Air Force Institute of Technology

Integrity - Service - Excellence

Are New Acquisition Programs Taking Longer to Develop / Field and, if so, Why?

U.S. AIR FORCE

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- **The views expressed in this presentation are those of the authors and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the United States government.**

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Overview

- Background
- Budget
- Technology
- Climate
- Acquisitions
- Schedule
- Conclusions

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Background

- Our charter, loose leash, group determined direction
- Scope of our research
  - Fighter acquisitions from the 1970s to the present
  - Primarily F-15, F-16, F/A-22, F-35
- Methods
  - Personal interviews
  - Archive research (ASC/HO)
  - Extensive Literature Study

The Short Answer

Yes

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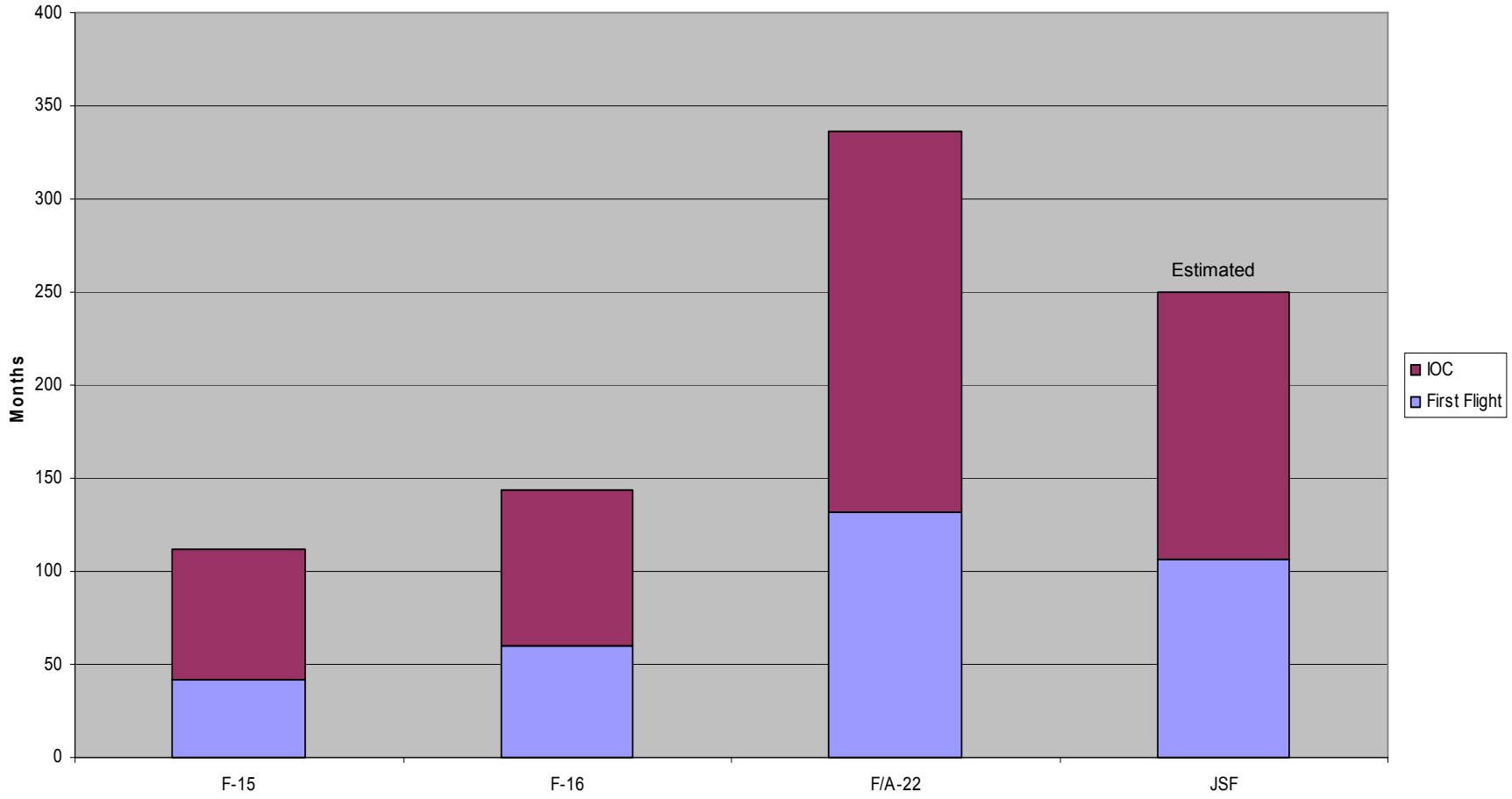
The Short Answer



Fighter Aircraft Development Times, Gebhard, 2005

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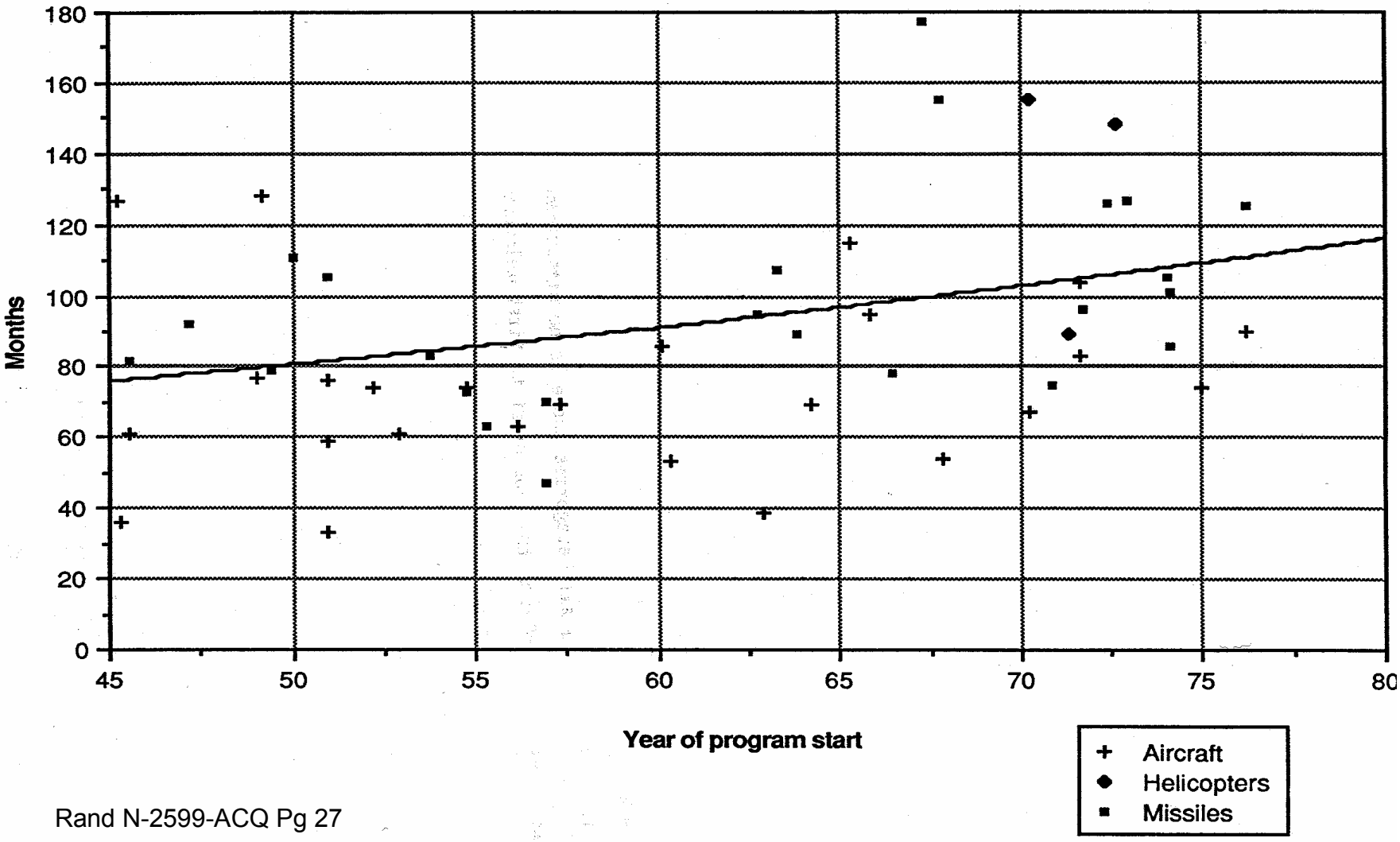
The Short Answer



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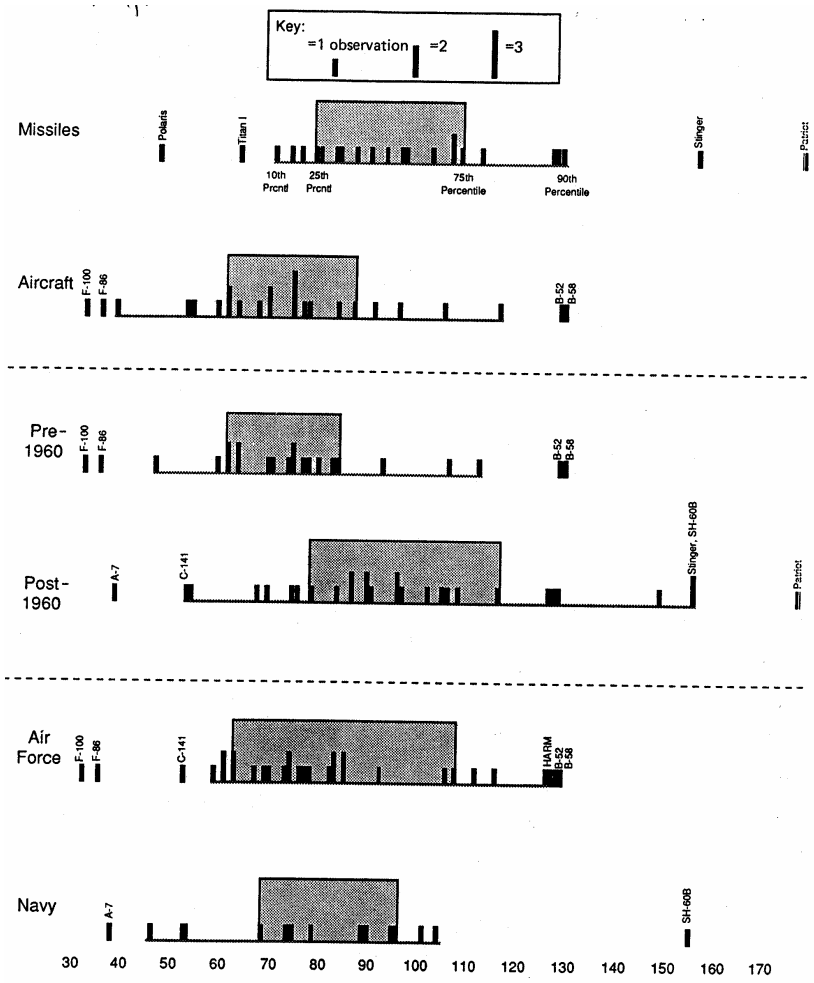

Fig. 1 — Distribution of months from program start to first delivery

Rand N-2599-ACQ Pg 14

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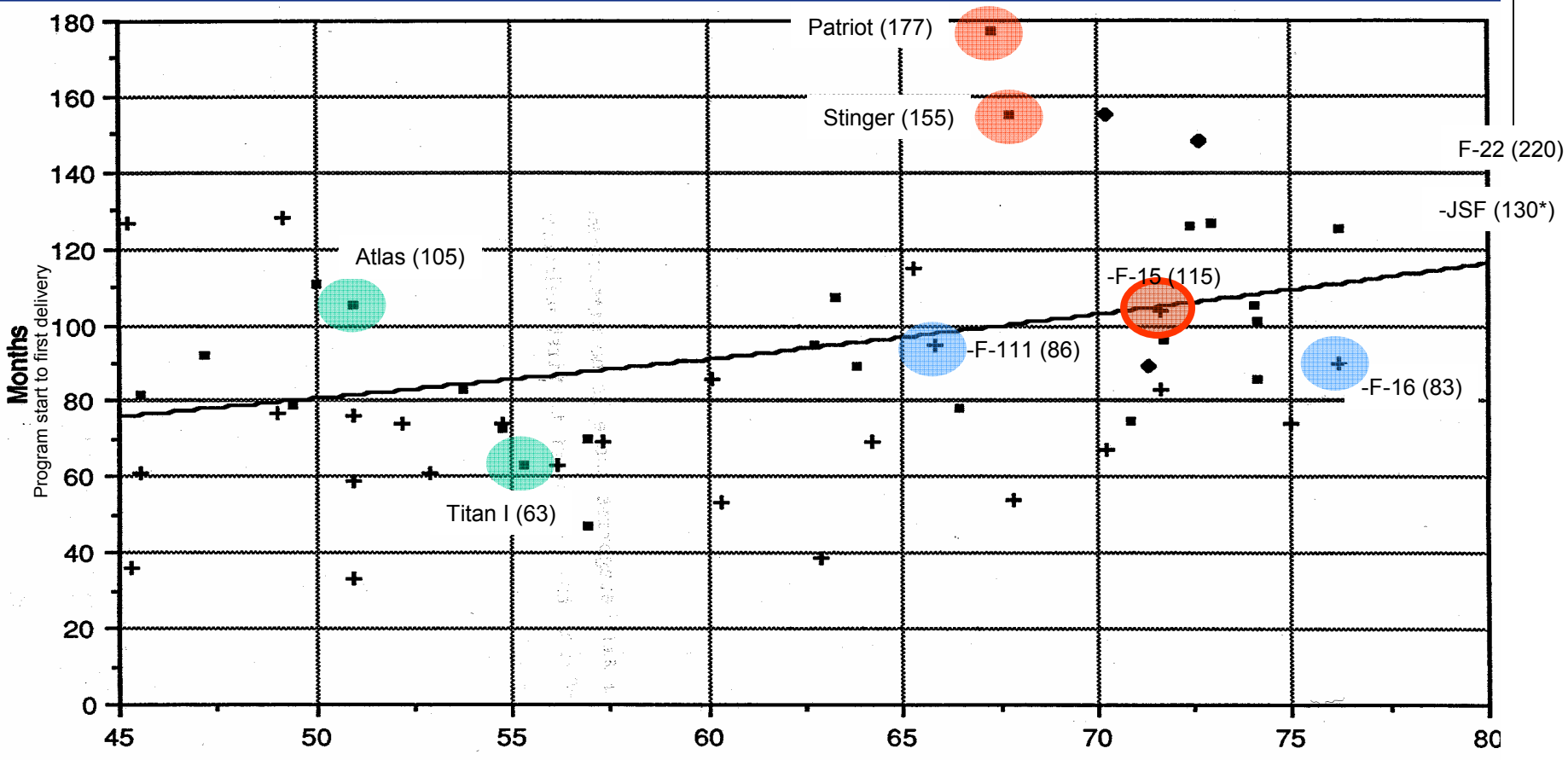
The Short Answer



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- Comparison of Atlas (105 mths) to Titan I (63 mths)

- Examples: Patriot (177 mths) and Stinger (155 mths)

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The Long Answer

- List of contributing factors is long
  - This is an issue that requires systems thinking
- We broke it into five areas
  - Budget
  - Technology
  - Climate
  - Acquisition
  - Schedule

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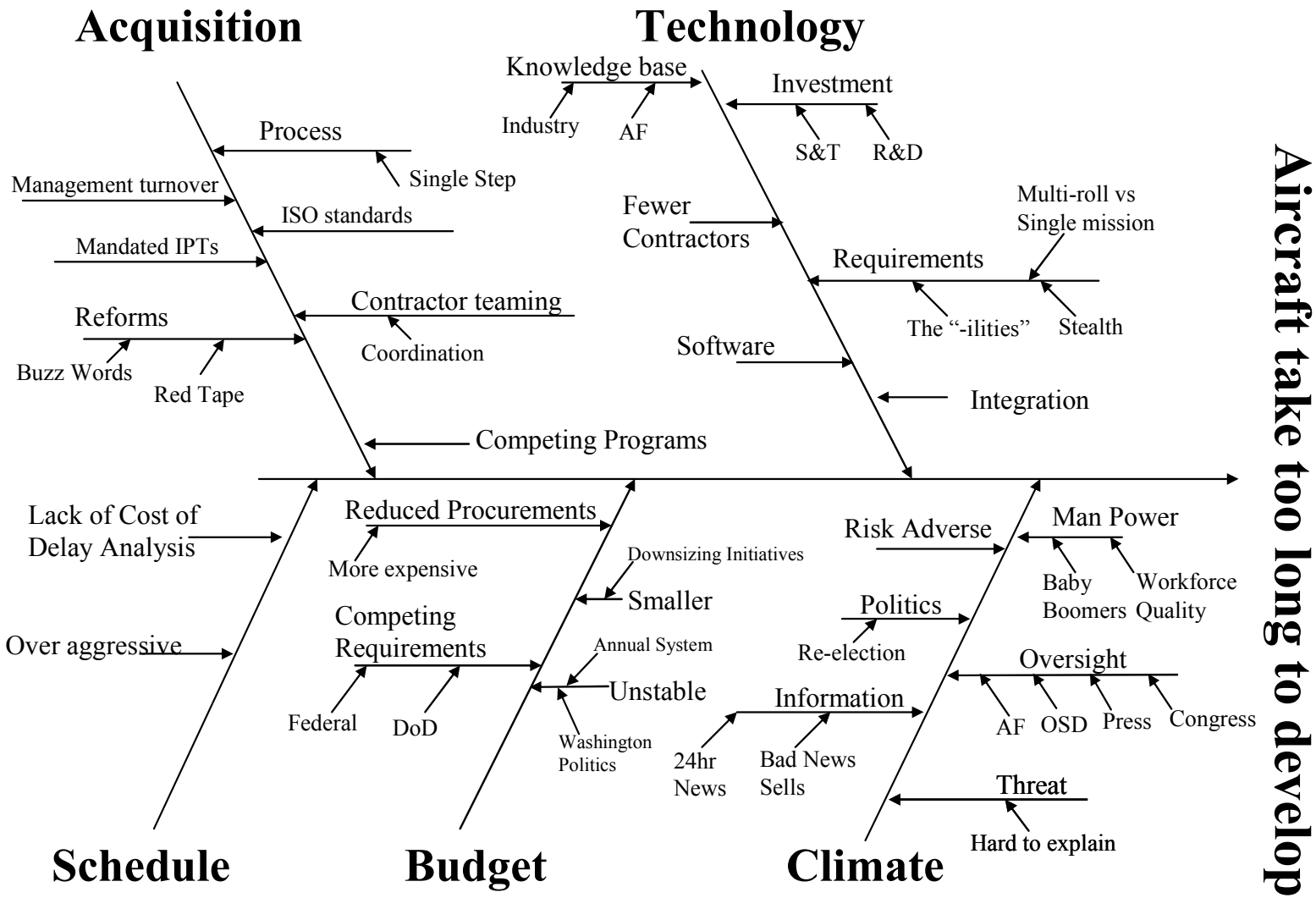
The Long Answer



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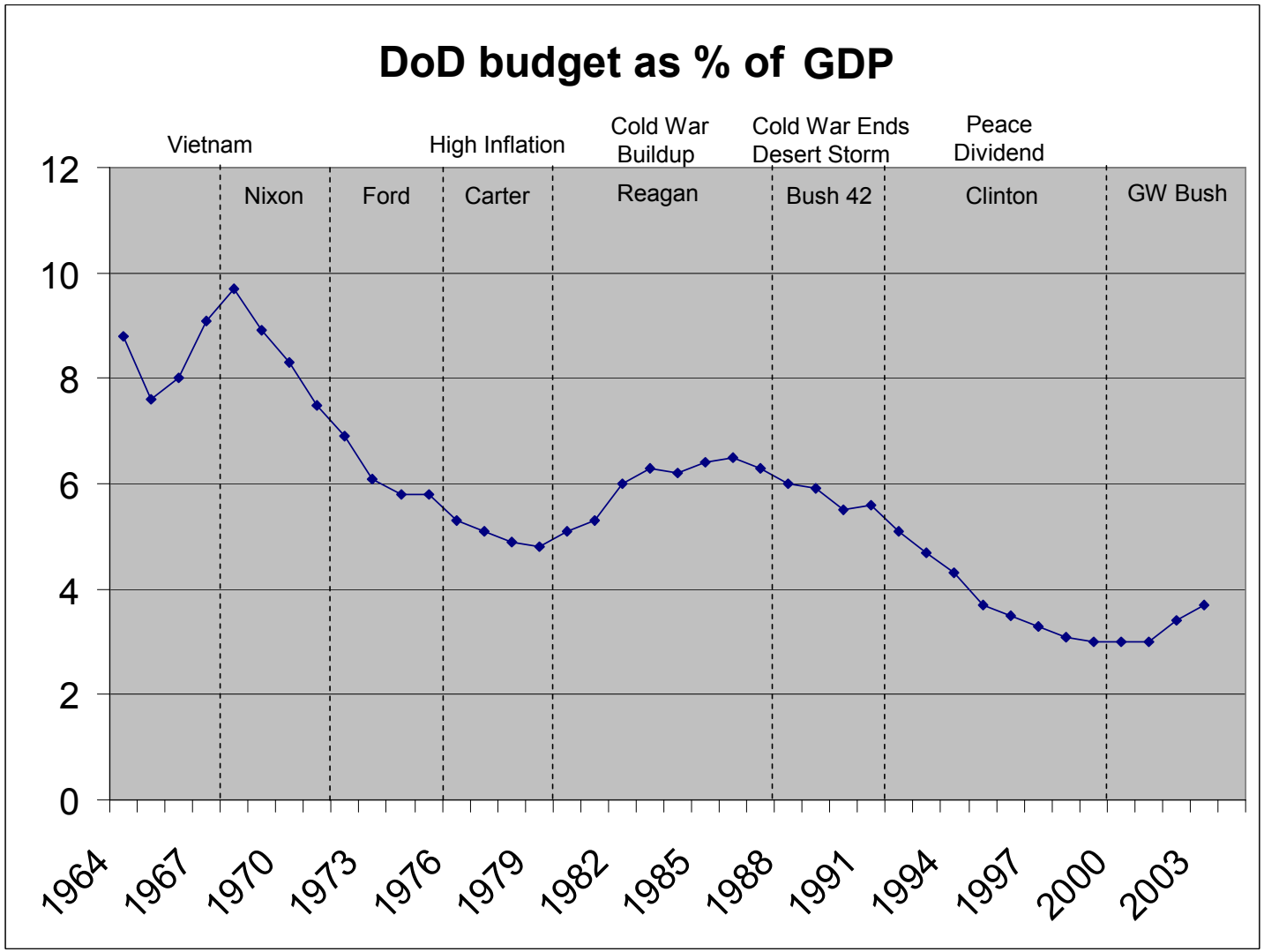
Budget



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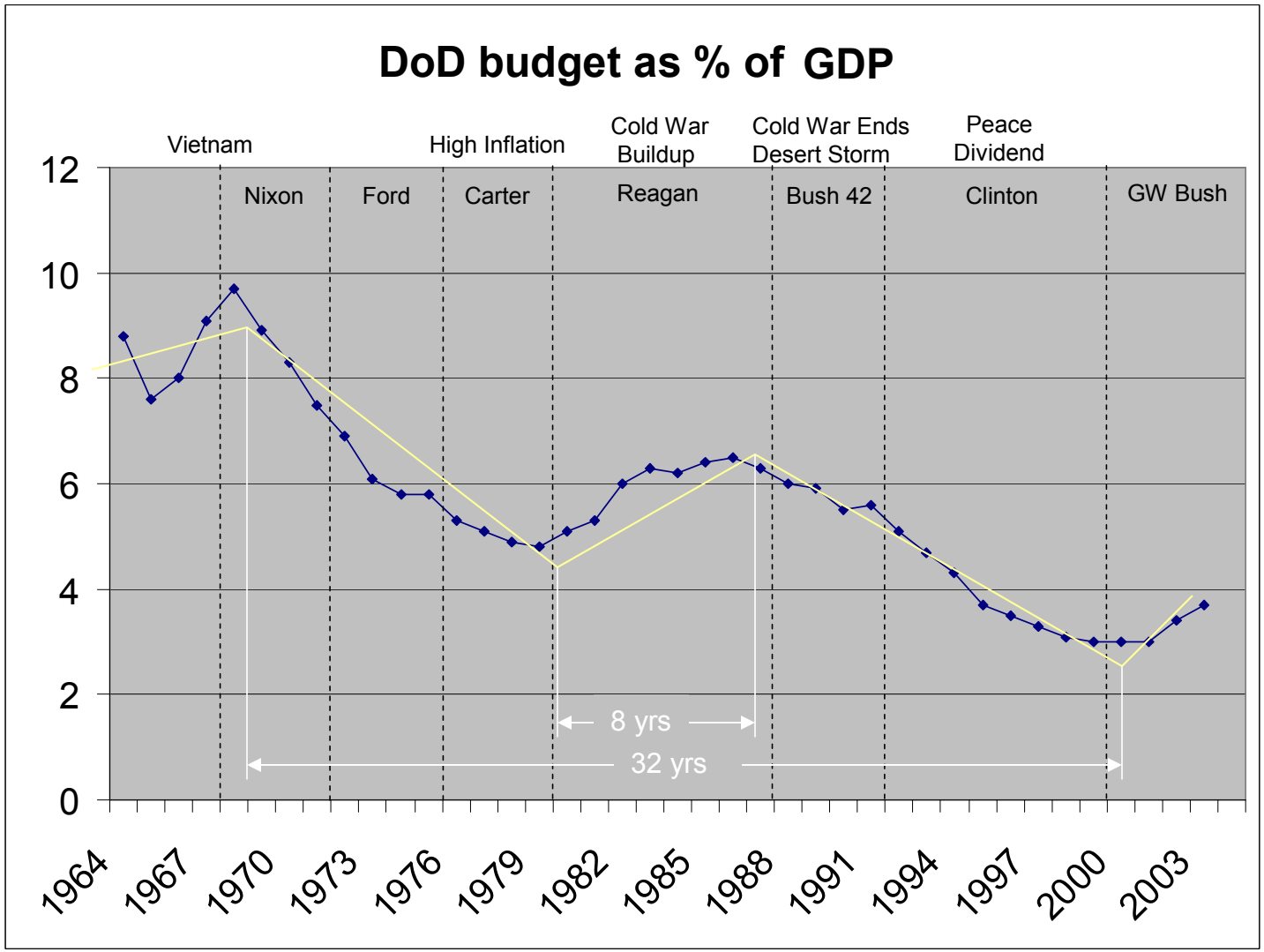
Budget



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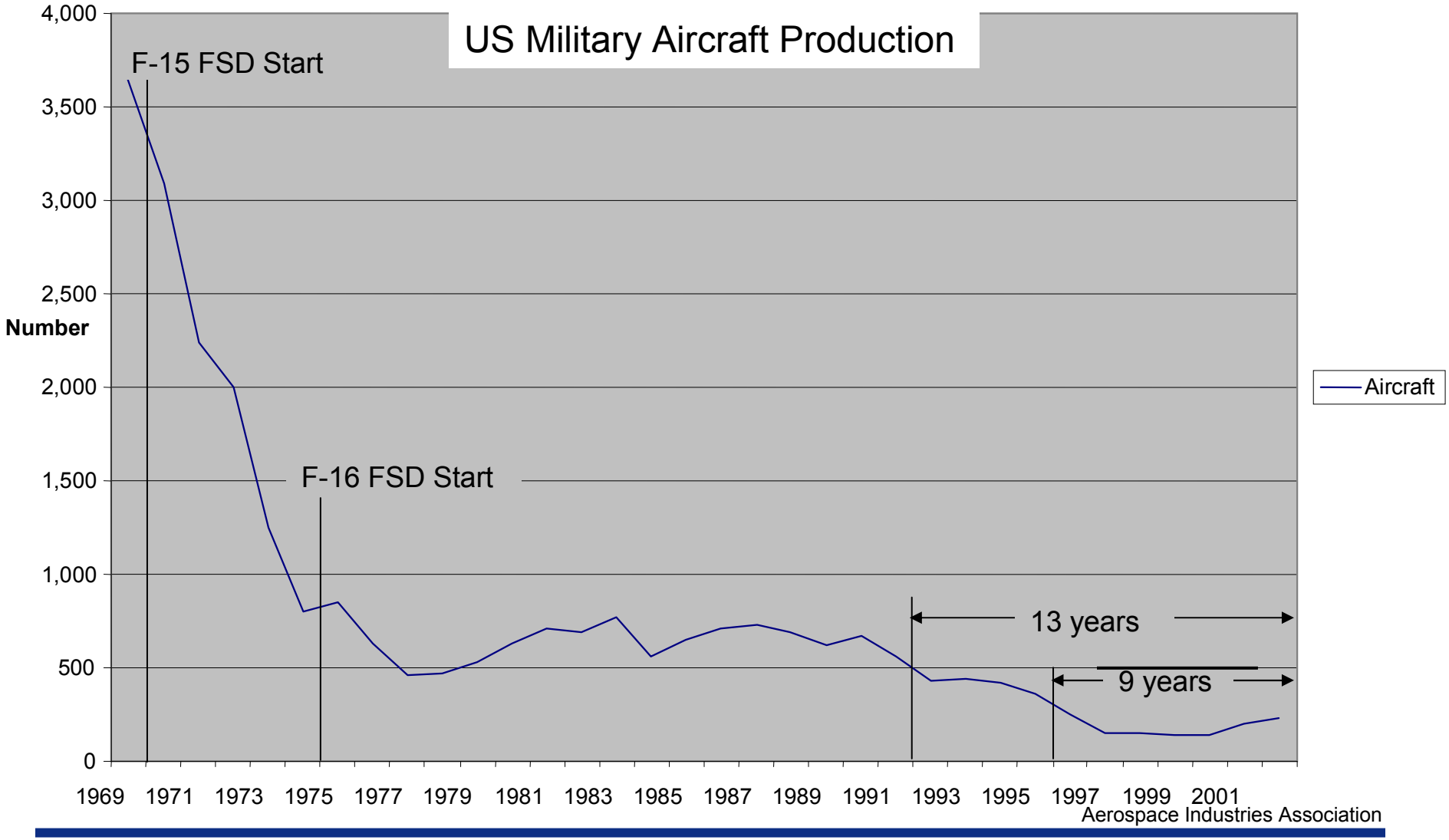
Budget



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Budget

- The simple issue of Economies of Scale
  - More expensive programs are stretched out over more budget cycles in order to “afford” them
  - Critics and opponents of expensive programs propose, and many times win, reductions in total quantities acquired to “save” money.
  - Fewer items purchased = more cost per item. Sounds simple to me but appears to get overlooked quite often.
    - RDT&E costs don’t change with quantity purchased
    - Tooling costs usually don’t change either

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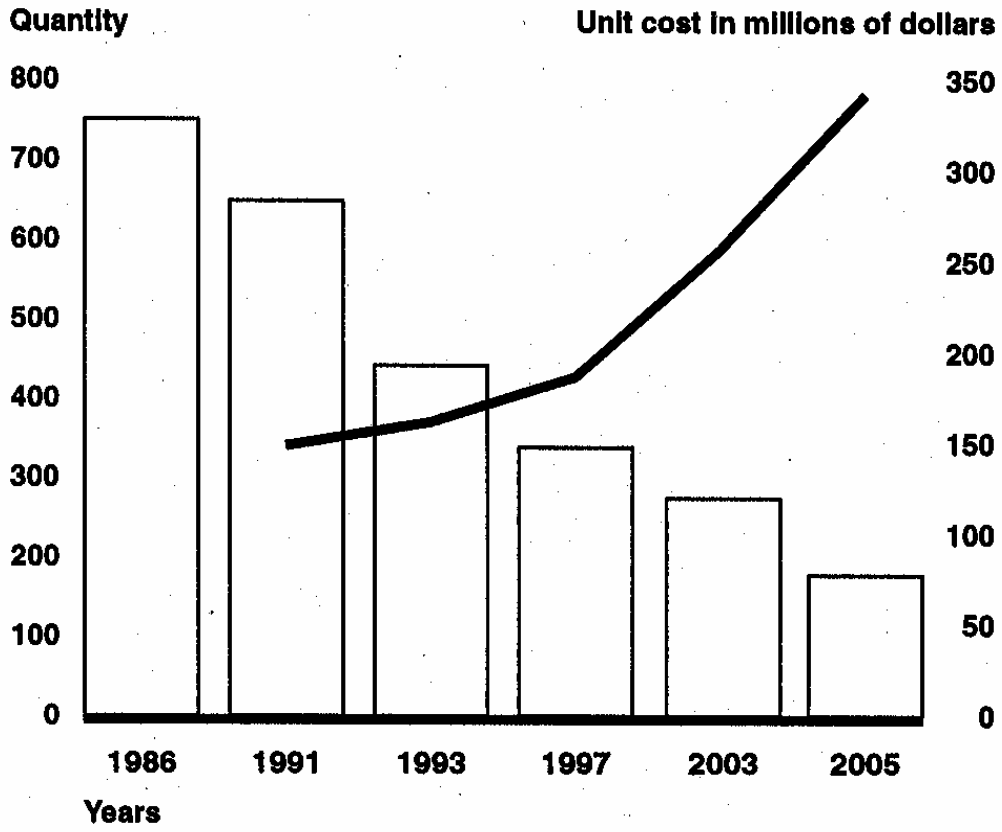
Budget



Source: U.S. Air Force (data); GAO (presentation).

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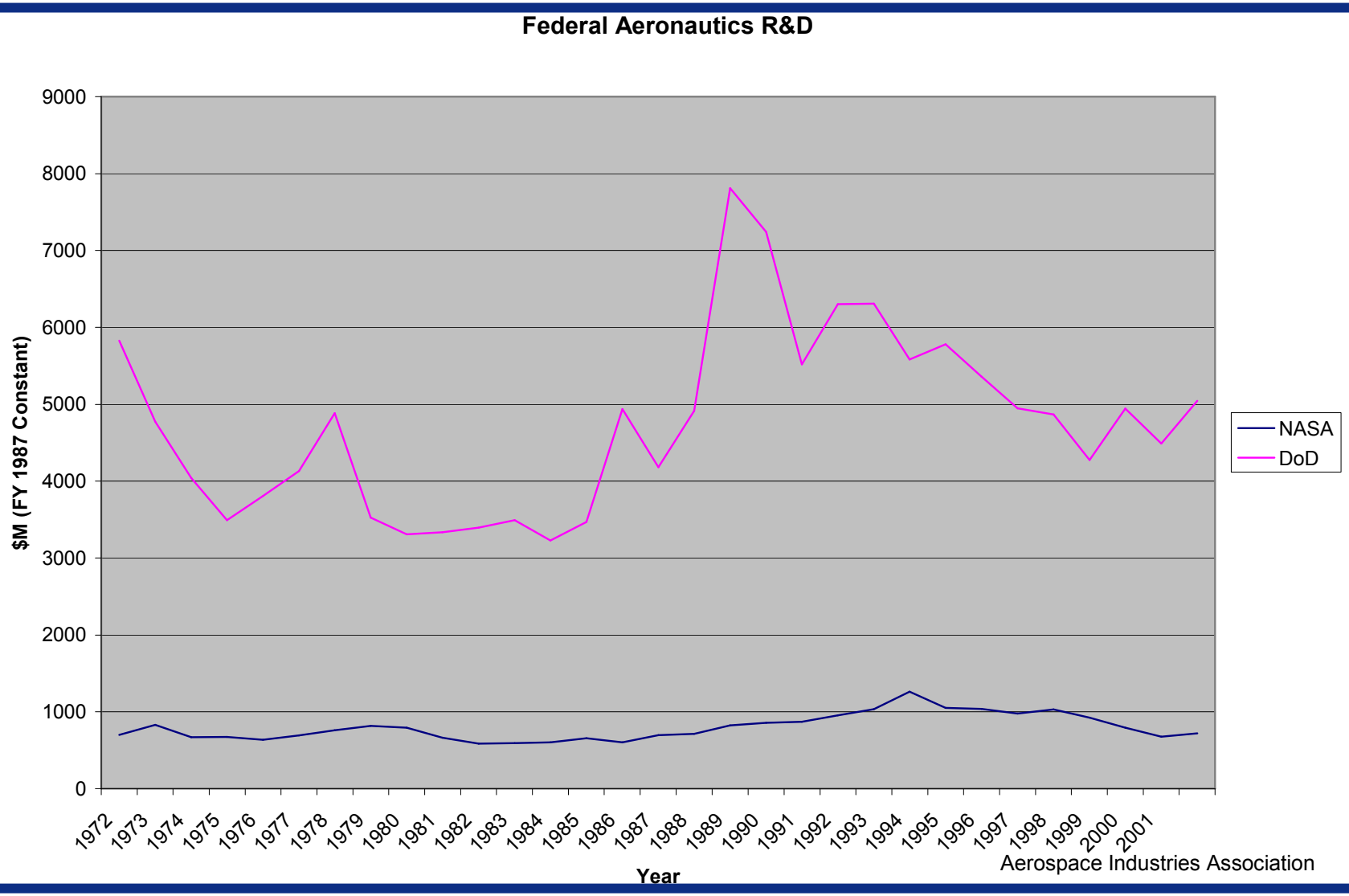
Budget

- Research and Development Test and Evaluation Spending
  - Critical to development of new higher-performance aircraft
  - Major technology breakthroughs have come more often from government labs or by government sponsored R&D than from the commercial sector
    - Supersonic flight in 50s from R&D of the 40s
    - Stealth combat aircraft of today were generated by sustained research in government and industry labs in the 1950's and 1960's
- Health of R&D budget 10 years ago drives the technology in use today


Federal Aeronautics R&D
$M (FY 1987 Constant)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
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Year
NASA
DoD
Aerospace Industries Association

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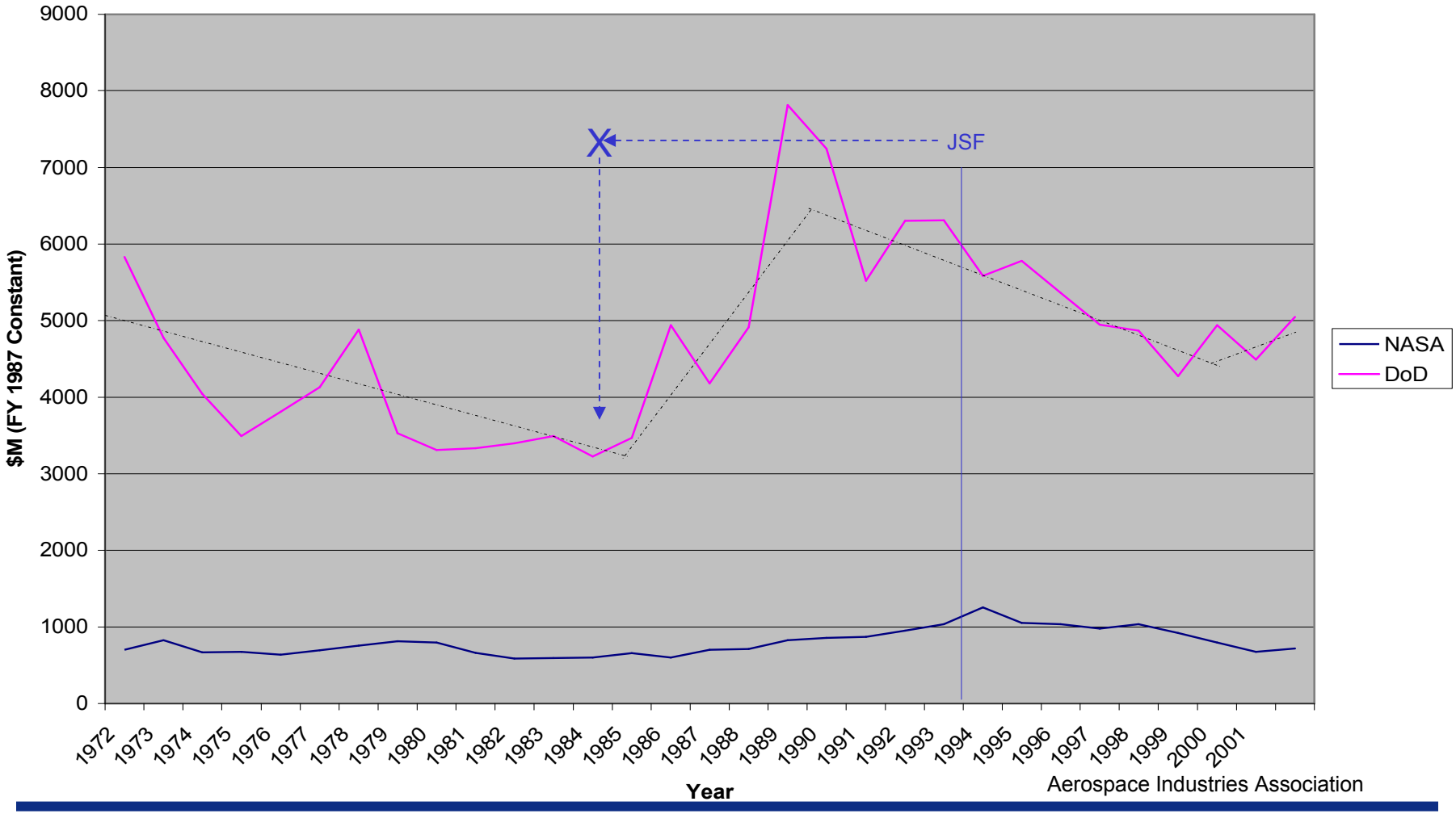
Budget

Federal Aeronautics R&D



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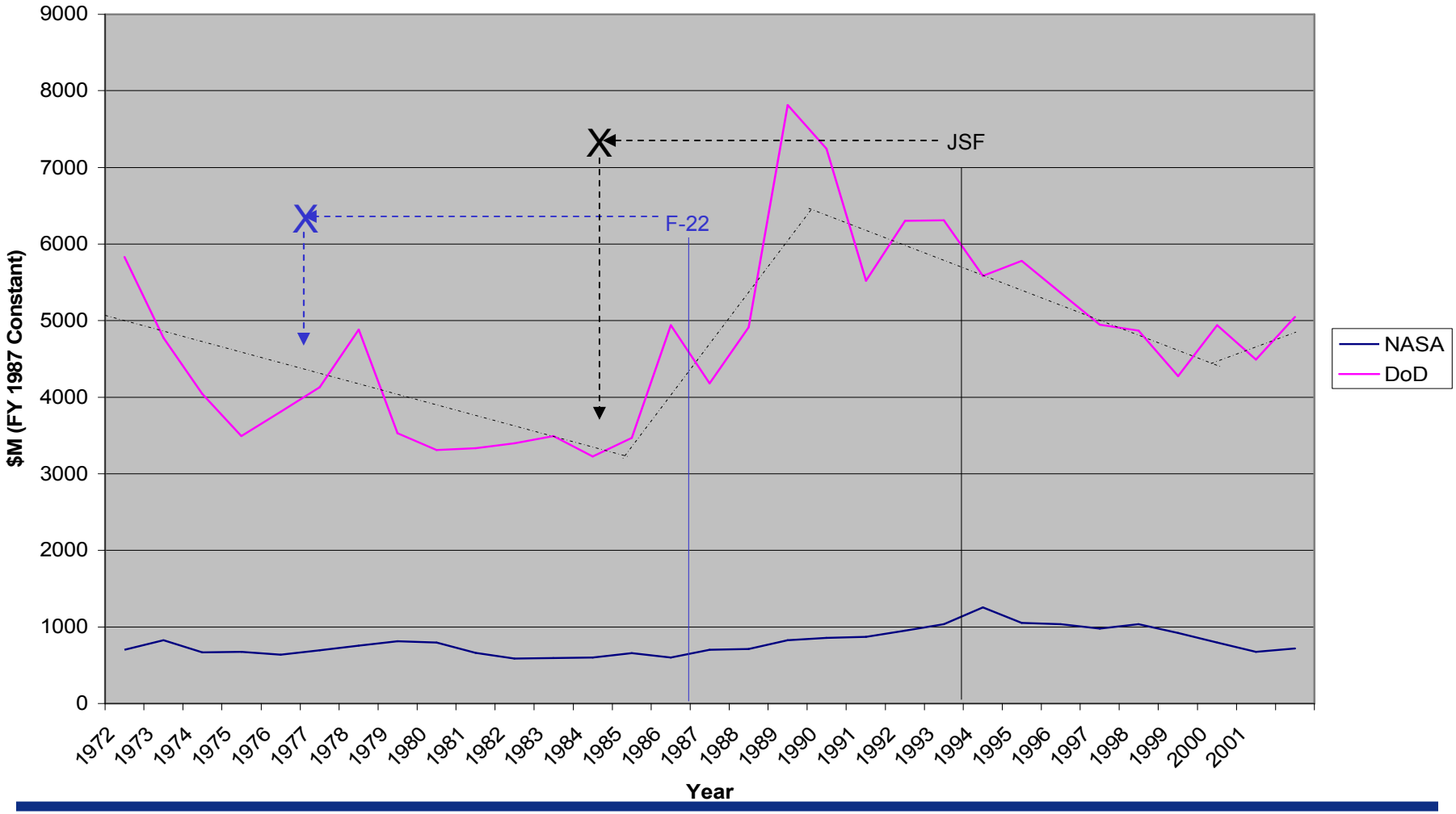
Budget

Federal Aeronautics R&D



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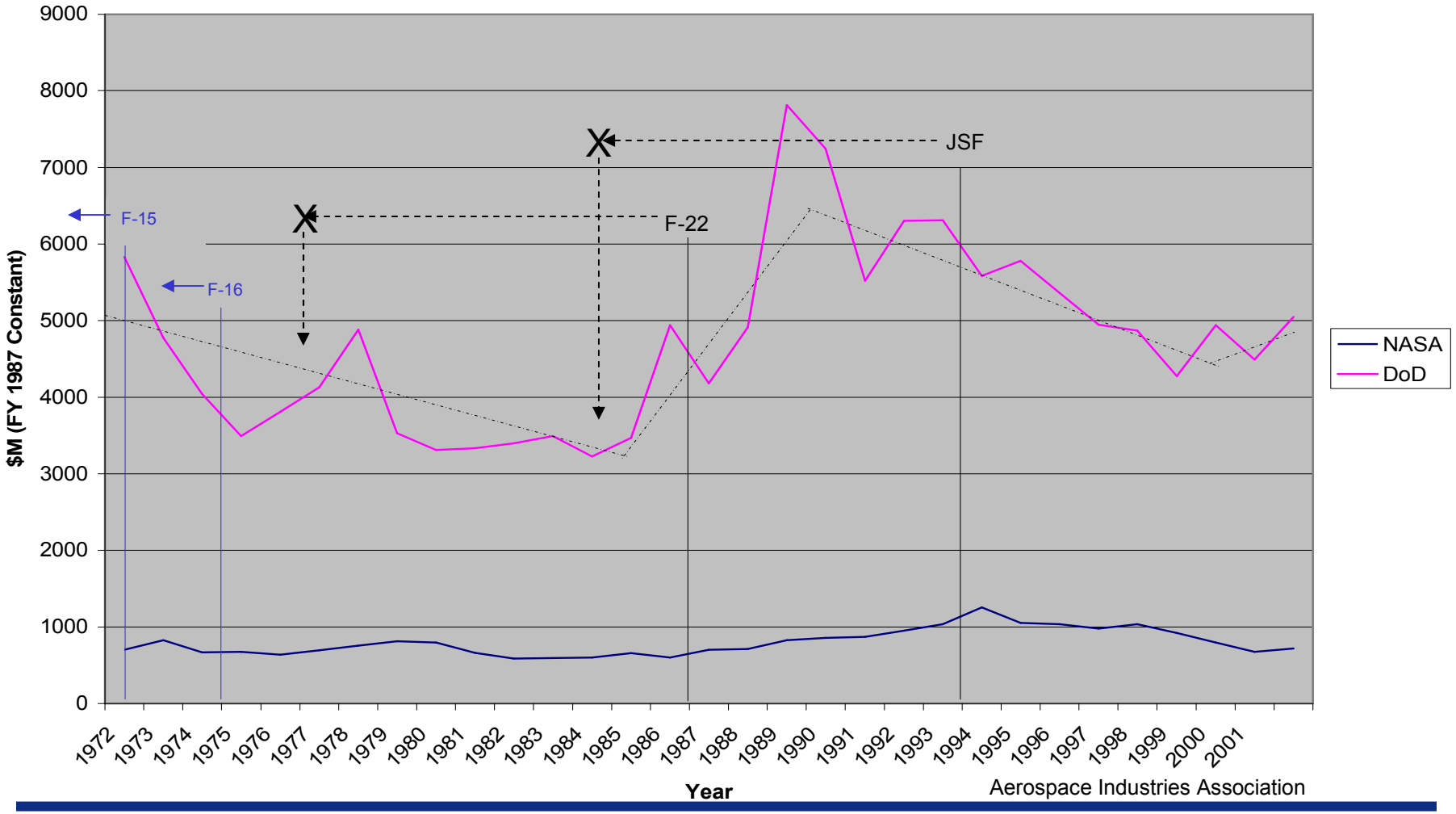
Budget

Federal Aeronautics R&D



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Budget

- Digging one level deeper into the chart, we see that one line does not paint the entire picture. As always, it is more complex than first glance.
- During any particular year, there is fierce competition within the RDT&E community for funding. This competition will can negatively affect other program's budgets but is very difficult to trace on a large graph.

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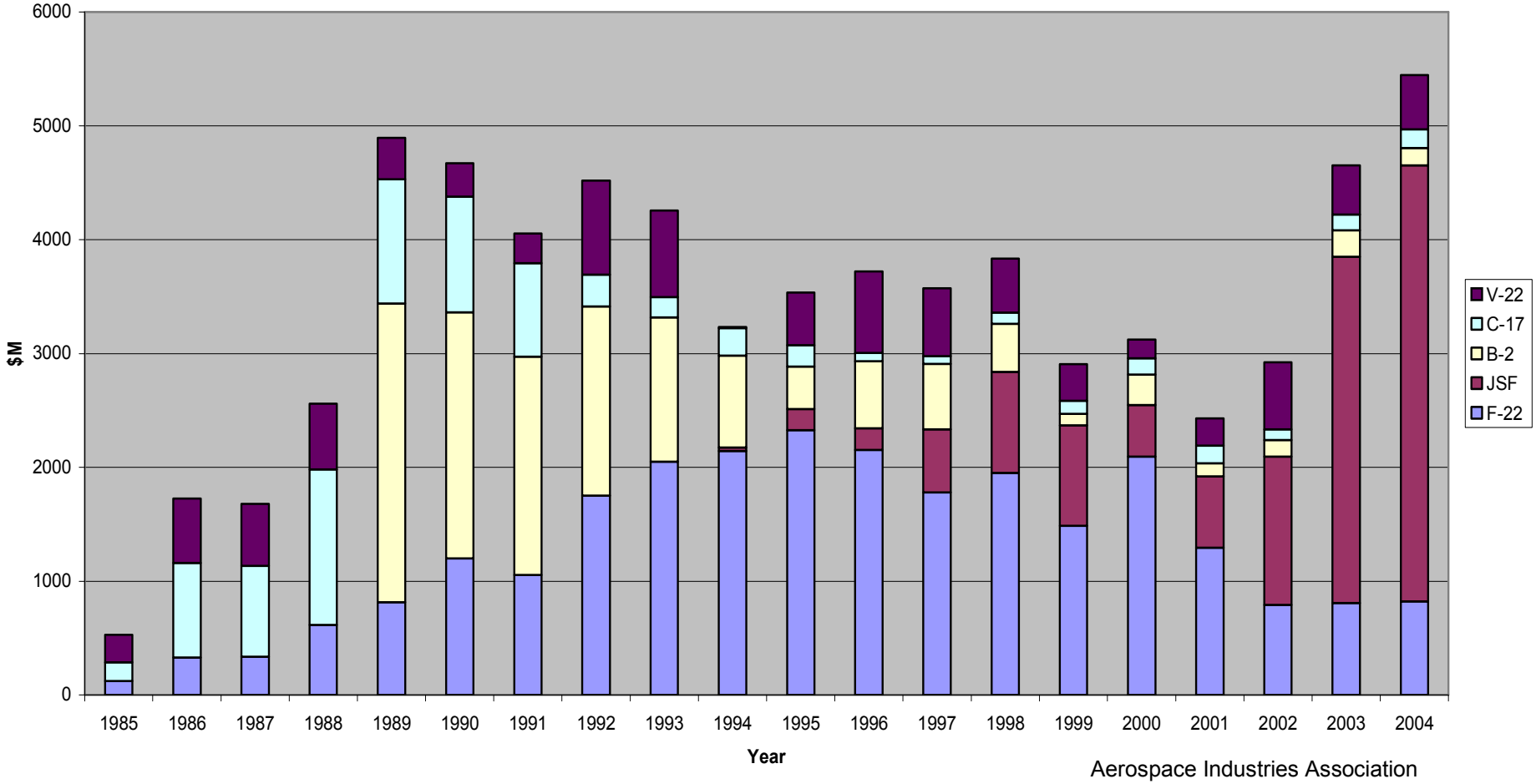
Budget

RDT&E By Aircraft (1996 Constant)



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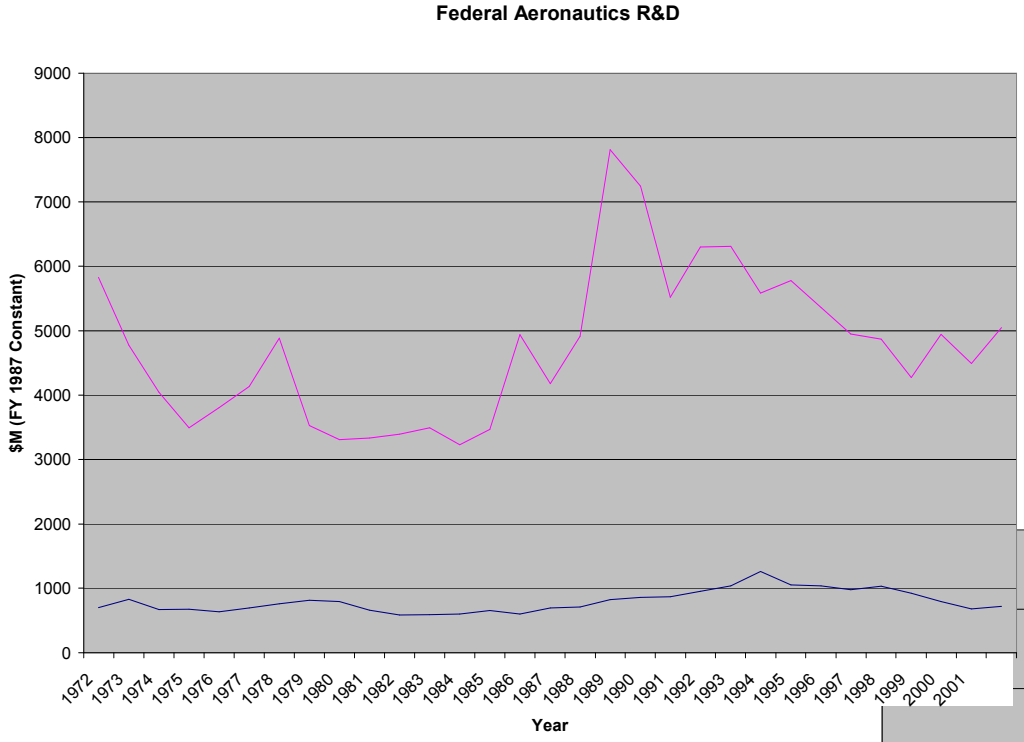
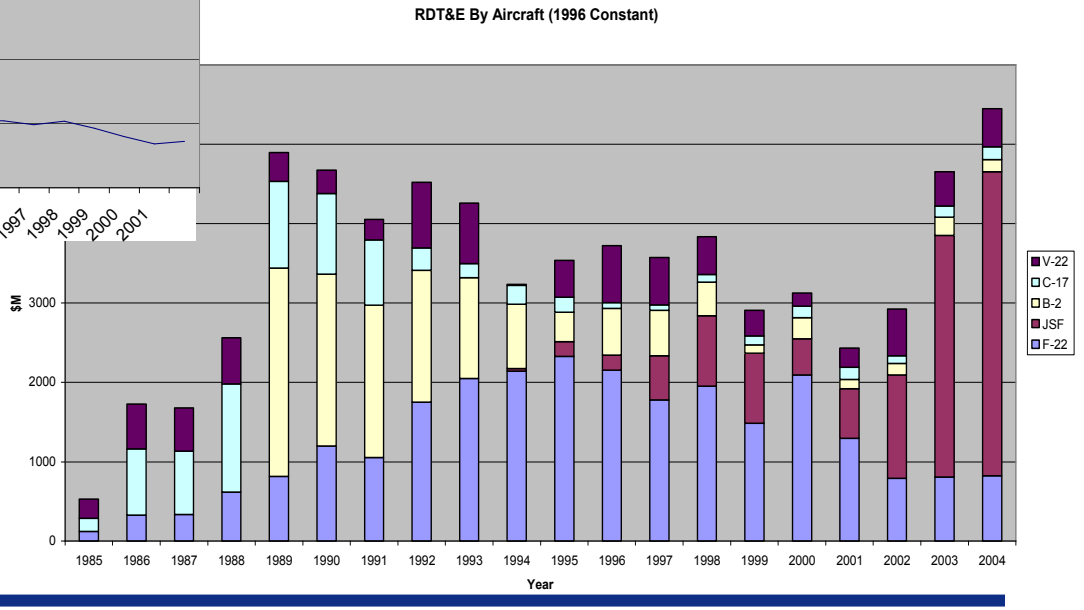
Budget





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Budget

- Budget Conclusion
  - Less DoD spending reduces available resources for acquisition across the board
  - Industry is in a very unhealthy state due to low procurement quantities
    - Simple Economy of Scale concept
  - Reductions in R&D spending causes negative affects 5-10yrs down the road
    - Difficult to quantify historical R&D affects on present day acquisition programs

- According to Mr. Augustine (former CEO Lockheed) – "In the year 2054, the entire defense budget will purchase just one aircraft. This aircraft will have to be shared by the Air Force and Navy 3-1/2 days each per week except for leap year, when it will be made available to the Marines for the extra day."

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Technology

- "Historically, the performance requirements generated for new fighter designs have often pushed the outer limits of design and engineering knowledge during any given period." – RAND
- Our Process
  - Determine the technology challenges for F-15, F-16, F/A-22 and JSF
  - Determine differences between the 1970's and today
  - Determine any quantifiable reasons

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Technology

- Technology Challenges Then
  - F-15
    - Engine – Requirement for High Thrust/Weight
    - Radar – Look Down Shoot down capability
  - F-16
    - Fly by Wire
    - Relaxed static stability

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Technology

- Technology Challenges Now
  - F/A-22
    - Supersonic Low Observables
    - The “-illities”
      - Deployability, Maintainability, Supportability, Reliability
    - Integrated Avionics
  - JSF
    - Supersonic Low Observables
    - Commonality
    - The “-illities”
    - Integrated Avionics

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Technology

What are the differences?

- F-15 "KPPs"
  - Max Speed @ S.L.
  - Max Speed @ Altitude
  - Mission Range - Cruise
  - Mission Range - Dash
  - Thrust/Weight
  - Thrust/Engine weight
  - T.O. & Landing distance
- F/A-22 KPPs
  - Supercruise
  - Maneuverability
  - Acceleration
  - Airlift Support
  - Sortie Generation Rate
  - Radar Cross Section
  - MTB/M
  - Payload
  - Combat Radius
  - Radar Detection Range

F-15, F-16 designed for single missions – F/A-22 and JSF Multi-role

Technology

- What is the Technology Long Pole?
  - Avionics/Software
- Software development is still more of an art than a science
- Software is invisible and intangible and hard to visualize – CSCE 593
- Software development is our most significant problem - Eisner
- "Software is like entropy, it is difficult to grasp, weighs nothing, and obeys the second law of thermodynamics, i.e., it always increases." – Norman Augustine former Lockheed Martin CEO

Technology

- Software use has increased dramatically

Aircraft	Year	% Functions Performed by software
F-4	1960	8
A-7	1964	10
F-111	1970	20
F-15	1975	35
F-16	1982	45
B-2	1990	65
F/A-22	2000	80

Hallion, 1990

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Technology

- Software Lines of Code (SLOC) has increased
  - F-15A – 60,000
  - F/A-22 – 2,100,000
  - JSF – 17,000,000
- Increases Testing requirements
  - F/A-22 has twice the avionics test aircraft the F-15 had
  - F/A-22 will require a new computer architecture and processor
    - The old ones are “Obsolete”
- F/A-22 took 9 years for avionics to reach a mature enough level to BEGIN production development
- The cost of the F/A-22’s avionics has increased by over $980M

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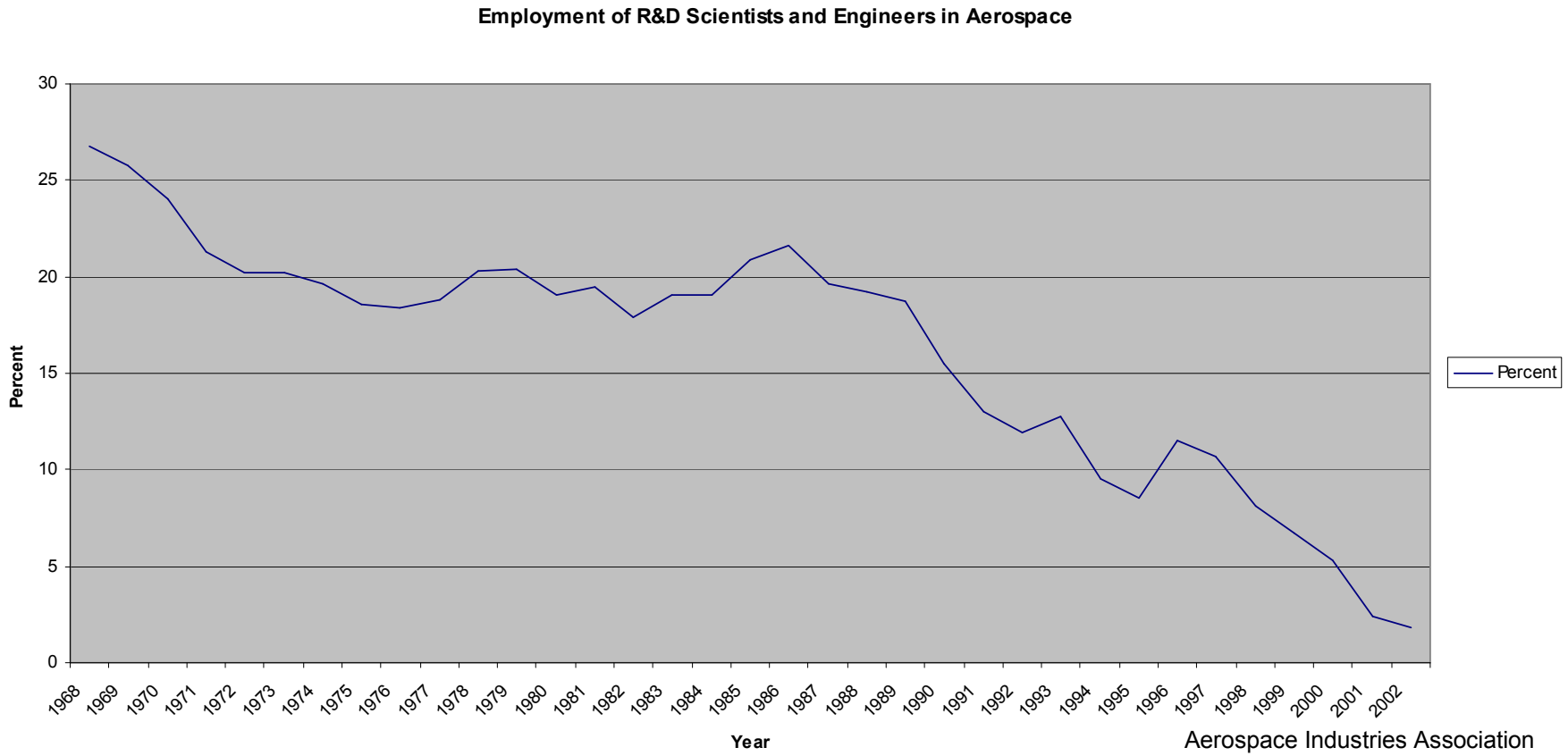
Technology

- JSF Issues
  - Only about 40 percent of the 17 million lines of code needed for the system's software have been released (April 2005)
  - Software required for mission systems integration will not be ready until 2010 - 3 years after JSF is scheduled to enter production.
  - "The JSF, like many past DOD weapons programs, is very susceptible to discovering costly problems late in development when the more complex software and advanced capabilities are tested." - GAO April 2005

Technology

- Fewer Aerospace Contractors Today
- Fewer Scientists and Engineers working in Aerospace Fields



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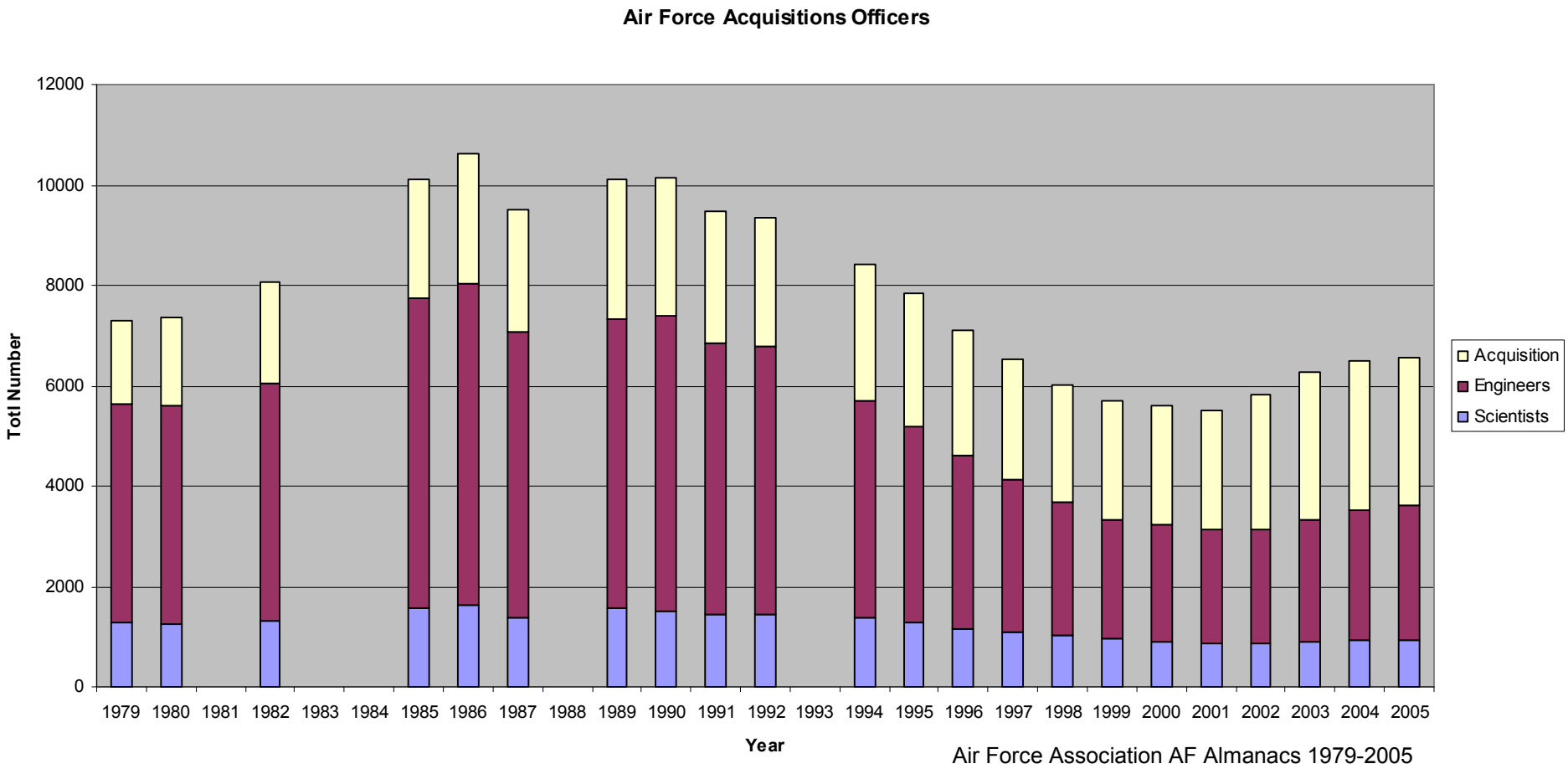
Fewer Blue Suit S&E's



Air Force Association AF Almanacs 1979-2005

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Technology

- Technology Conclusions
  - Fighter aircraft push the edge of technology
  - The largest growth area has been avionics/software
  - There are fewer people in the business – government and contractor
  - Technology is definitely a contributing factor in why the F/A-22 and JSF developments are taking longer

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Climate

- The Systems Approach dictates we look at the external system
  - Threat
  - Culture
  - Organization

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Climate

- The Threat – 1970's
  - Poor showing in Vietnam War – 2.5 to 1 Kill Ratio vs Russian MiGs
  - New MiGs released – MiG-25 and MiG-23
    - Didn't think F-4E was a match

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Climate

- The Threat – 1970's
  - Air Force hasn't developed an air-to-air fighter since the F-86
  - Thanks to failed commonality of the F-111 – specialized aircraft
    - F-15 air superiority
    - F-16 light weight "inexpensive" fighter
    - A-10 CAS
    - Navy F-14 fleet defense
  - 1970 – F-15 development is the Air Force's #1 priority

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Climate

- The Threat – 1990's
  - Cold War is won – We should have a peace dividend
  - F-15 is undefeated in air-to-air combat
  - Gulf War I – Air Power success
  - Gulf War II – Iraqi Air Force buries itself in the sand

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Climate

- American Culture Today
  - Inundated with news
  - Multiple 24 hour new sources
  - Perceived fraud and waste of the 1980's
    - $400 hammer, $500 toilet seat
  - Mistrust of government spending in the press
  - Leads to additional oversight
- Government Accounting Office By Law investigates F-22 and JSF programs for "performance, schedule and cost"
  - F/A-22 – 45 studies; JSF – 16
  - F-15 – 4; No F-16 studies
- Drop of congressional military experience

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Climate

- "If I wanted an airplane and the secretary of the Air Force agreed, we had four key congressional committee chairman to deal with and that was that. The same was true of the stealth fighter project -- except we had eight people to deal with on the Hill instead of four. But by the time we were dealing with the B-2 project, we had to jump through all the bureaucratic hoops at the Pentagon and on the Hill."

- General Larry Welch, former CSAF

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Climate

- Air Force Organizational changes
- 1970
  - Deputy Chief of Staff for R&D
  - F-15 SPO Director reported directly to DCSR&D
  - Air Force Systems Command handled funding
- Currently
  - DCSR&D position doesn't exist
  - JSF Program Director (also PEO) reports to AF Acq Executive thru OSD(AT&L) except when an Air Force PEO is in charge, then it goes to the Navy Acq Executive thru OSD(AT&L)
  - AFSC merged with AFLC to form AFMC
  - Funding comes through MAJCOMS (PEMs in SAF/AQ)

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Climate

- Climate conclusions
  - Threat is different today – harder for the novice to understand
  - American Culture is different today
  - More oversight
- The climate has an effect on the length of time to develop weapon systems

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Acquisition

- Maybe the Acquisition System is part to blame
  - Acquisition Reforms
  - Acquisition Process
  - Acquisition Professionals
  - Spiral Development

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Acquisition

- Acquisition Reforms
  - Since Revolutionary War to 1996
    - Congress passed over 4000 acquisition related statutes
    - GAO issued over 900 acquisition related reports
  - Since WWII
    - 12 major commissions

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Acquisition

1949	Hoover I
1953	Rockefeller Committee
1953	Hoover II
1961	McNamara Initiative
1970	Fitzhugh Commission
1972	Commission on Government Procurement
1983	Grace Commission
1985	Packard Commission
1989	Defense Management Review
1993	Section 800 Panel Report
1993	National Performance Review
1994	Federal Acquisition Streamlining Act

Reeves, 1996

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Acquisition

- Acquisition Process
  - Consequences of heavy bureaucratic system
    - Briefings
    - Road shows
    - Justifications
  - All lead to slow, inefficient process
- "...the most obvious place to start in achieving greater efficiency is to ferociously attack unnecessary bureaucratic red tape and paperwork." (Rich, pg. 328)

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Acquisition

- Acquisition Professionals
  - Similar impact from the technological section
  - High turnover is also an issue
    - 'Passing the buck'
    - Typical 11 year program (McNutt, pgs. 48-49)

Position	Number
Program Director	4
Program Executive Officer	5
Service Acquisition Executive	8
Defense Acquisition Executive	8
Chairman of Joint Chiefs	5
Secretary of Defense	7
President	3
Budget Cycles	11

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Acquisition

- Spiral Development
  - Recent programs seek 'Whole Enchilada'
  - F-15
    - F-15A – F-15C – F-15C MSIP – F-15E
    - F/A-22
    - "…the F/A-22's acquisition approach was not knowledge based or evolutionary. It attempted to develop revolutionary capability in a single step. This caused technology and design uncertainty, which led to cost overruns and schedule delays." (GAO-05-390T)

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Acquisition

- Contractor Teaming
  - Leads to Inefficiencies
    - More communication
    - More meetings
    - Etc.

  - Fewer contractors for the government
    - Fewer ideas / less originality
    - Inferior designs?

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Acquisition

- Acquisition system has ballooned into a cumbersome, slow process
- "The pace at which we develop weapon systems is too slow to keep up with the pace of technological change. Because of this mismatch, the acquisition process produces 'yesterday's capabilities for tomorrow.'" (Vollmecke)
- May 2003 changes (DOD 5000.1 and DOD 5000.2)?

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Schedule

- Interviewed Lt Col Ross McNutt, read dissertation on reducing cycle time
  - Great insights into SPO, Pentagon, and Contractor attitudes
  - We do not value time
  - The contractor bids the schedule we ask for
  - We base our schedule on funding and judgment, not minimum time to complete
- Highly instructive, recommendations will help…we're just not sure these attitudes are new

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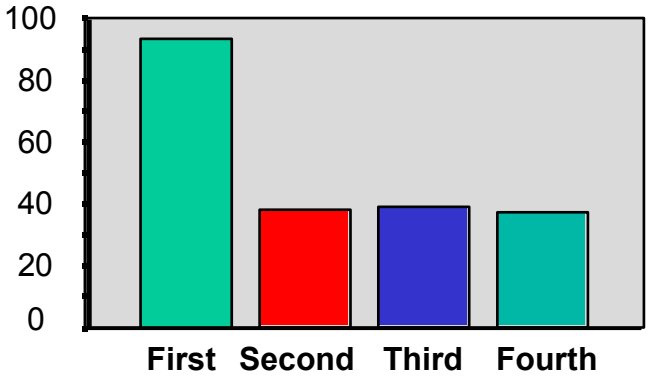
Schedule

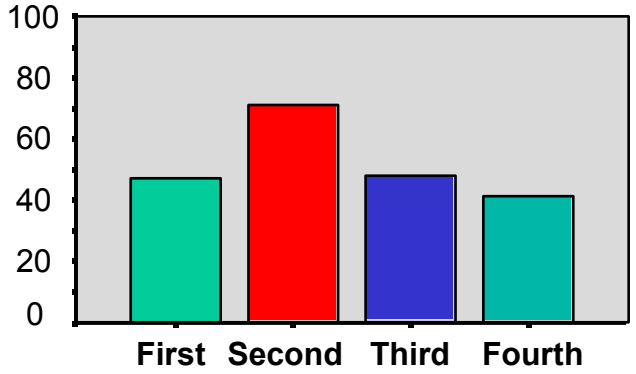
Pentagon & SPOs asked to rank 1 to 4

Axis: Number of Programs Responding

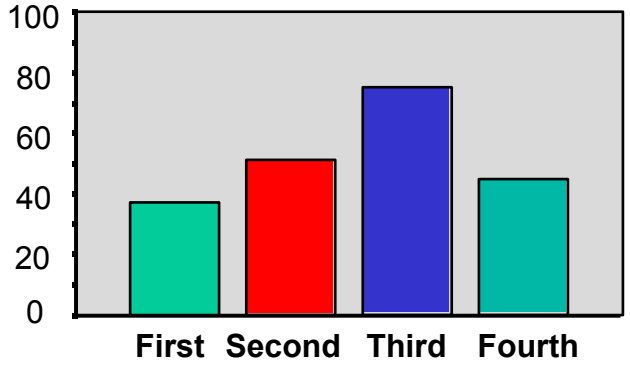
Superior Performance



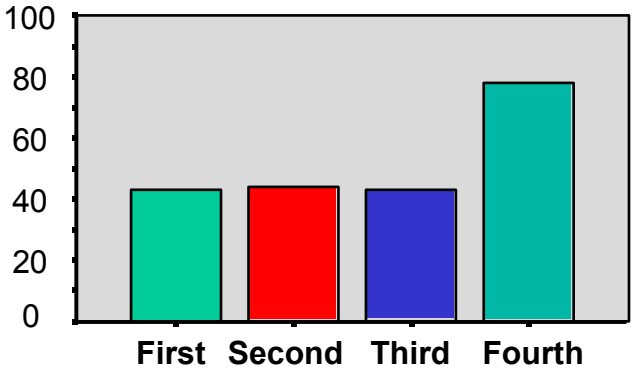
Low Acquisition Cost



Low Operation Costs



Shortened Schedule



PEM and SPO Surveys N=208

McNutt, Pgs 188-189

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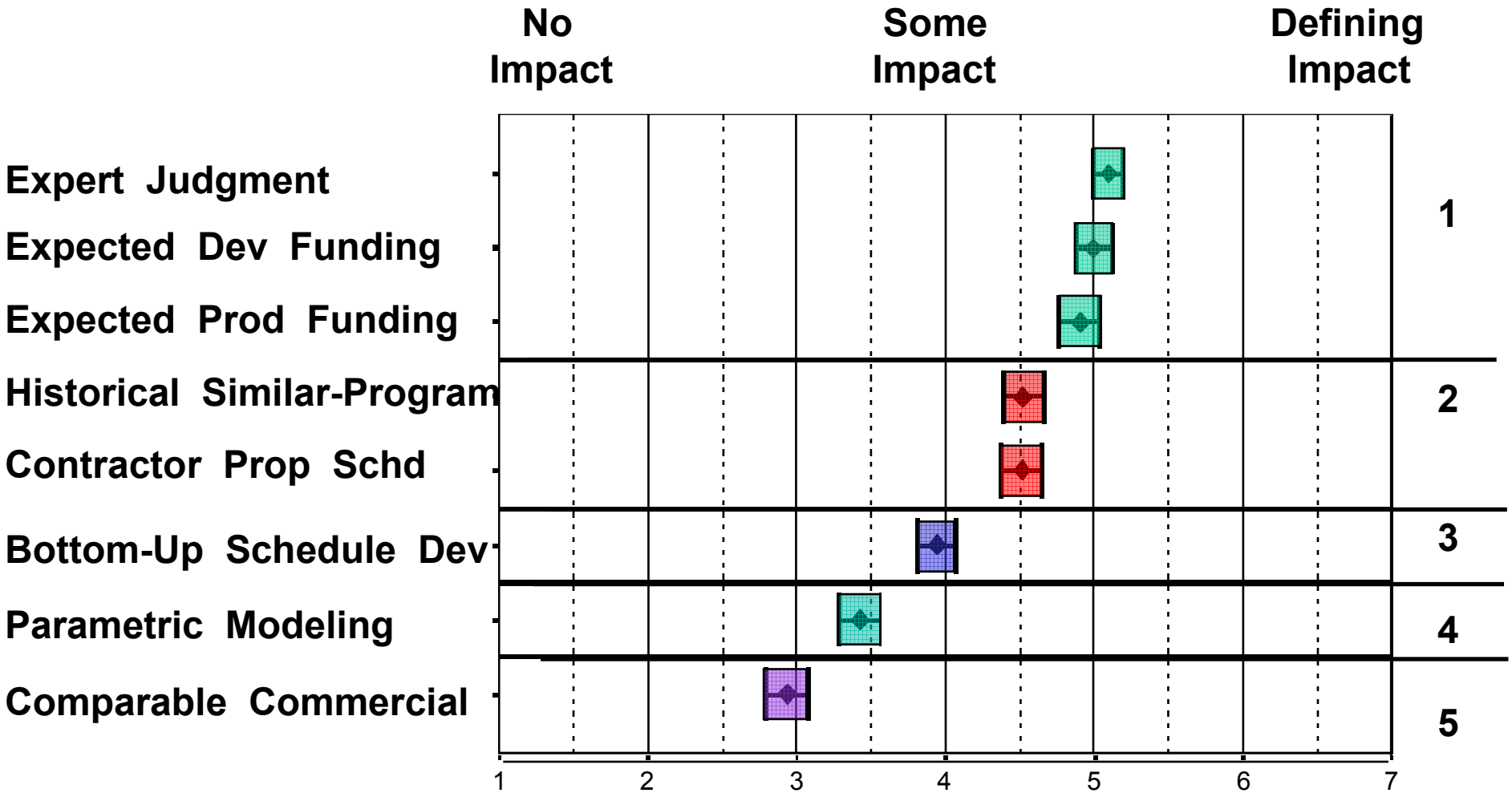
Schedule

SPOs, "What is initial schedule based on?"



SPO and Pentagon Survey N = 178
Mean +- 1 SE

McNutt, pg 214

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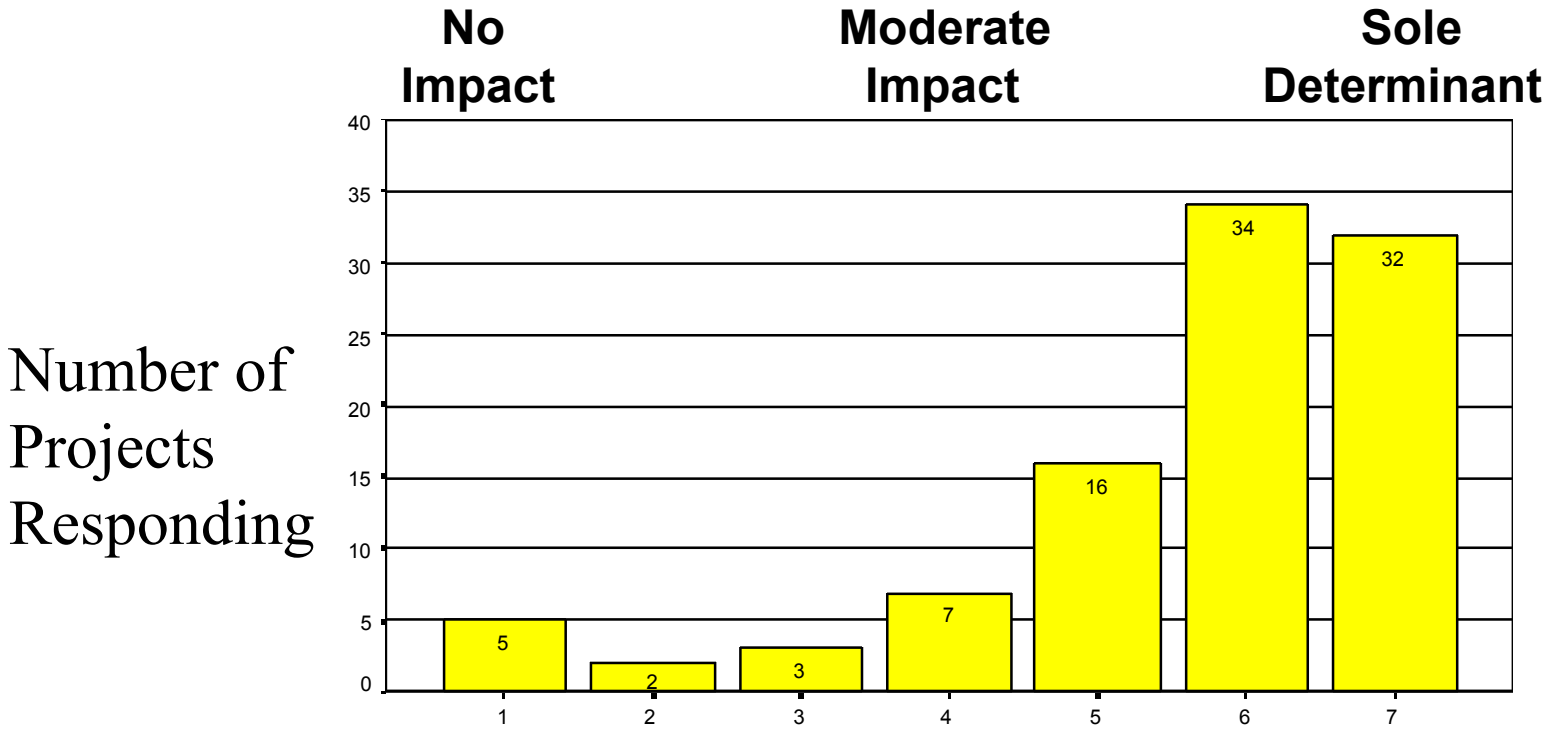
Schedule

Contractor, "What is yours based on?"



McNutt, pgs 225-226

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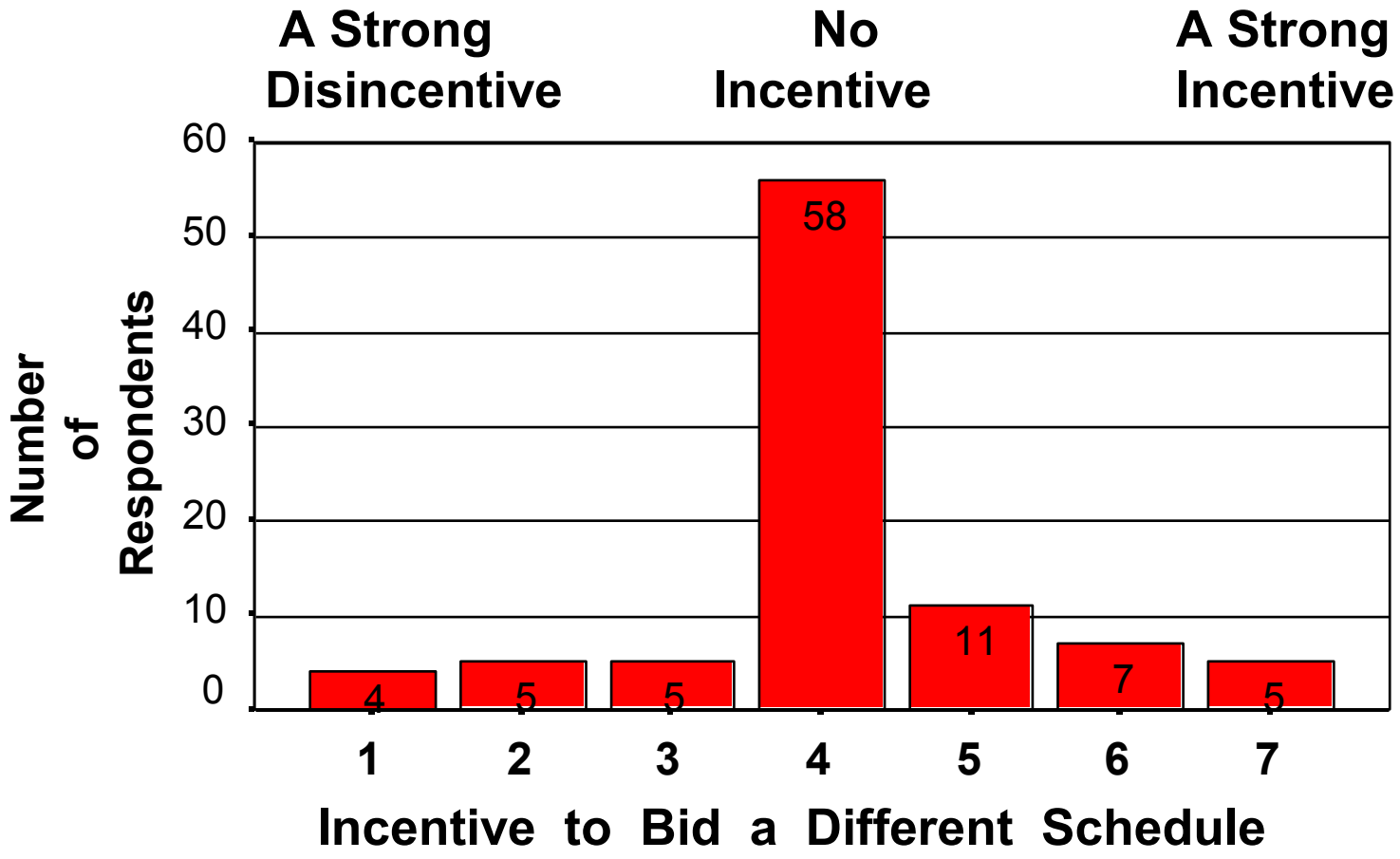
Contractor, "Why not bid something else?"



Contractor Survey N=97

Adapted from McNutt, pg 260

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Schedule

- Schedule conclusion
  - Schedule is viewed as an outcome, not a goal
  - Initial project schedules are based on funding
  - The contractor bids the requested schedule
  - There is no incentive for quicker work
- SPO survey: 37 projects with 1 yr or more remaining
  - "…asked project managers how long it would take to field the first system if it was deemed essential in a war…project managers estimated that the time required…was 52 percent of the current schedule." (McNutt, pg 279)

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Conclusions

- Are New Acquisition Programs Taking Longer to Develop / Field?
  - YES
- Why?
  - Well…

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Conclusions

- Applying Systems Thinking
  - "So many important problems that plague us today are complex, involve multiple actors, and are at least partly the result of past actions that were taken to alleviate them."

    -- Daniel Aronson

  - No "Silver Bullet"
  - AF Product Development System is just that – a system
  - Many, if not most, if not all of the constituent parts tend toward slower

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Conclusions

- To develop a new weapon system we need:
  - Money, Gov't Acquisition folks, Aerospace workforce, A Sense of Urgency
  - We have less of all of these

- We do NOT need:
  - More Mangement, Oversight, Reports, Technology Challenges
  - We have more of all of these

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Questions?

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