

Aging Naval Aircraft Study

**Naval Research Advisory Committee
Report to the
Assistant Secretary of the Navy
(Research, Development & Acquisition)
Mr. John J. Young, Jr.
26 September 2002**





Aging Aircraft

Huge Problem?

and/or

Business Opportunity of
Immense Proportions!!!



Aircraft Inventory Management

$$1 - \left\{ \frac{\text{Fleet Squadron Requirement}}{\text{Total Inventory}} \right\} = \text{Program A/C Pipeline}$$

SH-60F 06%
KC-130R 32%



**Converting Pipeline to Readiness ...
Requires a “Revolutionary” Approach**



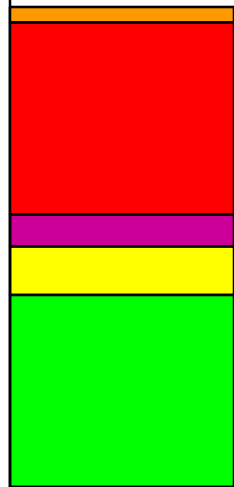
Opportunity

Parts/Component Management

Inventory

\$20B

\$0



02 % Other (Not Ready for Issue)

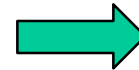
46 % -“F” Condition (Not Ready for Issue)

04 % -“G” Condition (In Depot Awaiting Parts)

08 % -“M” Condition (In Depot Repair-In Process)

40 % - “A” Condition (Ready for Issue)

*Data Source NAVICP Master File as of 1 Jan 1997



Component Pipeline

Component Pipeline



Reinvestment

\$



Combat Readiness

**Converting Inventory to Readiness ...
Requires a “Business” Approach**

Capturing the Opportunities

- **Establish Executive Level Ownership**
- **Integrate Best Business Practices for Combat Readiness**
- **Exploit Naval Aviation As a Team**
- **Apply System Engineering Approach**
- **Demo Weapon Systems “Proof of Concept” Now!**



Terms of Reference

- *Review the current state of need*
- *Identify mitigation opportunities*
- *Link needs and opportunities to S&T Objectives*
- *Recommend technology planning, transition, and insertion*
- *Recommend steps to mitigate cost and readiness impact*

Study Scope

- **Looked for systemic causes of soaring maintenance costs and declining readiness**
- **Chose not to focus on one or two “bad actors” with unique Type/Model/Series fixes**
- **Balanced technology development, technology transition and business processes**
- **Found aging issues begin early**

Panel Membership



Chair:

- **Jim Sinnett**

Consultant

Boeing (Ret.)

Panel Members:

- **VADM Brent Bennett**
- **MajGen George Karamarkovich**
- **Aubrey Carter**
- **MajGen Warren Johnson**
- **Chester Kennedy**
- **Paul Martin**
- **Richard Rumpf**
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Veridian Aeronautics

USN (Ret.)

Financial Advisor

USMC (Ret.)

GM, Structural. Prog. & Adv. Tech.

Delta Air Lines

Consultant

USMC (Ret.)

Dir. Electronic Tech.

Lock. Martin

VP Engineering

Sikorsky

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Fmr. PDASN

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- **RADM Walter Massenburg**

Asst. Commander, Logistics, NAVAIR

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- **Dr. Inderjit Chopra**

Professor

U of Maryland

Executive Secretary

- **Robert Ernst**
- **LCDR Greg Olson**

Head, Aging Aircraft Program, NAVAIR

USN

Program Support, Aging Aircraft

USN (Ret.)

NRAC Staff Support

- **LtCol Bill Waters**

Sr. Engineer, Jorge Scientific

USMC (Ret.)

Site Visits



- **NAVAIR/OPNAV/ONR Briefs - DC**
- **NADEP and NAS Jacksonville, FL**
- **Northrop Grumman - St. Augustine, FL**
- **Boeing Aerospace Support Center -Cecil Field, Jacksonville, FL**
- **NADEP Cherry Point, NC**
- **ASC and Aging Aircraft SPO - Dayton, OH**
- **Delta Air Lines Inc. Atlanta, GA**

97+ Briefings

A Historical Baseline of Naval Aviation Costs (NAVAIR-4.2.5)	P-3 / EA-6B / F-14 Depot Programs (NADEP Jacksonville)
Aging Aircraft Issues (OPNAV N-78C)	Fleet Replacement Squadron Perspective (VP-30)
System Engineering Approaches (NAVAIR 4.1D)	Intermediate Level Maintenance Perspective (AIMD Jacksonville)
CNO Executive Brief IV Synopsis (NAVAIR 4.1D)	Sustaining Aging Wiring (AIMD Jacksonville/Eclipse)
Propulsion Management (NAVAIR 4.4)	Maritime Prepositioning Force Maintenance (Blount Island, USMC)
ONR Perspective (Chief of Naval Research)	Commercial Depot Repair/Lean Initiative (Northrop Grumman)
FAA Aging aircraft issues (Manager, FAA Aging Aircraft Program)	Commercial Modification Facility (The Boeing Co.)
Aging Aircraft Wiring (NAVAIR 4.1D)	Air Force Aging Aircraft programs (USAF Aging Aircraft SPO)
Performance Based Logistics (NAVAIR 3.5)	F-15 / F-117 / B-52 / KC-135 Issues (USAF Personnel)
Safety Perspective (Director U.S. Navy Safety & Survivability)	Defense Logistics Agency Perspective (DLA Aging Aircraft Prgm)
Fatigue Life (NAVAIR 4.3.3.1)	Electronic Parts Obsolescence (AFRL Electronics Branch)
NAVICP and LECP Process (Div Head, Supply Chain Solutions)	Obsolescence Management/DMSMS (AFMC DMSMS Prgm Office)
Design Build Process and Bold Stroke Initiative (The Boeing Co.)	Boeing Advance Support Concepts (The Boeing Co.)
Flight Critical Parts (NAVAIR 4.1C)	Integrated Diagnostics/Health Management (The Boeing Co.)
Program Executive's Perspective (PEO (A))	My Boeing.com/Information Services (The Boeing Co.)
Program Manager's Perspective (PMA-290)	USMC Depot Issues (NADEP Jacksonville)
The Carrier Perspective (NAVSEA PMS312)	Commercial Aging Aircraft Perspective (Delta Air Lines)
FAA Airworthiness Assurance Wking Group (Director R&D Delta)	Alliance Initiative (CaterpillarLogistics)
Commercial Aircraft Aging Wiring (United Air Lines)	United Kingdom Structures and Avionics Interview*

*(RAF Wyton) (MOD Abbey Wood)

Related Studies

- **National Research Council, Aging of U.S. Air Force Aircraft, 1997**
- **National Academy of Sciences, Aging Avionics, 2001**
- **NPGS Report, ADA-379704, (*Master's thesis*) Cannibalization study, June 2000**
- **GAO Report, GAO-01-693T, May 22, 2001**
- **GAO Report, GAO-01-587, June 27, 2001**
- **CBO Report, Effects of Aging on the Costs of Operating and Maintaining Military Equipment, August 2001**
- **NAVAIR, Aging Aircraft System and Component Repair Growth, September 11, 2001**
- **Navy IG, Naval Aviation Spares and Readiness, Sept 2001**
- **CNA Report, Effect of Aging Equipment on Support Costs, November 1, 2001**
- **NRAC Studies (see Appendix A)**

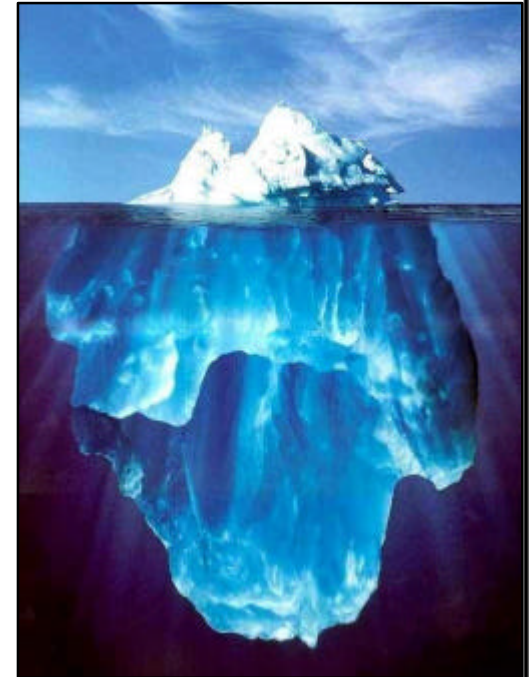
Technology Insertion

Common themes emerge...

- *Technology transition depends on focused senior management*
- *Technology Transition Executive*
- *Focus on reduced cost*
- *Long technology insertion cycles*
- *Gain-sharing incentives for contractors*
- *Speed up contracting process*
- *Leverage other sources of R&D*
- *Integration between S&T and R&D required*

Observations

- Tremendous capability exists
- All players want to improve
- No single solution
- Stove piped decisions;
Default- Comptroller
- Deferred maintenance and
cannibalization kills readiness and
personnel retention
- System Engineering/ Reliability
Management needed
- No integrated strategy



Opportunities for step improvements exist

Fleet Sailor's and Marine's Perspective

Naval Aviation is Broken:

- Record low procurements and mods
- Flying hour program underfunded
- Lack of spares /high cannibalization rates
- Unprecedented maintenance required
- **Aircraft on the line are NOT fully mission ready**
- Quality of Service impacted
- Shortages of resources limit combat readiness

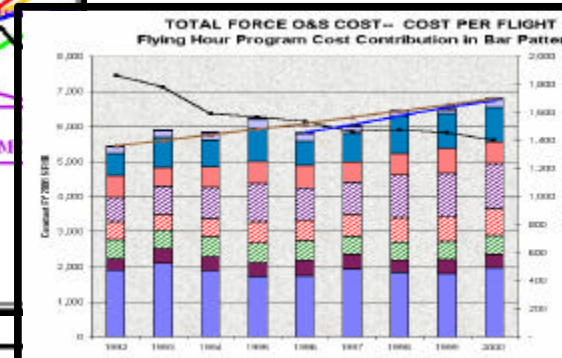
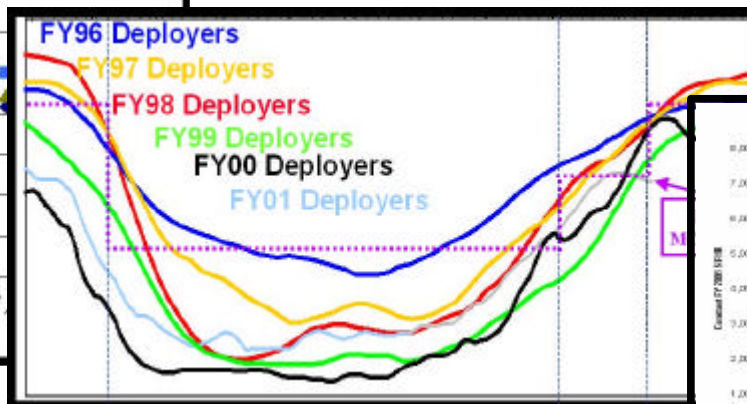
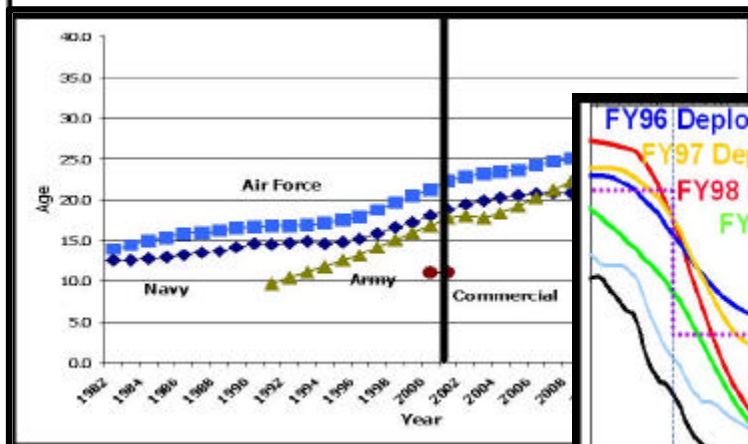
Frustration is driving professionals out

The Challenge

- Fleet average age is **18.8** years and climbing
- Equipment/ILS not designed for **30+** years
- Costs to sustain combat capability soar
- Readiness continues to decline

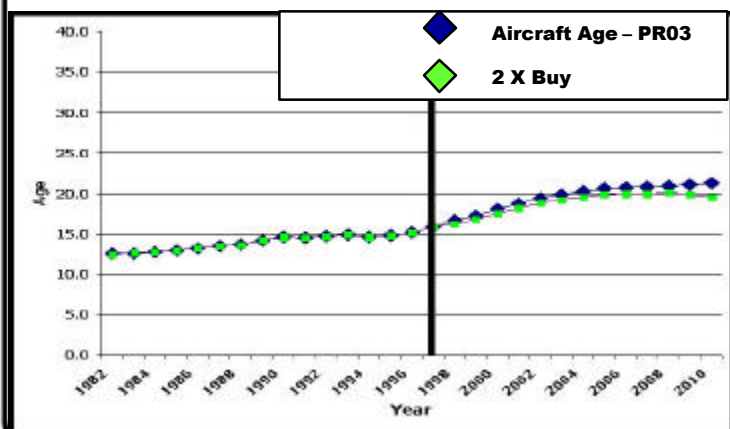
READINESS

COSTS



Cannot Just “Buy” Our Way Out

- DOUBLING the number of procurements will only reduce the average age by three years in 2010... **and costs >\$70 Billion!**
- “Repair Only As Necessary” maintenance philosophy will not do the job
 - *SLEP/Remanufacture/Block Upgrade / RCM*
 - *Funded ‘System Engineering’ essential*



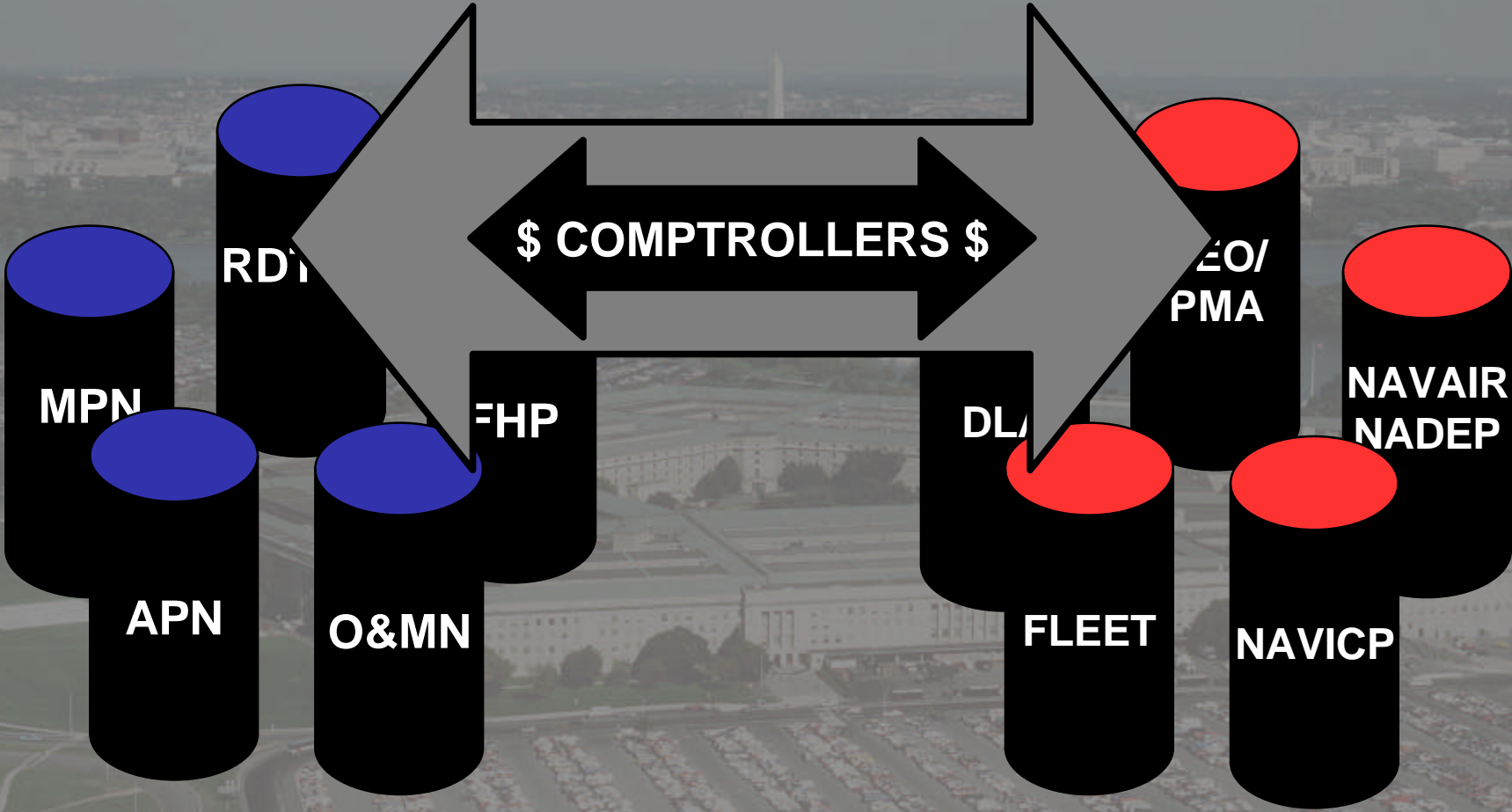
**Funding is Required,
but funding alone is not enough**

Addressing the Issues...





Eliminate Funding Stovepipes & Fragmented Program Management





Leadership Team

- “Ownership” at SecNav/CNO/CMC level required to make things happen
 - *Charter Leadership Teams*
 - *Empower PEOs and Program Managers (Budget authority)*
 - *Program Management to control resources for attainment and sustainment of combat capability*
- Guiding Principles
 - *Goals and Objectives*
 - *Business Base metrics*
 - *Enterprise Wide*
 - *Best Business Practices*
 - *Full Resource Control*
 - *Balanced technology insertion*
 - *Accountability*





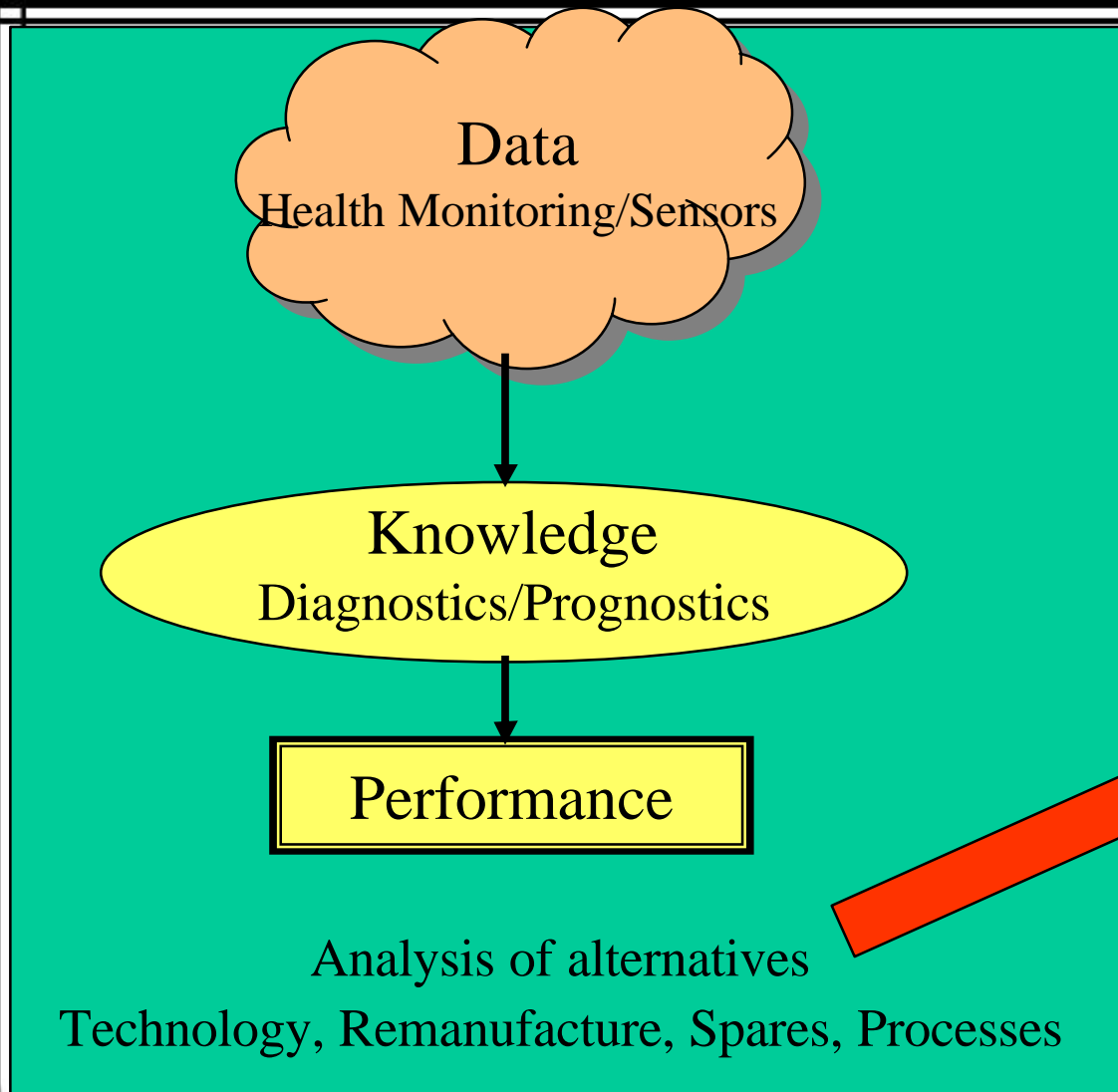
Use Best Business Practices

- Identify capabilities that are “world class” discriminators
- Create component centers of excellence within the depot system
- Implement overarching lifecycle analyses
 - *System Engineering*
 - *Maintenance practices*
 - *Supply Chain Management*
 - *Make/Buy Decisions*
- Program Managers require resources/authority to enforce cross-cutting business decisions
- ROI decisions must be data driven and include readiness, capability, all elements of manpower, infrastructure, **and the cost of NOT flying**



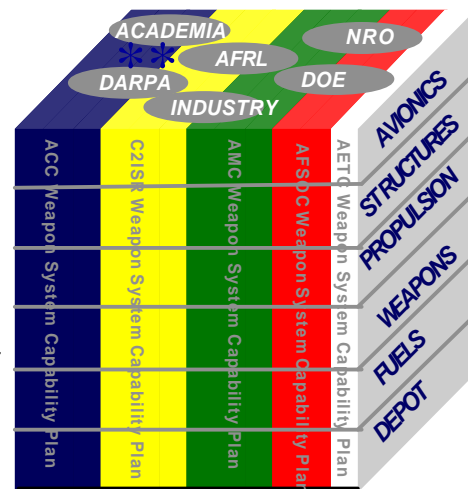
System Engineering Process

Integrated Business Model



Desired Output

Increased Availability
Lower Operating Costs
Across All Dimensions



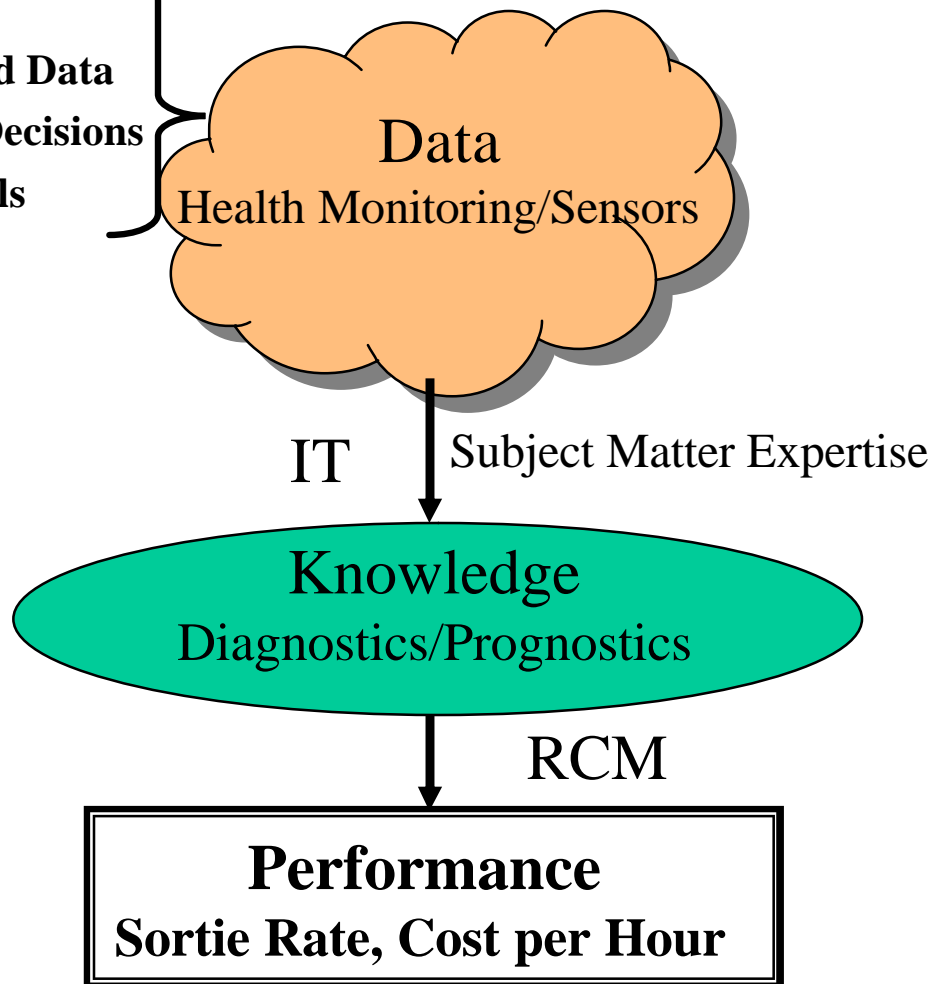
**** Courtesy, USAF Aging Aircraft SPO**

System Engineering Process

Resources and Infrastructure

Issues

Models and Integrated Data
Fragmented Budget Decisions
Skill/Experience Levels



Expertise

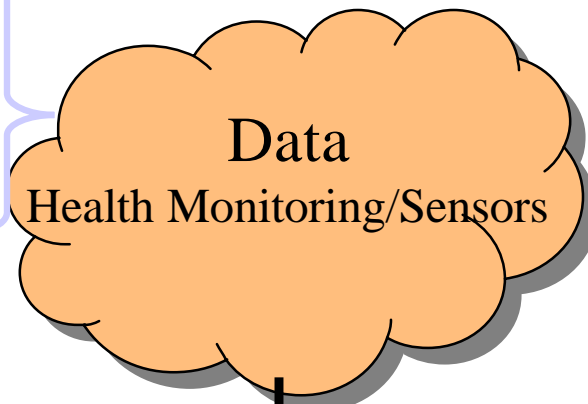
Prob. Methods
Fracture Mechanics
Materials
Coatings
Reliability
Statistics
Avionics
Thermodynamics
Vibration
Fatigue
EMI
Systems
Propulsion
Advanced Technologies

System Engineering Process

Overarching Review of Cross-Cutting Processes

Issues

Models and Integrated Data
Fragmented Budget Decisions
Skill/Experience Levels

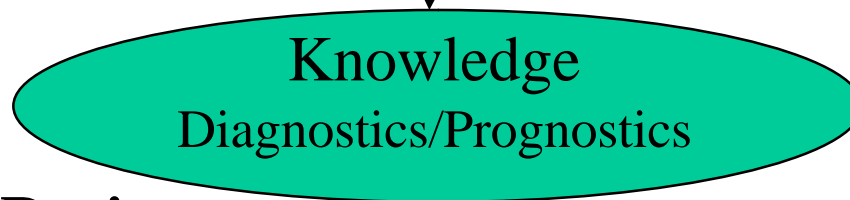


Expertise

Prob. Methods
Fracture Mechanics
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IT

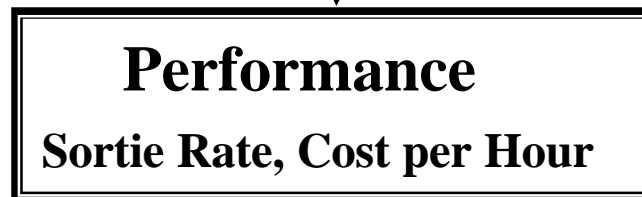
Subject Matter Expertise



Over Arching Review

Safety
Process Technology
Planning/Programs
Reliability
Engineering

RCM



Analysis of alternatives
•Technology
•Repair or Remanufacture
•Spare
•Process



Implementing System Engineering is a Problem

- **No Single Point of Responsibility, Accountability, and Authority**
- **Lack of Integrated Analysis and Data**
 - *“Data Morgue”*
 - *No Proactive Approach*
- **Fragmented Budget Decisions and Stove Pipes**
- **Teams often lack proper mix of critical business, technical and depot expertise**
 - *Unable to complete proper analysis of alternatives*

Turn Data Into Knowledge and Performance



System Engineering Demo

- Systems oriented, 'Measured' results, Transition focused
- Step improvement in performance
- "ACARD" -- Advance Concept Affordable Readiness Demo
 - ***"TOTAL SYSTEM" APPROACH (e.g. E-2C or F/A-18C)***
 - ***TARGETED GOALS for Cost and Readiness***
 - Establish MC/FMC, depot in-process time, TOC goals
 - Eliminate 50% aircraft/component pipeline
 - ***EMPOWER AND RESOURCE 'Cross Stove Pipe' Team***
 - PMA Lead, OPNAV, NAVAIR, NAVICP, Fleet, NADEP, DLA, Industry, DOE
 - Full System Engineering Approach
 - Identify How to Overcome Impediments to Best Business Practices
 - Incorporate/Integrate 'Best of Breed' Concepts/Technologies
 - IMC, RCM, SCM, ERP, LEAN, PPP, Six Sigma, TSPR



Do a Sustainment Sea Trial for Naval Aviation

Creative Contracting Examples





Creative Contracting Examples

- Performance based logistics
 - *Contracts structured with incentives to maximize desired performance*
 - *Share savings with contractor*
- Strategic partnerships
- Long term contracts
 - *Enable investments by industry partners*
- Hybrid contracts
 - *Combine types of contracting in one (e.g. Award & Incentive Fee, T&M)*
- Good examples exist-- Marine Corps MPF Program / APU / F-117 TSPR



Leverage Partnerships



Improve Utilization of Depot Capability and Capacity

- Use existing skills and facilities to reduce costs and improve readiness:
 - *Backshop skills to advantage*
 - *Fast-shop concept (all sources)*
 - *Bonding capabilities for repairs*
- Exploit “Centers of Excellence”
- Exploit public/private partnering arrangements (e.g. APU)
- Ensure availability of tech data and pubs
- Incorporate proven process technology
- Instill “lean & clean” philosophy - *workforce ethos*

Leverage Internal Assets



Technology Dilemmas

- Fully Utilizing Information Technology
- Using ManTech for repair processes
- Upgrading Materials Technology
- Synchronizing TYCOMs / S&T communities
 - *42% of the known problems have no solution*
 - *12% of degraders that have known solutions are unfunded*
- Integrating Capabilities of Services/Industry/
other sources
- Strategically Inserting Technology

Leverage Previous Efforts



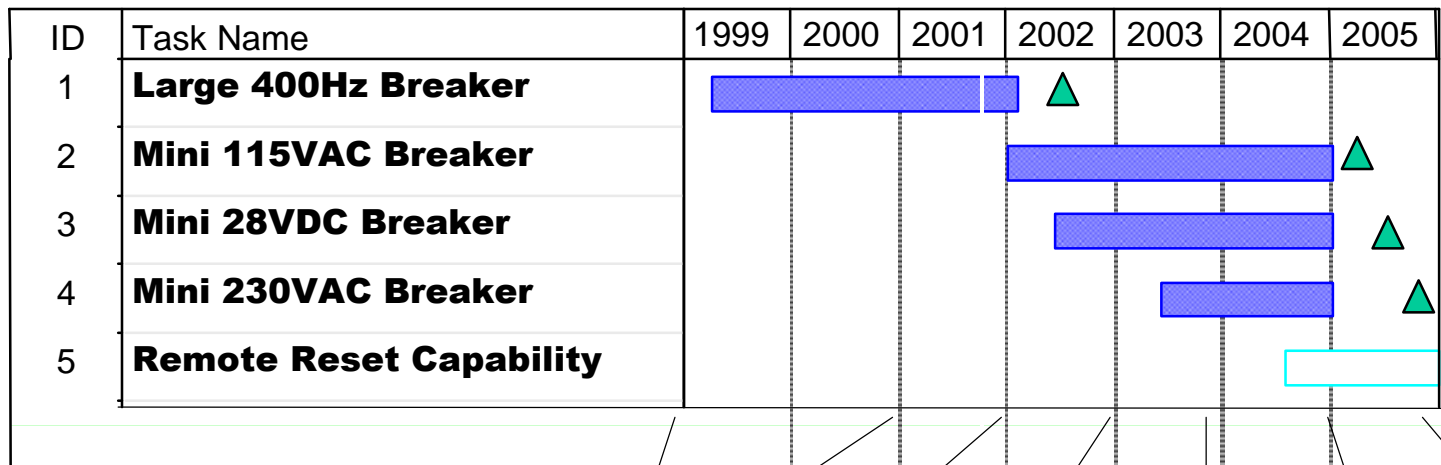
Integrated Technology Roadmaps

...in short supply

- **Understand Fleet Requirements**
- **Identify Available Alternatives**
- **Conduct Analysis of Alternatives**
 - *Readiness*
 - *Safety*
 - *TOC*
- **Develop DETAILED Insertion Plan**
 - *Resource Allocation*
 - *Timing*

Plan for Success

Circuit Breaker Technology Roadmap ...a Good Example



Transition
Planning
Integral

	Prior	FY01	FY02	FY03	FY04	FY05	FY06
Large 400Hz	600 Navy 550 FAA	300 Navy 400 FAA					
Mini 115VAC		500/500 USAF & Industry	(300) Navy 150 USAF	(300) Navy 250 USAF	(300) Navy 150 USAF	1000 Navy	
Mini 28VDC			300 FAA	300 FAA	300 FAA		
Mini 230VAC			100 USAF	250 USAF	100 USAF		
Remote Reset Capability					(??)	(??)	(??)

Example* for a Critical End Item

- **System Engineering**
 - *Analysis of Alternatives*
 - *Metrics*
- **Best Business Practices**
 - *Supply Chain Management*
 - *Reliability Centered Maintenance*
 - *Integrated Funding Decisions*
- **Creative Partnerships**
- **Technology Insertion**

*From CIP Plan POC: Mr Dave Pauling NAVAIR 4.4

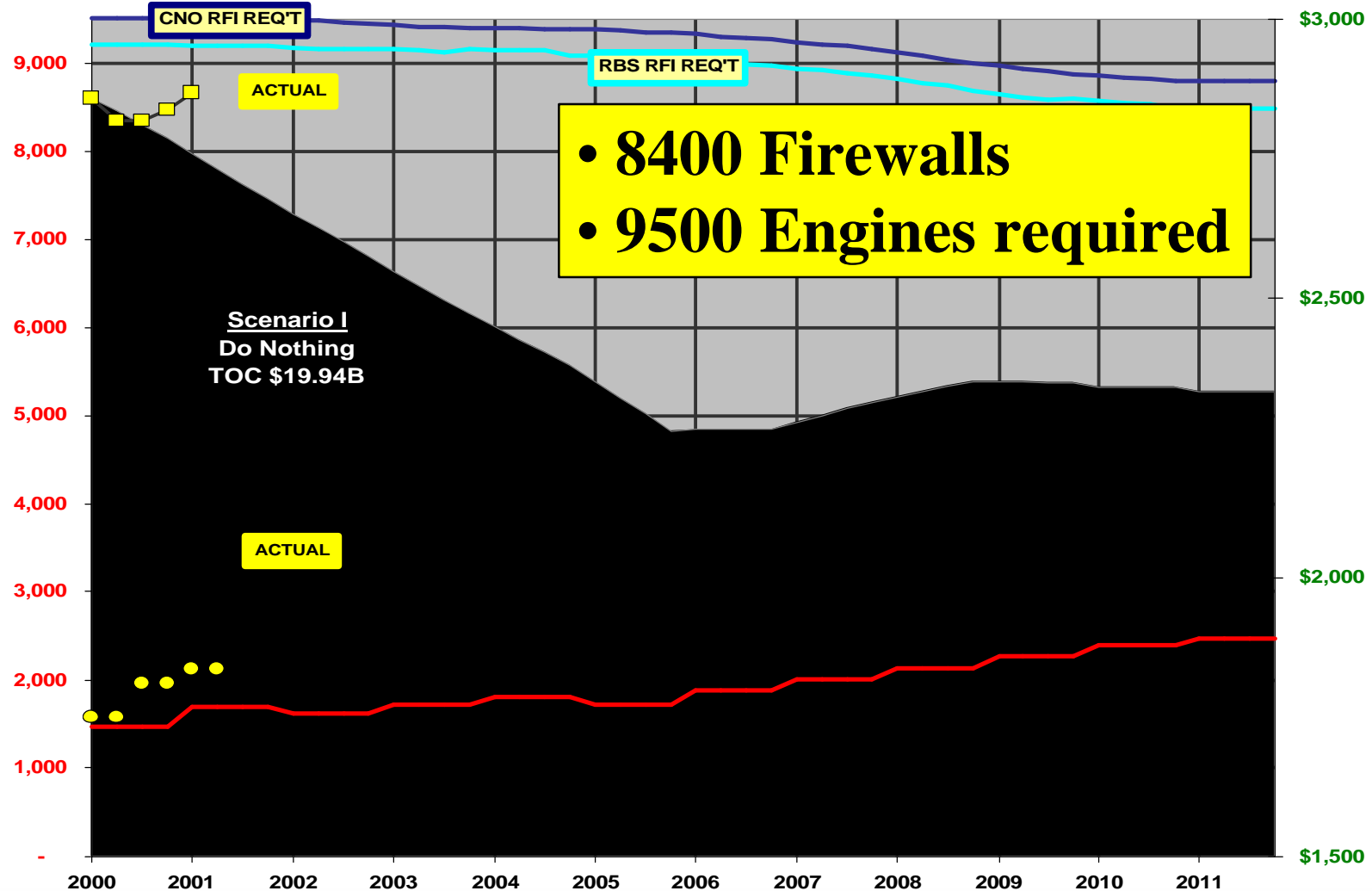
Focus on Readiness

Critical End Item: Engines

Scenario I
Do nothing

RFI Engines Axis

Annual Budgets \$M Axis



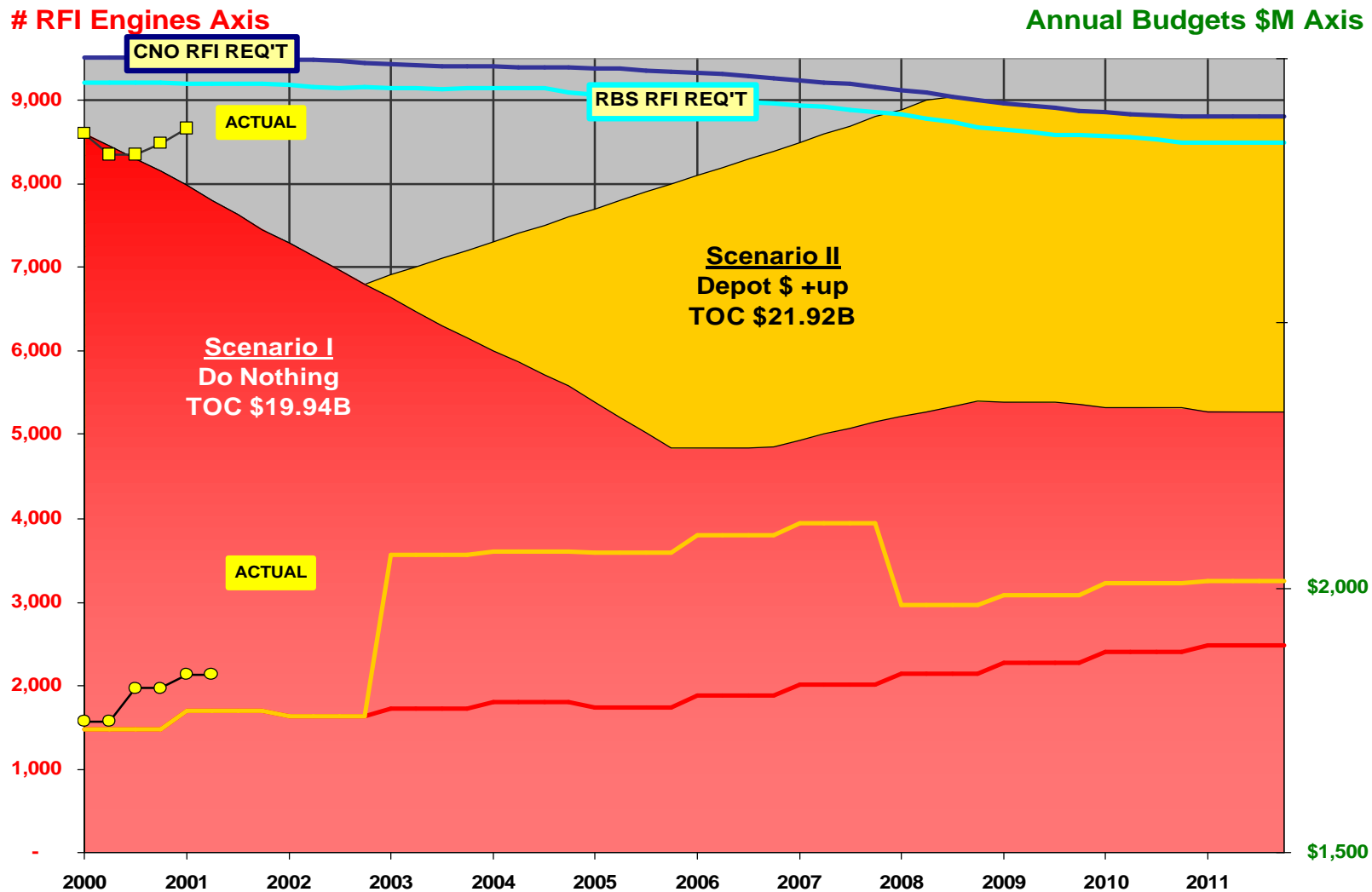
A Critical End Item - Engines

Option		Total Cost FY00-12	Min. Engines Available	Recovery Date	Annual Cost (FY12)
I	Status Quo	19.94B	4800 (FY05/07)	N/A 5200	1.9B/Yr
II	Increase Depot Funding, No Process Change	21.92B	6800 (FY05/07)	FY08/09	2.0B/Yr
III	Shift to Investment Accounts	19.95B	4800 (FY05/07)	FY11/12	1.5B/Yr
IV	Combine II and III Increase Depot and Invest in Process/Technology	20.63B	6800 (FY05/07)	FY08	1.5B/Yr
V*	IV with "Bridge" Funding to Maintain Readiness	21.13B	8300 (FY05/07)	FY02	1.5B/Yr

*Estimated

Critical End Item: Engines

Scenario II Depot \$ Plus Up Only

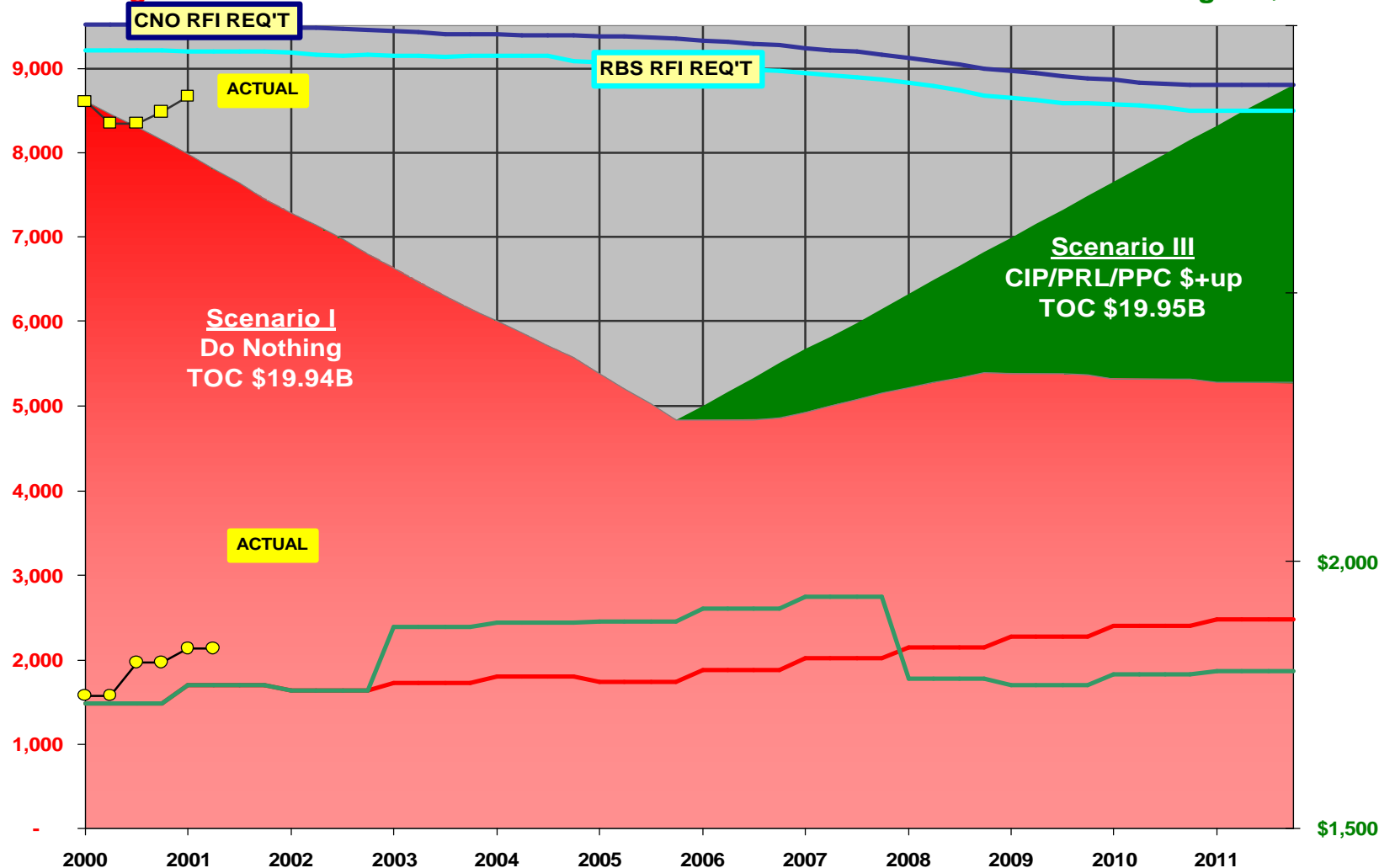


Critical End Item: Engines

Scenario III
CIP/PRL/PPC \$
Plus - Up Only

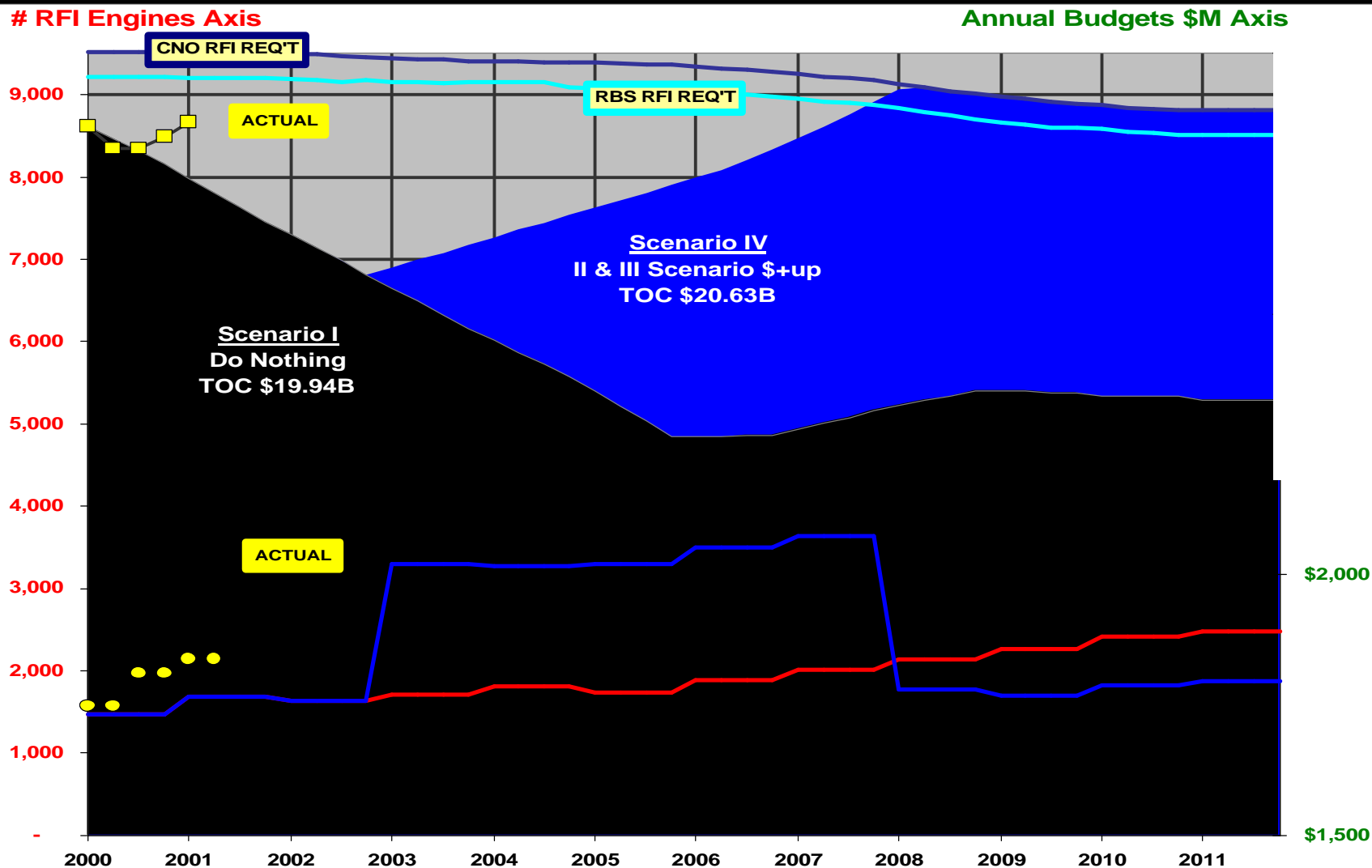
RFI Engines Axis

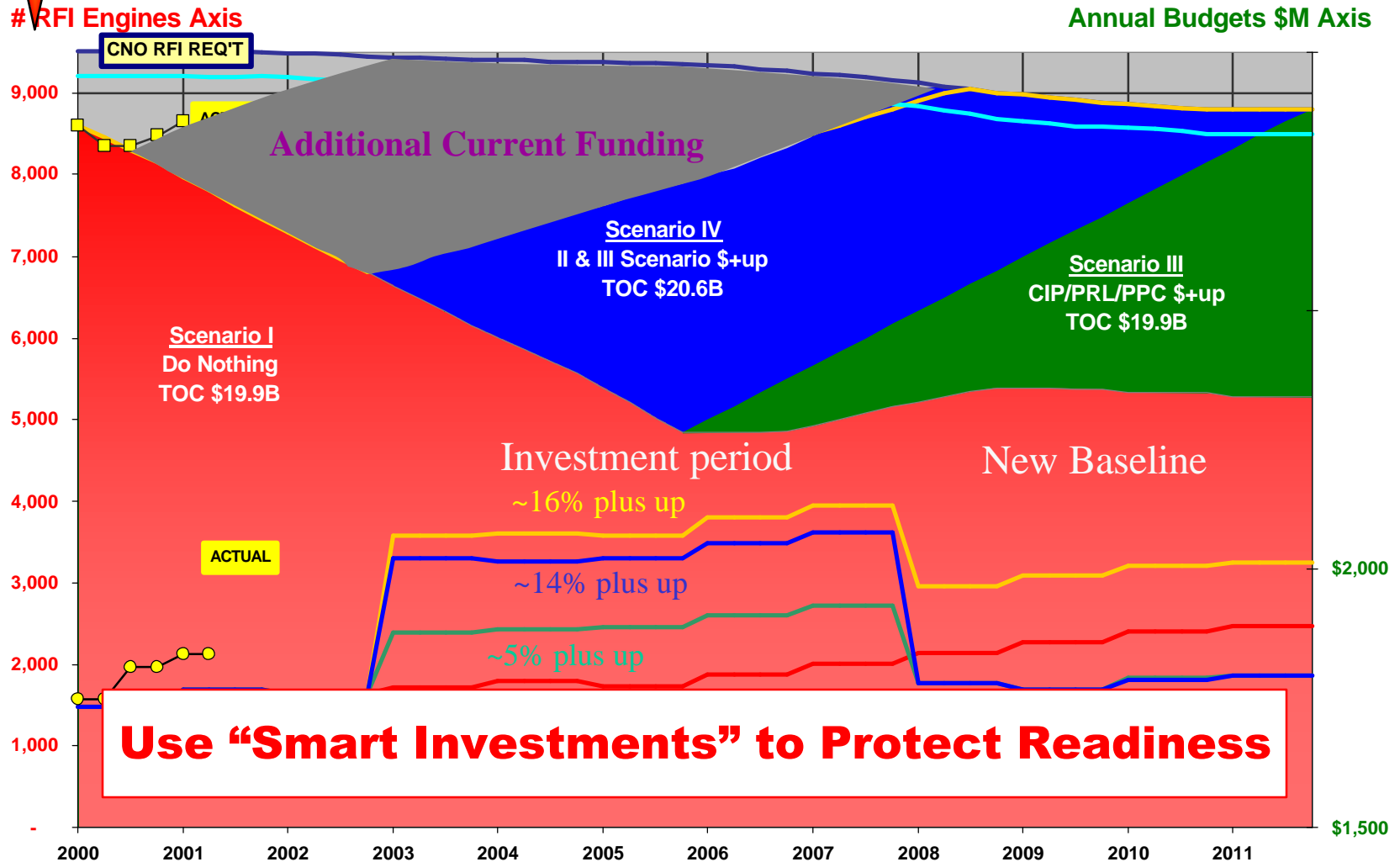
Annual Budgets \$M Axis



Critical End Item: Engines

Scenario IV Scenario II & III \$ Plus Ups





Hidden Pipeline:

(No ROI metrics address it)

‘Pipeline’ is not available to the fleet

- **Two Components**

- *Planned Pipeline*

- » Aircraft -- Typically 17 – 24%

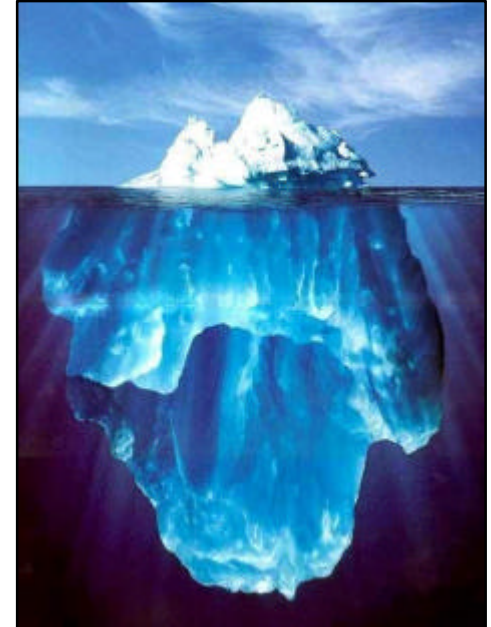
- *‘Hidden’ Pipeline - result of declining materiel readiness*

- » Aircraft -- An additional 25%

- » Component -- As much as 200%+!

- **Pipeline is ‘absorbed’ by turn-around training squadrons**

- **We retain the entire inventory, but only a fraction is available**



Eliminate the cost of NOT Flying

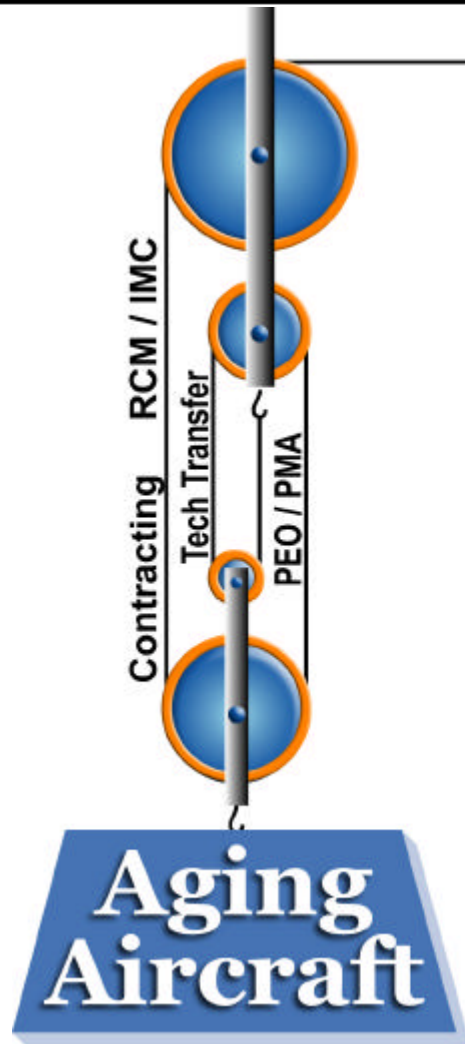


Recommendations

- **Provide PEOs and Program Managers with the resource control and authority necessary to comply with SecNav Instruction 5400.15A and best business practices**
- **Exploit Naval Aviation as a Team**
 - *Focus technology transition to implement RCM and reduce Total Ownership Cost*
 - *Immediately implement creative contracting arrangements to fully exploit NADEP and Industry capabilities (e.g. AVDLR)*
 - *Infuse System Engineering Discipline into Naval Aviation Sustainment Process*
- **Implement ACARD “Proof-of-Concept” by POM-04**

SecNav, CNO and CMC verify implementation of recommendations by December 2002

Benefits vs Cost



Investment

Executive Ownership

Best Business Practices

Exploit as a Team

System Engineering

“Proof-of- Concept”



Appendix A

Previous NRAC Studies

November 1992 -- Science and Technology (Techbase Strategy for the Year 2010)

...organizational structure and the management processes of OCNR were intensively reviewed. The Panel concluded that the present organization is not well suited to the new paradigm for S&T and recommends that the CNR create a nearly seamless organization that has an integrated Planning and Assessment staff and a set of Program Directors, organized along the lines of the S&T customers, that manage funds from all three appropriations (6.1, 6.2, 6.3A).

October 1994 -- Naval Research and Development

...report recommends that the DON standup a single Warfare Systems Command that reports directly to the ASN (RD&A) and Chief of Naval Operations, in lieu of the current individual systems commands, creating a central focal point and advocate to address the long-term R&D/Material needs of the Navy.

November 1995 -- Life Cycle Cost Reduction

...the Panel soon found that although numerous opportunities existed for for S&T investment to beneficially impact LCC problems, the underlying problem was a lack of visibility and consideration of LCC implications of decisions made early in the requirements definition and concept development phases of programs where LCCs are largely determined. This general lack of visibility of LCCs was found to continue throughout the life of most systems.

...If allowed to continue, this situation will prevent the DON from re-capitalizing its force structure

...the Panel was unable to identify a [systematic] DON-wide process for reducing O&S costs. In addition to lack of timely availability of historic LCC data, the DON has little, if any, ability to predict future LCCs...

August 1996 -- Review of the Department of the Navy Science and Technology Program by NRAC Visiting Panel

...Federal policies regarding the governance of almost all Federal agencies impose excessive accountability and create employment and staffing obstacles to maintaining a strong S&T staff. The segmentation of R&D funding assignments within the Department of Defense into numerical categories (6.1, 6.2, ..., 6.7) leads to communication and administrative barriers that degrade effectiveness. These communication problems are especially serious between the DON S&T community (ONR, NRL) and the Fleet operations and requirement organizations (SYSCOMS and No91).

...The present process of converting technology into products and services for use by the DON takes far too long...

...One way to increase the pace of technology insertion is to make greater use of industry in all aspects of the development/procurement process, including exploratory development

Appendix A cont.

Previous NRAC Studies (cont.)

June 2001 -- Commercial Science and Technology Panel

- ...The magnitude of commercial R&D investment is significantly greater than that of the Department of Defense (DoD), and the disparity has been growing for years.
- ...The panel found that the commercial sector has a comprehensive technology plan and a willingness to share it openly. However, the DON's ability to influence commercial technology development is minimal, if at all.
- ...the DON should adopt commercial products "as is" to keep up with certain technologies and save money. The panel also emphasized that the use of open architectures is essential for effective incorporation of the rapid changes in technology...
- ...The panel recommended that the ASN(RD&A) drive the adoption of commercial systems and establish a policy for exploiting commercial technology...
- ...The key elements of the recommended panel methodology are to: (1) identify product lines and/or technologies of interest to the DON that are led by the commercial sector; (2) understand those product lines and/or technologies with respect to DON requirements; (3) determine future commercial product stability and development strategy; and (4) incorporate commercial products into the DON investment strategy.

March 2001 -- Quality of Life Report

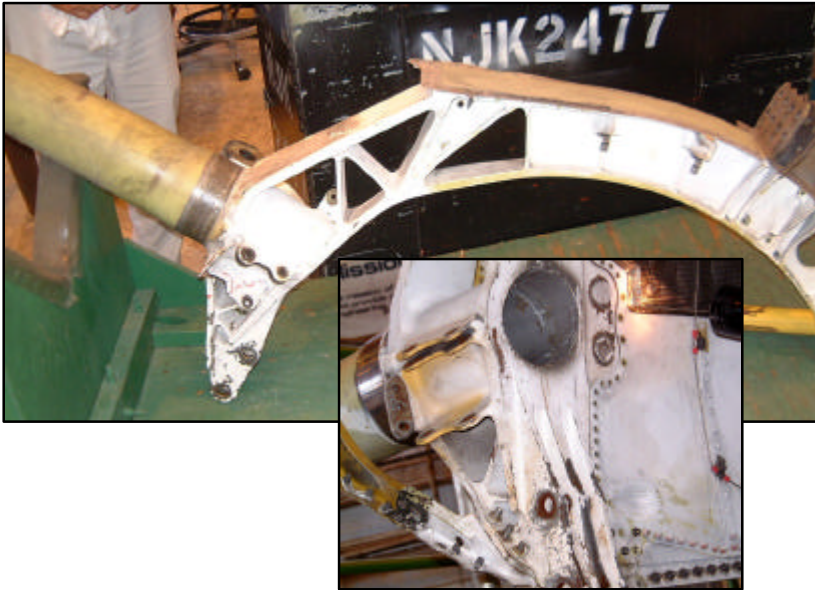
- ...Spare parts shortages (and resulting cannibalization from other equipment) underlie workplace dissatisfaction. How frequently and widely the problem of spare parts was mentioned was a real surprise to the panel. The reason for this focus is likely due to how the absence of spare parts demoralizes individuals with respect to their being able to perform their jobs.
- ...Conclusions – spare parts must be made available when needed
- ...Recommendations – fix the spare parts problem (SecNav) – aggressively seek opportunities to insert emerging technology into legacy... platforms... for reduction of workload, manning, and cost.. CNR focus technology programs to provide emphasis in this area. SYSCOMS develop criteria for technology insertion into legacy and new systems.

Appendix B

Linked Charts

Structural Repair

- Depots experiencing high level of major structural repair
 - *F-14 Engine rear support bulkhead*
 - *Components “hand manufactured” and not interchangeable*
 - *High manufacturing and Installation time*



Solution:
Leverage advanced manufacturing
procedures available in industry

**Strategic Partnership –
Attack the Cost of NOT Flying**

Aircraft Wiring

Problem:

- Naval environment is incompatible with long life expectations for wiring
 - *Twists and turns*
 - *Salt water*
 - *Broken insulation / abuse*
- Quickly becomes a safety issue
 - *Arcing and Fire*
 - *Loss of function (including flight critical functions)*



What we saw:

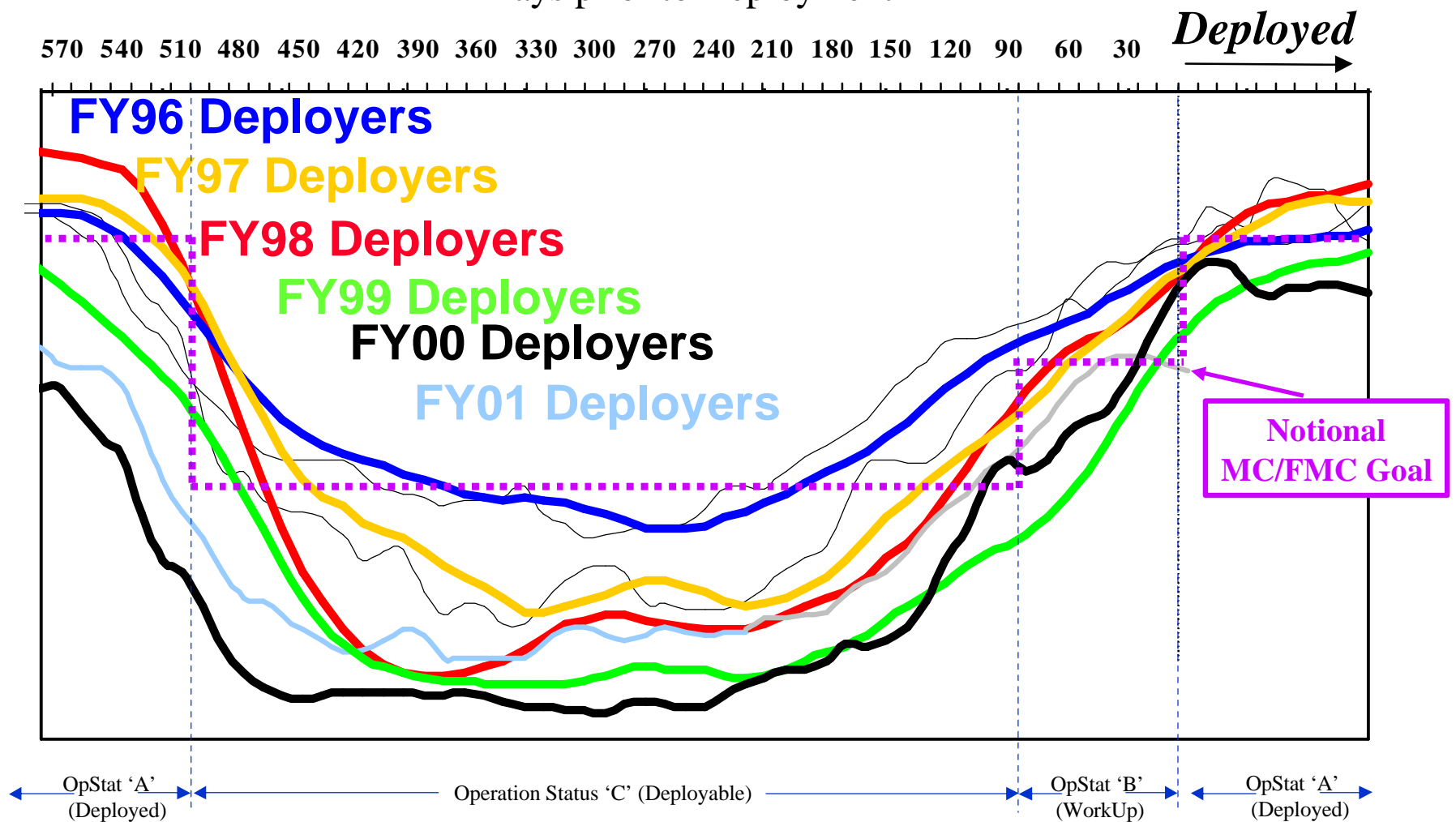
- New technology is available (e.g. arc fault circuit breaker, improved materials)
- Replacing wiring harnesses is very labor intensive (expensive)
- Wiring harnesses that are beyond reasonable life were being removed from CH-46's to facilitate other repairs, rolled up and put back in (not replaced because it was not specified on the "service order")



Solution: Empower the Workforce to do the RIGHT thing

NAVRIT - ‘Readiness Improvement Team’

CARRIER AIRWING IDTC READINESS by Fiscal Year of Deployment Days prior to Deployment

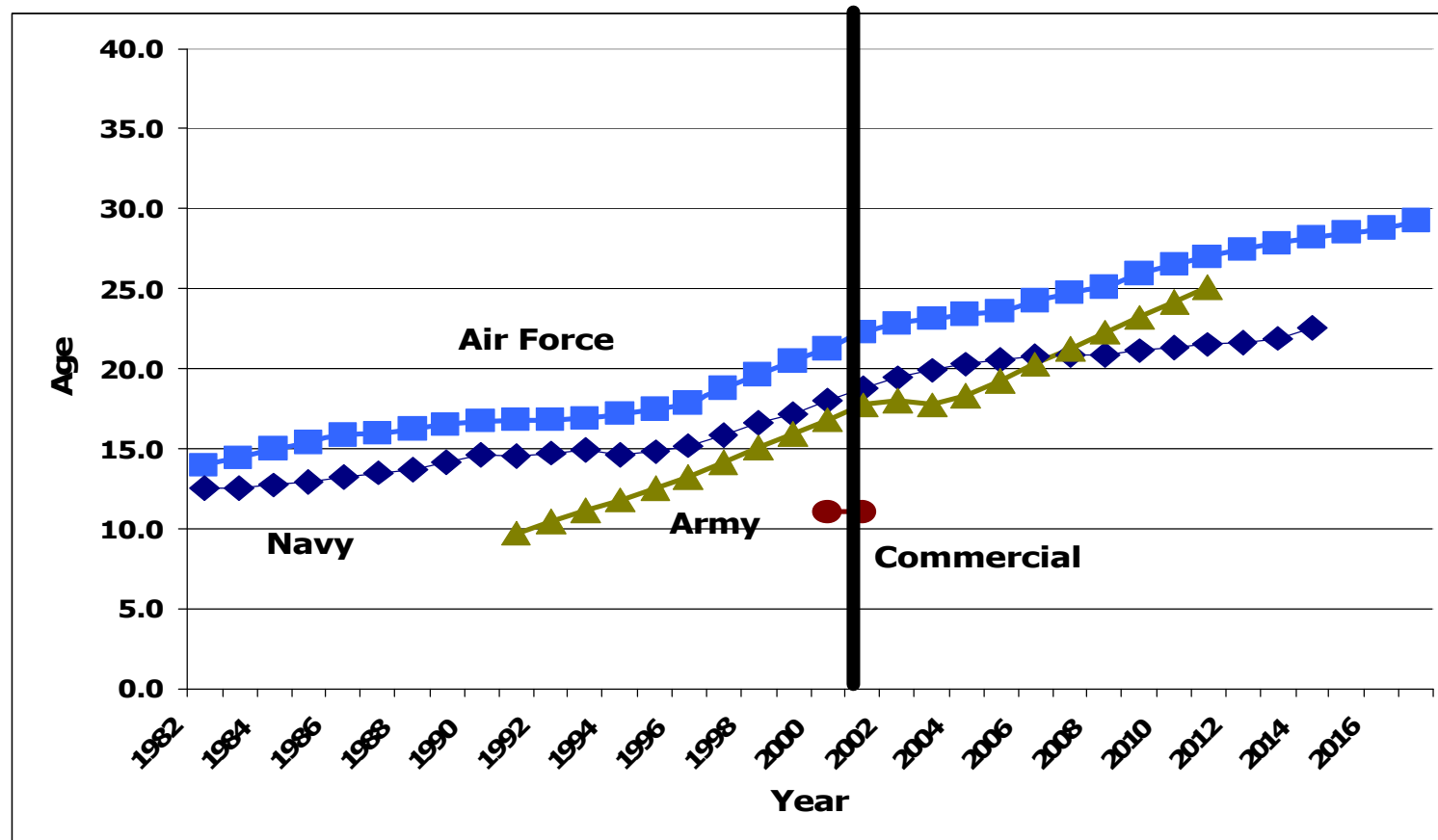


Ref: OPNAVINST 5442.2G

DATA SOURCE: SORTS
DATA Date: 15 OCT 00

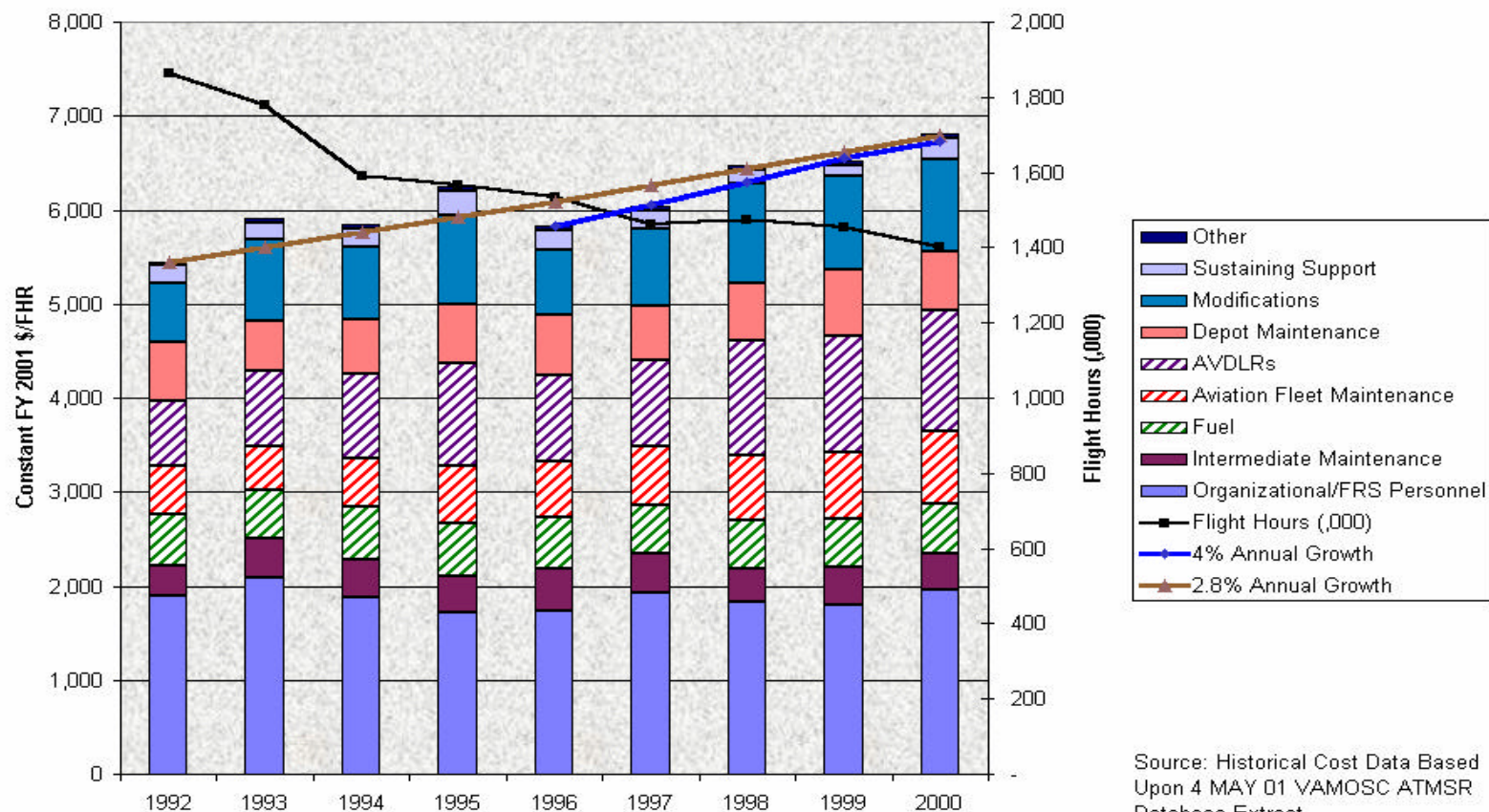
Aging Problem

Average Age Trend



TOTAL FORCE O&S COST-- COST PER FLIGHT HOUR

Flying Hour Program Cost Contribution in Bar Pattern Blocks



Source: Historical Cost Data Based
Upon 4 MAY 01 VAMOS ATMSR
Database Extract