GAO Best Practice Review of Technology Transition

20th Annual Systems and Software Technology Conference

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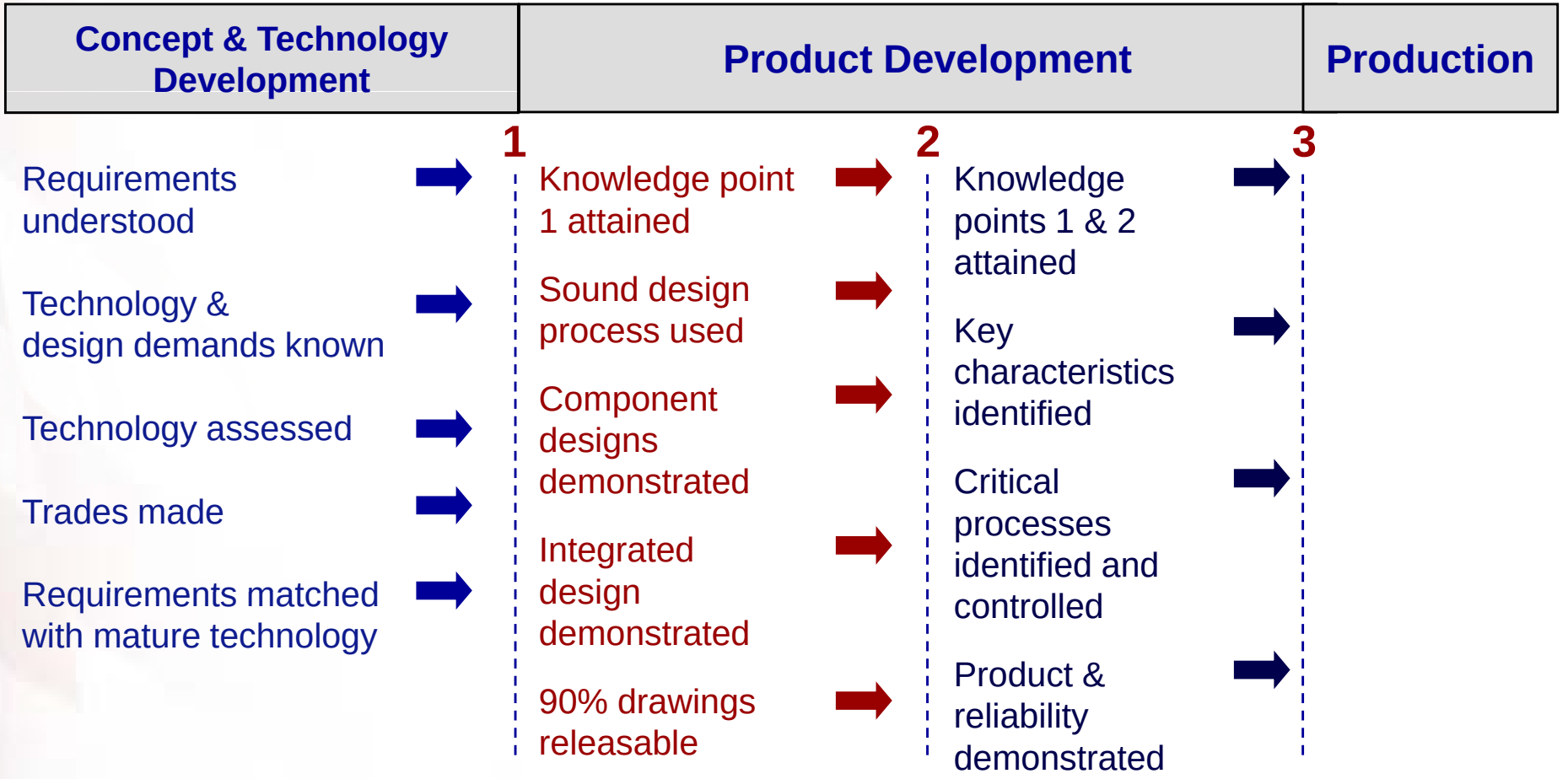
Prologue: Knowledge Needs to be Attained at key junctures

Knowledge Point 1: At milestone B, a match is achieved between the user's needs and the developer's resources (indicator: technology readiness level).

Knowledge Point 2: At Critical Design Review, the product design demonstrates its ability to meet user needs and is stable (indicator: % of engineering drawings released).

Knowledge Point 3: At milestone C, it is demonstrated that the product can be produced within cost, schedule, and quality targets (indicator: % of key processes in statistical control).

Prologue: Knowledge-Based Approach



Prologue: Past GAO Recommendations to DOD to Improve Outcomes

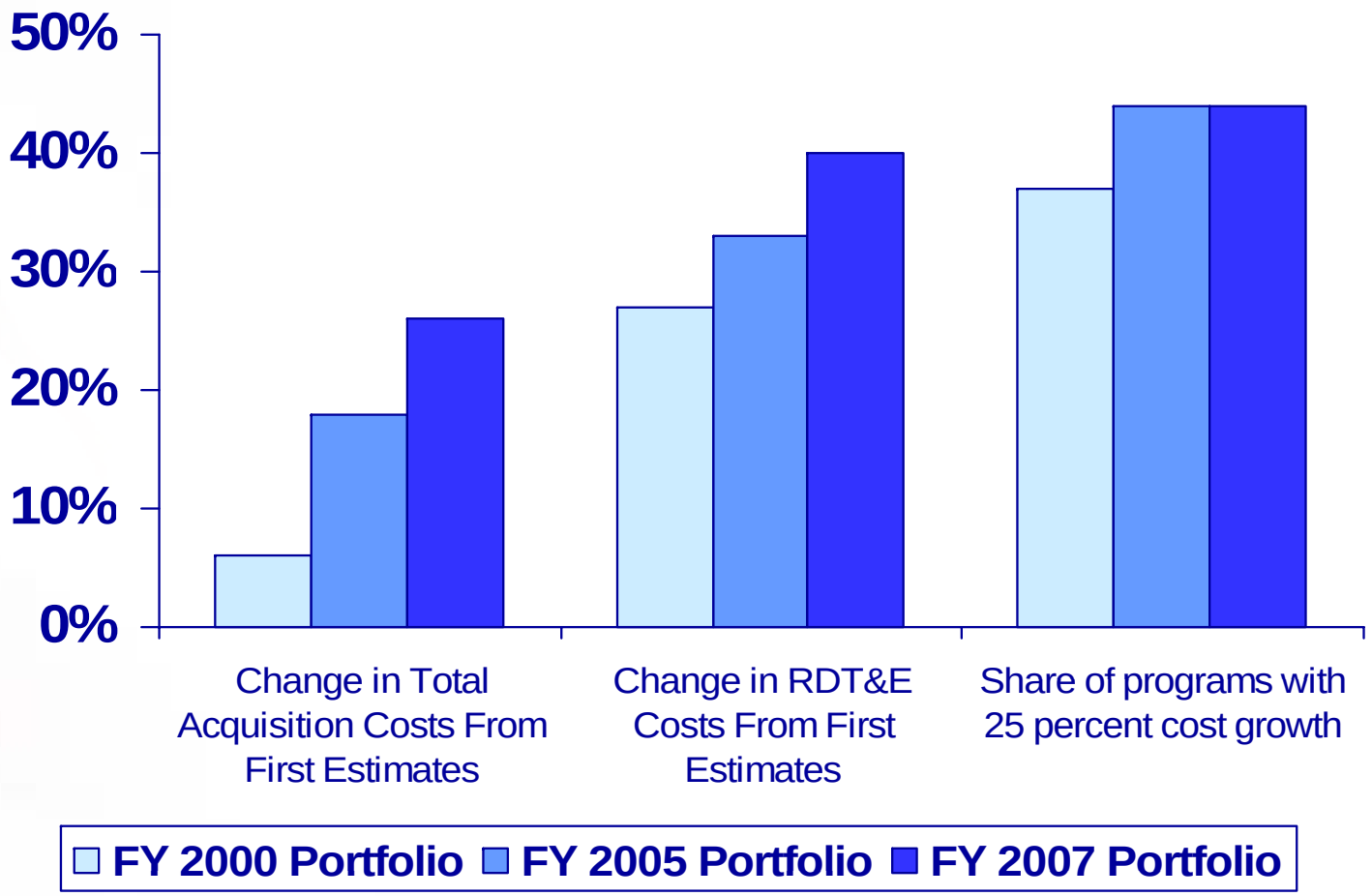
- Adopt a disciplined, knowledge-based method, such as TRLs, and standards for assessing technology maturity DOD-wide that are based on a technology's demonstrated readiness and criticality to the weapon system.
- Require that technologies demonstrate a high readiness level –TRL 7-- before Milestone B of a major acquisition.
- Provide more flexibility to acquisition programs with regard to a weapon system's performance requirements.
- Consider requiring S&T organizations to mature technologies further and empower them with additional funding and improved organization.

Prologue: Despite Constructive Policy Changes, Implementation Still A Challenge

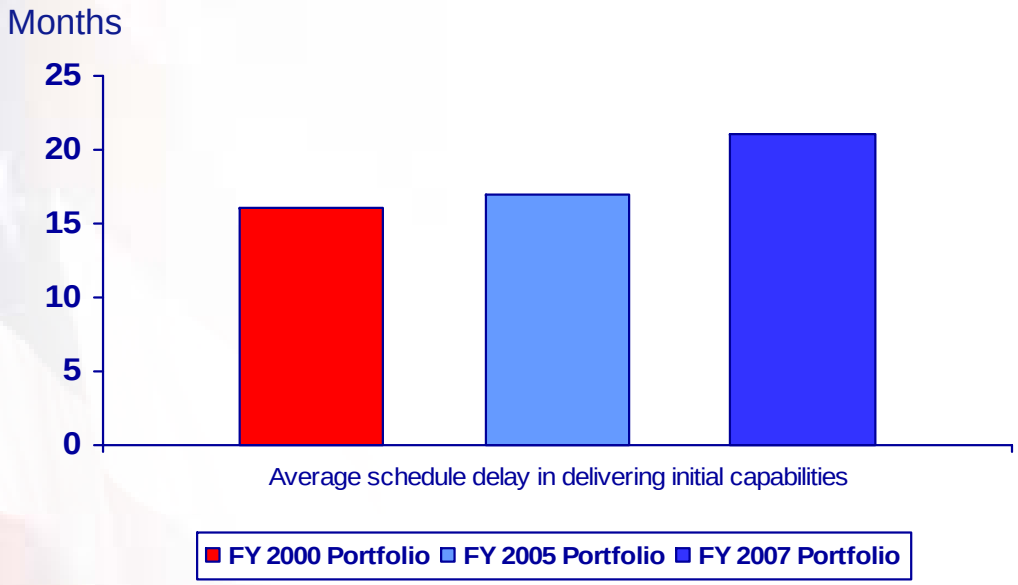
- **DOD 5000 policy says most of the right things about separating technology development from system development**
  - Calls for technology maturity to TRL 6 (relevant environment)
  - Calls for evolutionary approach as a check on reqts.
  - Short development cycle times (5 years or less)

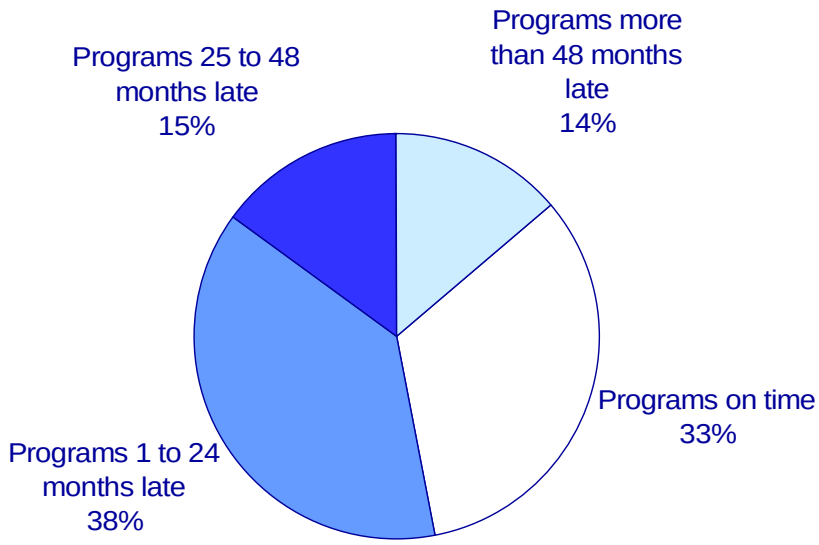
- **However,**
  - Best practice standard is TRL 7 (operational environment)
  - Most individual programs do not even abide by policy
  - Many programs fall outside: satellites, MDA, ships
  - Those within are unique: eg., FCS, JSF
  - Preference is still for revolutionary, not evolutionary
  - Knowledge gaps and optimistic estimates at MS B are the norm and are reinforced with approval and funding

GAO Observation: DOD Cost Outcomes Are Not Improving



GAO Observation: Delivery of Operational Capabilities Continues to Be Late

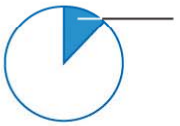
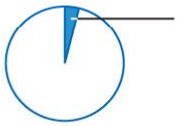
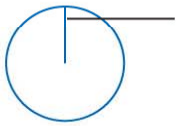




Status of FY 2007 Portfolio

GAO Observation: Lack of Widespread Knowledge-based Acquisition Process

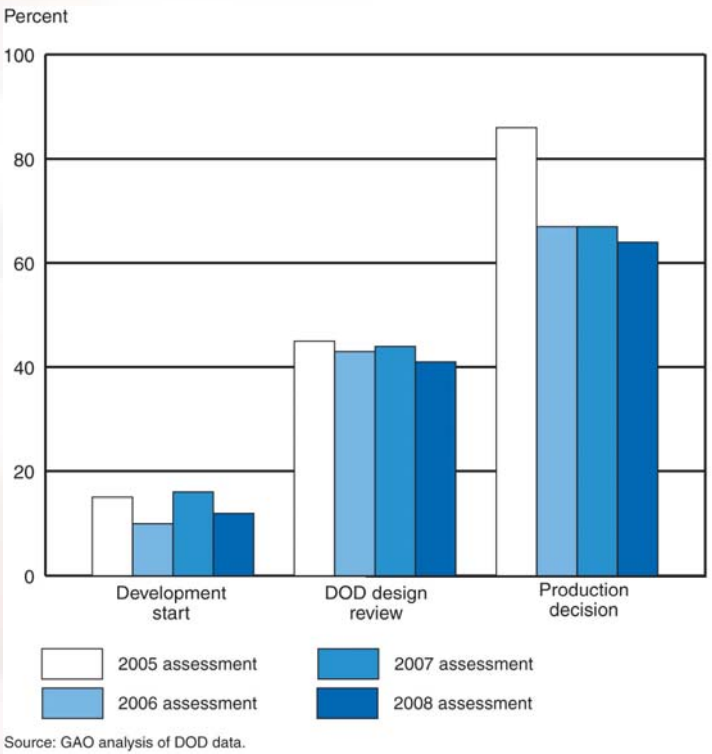
- DOD's acquisition practices necessary to ensure effective implementation of knowledge-based process are not always followed despite policies and guidance to contrary.

Key junctures	Development start	Design review	Production start
	Knowledge point 1	**Knowledge point 2**	**Knowledge point 3**
Best practices	Mature all critical technologies	Achieve knowledge point 1 on time and complete 90 percent of engineering drawings	Achieve knowledge points 1 and 2 on time, and have all critical processes under statistical control
DOD outcomes[a]	 12 percent of programs	 4 percent of programs	 0 percent of programs[b]

Source: GAO presentation of DOD data.

GAO Observation: Programs Enter System Development Without Mature Technologies

Percent of Programs Achieving Technology Maturity At Key Junctures



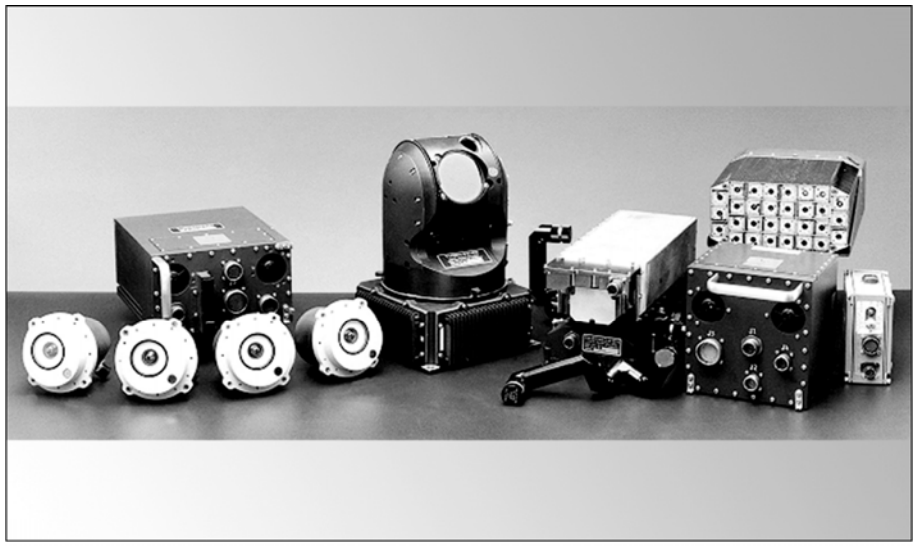
Source: GAO analysis of DOD data.

- Most programs did not achieve technology maturity at start
- No noticeable improvement over since 2005
- Forty-six percent of technologies (164 out of 356) immature state
- Cost growth for programs with immature technologies was 44 percent higher
- Many programs still maturing technologies into production

Best Practices for Technology Transition Study Objectives

- Identify techniques used by leading private companies to transition mature technologies to product lines by product launch.
- Assess practices used by the military services to transition technology.
- Determine potential technology transition practices DOD could use to improve its weapon systems outcomes.

DOD Example – ATIRCM/CMWS



Source: BAE Systems.

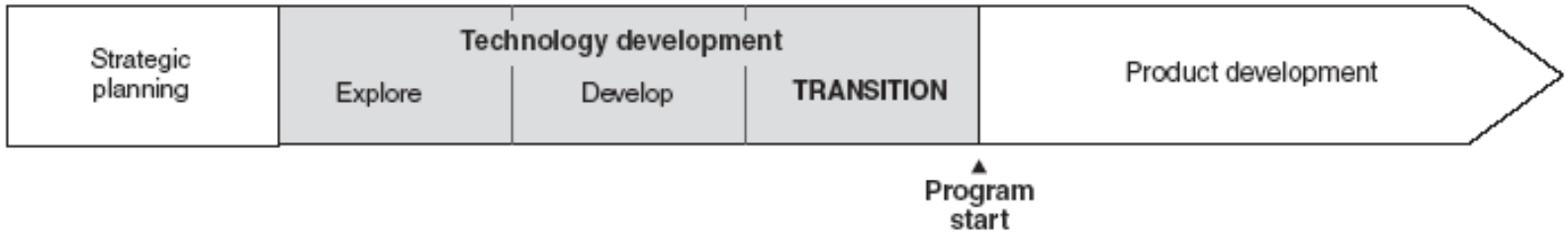
- Multi-laser technology not mature at program start in 1995
- Laser testing halted in fiscal year 2005
- Fielding delayed 5 years until 2010
- Cost of developing new jam head is estimated at $117 million

Private Industry Practices

- Merge technology development and product development activities prior to product launch.
- Have strong strategic planning to prioritize technology needs and a structured technology development process.
- Use 3 tools to support technology transition:
  - Relationship managers
  - Technology Transition Agreements
  - Metrics

Private Industry Practices – Merge Technology and Product Development

General Flow of Process Leading Up to Technology Transition



Source: GAO analysis and presentation of leading companies' practices.

- Hybrid phase used to merge technology development and product development activities prior to product launch.
- Responsibilities for managing and funding technology development gradually shift from labs to product line during this phase.

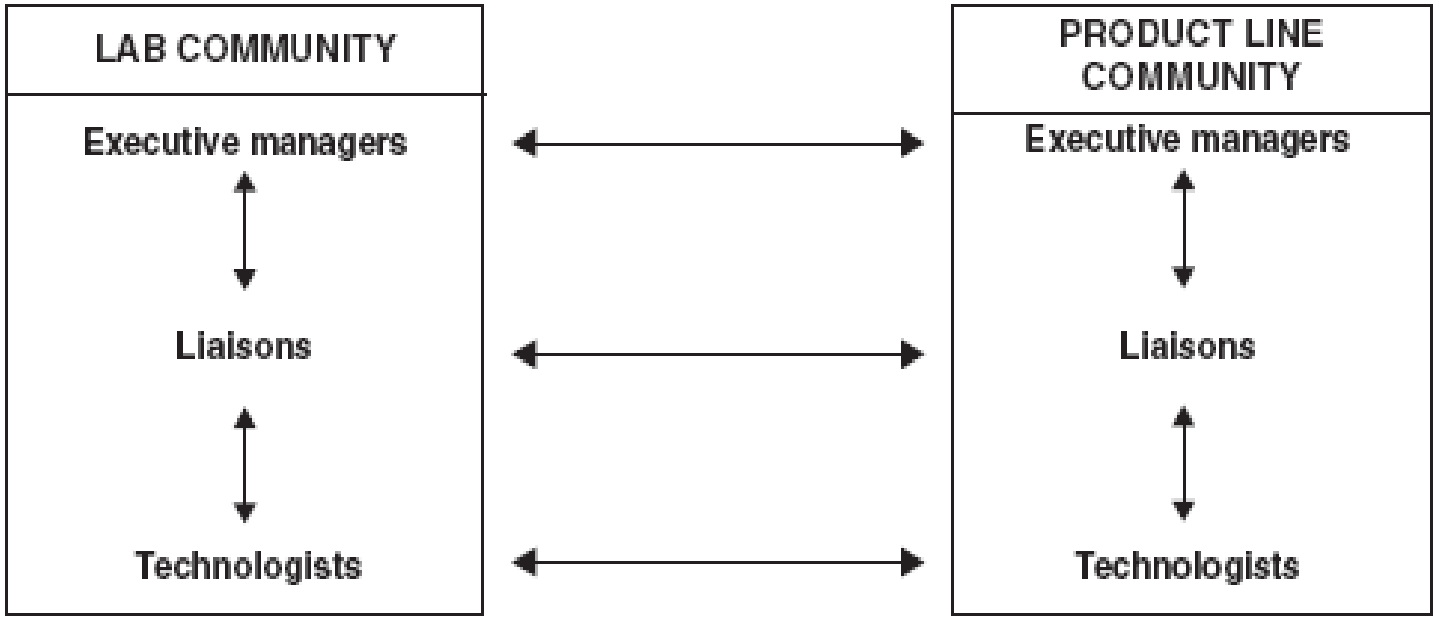
Private Industry Practices – Precursors to Smooth Transition

- Strong strategic planning processes used to identify and react to market needs quickly.
- Structured, gated technology development process.

TECHNOLOGY DEVELOPMENT GATES		
Explore Technology ideas and concepts are being explored	**Develop** Technology development activities are underway	**Technology transition** Technology is ready to transition from lab to product line team
Review	*Review*	
Deliverables • Technology is consistent with overall business strategy • Technology is promising and is likely to meet needs for potential product lines • Lab identifies potential products where technology can be used • Key cost, benefit, risk, marketing, manufacturing, and life cycle management issues are identified • Scalability approaches are identified • Technologies considered to be intellectual property are identified	**Deliverables** • Technology is consistent with technology strategy and other relevant strategies • Labs have high degree of confidence the technology will work • Product line team agrees that the technology will meet its needs • Technical requirements are identified • Cost, benefits, and risks are quantified • Scalability approach is selected • Strategies for addressing intellectual property rights are selected	**Deliverables** • Technology project complies with technology strategy • Technology is sound • Technology meets product requirements • Cost, benefit, and risks are well understood • Technology can be scaled to a magnitude appropriate for practical application • Product line team agrees technology is ready • Intellectual property rights methods have been pursued • Technology is demonstrated in an operational environment • Technical documentation is ready to be given to product line team

Private Industry Practices – Use of Relationship Managers

Relationship managers from labs and product lines serve as a communication link between the two communities and work out transition issues.



Source: Motorola; GAO (analysis and presentation).

Private Industry Practices – Use of Technology Transition Agreements

- Technology transition agreements document decisions made between labs and product lines:
  - Contain specific quantifiable cost, schedule, performance, and manufacturability metrics the labs must demonstrate before product line acceptance.
  - Feasibility, relevancy, and application of each technology are assessed in order to identify potential barriers to transition.
  - Identify lab and product line funding commitments.
  - May include loaning key lab technologists to the product line.

Private Industry Practices – Use of Project and Process Metrics

- Project metrics used to assess the status of technology development and whether the technology meets product needs
  - Size, weight, power, and reliability, as well as nonrecurring development and/or manufacturing costs.

- Process metrics provide information on the status, timeliness and impact of technology development efforts.
  - Return on investment, cycle time, technology yield, number of technologies commercialized, customer survey results.

DOD Practices

- DOD does not adequately prioritize the technologies that are most critical to acquisition programs.
- DOD does not merge S&T and product line activities prior to product launch; Transition often occurs at product launch irrespective of whether technologies are mature.
- New tools to support transition are being used, but:
  - Not as comprehensive as industry best practices.
  - Use is not widespread.

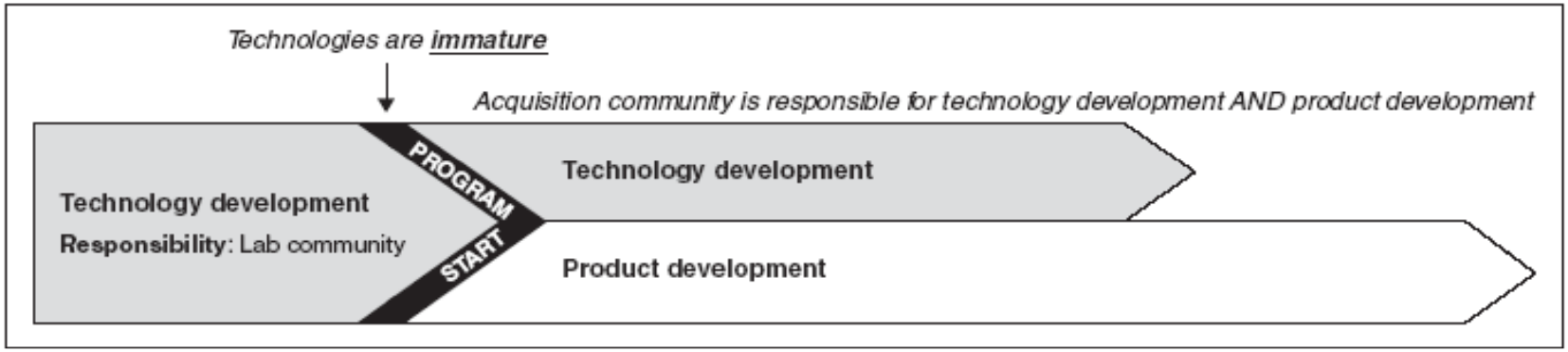
DOD Practices – Underdeveloped Technology Prioritization and Development Processes

DOD is not well positioned to develop and mature needed technologies on time.

- Strategic planning process does not consistently prioritize technologies most critical to acquisition programs.
- Military services have established S&T boards to select and oversee new technology projects, which increases visibility for some technologies, but the scope varies across military services.

DOD Practices – Technology and Product Development are not Effectively Aligned

DOD does not have a structured, gated S&T technology development process with deliverables to guide investments.



Source: DOD (data); GAO (analysis and presentation).

- S&T and acquisition communities do not communicate well and are not aligned in a way to effectively meet priorities, resulting in:
  - Irrelevant technologies advancing to final stages of lab development without commitment to field the technologies.
  - Technology not being ready to transition when needed.
  - Acquisition not being prepared to take over funding responsibilities.

DOD Practices – Tools to Support Technology Transition are Underutilized

- Relationship Managers
  - Generally used to market lab technology; not as a communication tool to assist in technology transition.
- Technology Transition Agreements
  - Use and coverage vary greatly among service S&T programs
  - Agreements contain some of the same elements seen in industry, but typically do not require the technology developer to demonstrate cost metrics.
  - Tool used mainly by labs; not valued by acquisition community as highly.
- Metrics
  - Few metrics used to gauge the impact of investments or the effectiveness of processes used to develop and transition technologies.

DOD Practices: Some Promising Initiatives to Aid Transition

- **Advanced Concept/Joint Concept Technology Demonstration** (ACTD/JCTD) -- Goal is to get technologies that meet critical needs to users faster and at lower cost, refine the the selection process to better match user priorities, and provide more funding in early stages of demonstration.
- **Manufacturing Technology Program** -- Aimed at quickly identifying and solving technology transition problems; focusing on affordable, low-risk development and production
- **Foreign Comparative Testing & Technology Transition Initiative** -- FCT identifies, evaluates, and procures technologies developed by other countries. TTI speeds transition of DOD lab developed technologies to acquisition programs.

Recommendations

- Develop a gated process for developing and transitioning technologies that establishes a transition phase and defines activities that should occur during this phase.
- Set aside a portion of advanced component development and prototype funds for the S&T to manage the transition of technologies to acquisition programs.
- Expand the use of technology transition agreements to applied and advanced development projects.
- Include additional metrics in technology transition agreements.
- Expand the use of relationship managers and define responsibilities.
- Adopt additional process-oriented metrics to measure the effectiveness of S&T processes and the impact of S&T investments.

Questions?

For further details, see GAO report: GAO-06-883, “Best Practices: Stronger Practices Needed to Improve DOD Technology Transition Processes” at www.gao.gov.

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