Probability of Success Report -- P(S)

- This dashboard is providing useful information.
- Smaller programs show very good awareness of program risk and correlate to P(S) results
- Larger programs do not correlate very well yet.

https://acc.dau.mil/CommunityBrowser.aspx?id=19273

Summary Recommendations 2

Suggested additions

- Team level performance measures such as the core software measures (stoplight chart)
  - Cost
  - Schedule
  - Performance
  - Defects
  - Requirements volatility
- Quality Index (next slide)
- PMO Internal process measures
  - Action item closure (or mean time to close)
  - Rework rates

Quality Index

Quality of process and product are both considerations.

Product quality examples are:

- Defects (find rates, density, test failure rate, etc.)
- Completeness of design and architecture (e.g. traceability)
- Complexity measures

Process quality examples are

- Quality audit results (process conformance)
- Effort ratios (Design/Code)
- Process effectiveness measures (defect identification and removal)

Challenges and Next Steps

All Army programs are interested in SoS Measurement

- Additional work is required in this area including better definitions of complexity and defects.

Make measured data visible to all participants

- Public data can be scary, but it scares both sides.
- It is much more difficult to criticize your judgment when you have data and the other guy does not.

Next Steps

- Pilot leading indicator work in a willing program office.

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