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Assessing the Effects of Test and Evaluation on Acquisition Program Schedules

**Presented at the NDIA 21st Annual National Test and Evaluation Forum
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Summary of Prior RAND Research

- **Test and evaluation is a core acquisition management activity**
- **Test and evaluation is a major component of acquisition program duration**
 - **Little evidence that the planned T&E phase is inappropriately long**
- **The length of the T&E phase is a function of the program's characteristics and external environment**
- **T&E is not a factor affecting schedule slip**
- **Recent trends in acquisition management and T&E practice have enabled accelerated delivery of new capabilities under certain circumstances**

Outline

- **An analytical framework for assessing T&E effects on program duration**
- **Results of prior RAND research**
 - **Factors affecting schedule**
 - **Streamlined programs**
 - **Catching major problems early**
- **Observations and Conclusions**

Analytical Framework (1)

Measuring Program Duration

- **Measured duration depends on when you start/stop the clock**
 - **No generally accepted definitions**
 - **Often somewhat arbitrary in each analysis**
- **Formal Milestones represent very different levels of maturity across different programs**
- **Program duration is affected by many variables**
- **Useful parametric schedule estimation equations have not been developed**
- **Schedules are largely driven by the policy of systematically eliminating risk**
 - **T&E is one way to demonstrate that risks have been adequately addressed**

Analytical Framework (2)

T&E in Context

- **T&E is driven by the unique characteristics of a program**
- **Cultural perspectives of communities differ**
 - **Objectives of T&E vary across organizations**
 - **T&E to discover, fix, refine vs. confirm performance (meets specific requirements)**
 - **Political interests vs. engineering interests**
- **Recent trends**
 - **Combined DT/OT (CTF, early user involvement) to reduce duplication and increase mutual leverage**
 - **Acquisition reform (requirements process, contractor responsibility)**
 - **Software-intensive systems**
 - **Modeling and simulation**

T&E Stakeholder Interests

- **Designers**
 - Provides important technical information and defines relationship between actual and expected performance
- **Program Managers**
 - Allows assessment of system maturity
- **Users**
 - Assures ability to meet mission critical performance
- **Independent testers and oversight organizations**
 - Assures independent performance assessment

Acquisition Reform's Effects on T&E

- **Changes to the requirements generation process**
 - **Flexibility and CAIV**
 - **Capabilities and effects**
 - **Minimum set of critical performance parameters (KPPs)**
- **Increased contractor responsibilities**
 - **Choice of facilities**
 - **Data generation and ownership**
 - **Oversight and independence**
- **Commercial products (COTS/NDI)**
 - **Integration challenges**
 - **Modifications and technical data**
 - **Commercial testing as indicative of performance in a military environment**

Observations on Effects of Trends

- **Capabilities are harder to measure and test**
 - **Ambiguous “requirements” and KPPs**
 - **Less detail on desired performance**
 - **Requires system-level, holistic view**
- **Managing the national test infrastructure**
 - **Variability in how “costs” or “prices” are determined between and within government agencies**
 - **Timely availability of critical or unique facilities**
 - **Investment in T&E resources and methods (instrumentation, modeling, facilities upgrades)**
- **T&E complexity**
 - **New capabilities (stealth, electronics)**
 - **Software-intensive systems**
 - **Combined or multiservice testing**

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Factors Affecting Program Schedule

Plan

- **Competition**
- **Concurrency**
- **Funding adequacy**
- **Prototyping**
- **Contracting strategy**
- **Relative priority**

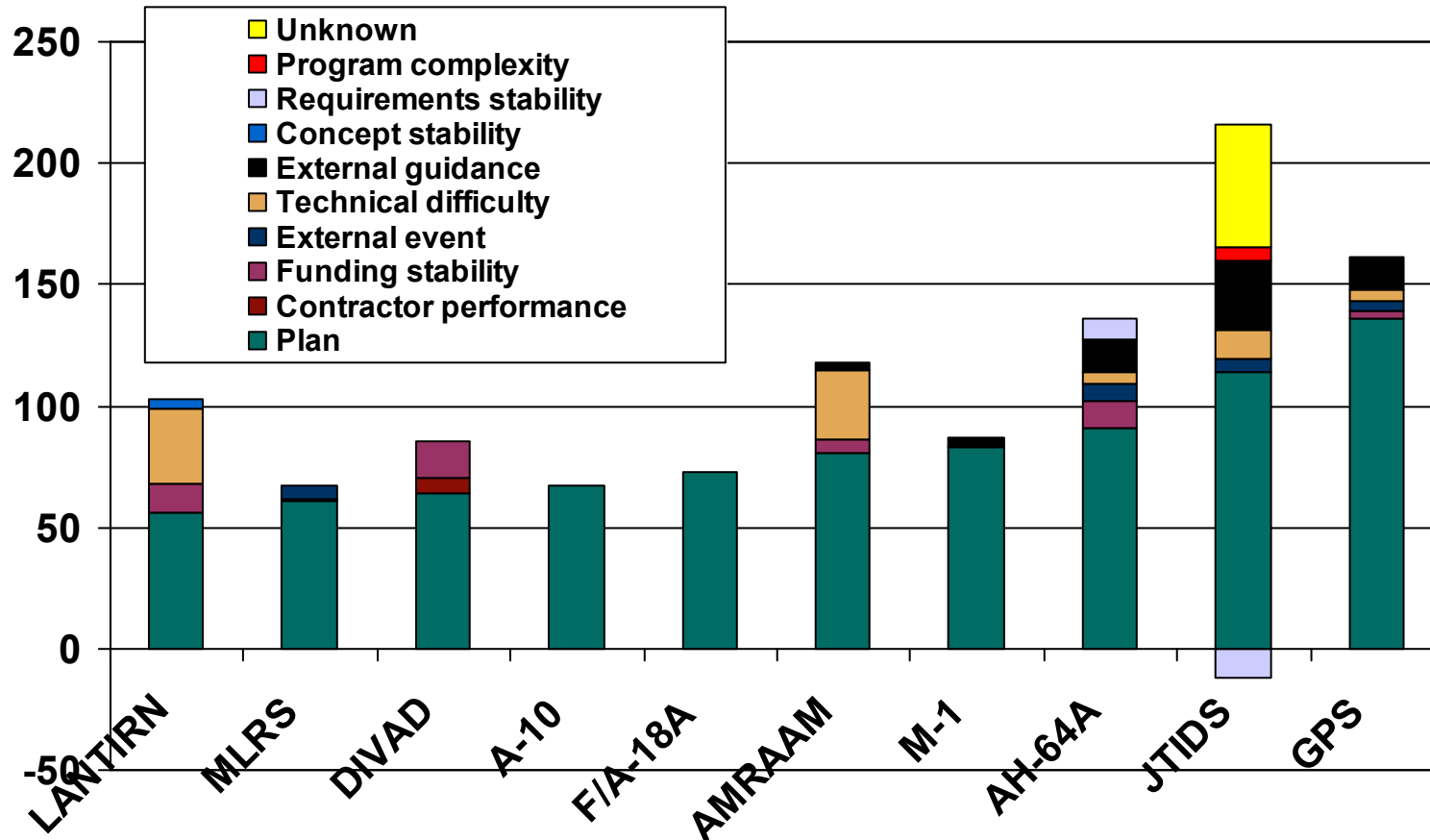
Plan/Slip

- **External guidance**
- **Joint management**
- **Complexity**
- **Technical difficulty**
- **Concept stability**

Slip

- **External events**
- **Contractor performance**
- **Funding stability**
- **Requirements stability**
- **Management turnover**

“Test” Does Not Usually Show Up as a Factor Affecting Program Duration



Note: Program duration defined as time from Milestone 1 to 1st Operational Delivery, or functional equivalents

Effect of T&E is Indirect

- **Testing associated with prototypes**
- **Adequacy of funding for T&E elements of the program**
- **Technical difficulties discovered through test**
- **Concurrency amplifies the cost/schedule impact of any deficiencies identified through testing**
- **Complex concepts may require complex testing**

HAE UAV ACTD Program History

•The Plan

- **Multi-phase competitive program structure (67 mo. total)**
- **Three segments managed by joint program office: Tier II+ (Global Hawk), Tier III- (DarkStar), Common Ground Segment**
- **Two transitions**
 - **From DARPA to Air Force management**
 - **From ACTD to MDAP**

•Outcomes

- **Program was executed within initial budget estimate with small (7 mo.) extension in schedule**
 - **Activity content was significantly changed: reduced fabrication, compressed D&E**
 - **Level of effort per dollar spent was high, resulting in relatively high system maturity at the end of the ACTD**
- **Considerable learning required on execution of innovative acquisition strategy**
- **DarkStar termination after minimal flight testing**
- **Very challenging transition of Global Hawk from ACTD to MDAP**

HAE UAV Original Flight Test Plan

- **A full three years of flight testing, half the total duration of the ACTD**
- **As many as 10 Global Hawks and 5 DarkStars would be available for testing during Phase III D&E**
 - **Each air vehicle would have a full sensor suite**
 - **Several ground segments available**
- **D&E would evolve from four 24-hr flights per month to 20 flights per month**
 - **“training condition” to “deployable condition”**
 - **Simultaneous deployment of a full system**
 - **Four Global Hawks, two DarkStars, one ground segment, a spares kit**
 - **Generate 250 flight hours per month**

DarkStar Key Events and Conditions

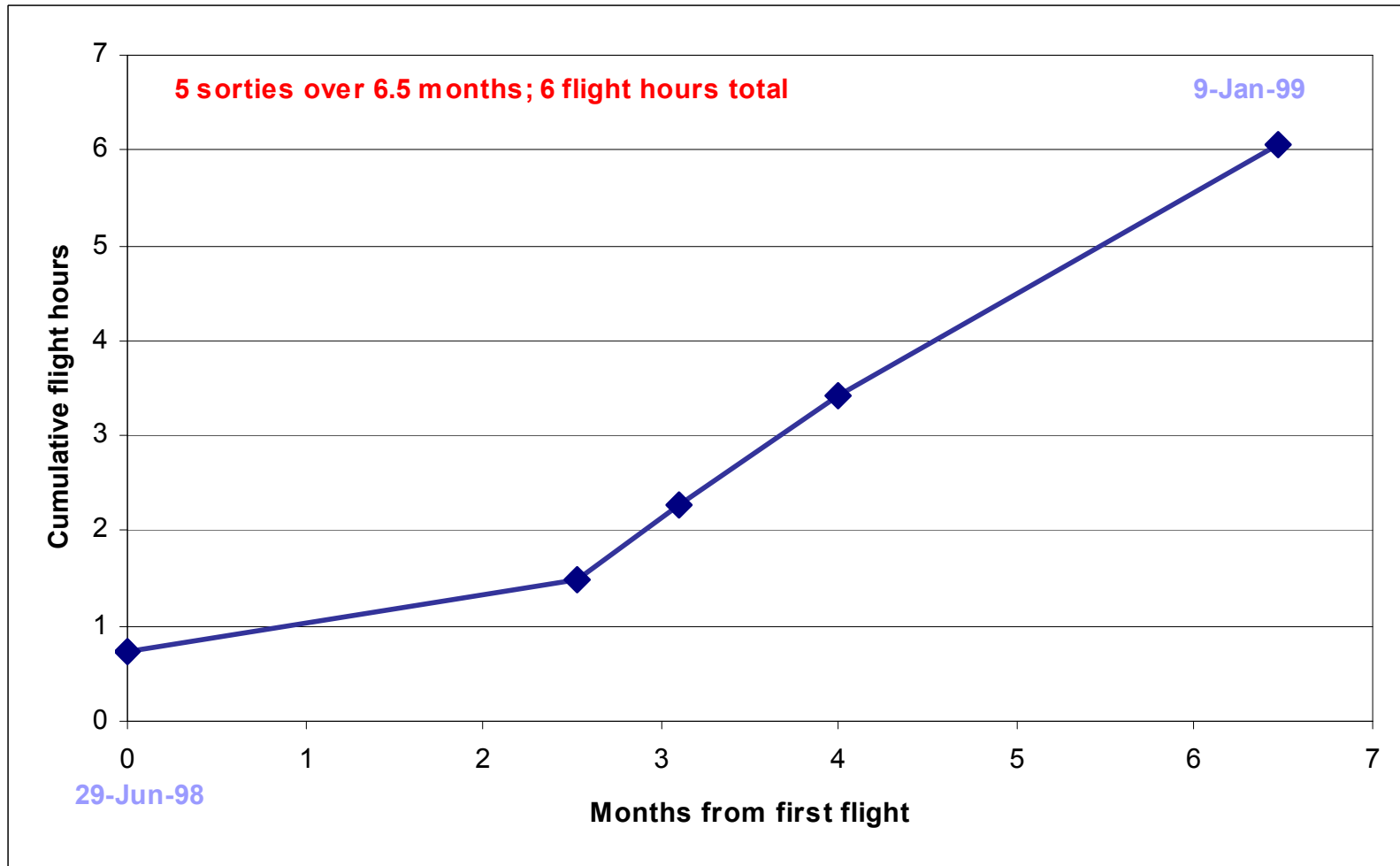
(Phase II)

- **Sole-source award based on prior experience**
- **High-risk aircraft configuration driven by low observability requirement**
- **Very large contractor(s) may not have applied best resources**
- **Extremely hard schedule push by contractor**
 - **Insufficient wind tunnel testing and database development in support of design decisions**
 - **Design frozen 11 days after Agreement award (7/94)**
 - **By 6/95 rollout, about 2 months ahead of schedule**
 - **Boeing wind tunnel at end of 1994 showed problems:**
 - **Predicted fuselage lift and drag incorrect, so wing reset +2 deg.**

DarkStar crash Apr96 on takeoff during second flight

- **Crash due to:**
 - **Schedule push by contractor**
 - **Less than adequate aerodynamic information**
 - **Poor judgment regarding risks and relevance of prior experience**
- **Crash resulted in:**
 - **Increased risk aversion for all program segments**
 - **Increased reviews**
 - **Robust single-point failure analysis**
 - **Greater emphasis on training**
 - **Schedule slip and cost growth**

DarkStar ACTD Flight Test Program (Air Vehicle 2)



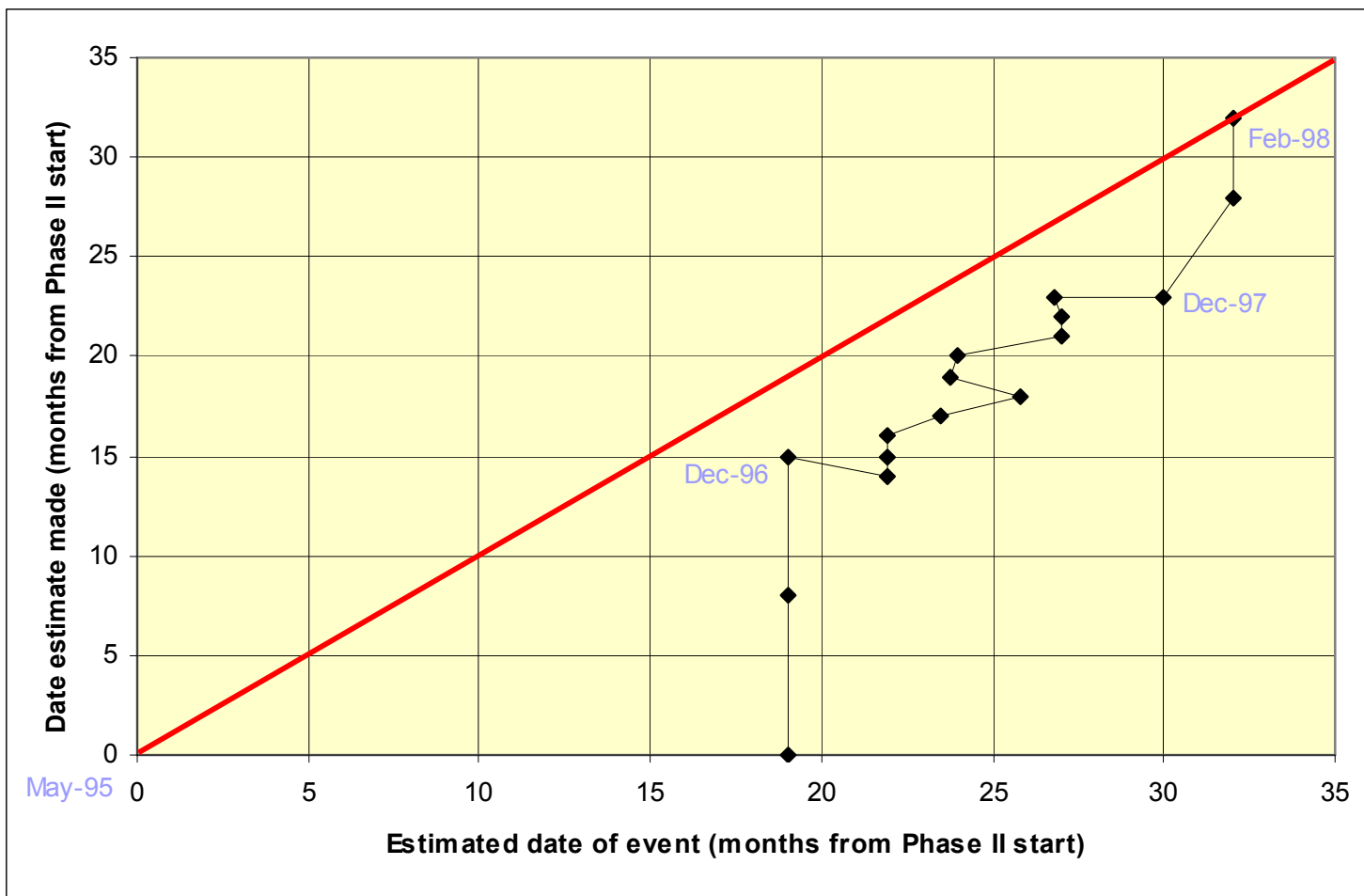
Global Hawk Flight Test Program

- **Master Test Plan (Nov 95) was very detailed, considering maturity of program when developed**
 - **Tailored to unique needs of program**
- **MUA process outlined in Integrated Assessment Plan (Jun 98) was complex and detailed**
- **Clear distinction between engineering and D&E flights**
- **Flight test execution reflected careful, systematic process of learning**
- **Engineering (“DT”) tests added on to demonstration (“OT”) tests when possible**

Global Hawk Early Notional Phase III Test Plan

	1998 (quarters)				1999 (quarters)			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Flights	12	24	60	60	60	60	60	60
Flight hours	300	600	1500	1500	1500	1500	1500	1500
Cumulative flight hours	300	900	2400	3900	5400	6900	8400	9900

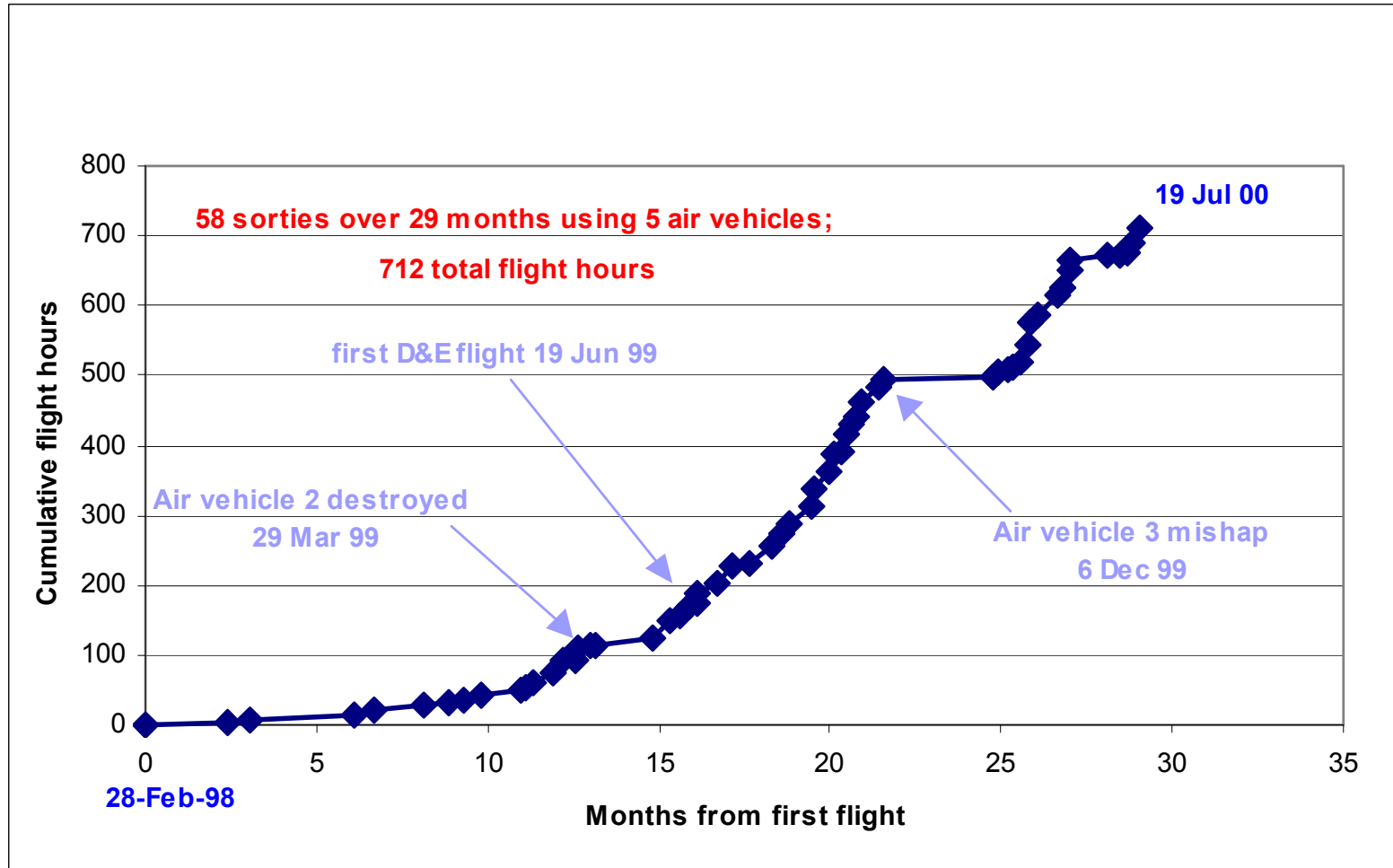
History of Global Hawk First Flight Estimate



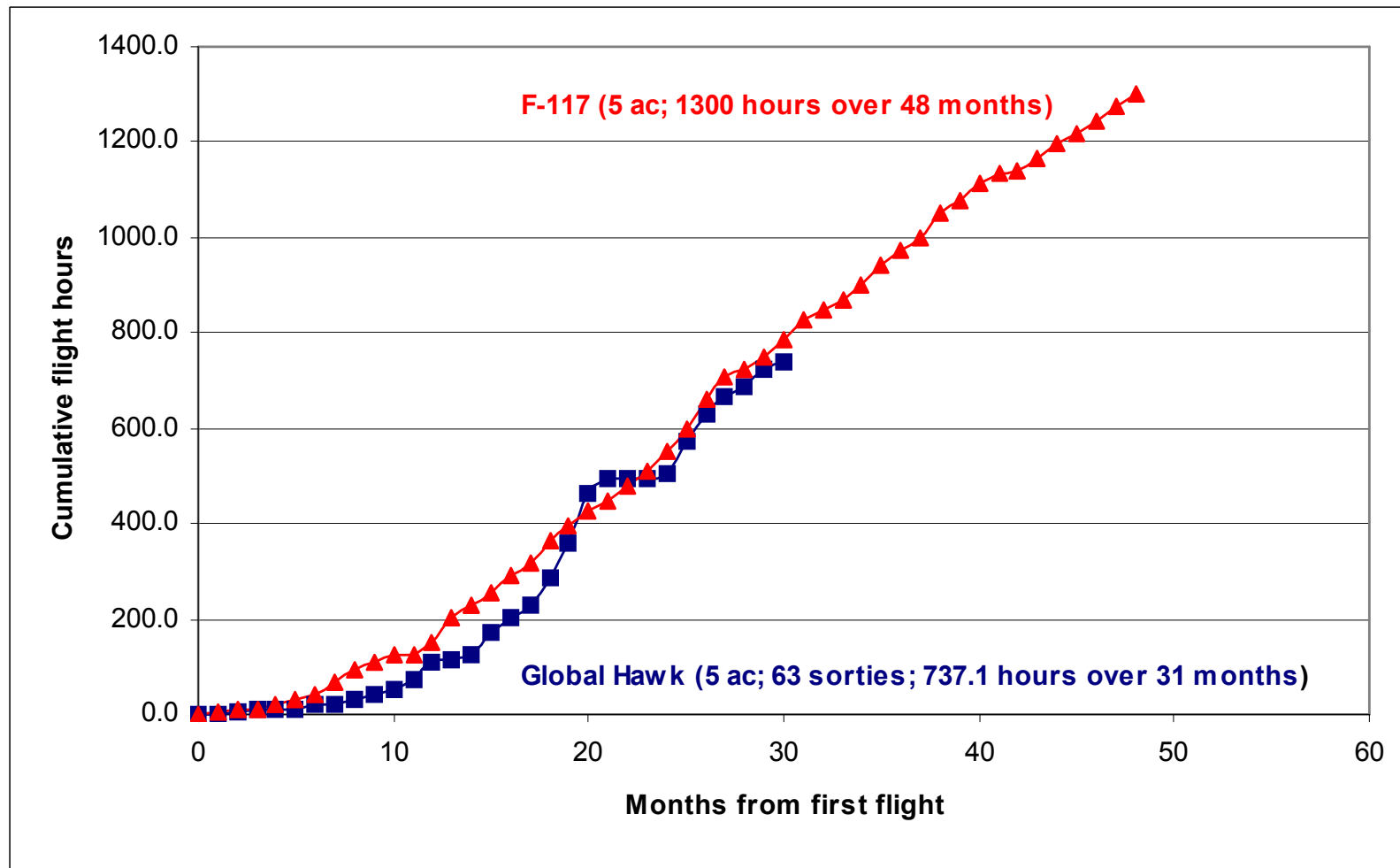
Global Hawk Flight Test Execution

- **Test duration shortened in order to accommodate developmental problems**
- **Flight test hours reduced dramatically from original plan**
- **Number of test articles reduced**
 - **Air vehicles: 10 to 5**
 - **Ground segment: 2**
 - **Payload:**
 - **Several separate EO/IR and SAR systems**
 - **One ISS**
- **31st Test and Evaluation Squadron**

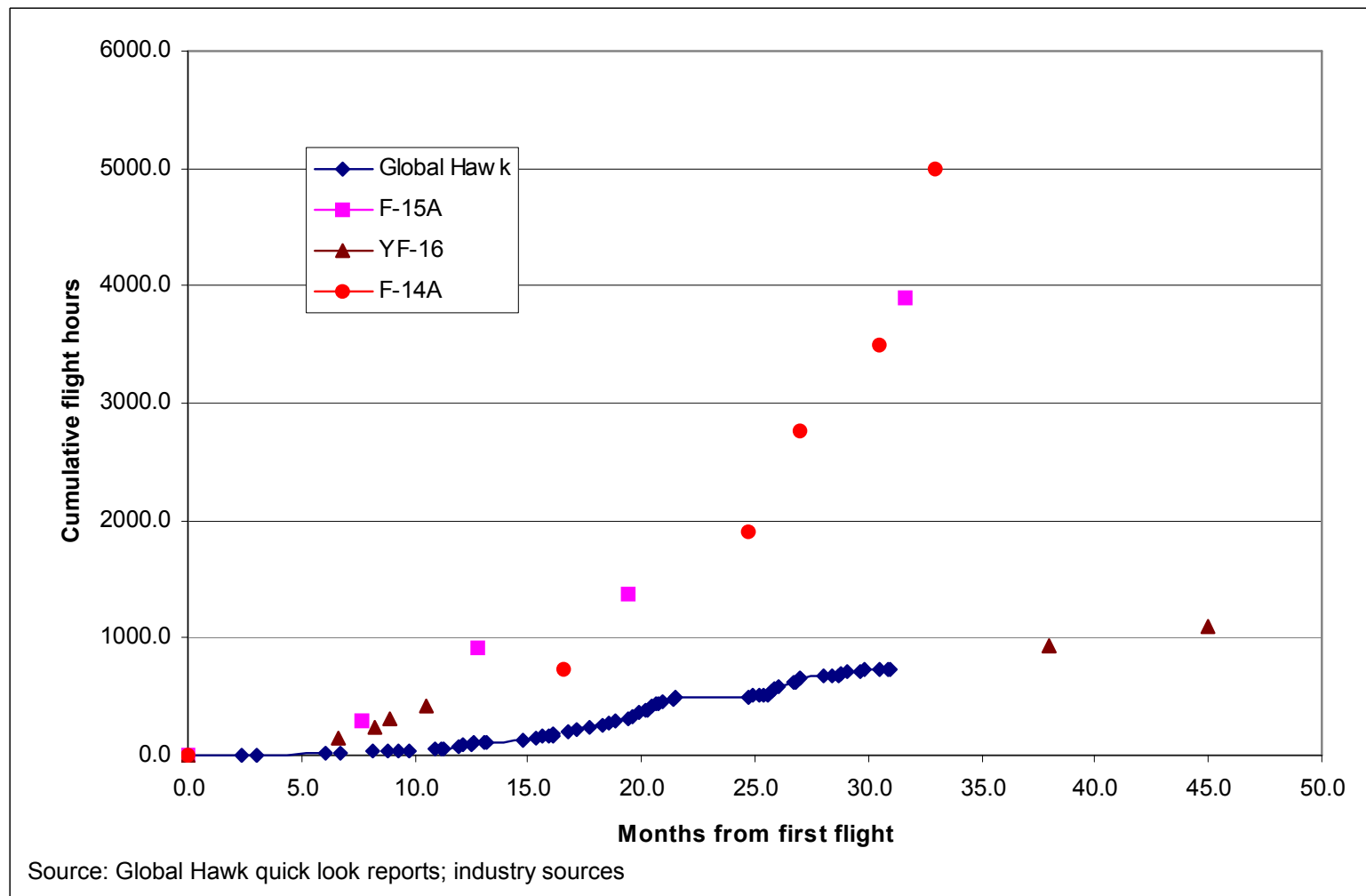
Global Hawk ACTD Flight Test Program



Global Hawk and F-117 Have Similar Flight Test Profiles and have relatively simple mission profiles...



...But Global Hawk Mission Profile Is Fundamentally Different Than Most Combat Aircraft



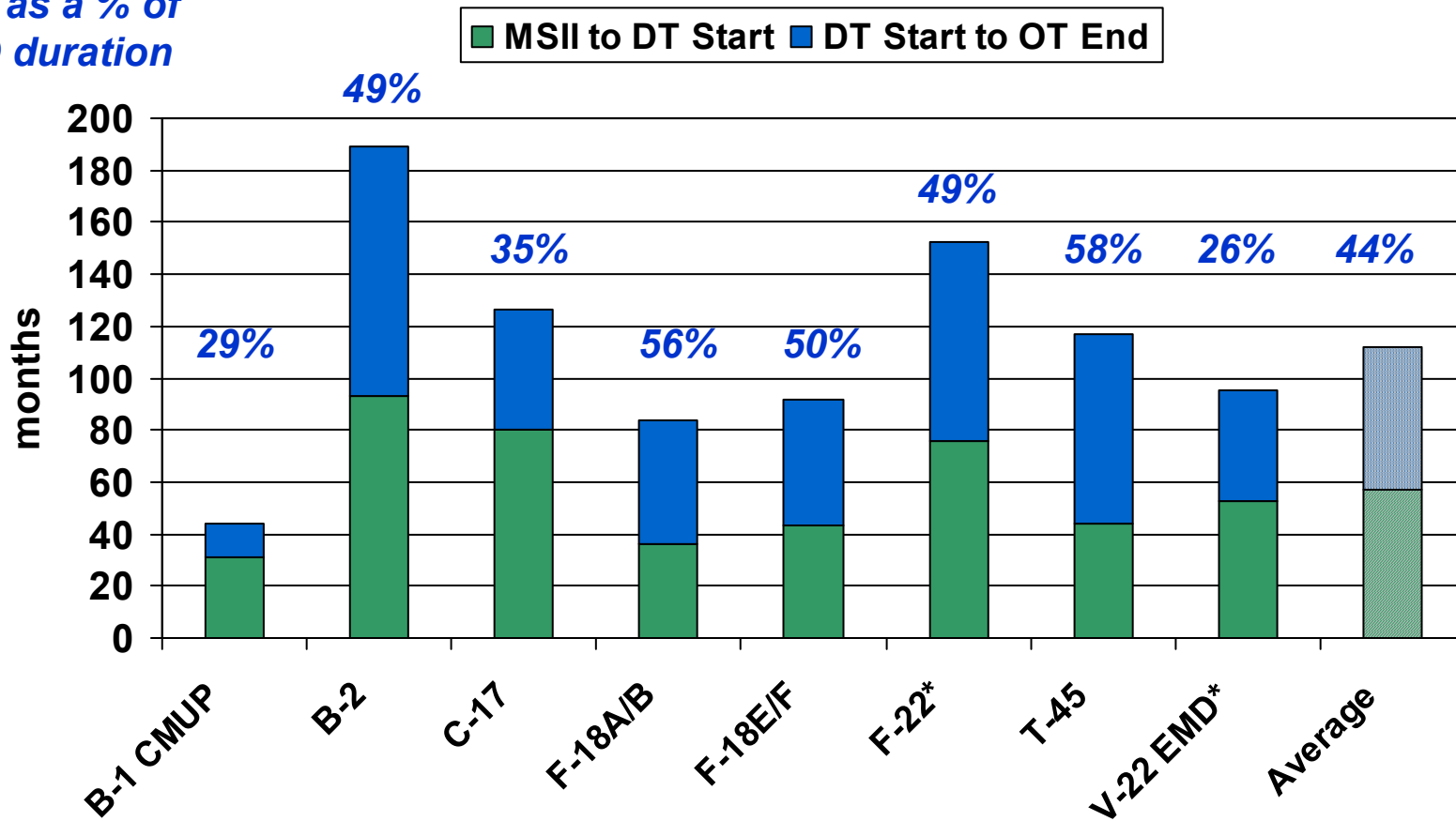
When are Problems Identified?

Major Problems Revealed During Flight Test

Program	Problem	Percent of testing complete
C-5A	Static test failure in wing root	20
	Hydraulic leaks/engine	25
	Landing gear mechanism	2
	Multimode radar deficiencies	15
	Wing fatigue	40-50
B-1A	Weapons bay acoustics	5
	Shock-induced oscillations	60
	Horizontal stabilizer fatigue	10
B-1B	Defensive avionics	10
	Terrain following radar	10
F-117	Tail size	1
	Wing structure	10
	Infrared attack and designation system	10
	Rudder	50
F/A-18A	Excessive drag	15
	Bulkhead fatigue cracks	10
	Inadequate roll rate	20

Development and Operational Test Durations As a Portion of Total Aircraft FSD/EMD Duration

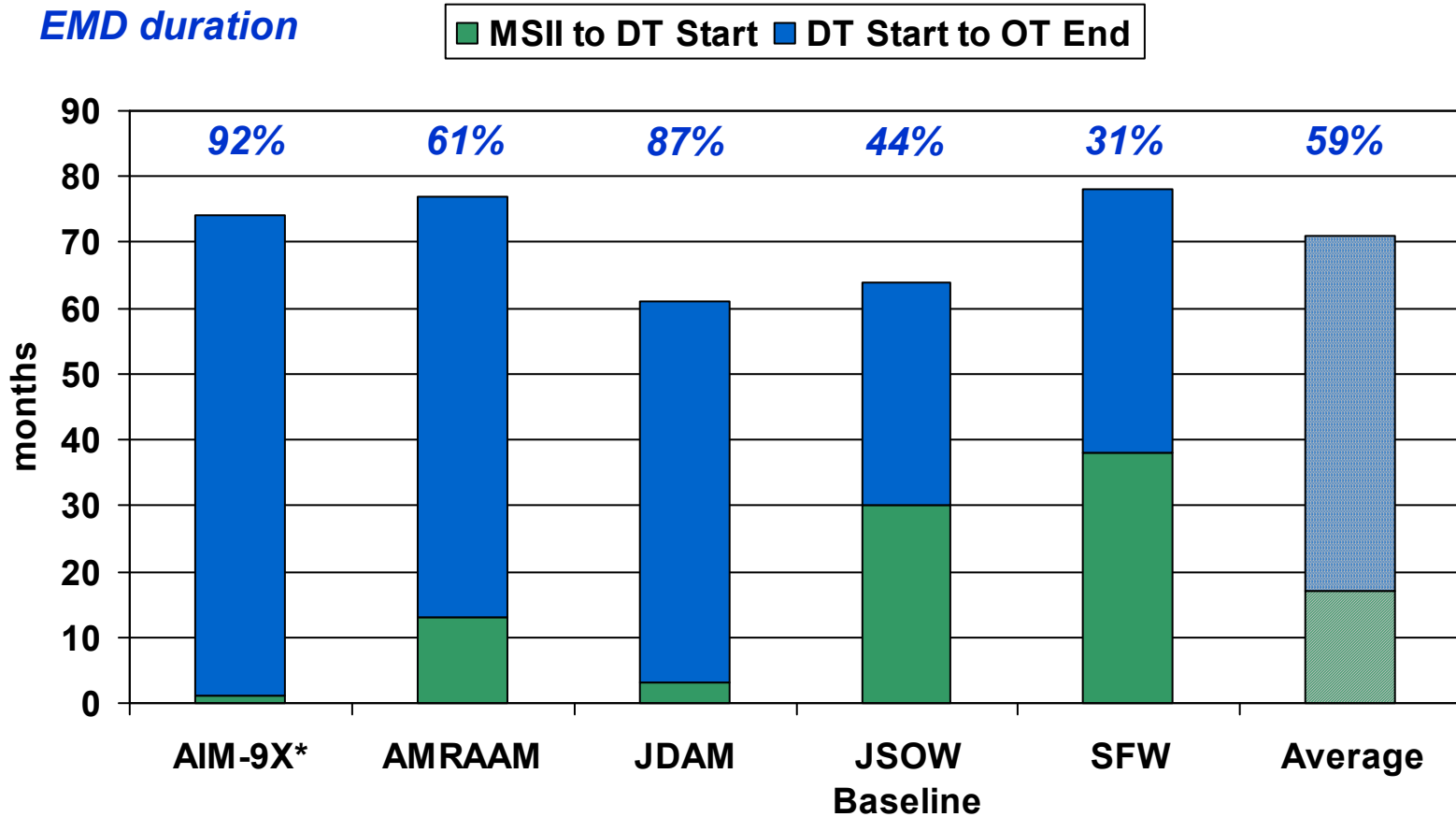
Test as a % of EMD duration



* On-going program

Development and Operational Test Durations As a Portion of Total Guided Weapon FSD/EMD Duration

Test as a % of EMD duration



* On-going program

T&E Phase Duration Is A Function of A Program's Unique Circumstances

Factors affecting T&E duration:

- **Program characteristics**
 - **Where in the life-cycle**
 - **Technological maturity**
 - **System type**
 - **Adequacy of T&E resource**
 - **Similarity to past systems**

- **External environment**
 - **Urgency of need**
 - **Funding stability**
 - **Availability of T&E resources**
 - **Political environment**

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Suggestions for Future Research

- **Conduct a broader analysis of trends in T&E cost and schedule, and the factors affecting those trends**
- **Conduct an empirical analysis to identify “redundant testing” and the consequences for specific programs**
- **Establish an improved link between the kinds of information needed at specific functional decision points and the kinds of information T&E can provide**



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Questions?

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