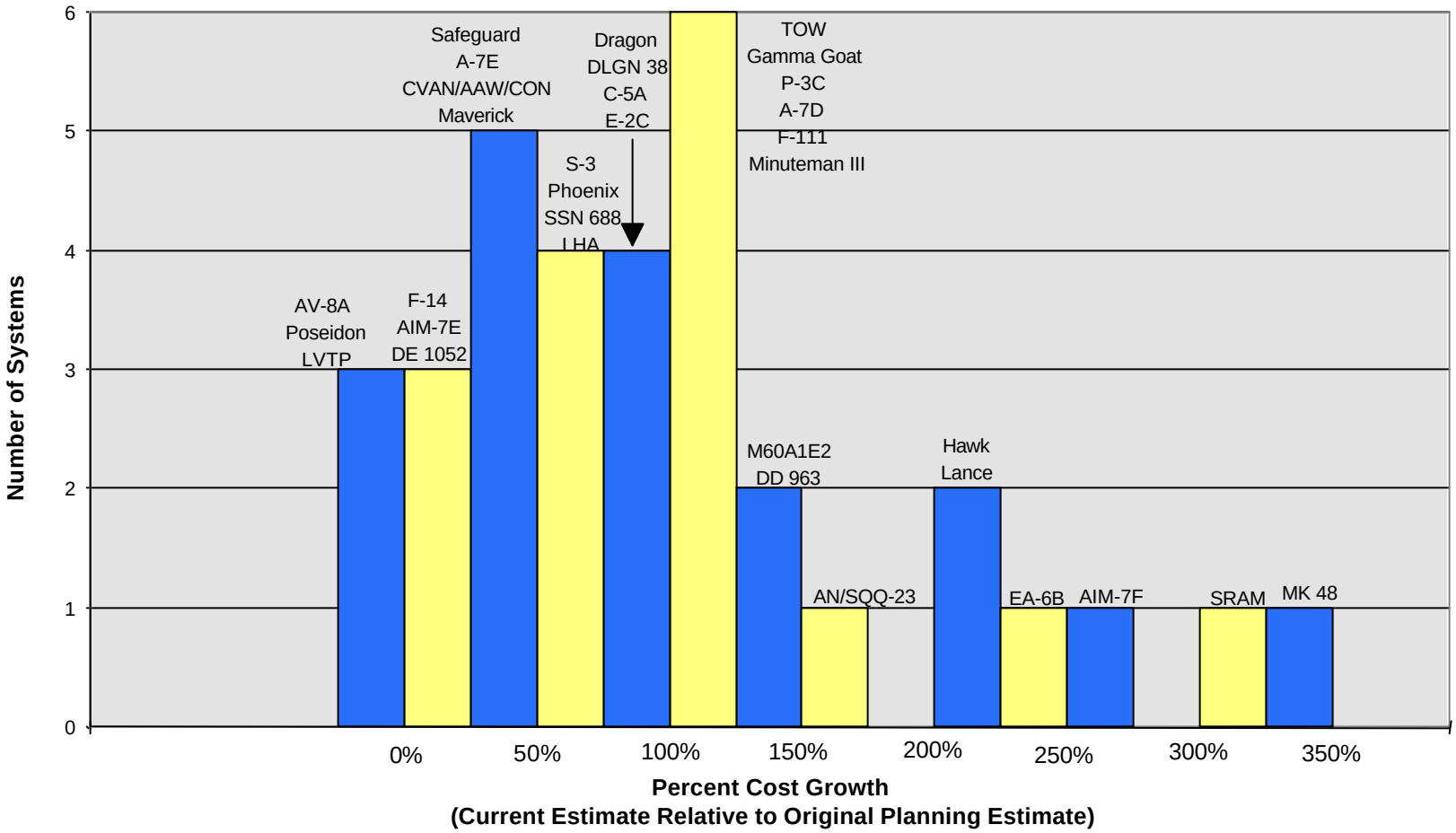
Cost Growth Mid to Late 1960s



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Abstract

Subject Terms

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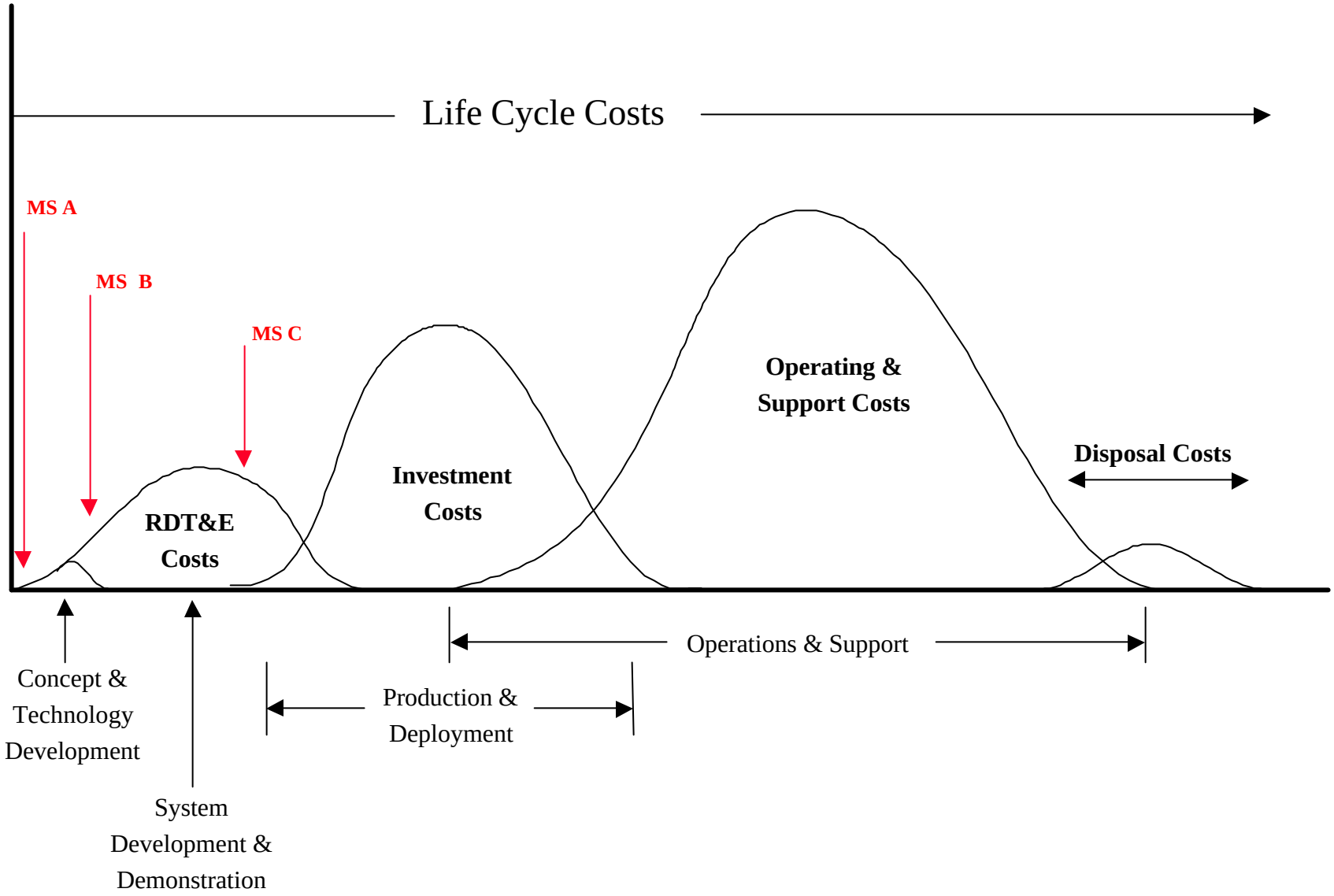
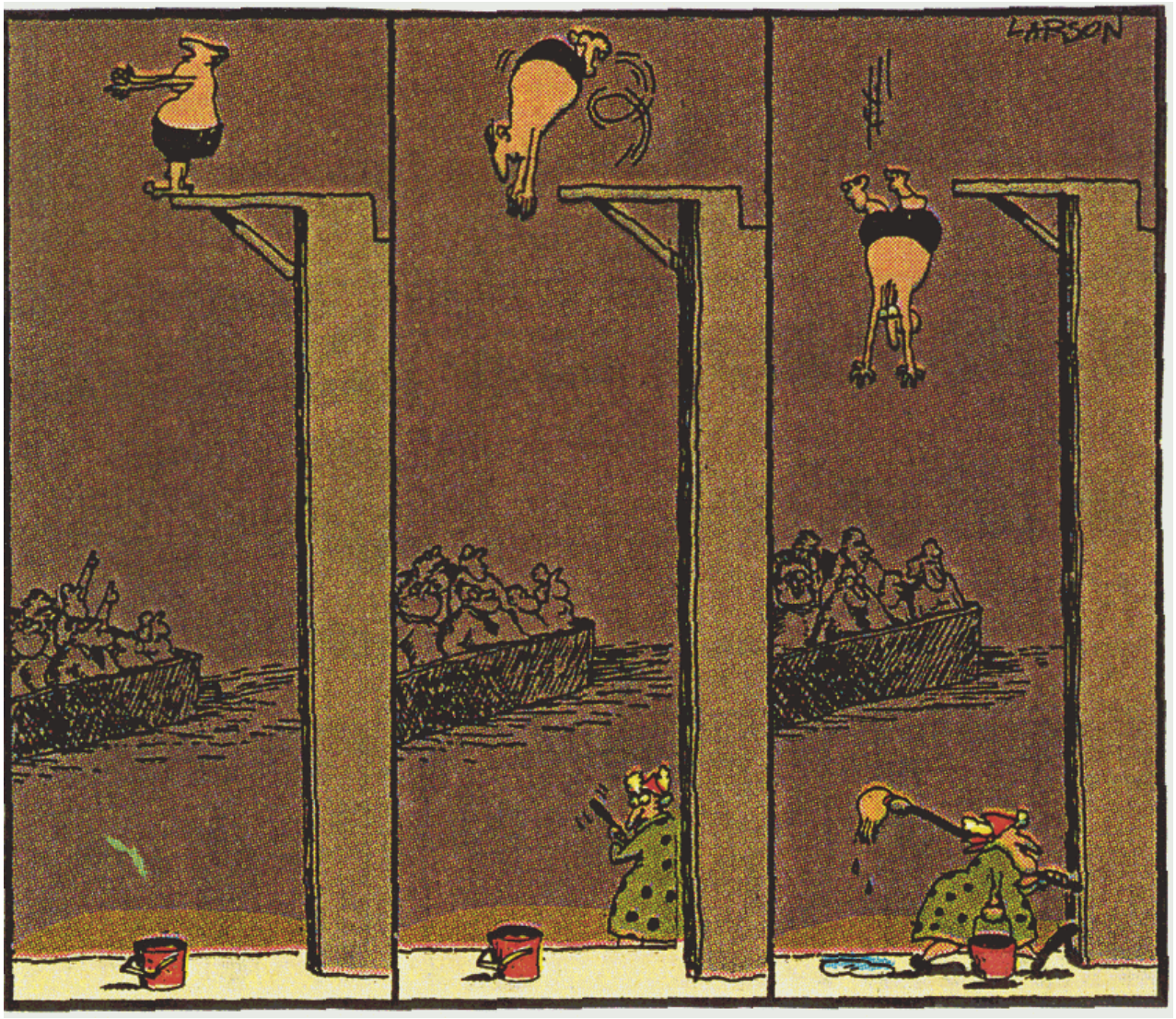
20


Life Cycle Costs
MS A
MS B
MS C
RDT&E Costs
Investment Costs
Operating & Support Costs
Disposal Costs
Concept & Technology Development
System Development & Demonstration
Production & Deployment
Operations & Support

A Cost Estimator's View of Reality



CARD Contents

System Overview

- **System Description -** mission, key performance parameters, relationship to other systems, picture or diagrams with major parts and subsystems identified.
- **Characteristics -** technical description of hardware and software, discussion should follow the elements in the WBS
- **Quality Factors -** operational availability, reliability, availability and maintainability requirements
- **Reference Systems -** describe currently operational system or/and systems with similar mission, discuss how this system is different.

Parametric Estimating

- **PROBLEM: Estimate cost of a new item**
- **SOLUTION: Scale and adjust actual costs for similar items**
- **Parameters scale costs to technical content**

Memory	HD Capacity	I/O Speed
Power	Video Memory	Processing Speed

- **Other adjustments account for temporal changes**

Inflation	Technology Advancement

A Parametric Example

Beam Steering Assembly of a Radar Seeker

- **Data base:**

-AMRAAM (Hughes)	-Phoenix A	-Phoenix C
-AMRAAM (Raytheon)	-Longbow	-Patriot
-Sparrow-M	-MLRS-TGW	-Other Systems

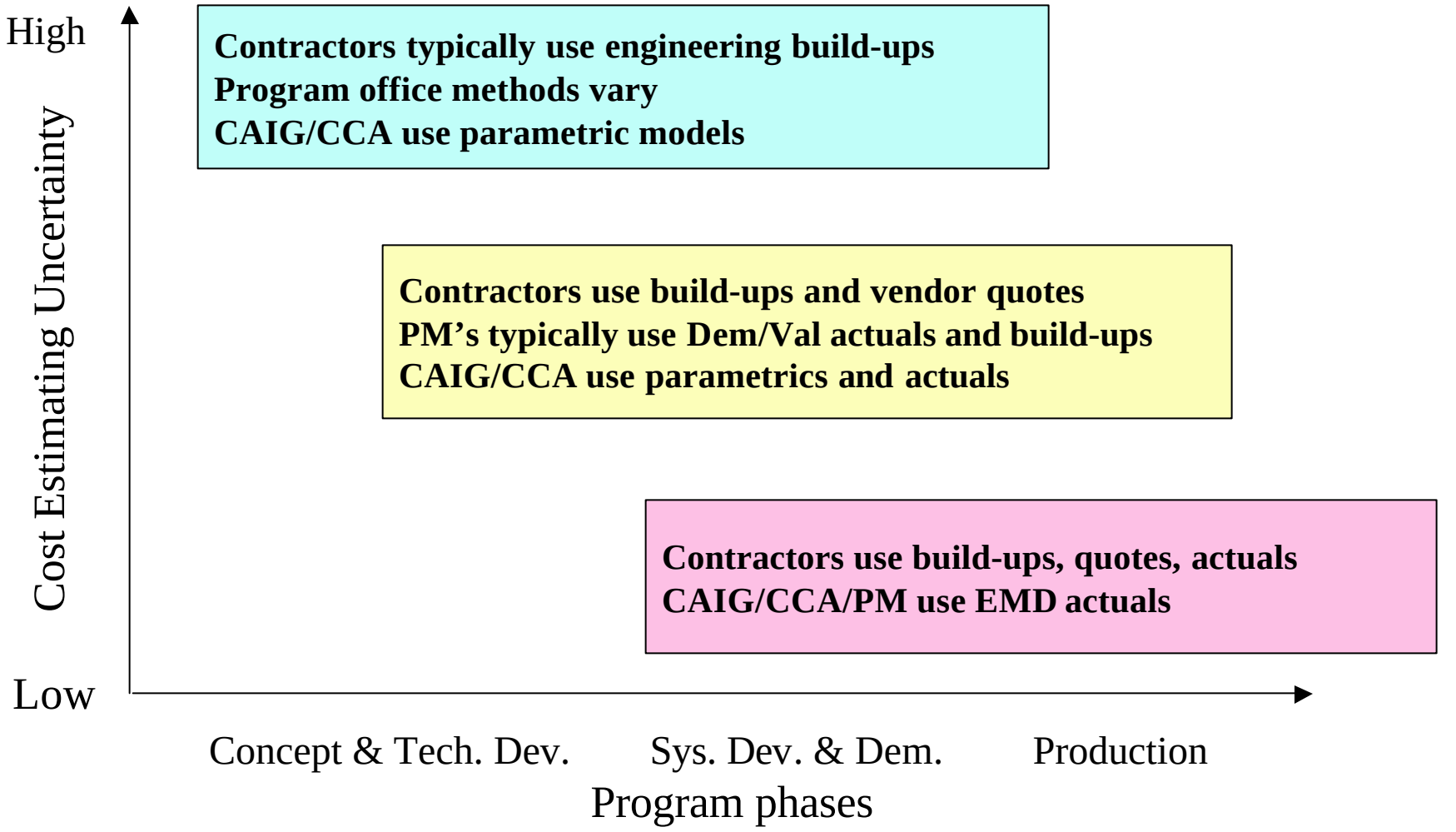
- **Cost-estimating relationship (first unit production cost)**

$$\text{Cost} = 0.007 * \text{Antdia}^{0.46} * \text{Channels}^{0.87} * \text{Axes}^{1.64} * \text{Error term}$$

Antdia = Antenna diameter, cm
Channels = Number of RF receive channels
Axes = Number of axes of articulation in gimbal

- **Suppose: Antdia=20 cm, Channels= 10, Axes=3**
- **Then: Cost = 0.361 (FY88 $M)**

Current Cost Estimating Techniques



Cost Growth Study

- Data taken from SARs up through Dec 1998
- Study compares final cost to MS II estimate
- Quantity normalized estimate at EMD approval (i.e., MS II) is baseline
- Percent cost growth metric is: $\left(\frac{CurrentEstimate}{BaselineEstimate} - 1\right) \times 100\%$
- Study has been publicly discussed, but not yet released

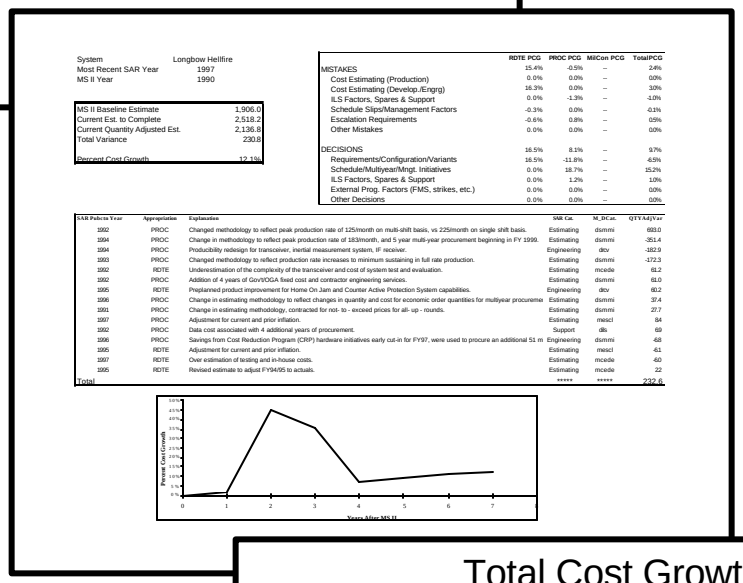
No other study of comparable scope that employs such detailed data

Study Details

Universe

SARs Currently Useable	143	In Our Sample	131
Excluded	95	Analysis in Process	12
Data Problems (in process)	13	SARs Currently Useable	143
Early EMD	13		
Total	264		

Sample Data Sheet



System	Longbow Hellfire
Most Recent SAR Year	1997
MS II Year	1990

MS II Baseline Estimate	1,906.0
Current Est. to Complete	2,518.2
Current Quantity Adjusted Est.	2,136.8
Total Variance	230.8
Percent Cost Growth	12.1%

	RDTE PCG	PROC PCG	MilCon PCG	TotalPCG
MISTAKES	15.4%	-0.5%	--	2.4%
Cost Estimating (Production)	0.0%	0.0%	--	0.0%
Cost Estimating (Develop./Engrg)	16.3%	0.0%	--	3.0%
ILS Factors, Spares & Support	0.0%	-1.3%	--	-1.0%
Schedule Slips/Management Factors	-0.3%	0.0%	--	-0.1%
Escalation Requirements	-0.6%	0.8%	--	0.5%
Other Mistakes	0.0%	0.0%	--	0.0%
DECISIONS	16.5%	8.1%	--	9.7%
Requirements/Configuration/Variants	16.5%	-11.8%	--	-6.5%
Schedule/Multiyear/Mngt. Initiatives	0.0%	18.7%	--	15.2%
ILS Factors, Spares & Support	0.0%	1.2%	--	1.0%
External Prog. Factors (FMS, strikes, etc.)	0.0%	0.0%	--	0.0%
Other Decisions	0.0%	0.0%	--	0.0%

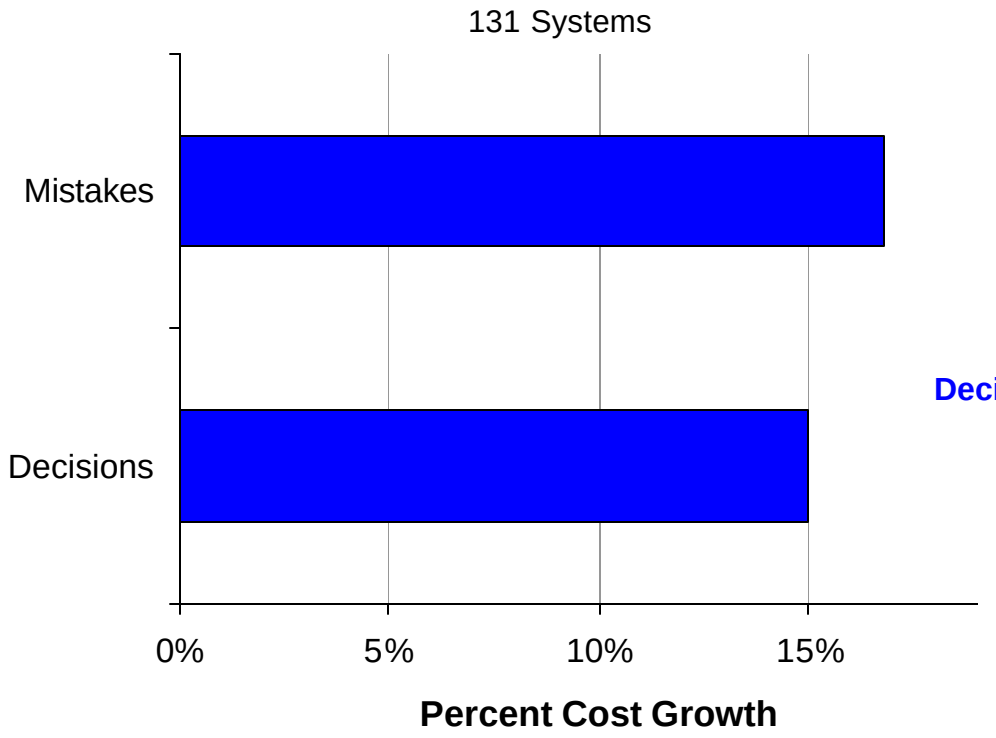
SAR Pubctn Year	Appropriation	Explanation	SAR Cat.	M_DCat.	QTYAdjYear
1992	PROC	Changed methodology to reflect peak production rate of 125/month on multi-shift basis, vs 225/month on single shift basis.	Estimating	dsmmi	693.0
1994	PROC	Change in methodology to reflect peak production rate of 183/month, and 5 year multi-year procurement beginning in FY 1999.	Estimating	dsmmi	-351.4
1994	PROC	Producibility redesign for transceiver, inertial measurement system, IF receiver.	Engineering	dcv	-182.9
1993	PROC	Changed methodology to reflect production rate increases to minimum sustaining in full rate production.	Estimating	dsmmi	-172.3
1992	RDTE	Underestimation of the complexity of the transceiver and cost of system test and evaluation.	Estimating	mcede	61.2
1992	PROC	Addition of 4 years of Govt/OGA fixed cost and contractor engineering services.	Estimating	dsmmi	61.0
1995	RDTE	Preplanned product improvement for Home On Jam and Counter Active Protection System capabilities.	Engineering	dcv	60.2
1996	PROC	Change in estimating methodology to reflect changes in quantity and cost for economic order quantities for multiyear procureme	Estimating	dsmmi	37.4
1991	PROC	Change in estimating methodology, contracted for not- to - exceed prices for all- up - rounds.	Estimating	dsmmi	27.7
1997	PROC	Adjustment for current and prior inflation.	Estimating	mescl	84
1992	PROC	Data cost associated with 4 additional years of procurement.	Support	dlk	69
1996	PROC	Savings from Cost Reduction Program (CRP) hardware initiatives early cut-in for FY97, were used to procure an additional 51 m	Engineering	dsmmi	-68
1995	RDTE	Adjustment for current and prior inflation.	Estimating	mescl	41
1997	RDTE	Over estimation of testing and in-house costs.	Estimating	mcede	60
1995	RDTE	Revised estimate to adjust FY94/95 to actuals.	Estimating	mcede	22
Total			*****	*****	232.6

Results

Total Cost Growth Since Milestone II

	RDT&E	Procurement	Total
Cost Growth			
Arithmetic Average	52%	26%	32%
Dollar Weighted Average	27%	15%	17%
Number of Systems	125	129	131

Decisions and Mistakes Cost Growth



Mistakes

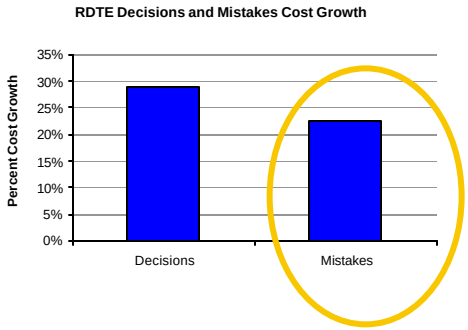
- **Production assumption and estimation changes**
- **Engineering, test, and development changes**
- **ILS changes, and spares and support changes not attributable to post-milestone II discretionary decisions**
- **Schedule slips attributable to technical problems**
- **Other changes not attributable to discretionary changes**

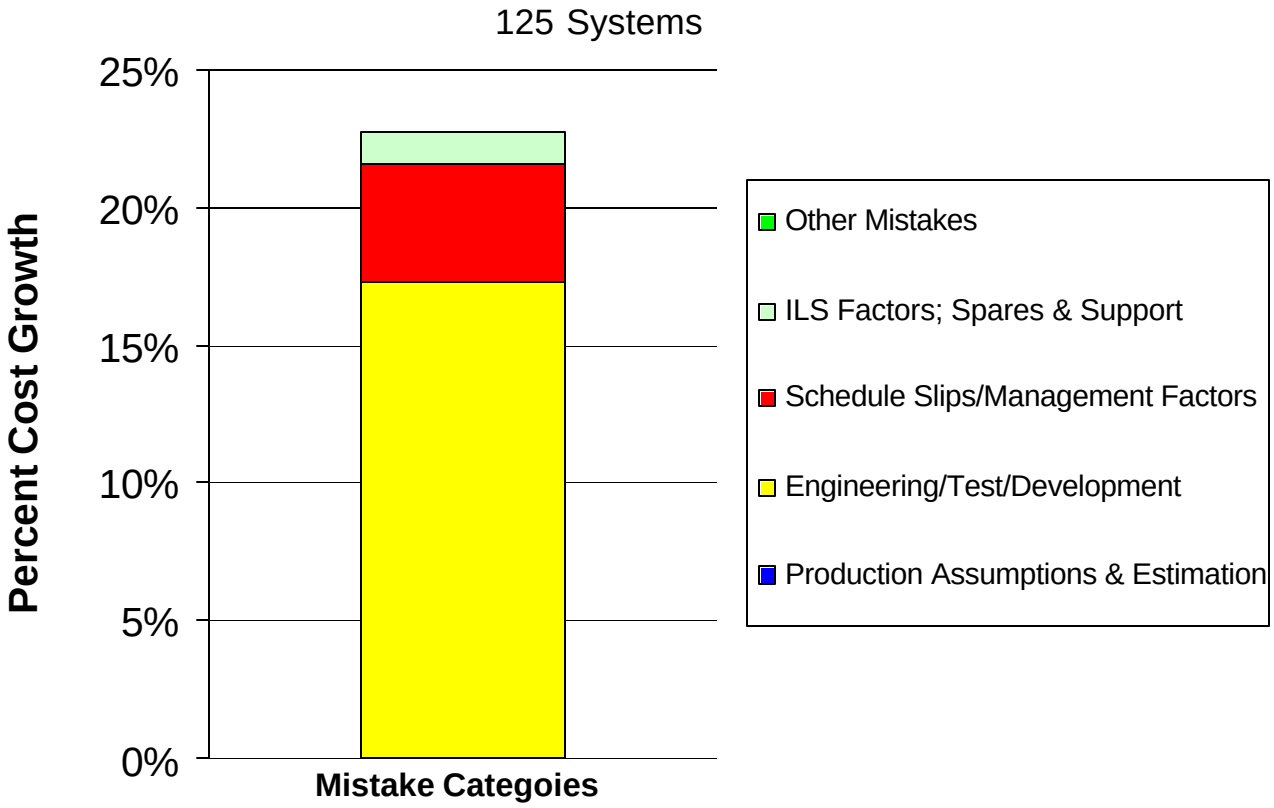
Decisions

- **Requirements, configuration, and variant changes**
- **Schedule changes, and acquisition strategy changes (e.g., mutiyear procurement, dual-sourcing), and management initiatives**
- **ILS changes, and spares and support changes**
- **External program factors (FMS, strikes, etc.)**
- **Other discretionary changes**

Nearly half of perceived cost growth is content change

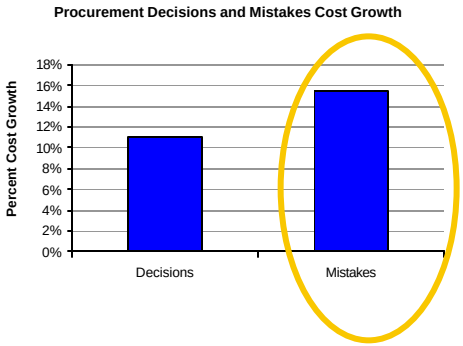
Mistakes RDT&E Cost Growth

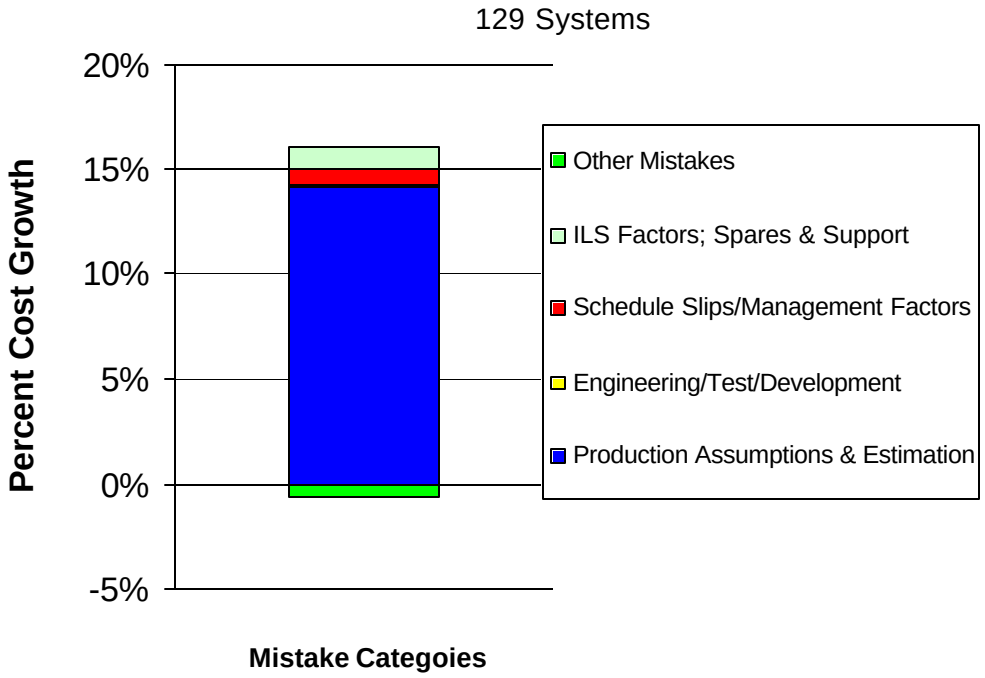




Underestimated engineering effort major source of error

Mistakes Procurement Cost Growth

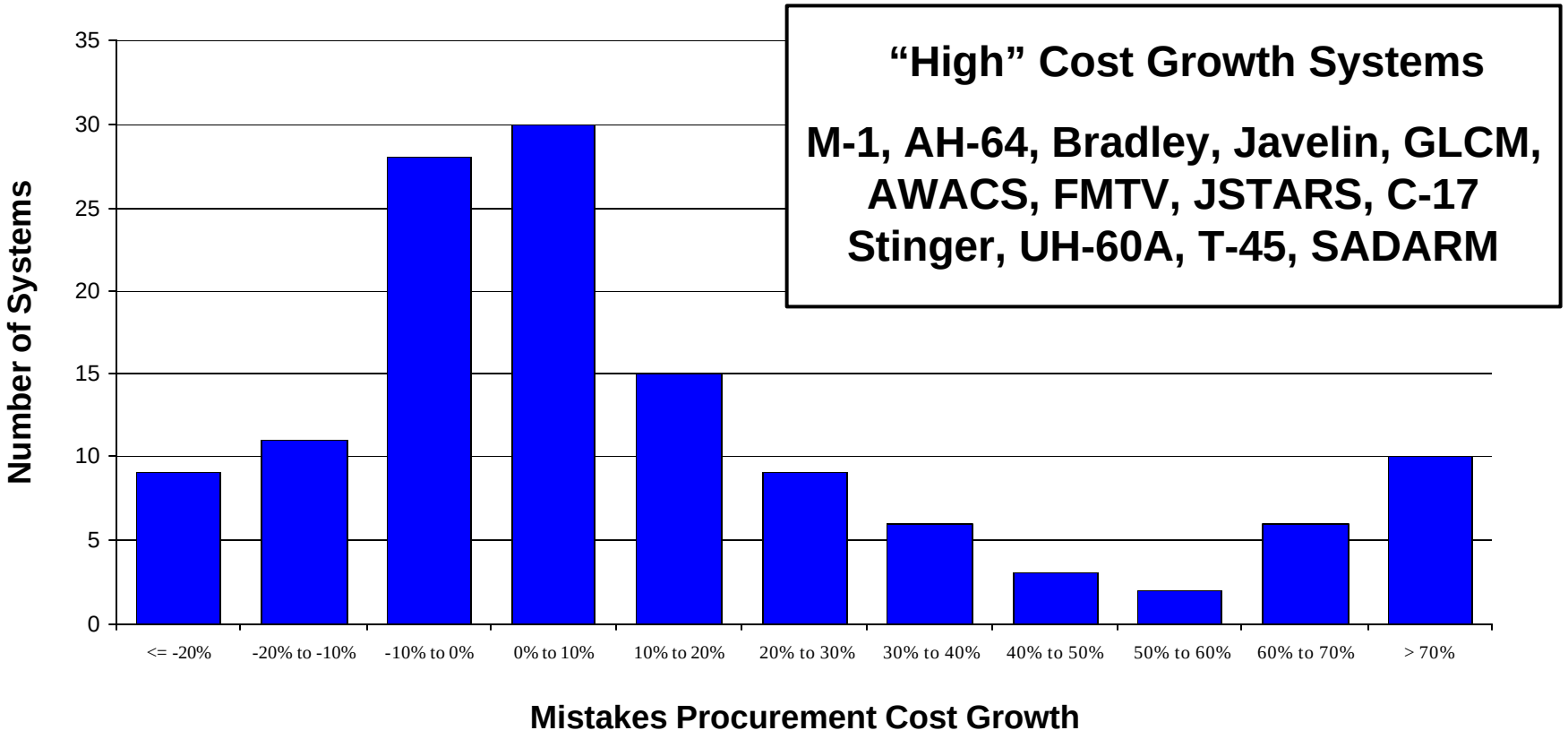




Major source of error: Too optimistic learning curve slopes

Mistakes Procurement Cost Growth

129 Systems

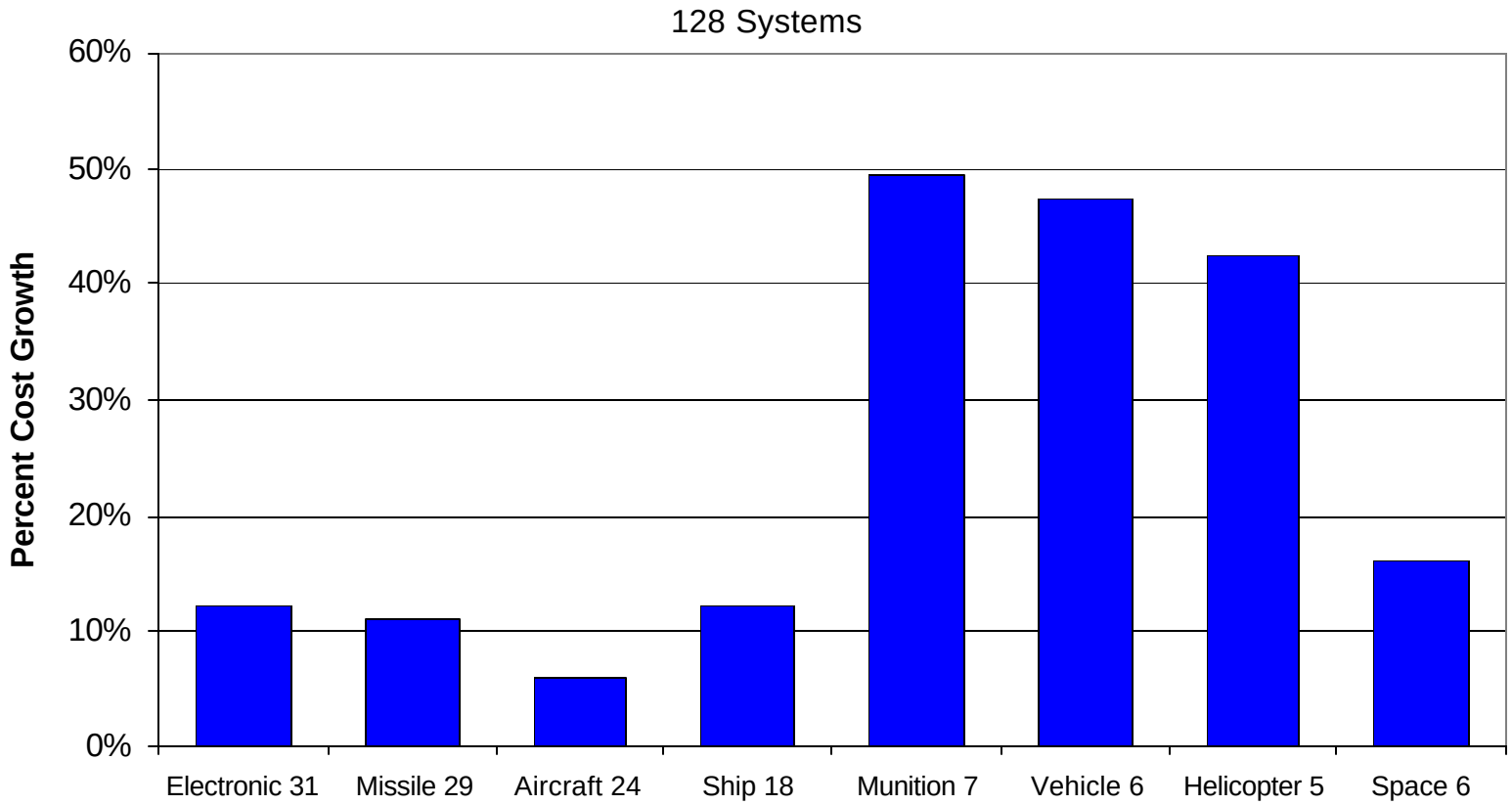


Problem is "high" cost growth systems, not the average

Hypotheses on Causes of Cost Growth

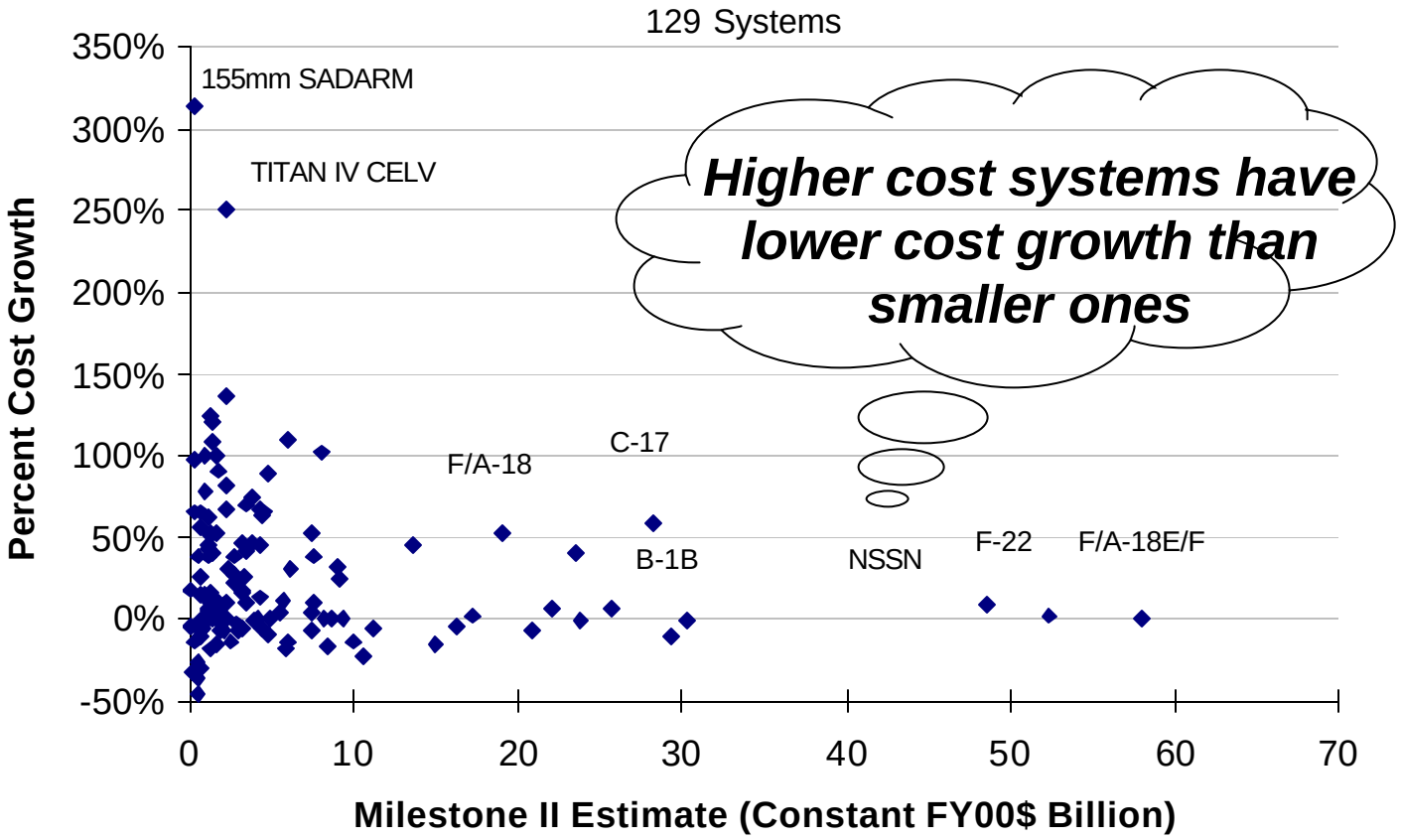
- **Honest professional error**
  - Poor data
  - Wrong technique
  - Technical assumptions
- **Institutional Imperatives**
  - “Camel’s nose” -- budget strategy
  - “Tension on the reins” -- contractor management
  - Requirement/resources standoff

Mistakes Procurement Cost Growth by Commodity Class



Commodity classes with fewer systems are more problematic

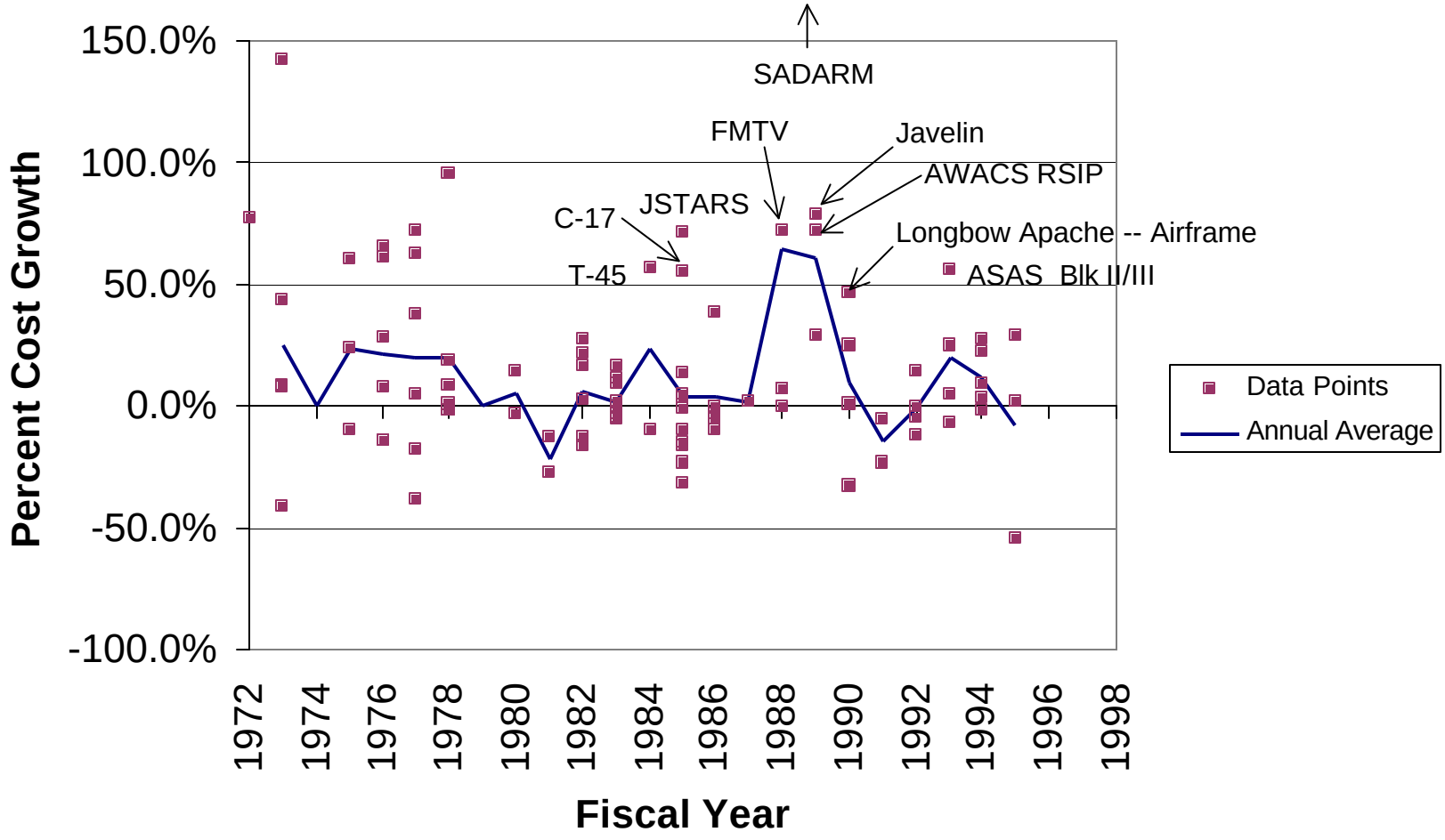
Procurement Cost Growth by Program Size



Do services budget to cost for large programs and cost to budget for smaller ones?

Mistakes Procurement Cost Growth

for Systems Passing MS II in the Fiscal Year



Levers for Improvement

- **Competition/Incentive Contracting**
  - Dual Sourcing
  - Price Commitment Curve (PCC)
- **Acquisition Policy & Budget Policy/Mechanism**
  - Carlucci Initiatives #6 -- Budget to Most Likely Costs
  - POM CAIGs
  - TRACE
  - Fully Fund PM's Estimate
  - Acquisition Stability Fund
  - SCA and M Accounts
  - Impoundment/Termination
- **Independent costing**
  - CAIG creation in 1972
  - IG report increased size in 1992
  - Statute enacted in 1984

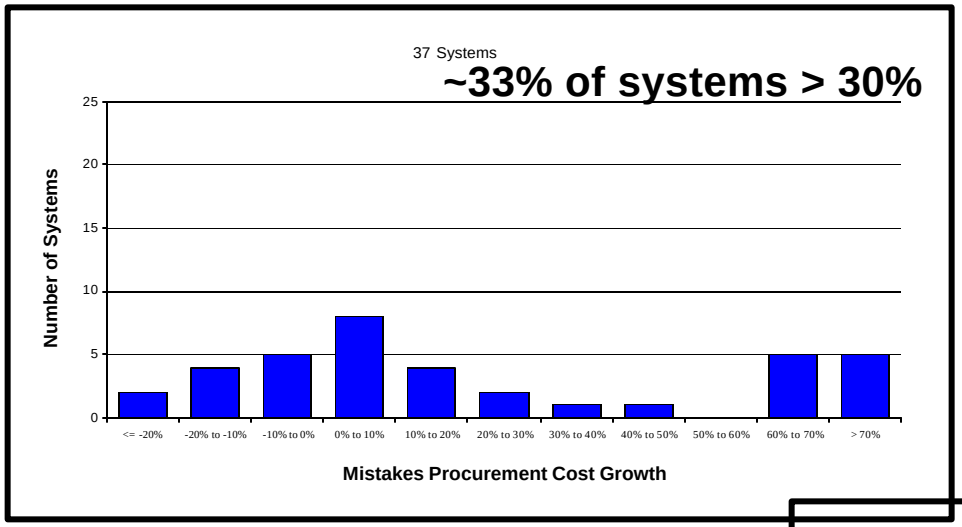
Mistakes Cost Growth in Dual Source Programs

	Missile Programs	
	Dual Source	Non Dual Source
Number of Programs	6	19
Percent EMD Mistakes Cost Growth	7.4%	29.4%
Percent Procurement Mistakes Cost Growth	4.1%	15.2%

- **Dual Source Programs include:**
  - AIM-9M
  - AMRAAM
  - HARM
  - Hellfire
  - Peacekeeper
  - Tomahawk

Cost Growth Histograms

Before 1980



After 1980