Leading Indicators of Program Management

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Problem

Historical data suggests that nearly every acquisition program gets into cost and schedule trouble at some time during the program.

- A few months before a program breach, all the indicators are **Green**.
- One month later, we receive notice that the program is late -- **Red** -- and will have to re-baseline.

Desired solutions

- Develop **"Leading Indicators"** for program managers that can provide warning about potential problems before the problem requires escalation such as a breach. Provide the information in a form that communicates the opportunity for an action response.
- Leading indicators must be customized to the selected program.

Leading and Lagging Indicators

LEADING indicators provide information about the drivers of program risk so corrective action can be taken prior to a risk event.

- Use of Earned Value to estimate completion time and cost
- Predict product quality with testing and peer review results
- Predict throughput and productivity with team performance measures
- Lengthening work queues suggest process or resource problem.

LAGGING indicators provide information about past performance

- status reports, and most progress indicators reflect past performance
- earned value data shows aggregated past performance

Outline

Sources of Uncertainty and Potential for Action

Uncertainty profiles and required learning

Representation and Indicators

Uncertainty Drives Risk

We do not know

- The estimate is correct – team performance, complexity, …
- The technology we will use
- The actual users and the actual threats they will meet

We must also learn:

- New design rules, technology,
- To work together
- To test, verify and validate the products

These uncertainties are both challenging and healthy for the program

No risk ➔ Little reward

Estimates contain uncertainty.

Feasibility

- Types of users
- External interfaces
- Constraints

ConOps

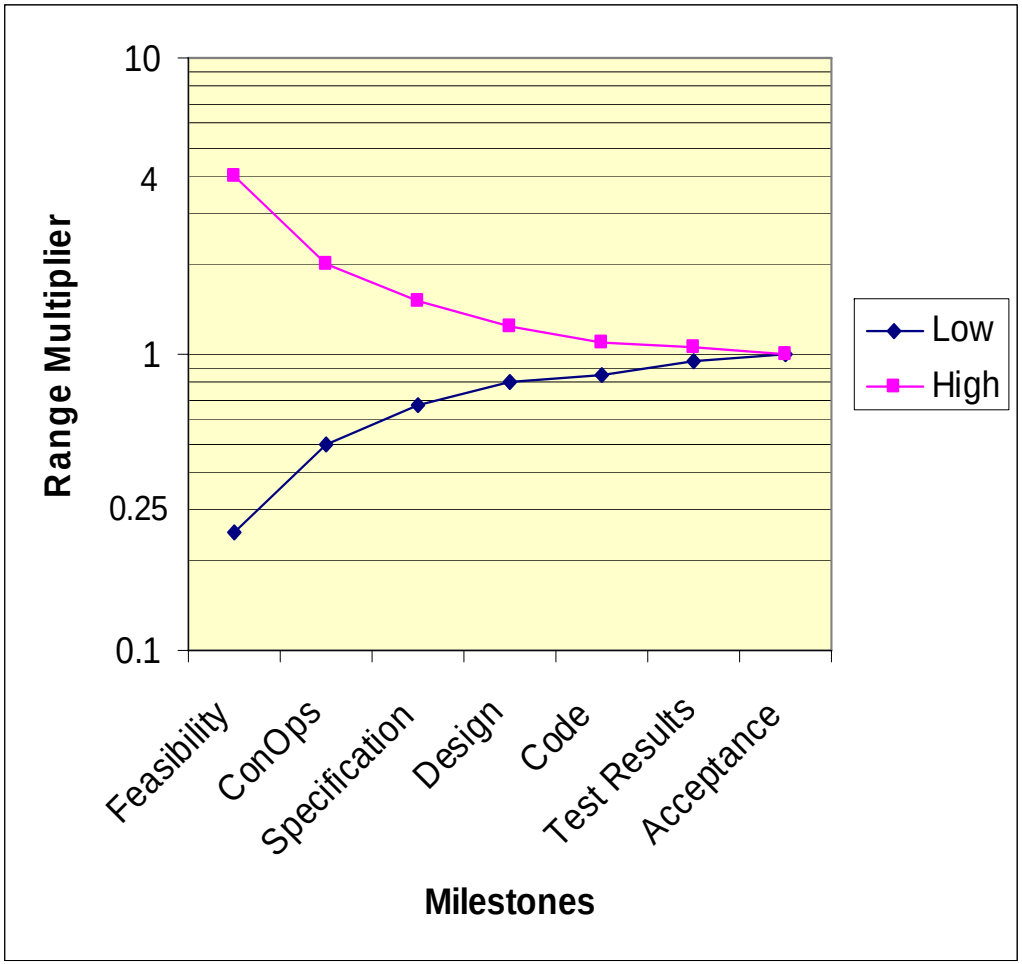
- Feasible performance bounds
- Understanding of user need

Specifications

- Secondary functions
- Storage needs
- Optimal architecture
- Developer skills

Code

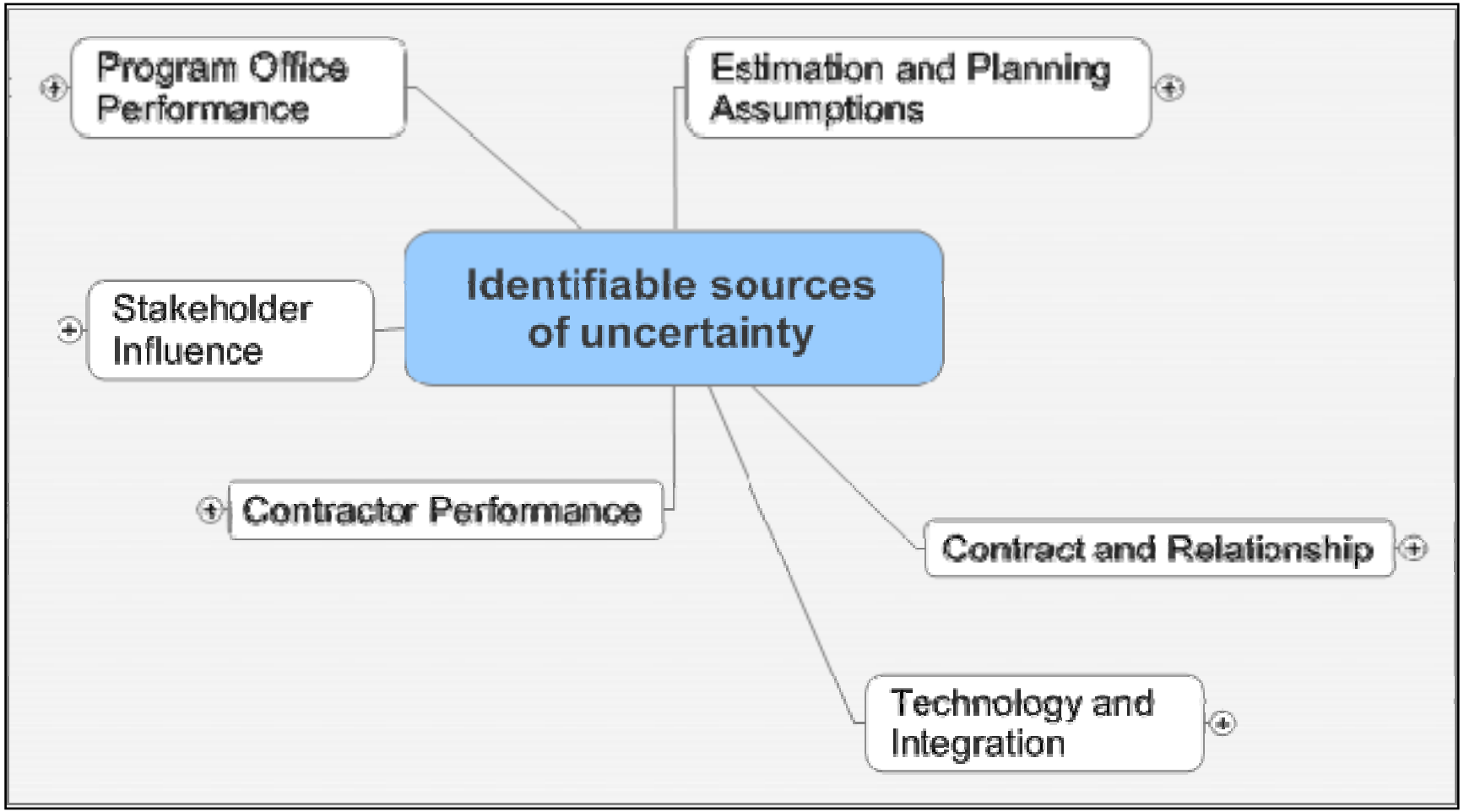
- Reliability
- Achievable performance
- Tester understanding of scenarios



Basili work at NASA-Goddard SEL

Acquisition sources of uncertainty

Things that may change during the course of development



Risks require potential for action response.

Technology

- alternative sources
- staff capability improvements (training/learning)

Contractor Relationship

- commitment and trust

External Stakeholders

- commitment and trust

Program Management (synchronization)

- team readiness, product readiness
- verification, validation results
- change management

From Risk Drivers to Leading Indicators

Resolving the unknowns in

- Development performance
- Product convergence on solution
- Domain of use
- Stakeholders
- Sponsor-user-developer relationship

Requires

learning and communications about learning problems.

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The Critical Questions

What has to be learned in order to develop and deliver this product?

What can we see that provides evidence of this learning?

How can we best measure team performance?

Who can we influence if the right things are not happening?

Also, looking to the future --

- What should we record as “learning”?
- How can we advertise success?

The “Learning” should correspond to reduced uncertainty.

Development Performance

Required Learning: Are any teams underperforming (vs. plan)?

Problem Drivers:

- Extreme schedule pressure
- Internal process problems (Including hiring practice)

Resources

- Resource capability and utilization compared to plan

Progress

- Size or count of work products delivered by date

Schedule

- Task completion per month as %tasks planned

Quality of work is important as well

- Verify and (internally) validate intermediate deliverables.

Product Integration

Required Learning: Teams must deliver products to each other to verify interfaces and integration

Drivers: include failure to integrate, verify and validate frequently.

- Requirements typically change by 2% per month (Jones).
- Changes affects design and test at a greater 3x-5x rate.

Product integration/validation results provide visible progress.

- Multiple integration points drives project planning WBS
- Systems engineering and architecture identify integration points
- Verification activities demonstrate low level functionality
- Validation activities demonstrate “fitness for use” for other development staff. (e.g. Document is easy to analyze and use).

Technology

Required Learning: Introduction of new technology requires the contractor and program office to develop many new capabilities. Progress must be made on other fronts as well.

- Technology Readiness Level (TRL) is evidence of the maturity of the technology (but not the process and other elements)
- Design rules for using the technology including interfaces, timing, and other aspects of system architecture
- How to verify and validate (test) components with the new technology
- How to write documentation for users and supporting elements
- Tooling and manufacturing required for production

Contract and Relationship

Required Learning: Contractor and acquirer must respect each others values and work toward common goals.

Evidence of problems between program office and contractor

- Increasing numbers of action items and issues.
- Lack of transparency and trust (calls for occasional review of relationship)

Possible drivers

- Too few or too many communications links.
  - Too few means that communications take too long.
  - Too many means that decisions can become invisible.
- Personnel turnover or role changes on either side.
- Change request queue is not managed promptly.

Program Office

Required Learning: Process and battle-rhythm

How much work needs to be done?

- What are the inputs (number, size, classification)?
- What things are not on the plan for the month?
- What resources and capabilities are needed and available?
- How do we prioritize the work?
- How much rework are we generating?

Problem drivers

- "Taskers" – which can be ignored? Which must be done?
- Availability of external users, GFE-suppliers, and other service sources.
- Missing process definitions cause many problems.

Other uncertainty

Stakeholder Influence

- Funding
  - Volatility in either direction causes some change impact.
- Specification and Validation
  - Lack of participation by users and sponsors as agreed is a strong warning
  - Both must participate in validation work.
  - Executives must be responsive to change requests (yes/no)
- Sponsorship
  - Advertising
  - Interest and support for the work

User Community Problems

- Timely participation, too much senior officer interference

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Development Performance Measures

Team Performance

- resource utilization, schedule, development progress (“EVM lite”)
  - *productivity or throughput is valuable to compare to estimates*
- Actual numbers are not as important as whether gaps form and grow

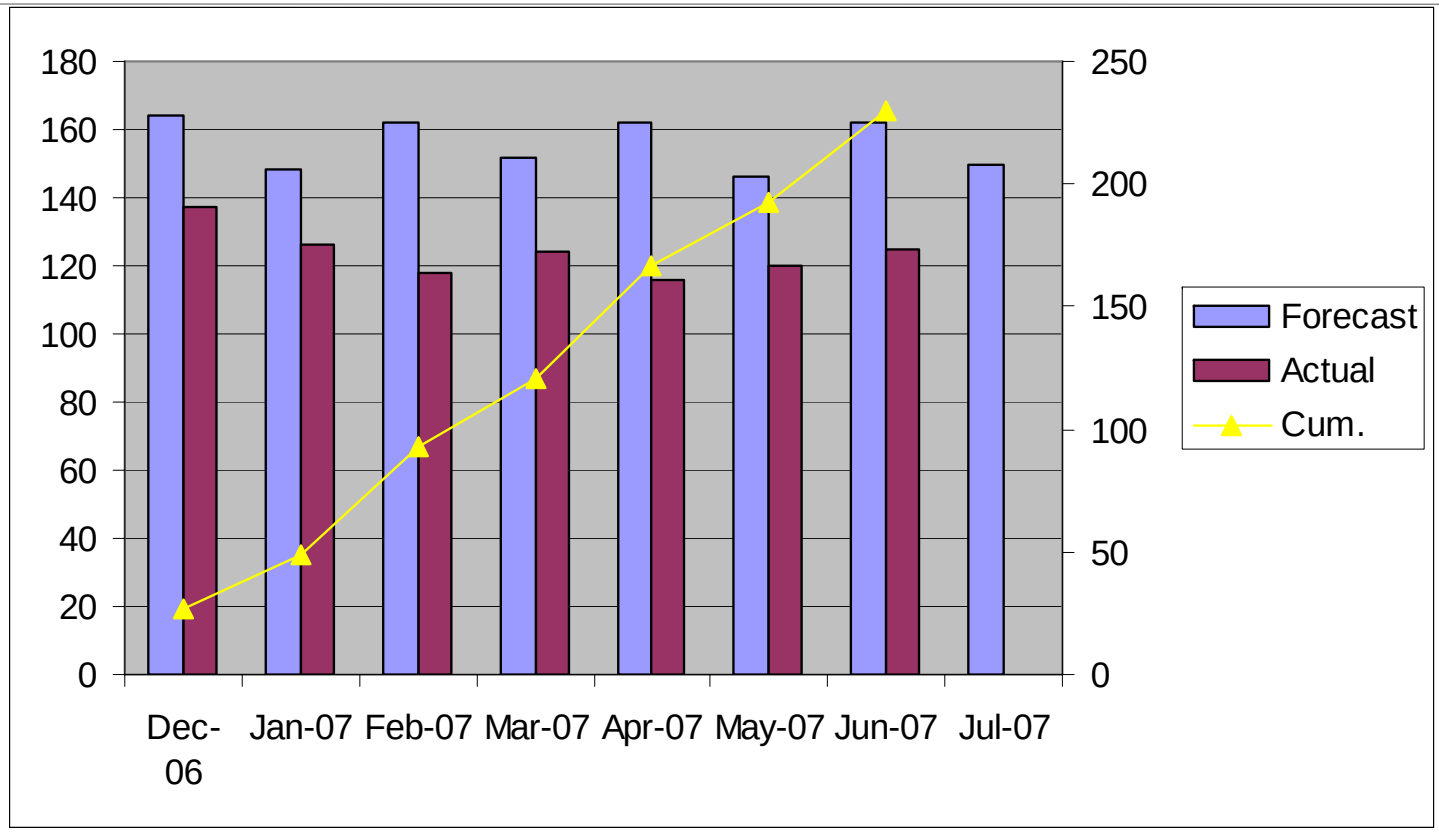
Contractor Development Performance

- EVMS
- Resource availability and program turnover
- Process quality assurance and program review
- Action items per review activity

Program Office Performance (gets its own discussion)

Contractor Resource Plans

Cumulative Problem: 230 person months behind



	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07
Forecast	164	148	162	152	162	146	162	150
Actual	137	126	118	124	116	120	125	
Delta	(27)	(22)	(44)	(28)	(46)	(26)	(37)	

Product Convergence Indicators

Extended technology readiness

Product design complexity

Integrated view of technical progress

- New technical review procedure in pilot within one program office.
- Involves a detailed validation procedure based on selected design reference cases.
- More next year

Technology Insertion

Assess organizational learning

- Is the technology ready? Performance satisfactory?
- Is the organization learning to use the technology?
- Are we prepared to use what we've learned (current phase)?

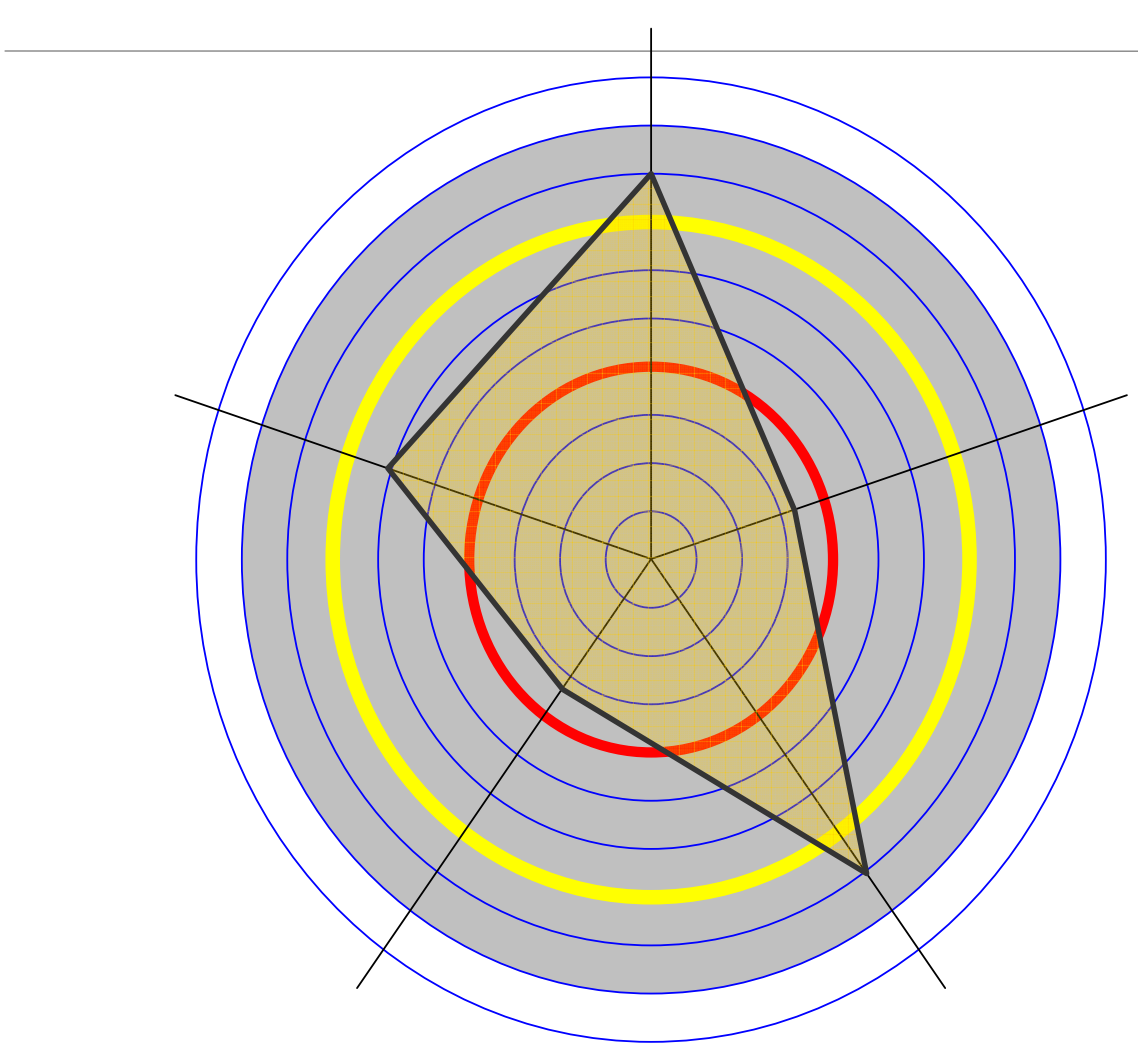
Changes in technology change all kinds of internal process.

- New design rules, design patterns, testing support, test design, technical documents, manufacturing, logistics, etc.

Assess by multiple views and by current milestone

- TRL – the technology works and has been used somewhere
- Org. Capability – the organization has learned to use it for the current phase of work.
- Performance, interface, other

Technology Insertion



Multiple axes represent the different things that have to be learned to deploy the technology

Rings can represent whether the level of completion is acceptable.

Program Office (SPO) Performance

All the usual problems exist.

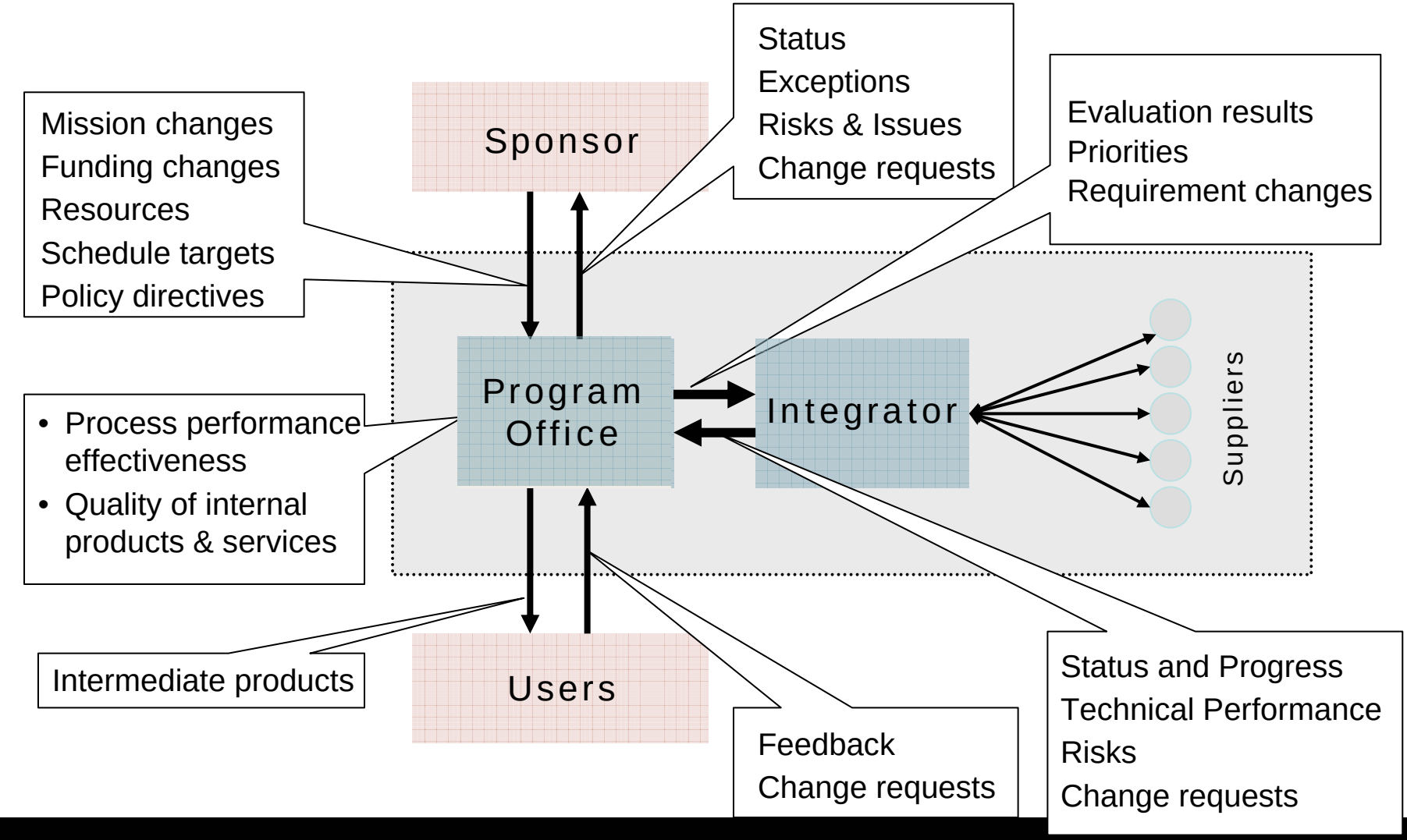
- Schedule
- Resources
- Process
- Quality Assurance and Rework
- Change Requests and Volatility

There is rarely any measurement data that addresses internal performance.

There is rarely a real project plan in use within the program office.

Only a few processes are documented and trained (source selection is).

What is the performance of the Program Office?



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Representation

Different stakeholders need different representations of the data.

- Stoplights might be ok for executives not ok for PM and staff.

The representation should communicate the opportunity for action.

- Who needs to know? Who can we influence? How urgent is the action?

Learn to ask the right questions.

- When you select the indicator (chart…), think about what you might see if something bad were happening? How would you ask questions to confirm your judgment?
- What does it mean if the graph goes down instead of up? If a threshold is crossed?
- Why would someone change the chart display? What might they be attempting to show you?

Stakeholder Views

Keep several viewpoints in mind when developing charts

Systems Engineer

Contractor Project Management

Program Management

PEO

Acquisition Executive

“Schoolhouse”

Field Commander

Primary Leading Indicators – 1

Work queues

- Queues describe input to processes
- If queues are growing in number or waiting time, the suggestion is that something about process or resource must change.

Rework

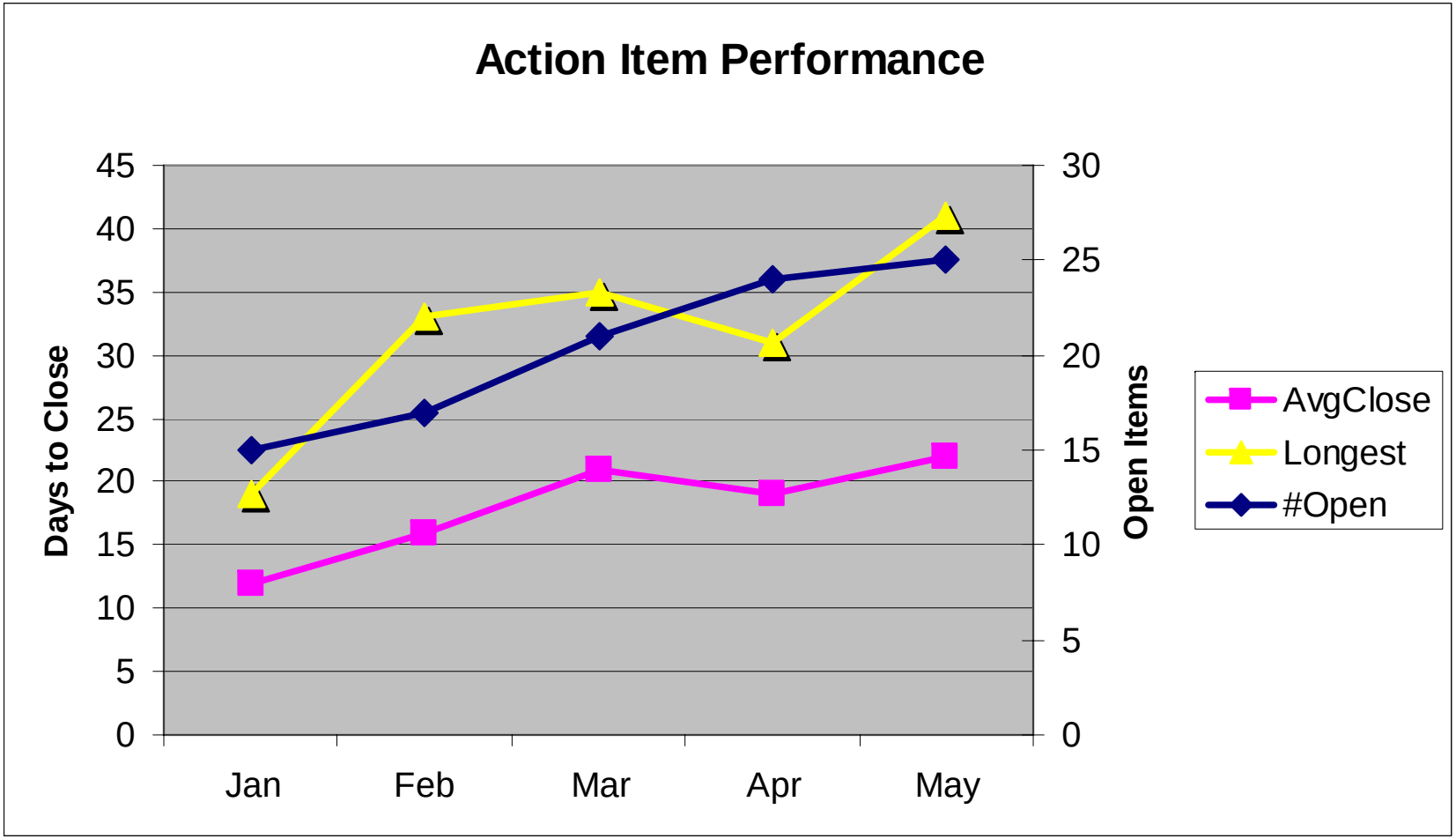
- Access to measurable quality data including QA summary
- CM churn or other churn evidence

Performance vs. plan

- Team level EVM-Lite

Action Item Performance
Representing work and communications

Rising trend lines suggest problems like missing communicator.



Primary Leading Indicators – 2

Domain

- #user - mission scenarios and volatility (requirements)
- External changes (interfaces with other systems)
- Funding and sponsorship

Contractor – Acquirer Relationship

- Action-item, change and issue performance
- Contract relationships, fees, etc.
- Key personnel and relationship turnover on contractor and SPO
- Shared view of risk and shared process for risk

Primary Leading Indicators – 3

Program Office

- Staffing and turnover
- Non-program workload queue (moves, taskers, …)
- Schedule performance
- Change response time or other throughput (e.g. CDRL review)

Critical Success Factors for Implementation

Selected indicators suggest potential for action response.

Each indicator has an owner.

- Owner knows what is normal and what is not.
- Owner knows what questions to ask and prepares for the occasion.

The person collecting the data has a use for the data as well.

Indicators are perceived as representing facts – not opinions.

Reference

Lean Aerospace Initiative: several interesting publications

http://lean.mit.edu

Aerospace Corp: “Bell-ringing Criteria” and “Patterns of Program Failure”

Suellen Estlinger, Richard Ableson, available at SSTC programs

Fred Schenker’s presentation at this conference

“Project Management by Functional Capability”

Army and Air Force “Probability of Program Success”

See DAU website and IT-COP