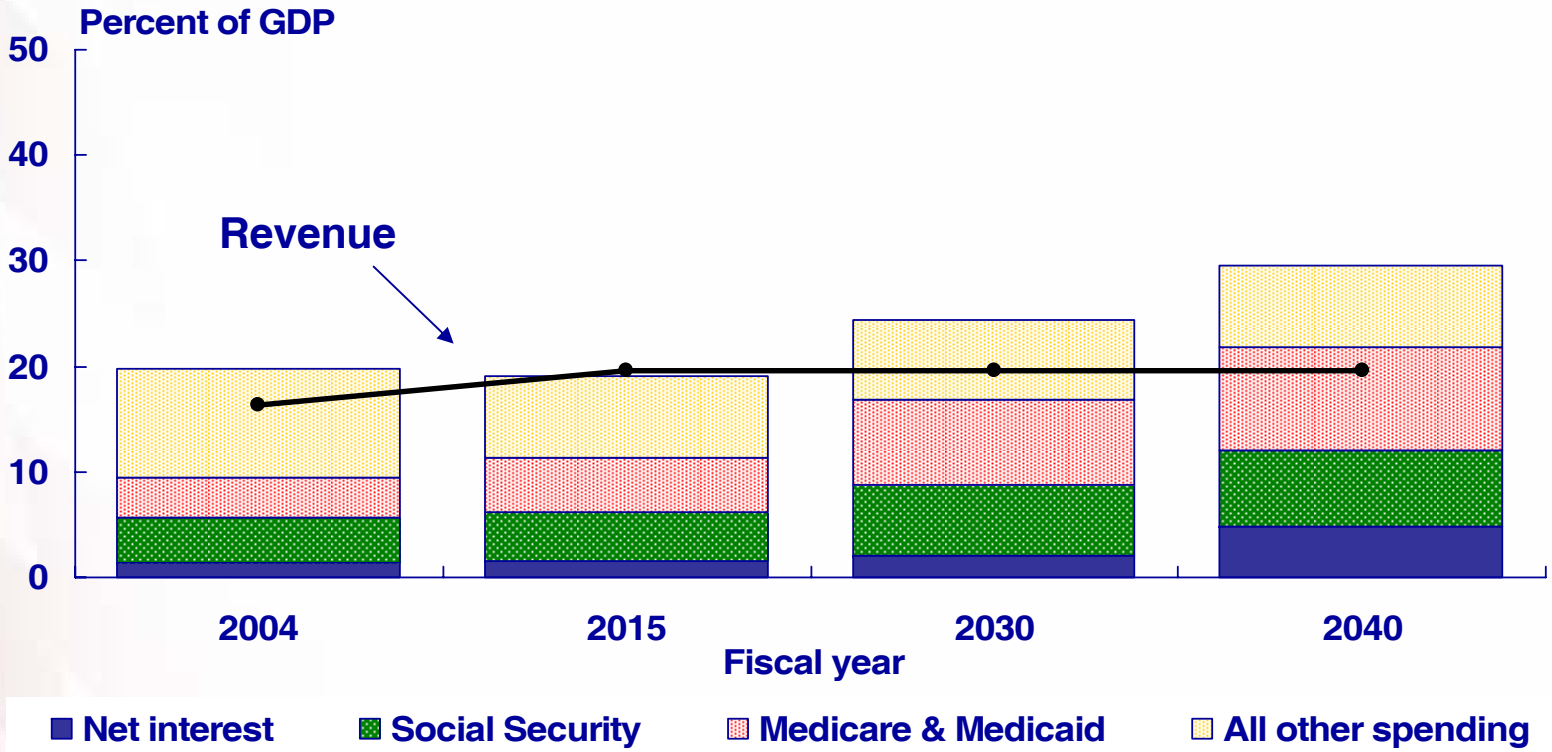
Evaluating Weapon System Programs Using A Knowledge-Based Approach

Presented to DOD's Business Managers' Conference

May 11, 2005

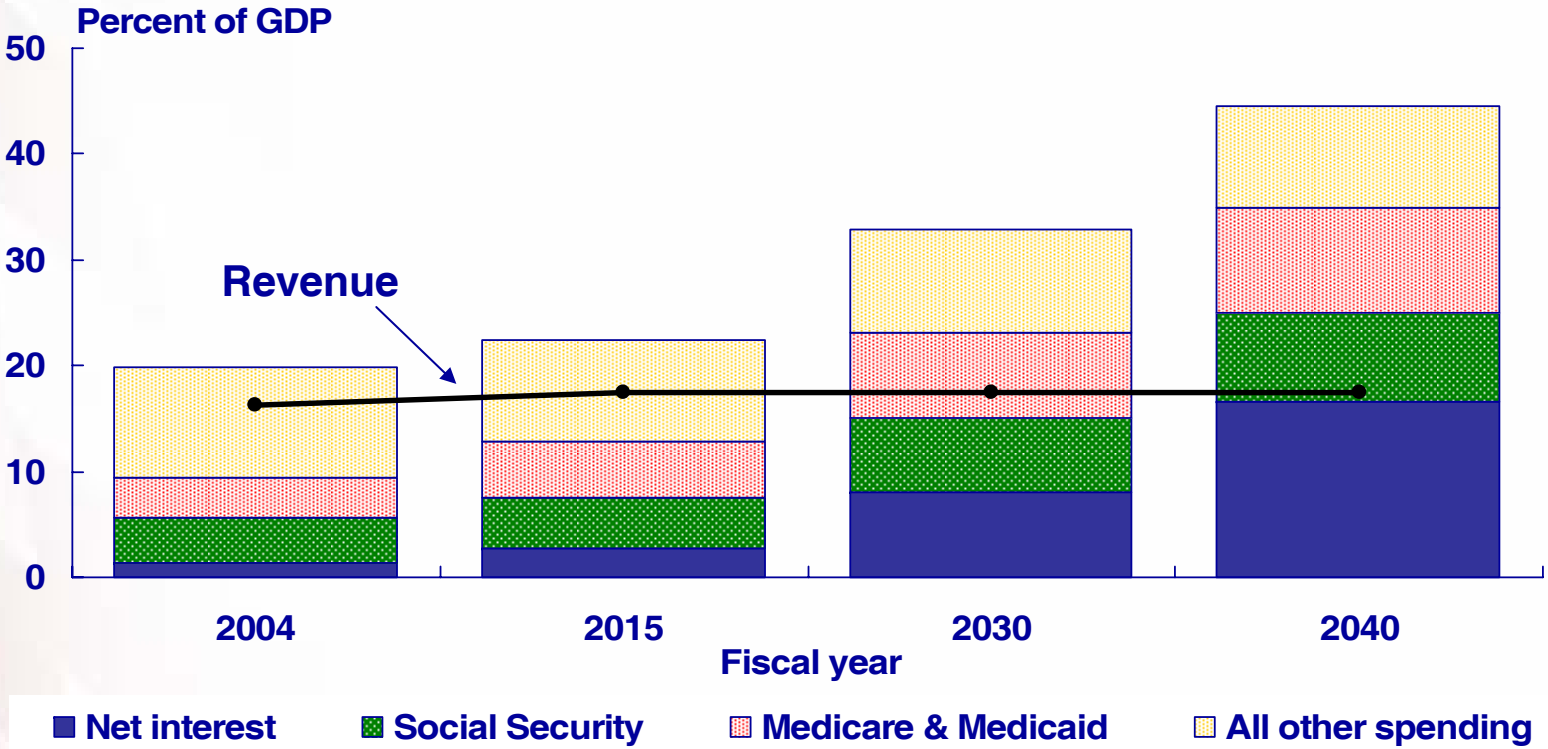
Composition of Spending as a Share of GDP
Under Baseline Extended



Notes: In addition to the expiration of tax cuts, revenue as a share of GDP increases through 2015 due to (1) real bracket creep, (2) more taxpayers becoming subject to the AMT, and (3) increased revenue from tax-deferred retirement accounts. After 2015, revenue as a share of GDP is held constant.

Source: GAO's January 2005 analysis.

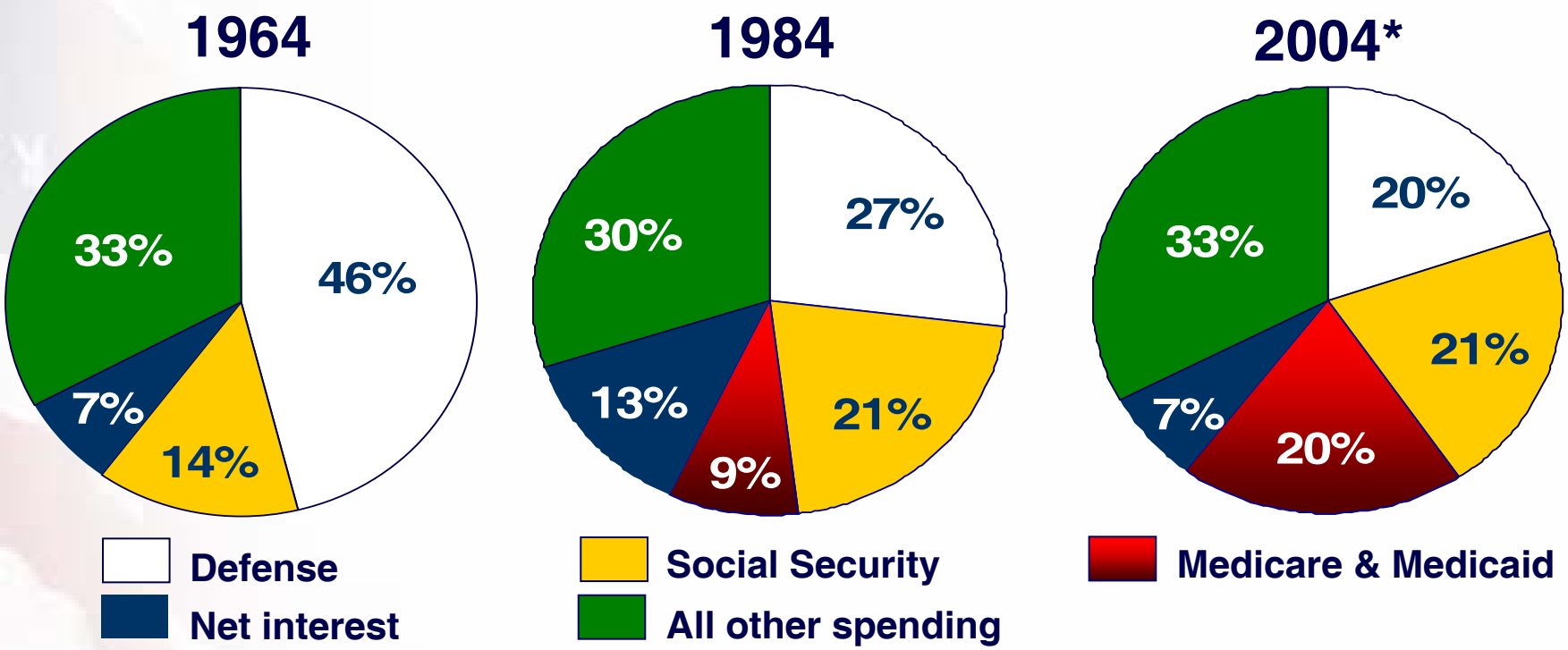
Composition of Spending as a Share of GDP Assuming Discretionary Spending Grows with GDP After 2005 and All Expiring Tax Provisions are Extended



Notes: Although expiring tax provisions are extended, revenue as a share of GDP increases through 2015 due to (1) real bracket creep, (2) more taxpayers becoming subject to the AMT, and (3) increased revenue from tax-deferred retirement accounts. After 2015, revenue as a share of GDP is held constant.

Source: GAO's January 2005 analysis.

Composition of Federal Spending



*Current services estimate.

Note: Numbers may not add to 100 percent due to rounding.

Source: *Budget of the United States Government, Fiscal Year 2005* (February 2004) and *Budget of the United States Government, Fiscal Year 2005, Mid-session Review* (July 2004), Office of Management and Budget.

Budgetary Pressures on DOD

- DOD must compete for a shrinking portion of discretionary funds

- O&M pressures compete with new investment (Afghanistan, Iraq, global war on terror)
  - Using US military equipment at 5 to 10 times the peacetime training rate
  - Spending $8 billion a year at current operating tempo for replacement

- Current programs are costing more and taking longer than originally agreed to and funded.

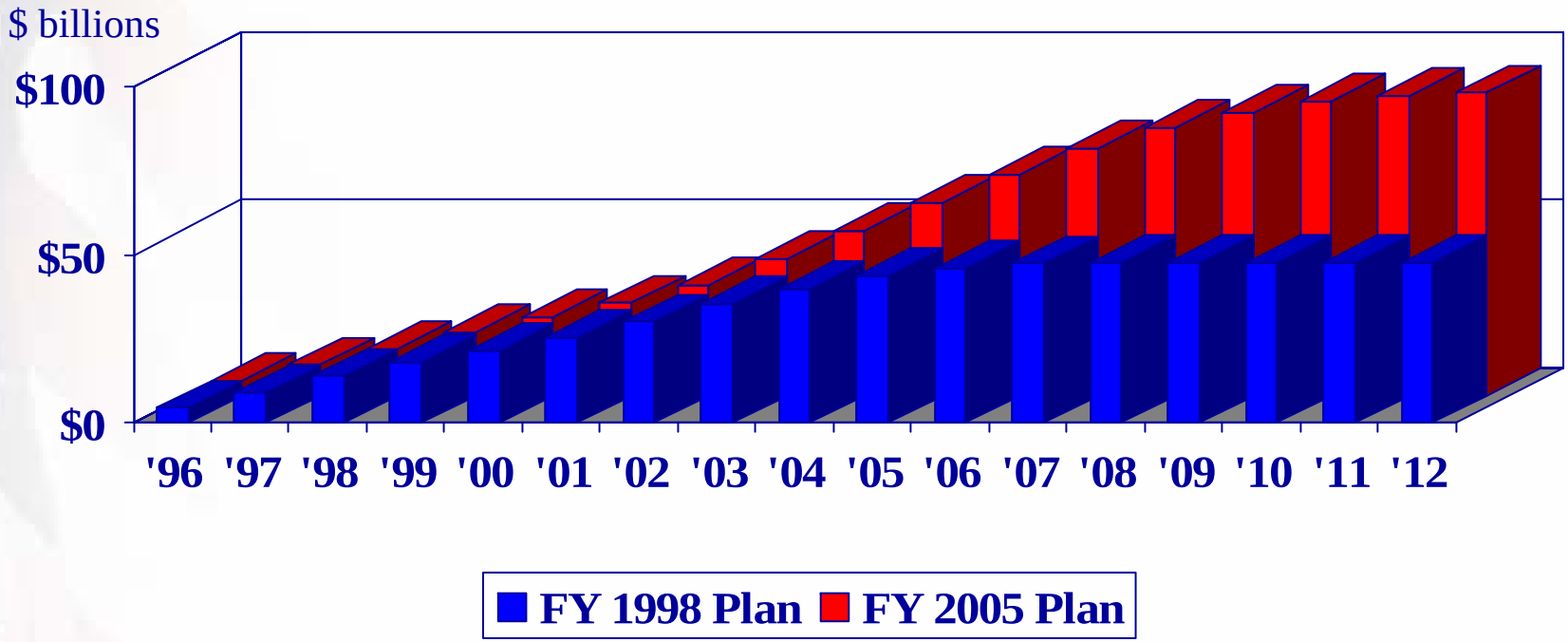
DOD Investment Accounts

- Investment in R&D and Procurement of major weapons is over $1.3 trillion and likely to grow
- Cost of top 5 programs has doubled from 4 years ago

2001		2005	
Program	Cost	Program	Cost
F/A-22	$62,844	JSF	$198,624
DDG-51	$62,299	FCS	$107,967
Virginia Sub	$60,062	F/A-22	$73,098
C-17	$49,370	Virginia Sub	$72,767
F/A-18E/F	$46,604	DDG-51	$68,753
Total	$281,179	Total	$521,209

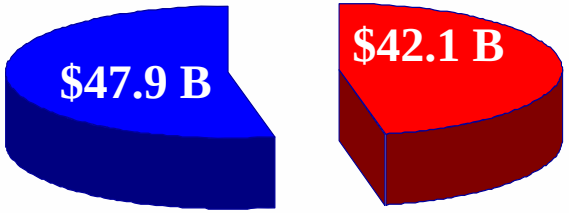
Note: compares 12/99 with 12/03 SAR data, $2005 in millions.

Cumulative Effect of R&D Cost Growth for Developing Weapon Systems[1]



FY '05: $89.95 billion total

FY 1998 plan for completing development of 8 programs



Additional investment needed under FY 2005 plan for completing the 8 programs

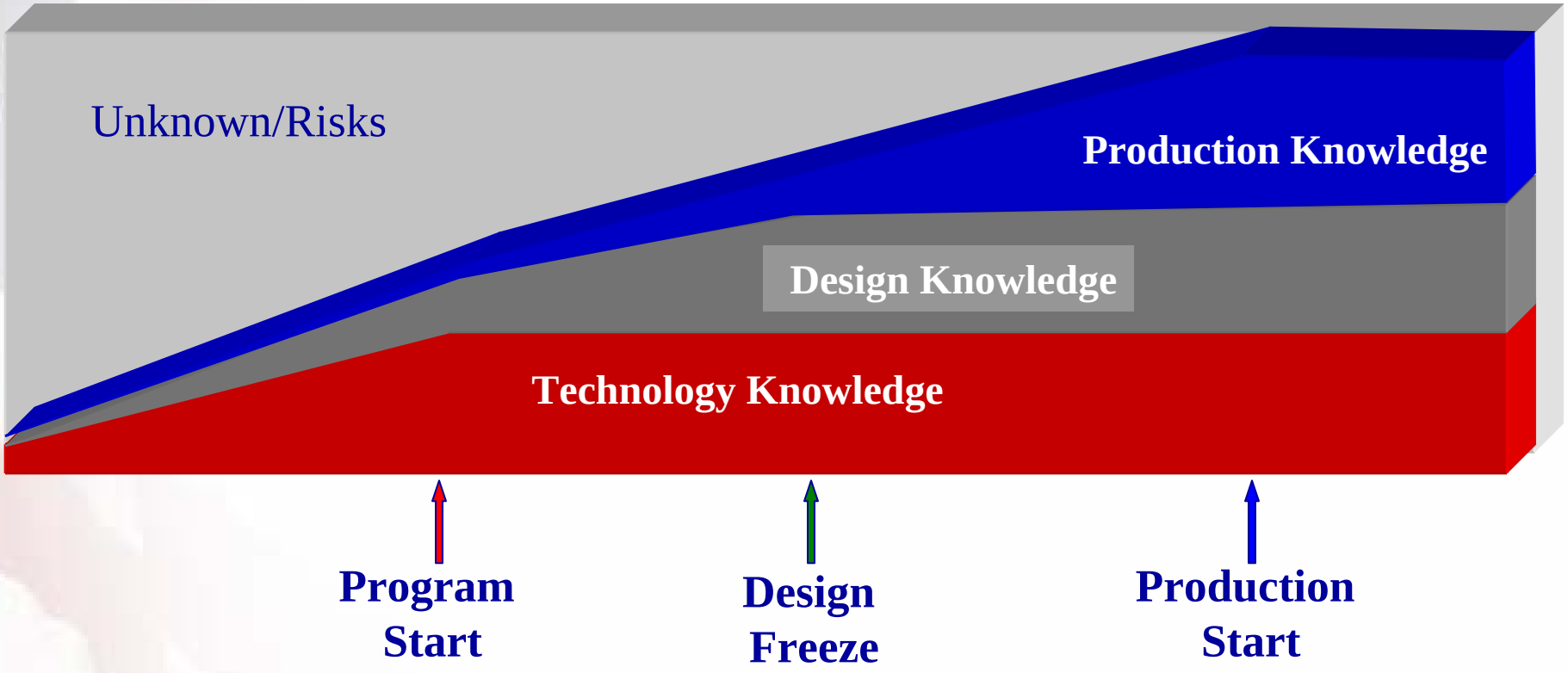
[1]Source: Selected Acquisition Report data (12/31/96 and 12/31/03) on the 8 weapon systems among the highest R&D budget requests for FY 2003. All dollars are in constant FY 2005 dollars.

Cumulative Unit Cost Changes

Programs*	Unit Cost Reported to Congress		Unit Cost Not Reported to Congress	
	% change	time elapsed (months)	% change	time elapsed (months)
AMRAAM	-(3.71)	87	125.52	254
AAWS-M (Javelin)	4.14	34	207.87	174
FMTV	-(4.67)	7	154.52	177
USMC H-1 Upgrades	-(.98)	20	101.52	87
V-22 Vertical Lift Aircraft	6.00	20	132.46	212
F/A-22	-(.33)	4	72.40	143

*We selected acquisition category 1C and 1D programs with the largest Average Procurement Unit Cost increase when comparing the current estimate with the first full estimate.

Knowledge Builds in Product Development



If knowledge deficits exist, successful outcomes are at risk.

The Knowledge-Based Approach

A knowledge-based approach enables better products to be developed faster and less expensively.

Knowledge Point 1: A match is achieved between the user's requirements and the developer's resources – time, money, people (indicator: technology readiness level).

Knowledge Point 2: The product design demonstrates its ability to meet user needs and is stable (indicator: percent of engineering drawings released).

Knowledge Point 3: Demonstration that the product can be produced within cost, schedule, and quality targets (indicator: percentage of key processes in statistical control).

Knowledge-based Decision Making

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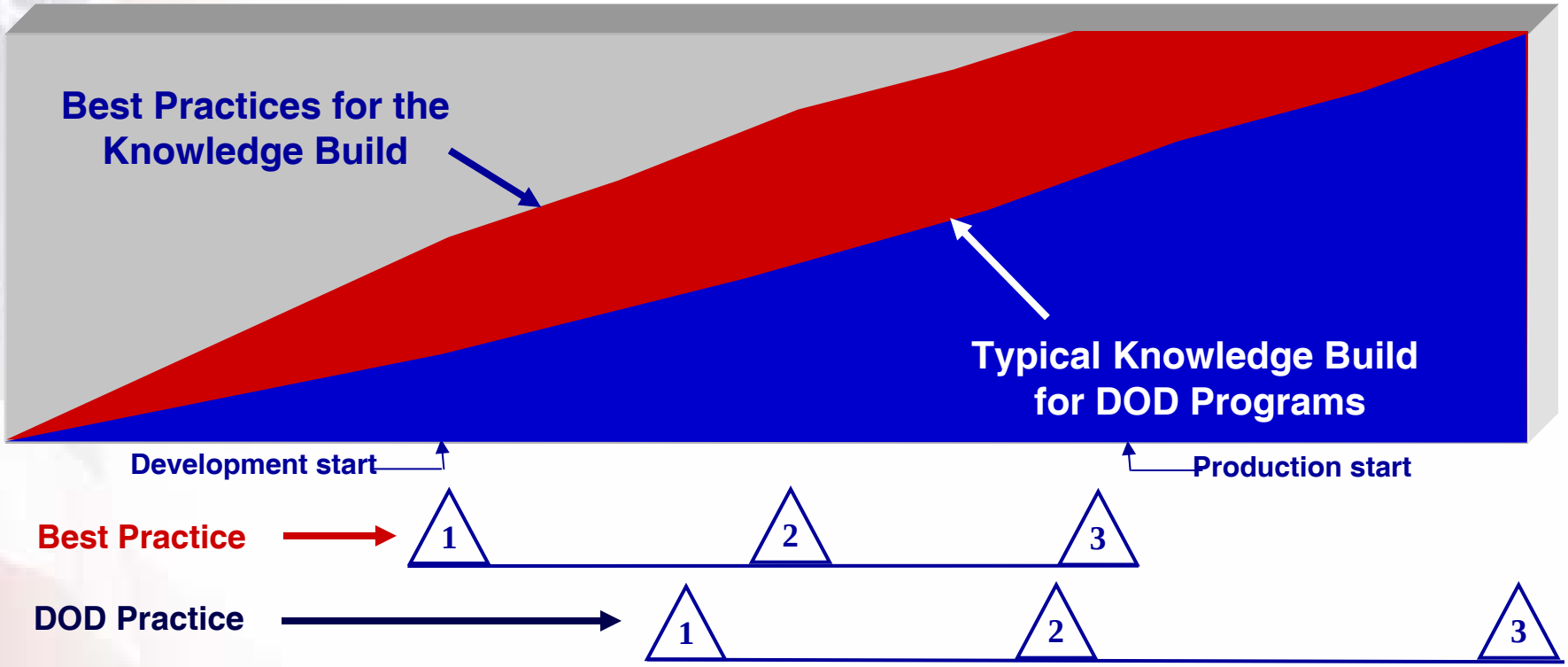
1	2	3
Requirements understood	Knowledge point 1 attained	Knowledge points 1 and 2 attained
Technology and design demands known	Sound design process used	Key characteristics identified
Technology assessed, trades made to match maturity levels	Component designs demonstrated	Critical processes identified and controlled
Funding committed, skills available, fielding date agreed on	Integrated design demonstrated	Reliability growth demonstrated
	90% drawings releasable	

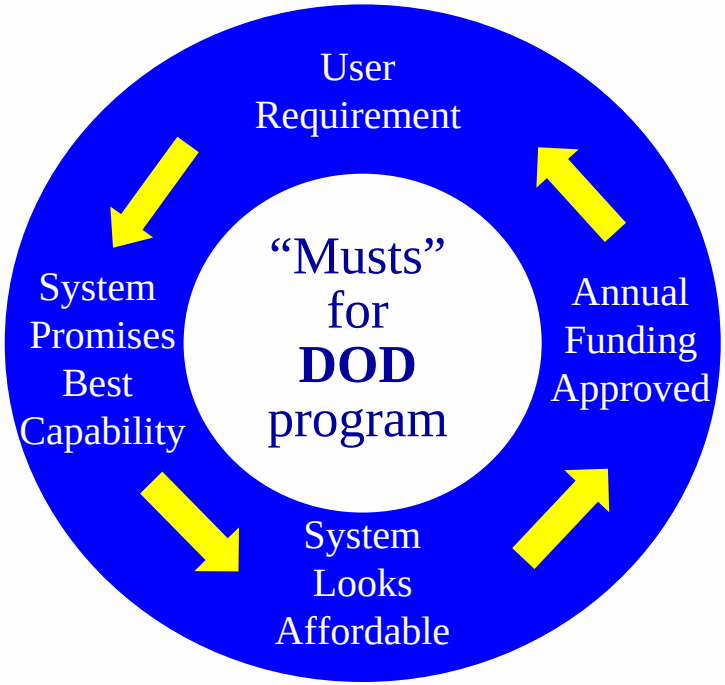
Concept and Technology Development	Product Development	Production

Good v. Problematic Knowledge Builds



For successful product developments:
KP1 occurs at program start
KP2 occurs at critical design review
KP3 occurs at production decision

Elements of the Business Case



Programs use funds
Sale follows development
Customer not vested
Goal: right product @ right price
Knowledge, candor, realism work

Programs generate funds
Sale in early development
Customer vested early
Goal > right equipment @ any price
Pressure to compromise good judgment
Process tends to be in equilibrium

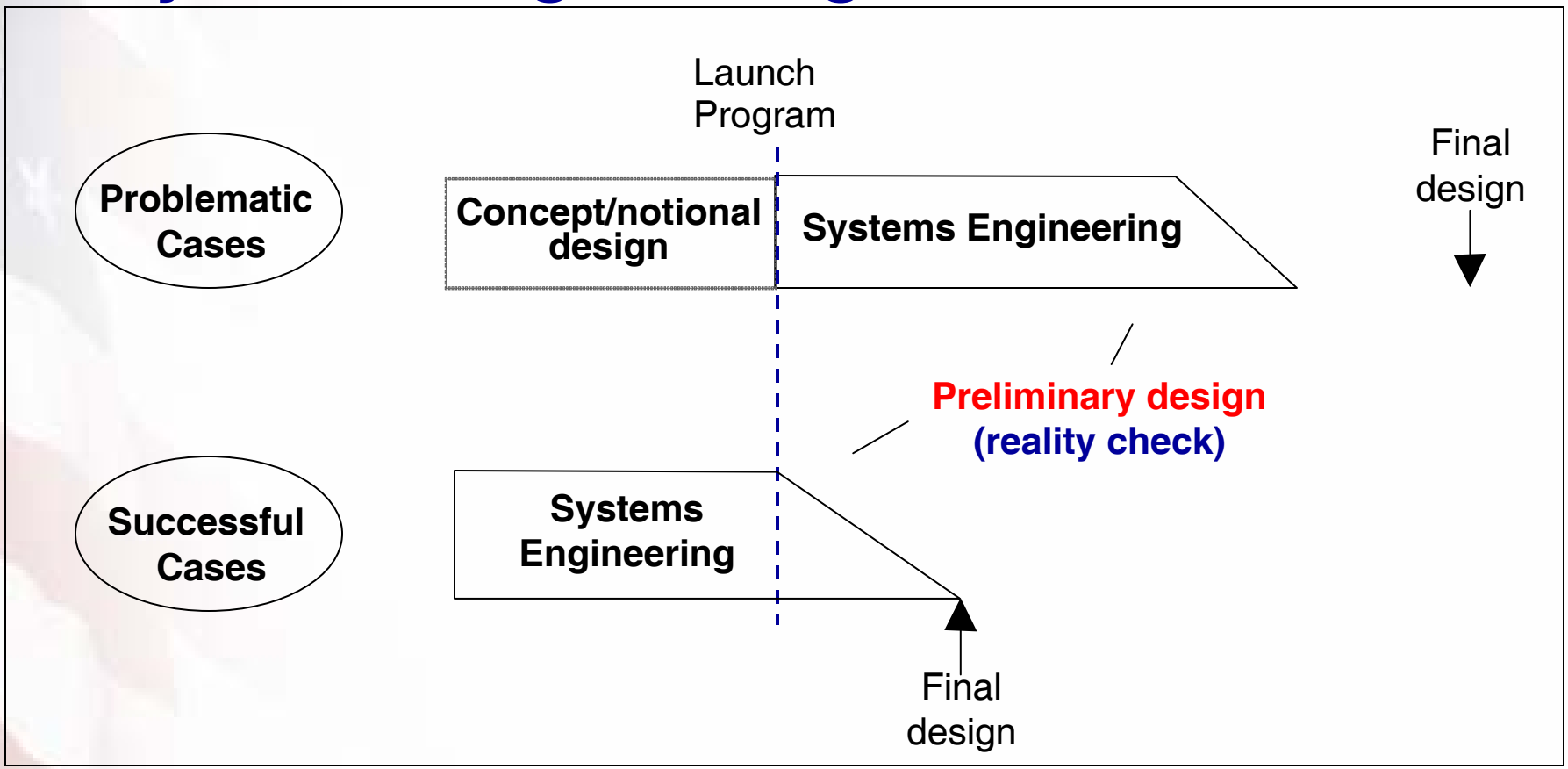
Program Start Business Case

MATCH: Requirements

TO: Resources

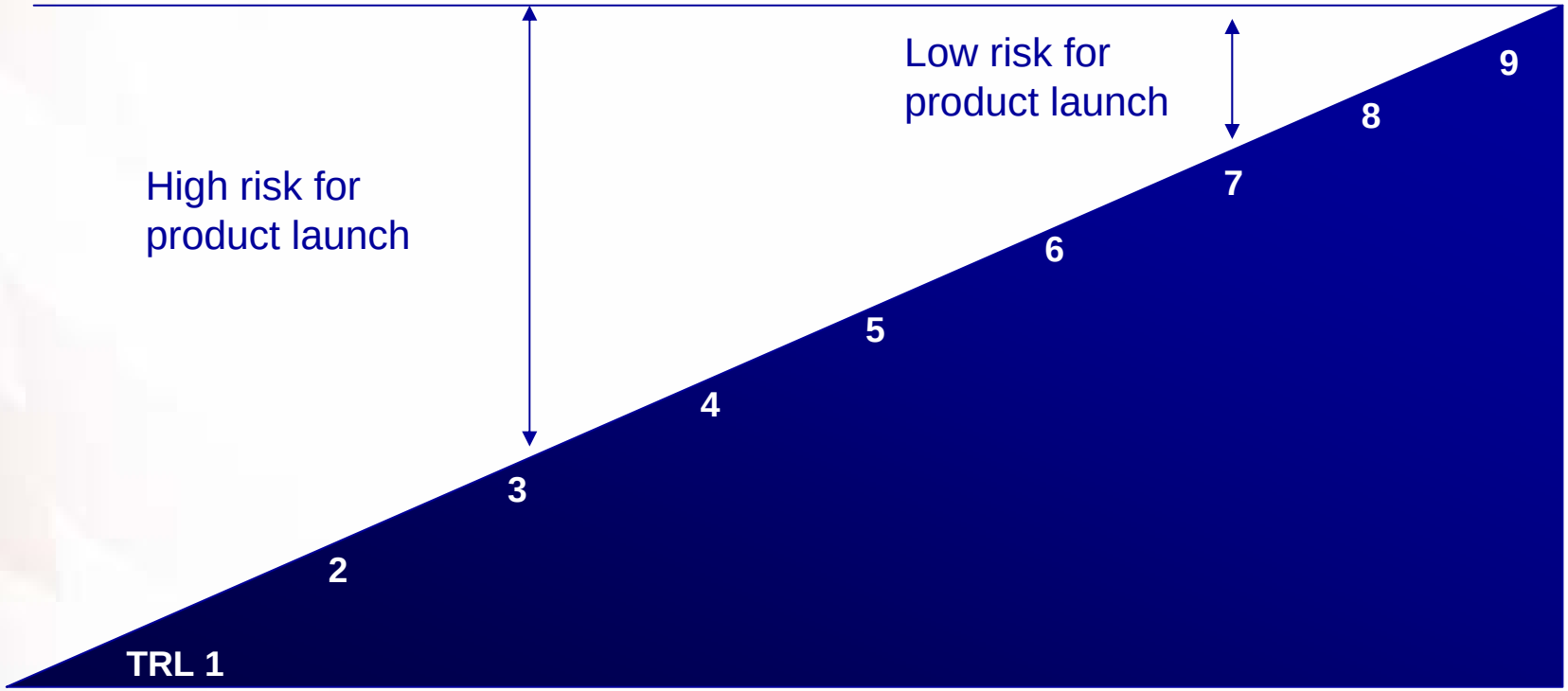
- Technology
- Funding
- Time
- People

Requirements Analysis: Timing of Systems Engineering



Technology Maturity: Matched Through Readiness Levels (TRLs)

Product Requirements

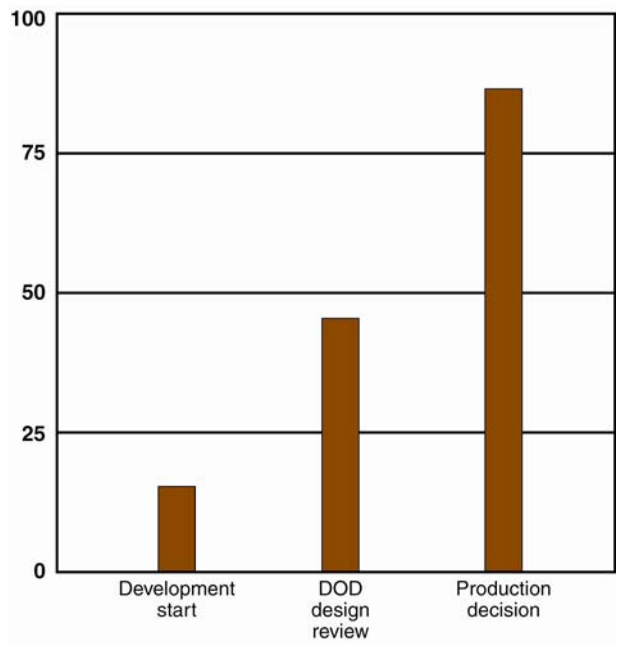


TRL = physical status + demonstration environment

Resources: Technology Maturity

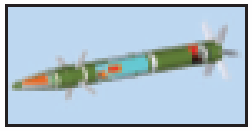
Most programs proceed with lower levels of knowledge at critical junctures than best practices

- Only 15% of programs began development with mature technology
- If technology is mature, R&D costs grew 9%; unit cost 1%.
- If technology is immature, R&D costs grew 41%, unit cost 21%.



Source: GAO analysis.

Resources: Funding Committed

Program		Initial investment	→	Initial quantity	Latest investment	→	Latest quantity	Percent unit cost increase
Joint Strike Fighter		$183.6 billion		2,866 aircraft	$198.6 billion		2,457 aircraft	26.2
Future Combat Systems		79.8 billion		15 units	108 billion		15 units	35.2
F/A-22 Raptor		78.4 billion		648 aircraft	73.1 billion		279 aircraft	116.5
Evolved Expendable Launch Vehicle		14.9 billion		181 vehicles	27.8 billion		138 vehicles	143.8
Space Based Infrared System High		3.9 billion		5 satellites	9.9 billion		5 satellites	149.9
Expeditionary Fighting Vehicle		7.9 billion		1,025 vehicles	9.5 billion		1,025 vehicles	21.0
Extended Range Guided Munition		389.3 million		8,570 munitions	598.4 million		3,141 munitions	319.4

Source: GAO analysis of DOD data. Images sourced in their respective order: JSF Program Office; Program Manager, Unit of Action, U.S. Army; F/A-22 System Program Office; (Left) © 2003 ILS/Lockheed Martin, (right) © 2003 The Boeing Company; Lockheed Martin Space Systems Company; General Dynamics Land Systems; Naval Gunnery Project Office.

Resources: Funding Committed

Cost growth for selected space systems

Total Cost	First Full Estimate	Latest Estimate	Percent Change
EELV	$14,923.9	$27,745.5	143.8
GBS	$494.6	$703.4	42.2
GPS II	$5,339.7	$5,987.5	12.1
SBIRS High	$3,948.0	$9,866.7	149.9

Millions constant 2005 dollars

Source: GAO analysis of DOD data.

Resources: Agreed Fielding

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Cycle time growth for 26 weapon systems

	First Full Estimate	Latest Estimate	Percent Change
Acquisition Cycle time	146.6 months	175.3 months	19.6

Annual change

	2004 Assessment	2005 Assessment	Percent Change
Acquisition Cycle time	166.1 months	175.3 months	5.5

Resources: Skills Available

- More Complex Procurements
  - Megasystems
  - Networks and platforms
  - Software intensity
- More Extensive Reliance on Contractors
  - Fewer program management staff
  - Decreasing in-house technical and engineering skills
  - Evolving concepts of inherently governmental functions

What Needs to Change

- External budgetary pressures call for delineating between wants and needs.
- Corporate level investment decisions are needed to preclude too many programs from starting, with unexecutable strategies.
- Definition of performance must change to include actual fielding and quantities of systems.
- Dollars wasted in individual programs must be seen as opportunity costs of modernization as a whole.

Sources

- Reports available at www.gao.gov

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