Innovate or Integrate: Controlling Schedule Risk

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Overview

- Thesis
- Review of DoD Acquisition Process
- Analyzing the process
- Thoughts on an alternate process
- Additional area for research
Shorter, integration based acquisition programs provide a means to deliver capability with much lower schedule variance.
The Defense Acquisition System

DoD procures new systems through the interaction of these three primary processes:

- Planning, Programming, Budgeting and Execution
- Joint Capabilities Integration and Development System (JCIDS)
- Defense Acquisition Process

From DAU: https://dap.dau.mil/APHOME/Pages/Default.aspx
Joint Capabilities Integration and Development System (JCIDS)

Process goal is to identify, assess and prioritize capabilities needed to fulfill DoD missions

- “The Requirements Process”—Three key documents
  - Initial Capabilities Document: Documents need for a materiel solution and summarizes supporting analysis
  - Capabilities Development Document: Documents information to develop a program and ID performance attributes
  - Capability Production Document: Address the production elements of a single increment of an acquisition program
Planning, Programming, Budgeting and Execution

Process goal: Develop the best mix of forces, equipment, manpower & support within budget

- Planning: Lays out “budget conscious” priorities for the services
- Programming: Detailed proposed budgets
- Budgeting: Detailed cost estimates and expenditures
- Execution: Reviews current effectiveness of budget, includes feedback mechanism for budget changes

From DAU: https://dap.dau.mil/aphome/ppbe/Pages/Execution.aspx
The Defense Acquisition System

Process Goal is to develop and deliver capabilities to answer requirements within PPBE fiscal constraints - System development phases separated by milestone decisions

From DAU: https://dap.dau.mil/aphome/das/Pages/Default.aspx
Analyzing the Process

- Process is “Broken”—quote from HASC
- Used F-22 and F-35 Examples to Assess Risk Areas and Consider Mitigation
  - JCIDS: Incorrect problem/threat definition, incorrect requirements, unstable or changing requirements
  - PPBE: Funding uncertainty, extended timelines as a result of funding cuts
  - Defense Acquisition System: Program management, changing requirements and technology development risks
- Developing an assessment model of Systems Development process
Complex System Acquisition - Conceptual Model

Program schedule and funding profiles built on planned duration

Composed of many events, each with some probability of success

- Planned duration
- High Probability of executing on time
- Some probability correctly defining environment
- Planned Duration
- High Probability of executing on time
- Some probability correctly defining requirements
- Some probability of completing on time
- Continues until success or relief from requirement
- Some probability of completing on time
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Modeling Program Execution - Logistics Series System Reliability Model

Viewing the process as a serial system allows for application of the logistics series system reliability model:
- Each event has some probability of success
- External influences

Some events have a discrete time—event occurs and either fails or succeeds.

Some events must continue until they have a success or decision is made to proceed without success—acceptance technology development or integration did not succeed.

External impacts from funding cuts and requirements changes.

Probability of successful completion of the serial process:

\[ P_S = P_{OE} \times P_R \times P_D \times P_I \times P_T \times P_F \]
Impact of Number of Technology Development and Integration Events

Technology development and technology integration can be decomposed into multiple technology development efforts

- Occur at the same time
- Must be completed for success

Probability of successful completion of serial process:

$$P_S = P_{OE} \times P_R \times P_D \times P_I \times P_T \times P_F$$

where

$$P_D = P_{D1} \times P_{D2} \times P_{D3} \times P_{D4} \times \ldots \times P_{Dn}$$

$$P_I = P_{I1} \times P_{I2} \times P_{I3} \times P_{I4} \times \ldots \times P_{In}$$

Then,

$$P_S = P_{OE} \times P_R \times (P_{D1} \times P_{D2} \times P_{D3} \times P_{D4} \times \ldots \times P_{Dn}) \times (P_{I1} \times P_{I2} \times P_{I3} \times P_{I4} \times \ldots \times P_{In}) \times P_T \times P_F$$
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Overall Probability of Success

Number of Events

Probability of Individual Events

5 technology development and subsequent integration efforts:
• 14 total events.
If each event has a probability of .9
• Probability of success is less than .23
Assessing the Impact of Technology Development and Integration

Each individual technology development and technology integration effort described with a Binomial Distribution
- Each year of development is a Bernoulli Trial, with some probability of success

Consider also funding impacts from budget cuts and changing requirements

Initial modeling and research indicate this is the largest impact to schedule (and as a result-cost)

Calculation is one minus probability of zero ‘successes’ in n trials, calculated with excel, backed up by StatTrek
Impact of Missed Schedule

Annual expenditures rapidly increase Schedule must be maintained to match funding profiles

Missed milestones cascade into production and deployment schedules

Program Life-Cycle (Illustrative)

From DAU: https://acc.dau.mil/CommunityBrowser.aspx?id=488332
Process Change Focus Areas

- PPBE changes beyond the scope
- Focused on interaction of JCIDS and the Defense Acquisition Process
Revising DoD Acquisitions

Integration focused
- Remove risk of technology development to separate process
  - Dedicated, directed technology development efforts
  - Program efforts receive mature technology
- Shorten acquisition timeline
  - Focus on nearer term threat definition
  - Limit process to integration of mature technologies
  - Feedback technology needs to technology development portfolio

Parallel Development Efforts
- “Fallback” low risk system
- Same form /fit
  \[ P_S = 1 - (1-P_A)*(1-P_B) \]
  - if \( P_A = .9 \) and \( P_B = .6 \), then \( P_S = .96 \)
An Alternate Approach To Acquisition: Integration

Increment 1

Concept Development Phase
Engineering Manufacturing and Development
Prototype and Test
Production
Operations and Sustainment
Upgrade Fielded Systems

Increment 2

Concept Development Phase
Engineering Manufacturing and Development
Prototype and Test
Production
Ops

Initial Technology Drop
Directed Technology Development
Follow-on Technology Drop
Directed Technology Development
Follow-on Technology Drop
Directed Technology Development

Technology Readiness Assessments Team

Follow-on System Increments

System Development Decision Points
Conclusion

Technology development introduces tremendous uncertainty to program

- Research indicates development risk frequently carries over into EMD
- Multiple developmental efforts appear to contribute to high probability of failing to meet schedule objectives.
- Program isolated technology development provides means to remove risk
- Integration focus offers means to accelerate development

Additional work needs to be done

- Develop probability curves for technology development
- Correlation with TRL? IRL? SRL?
- Role of professional judgement in predicting likelihood of development success
- Complete modeling of current process and alternate process(es)
- Quantify risk difference between short term threat definitions and long term threat definitions
- Is there an impact on quality of requirements
- Do short term acquisitions have a shorter shelf life?
  - If so, is the cost exchange viable?
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Thanks!
References


