Identifying Leverage Points in Defense System Acquisition

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LAI Web Knowledge Exchange Event

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Agenda

- Key Takeaways
- Studies of system
- Model of system
  - System testing
- Conclusions
- Implications

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Up-front Recommendations

- **#1: Leaders should ensure individual process steps truly add value or have a compelling purpose to justify the resources required by each program to accomplish**
  - **Eliminating unnecessary or duplicative processes and decisions will reduce program development time and cost.**
- **#2: For "best value" improvements, focus efforts to reduce variability in overall system**
  - **Improve systems engineering processes**
  - **Minimize technical & financial uncertainties**
- **#3: Strengthen system capability to say "no" or terminate programs**
  - **Delegate and/or establish true portfolio authorities and capabilities**

Foundations of Research

How does the current process really work?

- Study of acquisition system
  - Interviewed senior leaders at USAF product center
    - Open-ended survey; data coding; transcripts of interviews for analysis, etc
- Study of external systems to acquisition (JCIDS, PPBE)
  - Interviewed process and domain experts; relationship to acquisition system, etc.
    - Open-ended survey; data coding; transcripts of interviews for analysis, etc

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A Snapshot of Program Measures

Percentage of DOD cost overrun per decade for the past 30+ years*

1970-1979	1980 - 1989	1990 - 1999
Development cost overrun: 30% above initial investment estimate **($13 billion)**	**Development cost overrun:** 39% above initial investment estimate **($12 billion)**	**Development cost overrun:** 40% above initial investment estimate **($15 billion)**

(Fiscal year 2005 dollars)
*** For large programs totaling more than $1 Billion in Research, Development, Testing and Evaluation**
GAO 06-368

Similar evidence exists regarding schedule adherence

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Typical *System* Response to Poor Acquisition Outcomes

- Let's study it, make a policy, or pass a law….
  - Some well-known and far-reaching – others not

1970 – 1979	1980 - 1989	1990 - 1999
Key Studies and Initiatives Impacting the Defense Acquisition Process		
•1970 Fitzhugh Commission •1972 Commission on Government Procurement	•1981 Carlucci Initiatives •1982 Grace Commission •1986 Packard Commission	•1994 Federal Acquisition Streamlining Act •1996 Clinger-Cohen Act
DOD Acquisition Policy Changes		
•1971 DOD 5000 policy established •1975 DOD Policy revised •1977 Policy revised	•1980 Policy revised •1982 Policy revised •1985 Policy revised •1986 Policy revised •1987 Policy revised	•1991 Policy revised •1996 Policy revised

Source: DOD (data); GAO (Analysis and presentation) GAO 06-368

- Notable actions in the 2000s
  - DAPA Report – September 2006
  - DoD Acquisition Policy rewritten ~ 2002, 2008
  - Non-Acquisition changes: JCIDS Revised 2009; PPBES changed to PPBE

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Emergent Issues

- Consistently across all interviews
  - Money (constraining)
  - People (not enough; skill set & experience – lacking)
  - Requirements (constant pressure)
  - Program "interdependencies" have far-reaching effects
- Areas of disagreement among levels in the hierarchy
  - Staffs (purpose, function, need)
  - Level of thinking needed (strategic vs. tactical)
  - Value of non-program activities (non-essentials)
    - "The fact that I haven't had my PHA [a health screening] or that I am late on gas mask training is a far bigger deal up the chain than whether or not one of my programs slip." Acquisition Squadron commander

Findings Underscored a Need for a Model of the Acquisition System

- **Structure of model**
  - Scope: Stretches from Pre-MS A activities to MS C
  - Includes 5 communities: User, Requirements function (e.g. JCIDS), PPBE system, Acquisition system, and Prime Contractors
- **Outputs:**
  - Total number of programs arriving at MS C
  - Total time through the system
- **Inputs: a "Program"**
  - ACAT level, path taken during development are discriminators
- **Purpose:**
  - Examine possible outcomes based on ~50,000 iterations
- **Data sources:**
  - DAMIR, SMART, Expert Interviews

Model Development

- Assumes AF as representative surrogate of DOD processes
- Based upon official process documentation to understand the process as it "should be"
- Augmented by multiple interviews indicating the process "as is"

Model is a representation of the current, "as is," system

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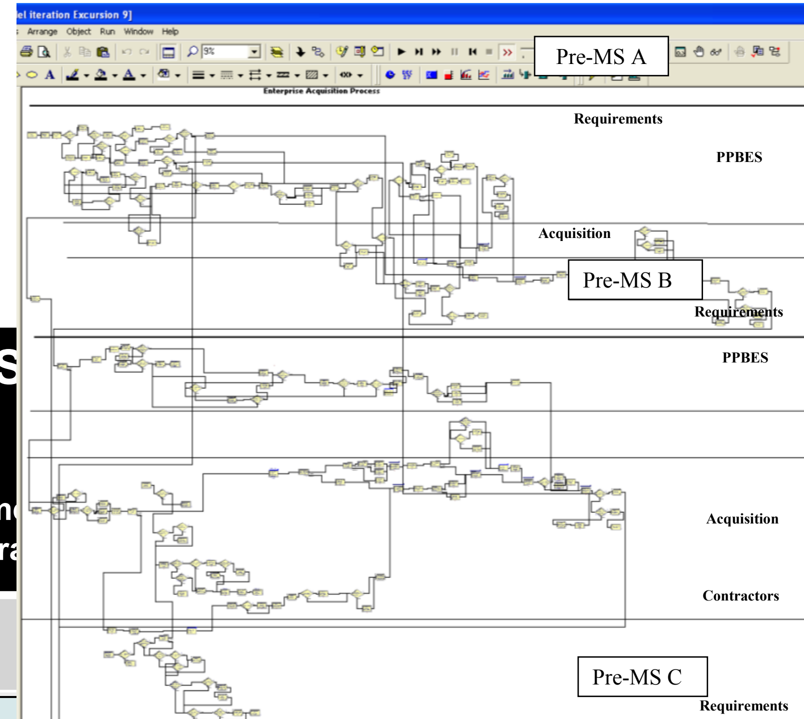
Acquisition System Model Scope

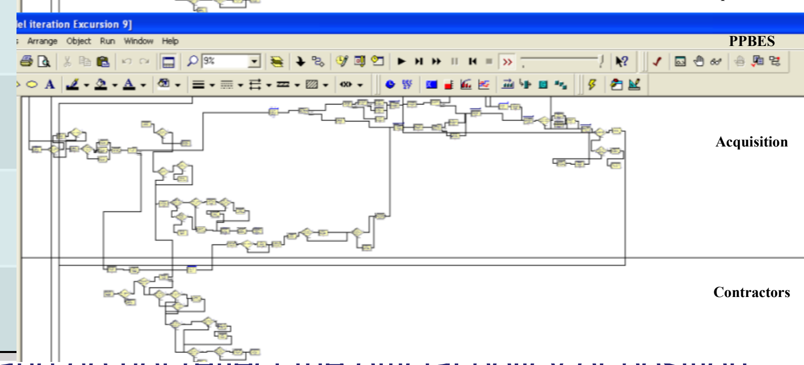
A Representation of the Enterprise of "Cradle to Grave" Acquisition in the US Air Force

Swim Lane	Pre-MS "A" (Concept Refinement)	Pre-MS "B" (Technology Development)	Pre-MS "C" (System Developm… Demonstra…
User			
Requirements			
Money			
Acquisition			
Contractor			

Scope of Model

Time →





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Key Breakthrough in Model Development

- **Interviewees were usually only able to articulate job descriptions in generalities**
  - **"It depends"**
- **However, every single interviewee *WAS* able to give me a time "distribution" or probability**
  - **"between 6 days and 5 weeks"**
  - **"usually 3 weeks"**
  - **Etc.**

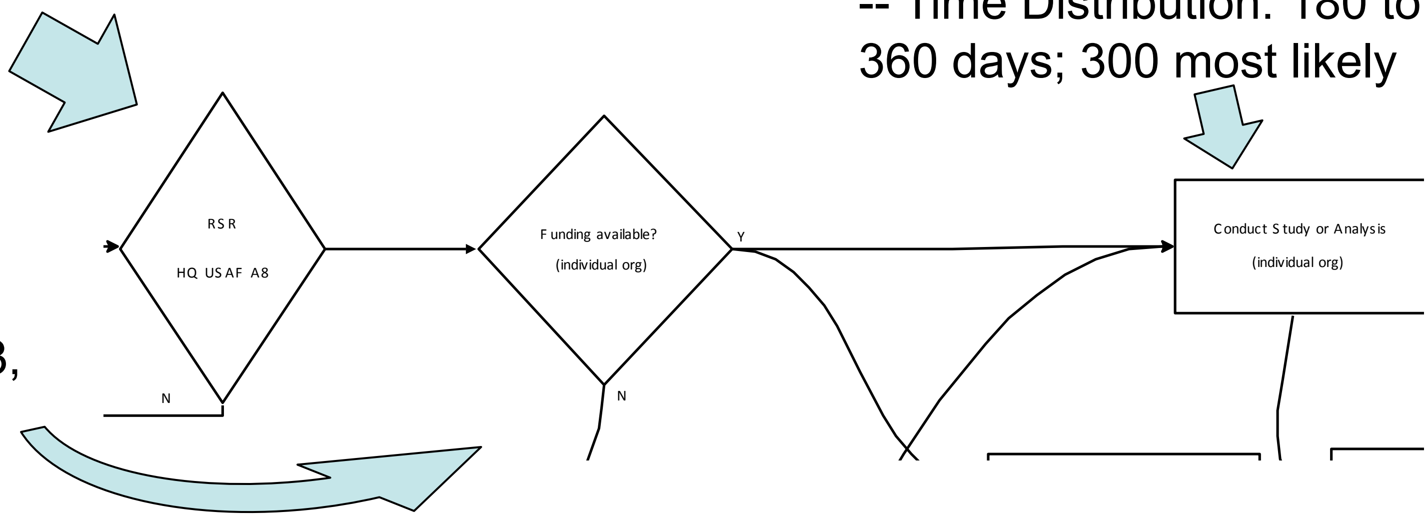
Acquisition System Model Built from Extensive Data

Model Design: Every decision point, every process task, where possible, is thoroughly documented and sourced

<u>RSR – **Decision Point**</u>
-Sources: Official Docs, Interviews (MAJCOM A5, HQ A3)
-Probability: 98%

<u>Funding Available? – **Decision point**</u>
-Sources: Interviews (MAJCOM A5, HQ A3, HQ A35)
-Probability: 80%

<u>Conduct study or analysis – **Task**</u>
-Sources: Official docs, Interviews (MAJCOM A5, HQ A35)
-- Time Distribution: 180 to 360 days; 300 most likely



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Verification and Validation

- Modeled by hand; checking for logic errors
- Modeled on paper; sought expert feedback
  - Many improvements received
- Coded in modeling tool; verified coding done correctly
- Compared model outcomes with real data
  - For all ACATs, there is no difference in means between the model data and actual data at the 95% confidence level (from a student t-test)
    - Also for individual ACAT levels
- Validated model structure and results with other acquisition professionals

How can the Model be used?

- **Using simulation, what kinds of issues can be explored with this model?**
  - **How can our understanding of the current system be enhanced?**
  - **What kinds of questions is this model well-suited to try?**

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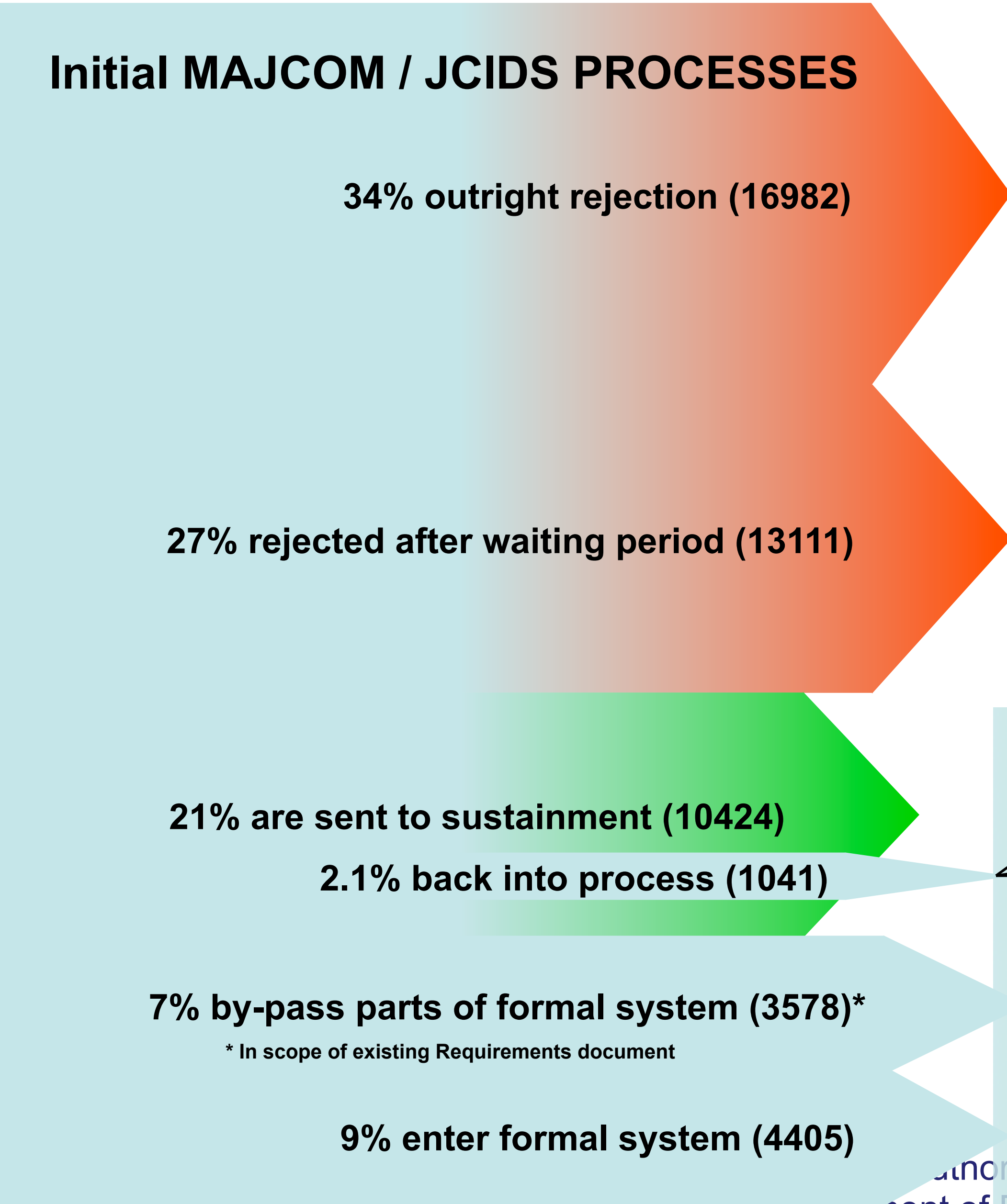
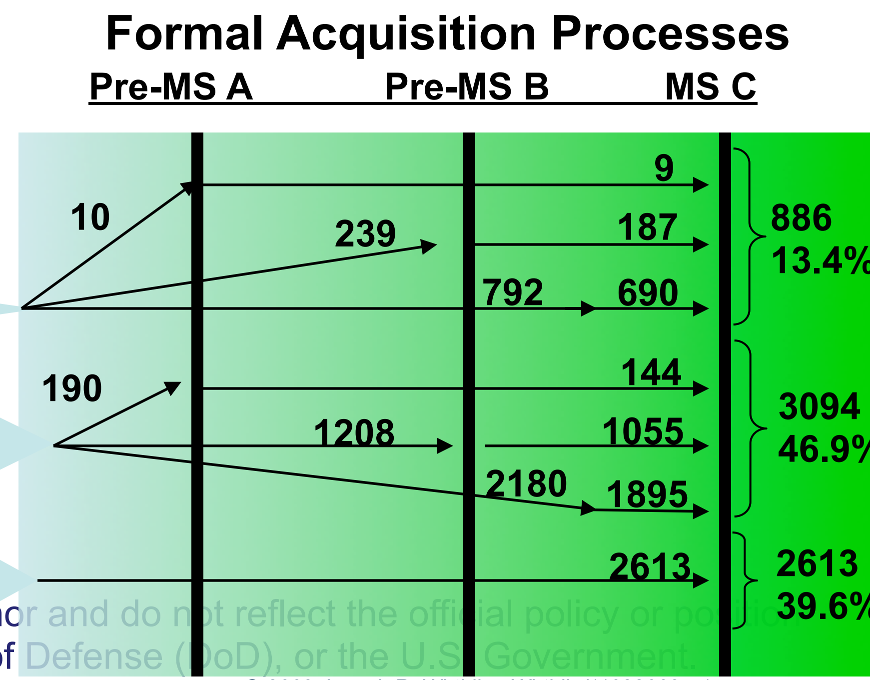
Experimental Model outcomes of 48500 samples



Key Insights from model results:

- Most programs at MS C (60%) entered the system somewhere other than at the beginning
- Once a program is started, it is very difficult to stop it
  - When programs bypass elements of the formal system, ~86% success rate to MS C



Distribution of Experimental Results

- Range of cycle times to MS C (short path)
  - ACAT I: 1238 to 7940 days (3329 – 9 yrs average)
  - ACAT II: 1389 to 7537 days (3039 – 8 yrs average)
  - ACAT III: 1119 to 7610 days (2767 – 7.5 yrs average)
- Range of cycle times to MS C (full path)
  - ACAT I: 4669 to 9815 days (6766 – 18.5 yrs average)
  - ACAT II: 3332 to 7587 days (5234 – 14 yrs average)
  - ACAT III: 2807 to 7450 days (4441 – 12 yrs average)

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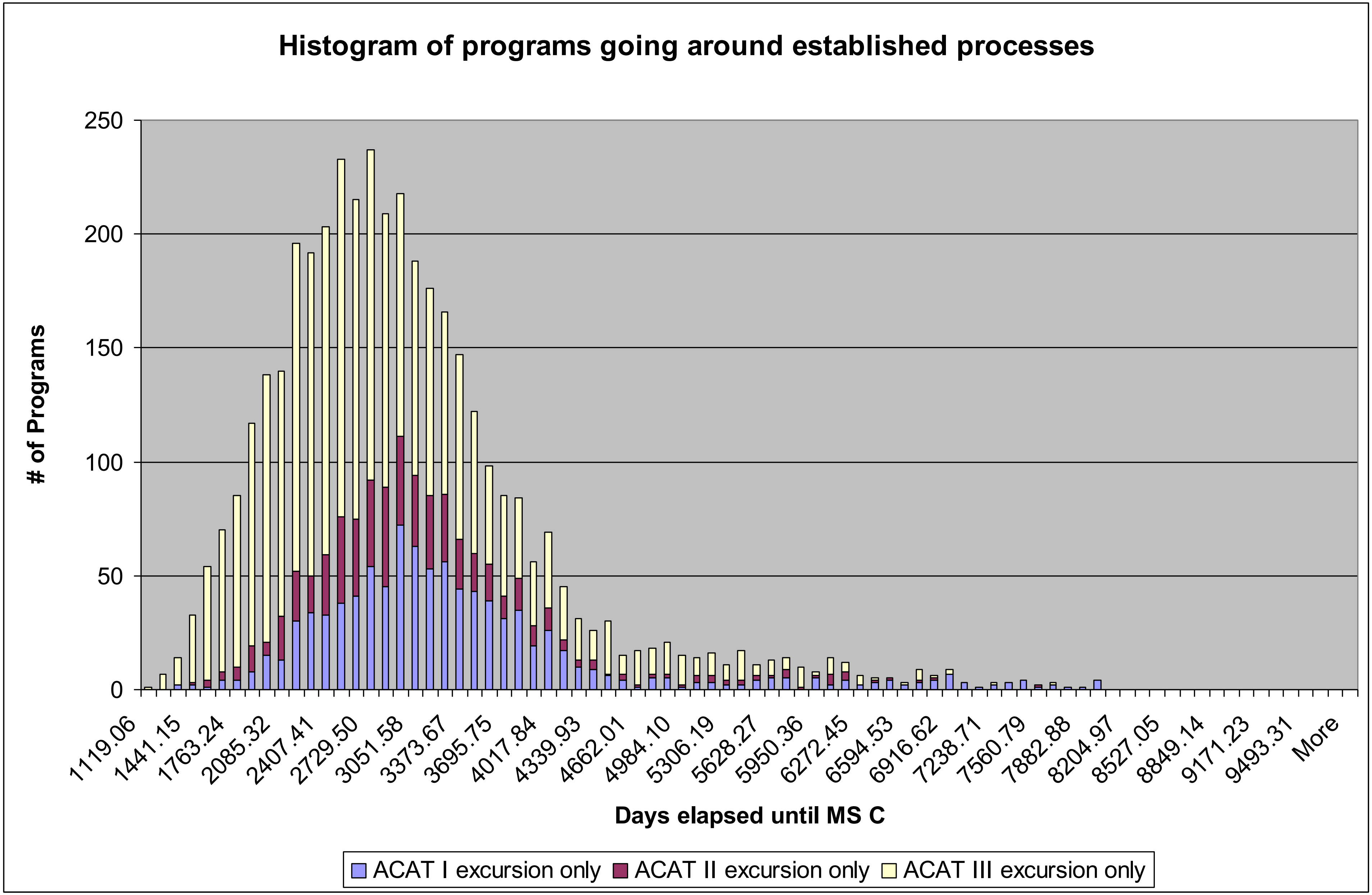

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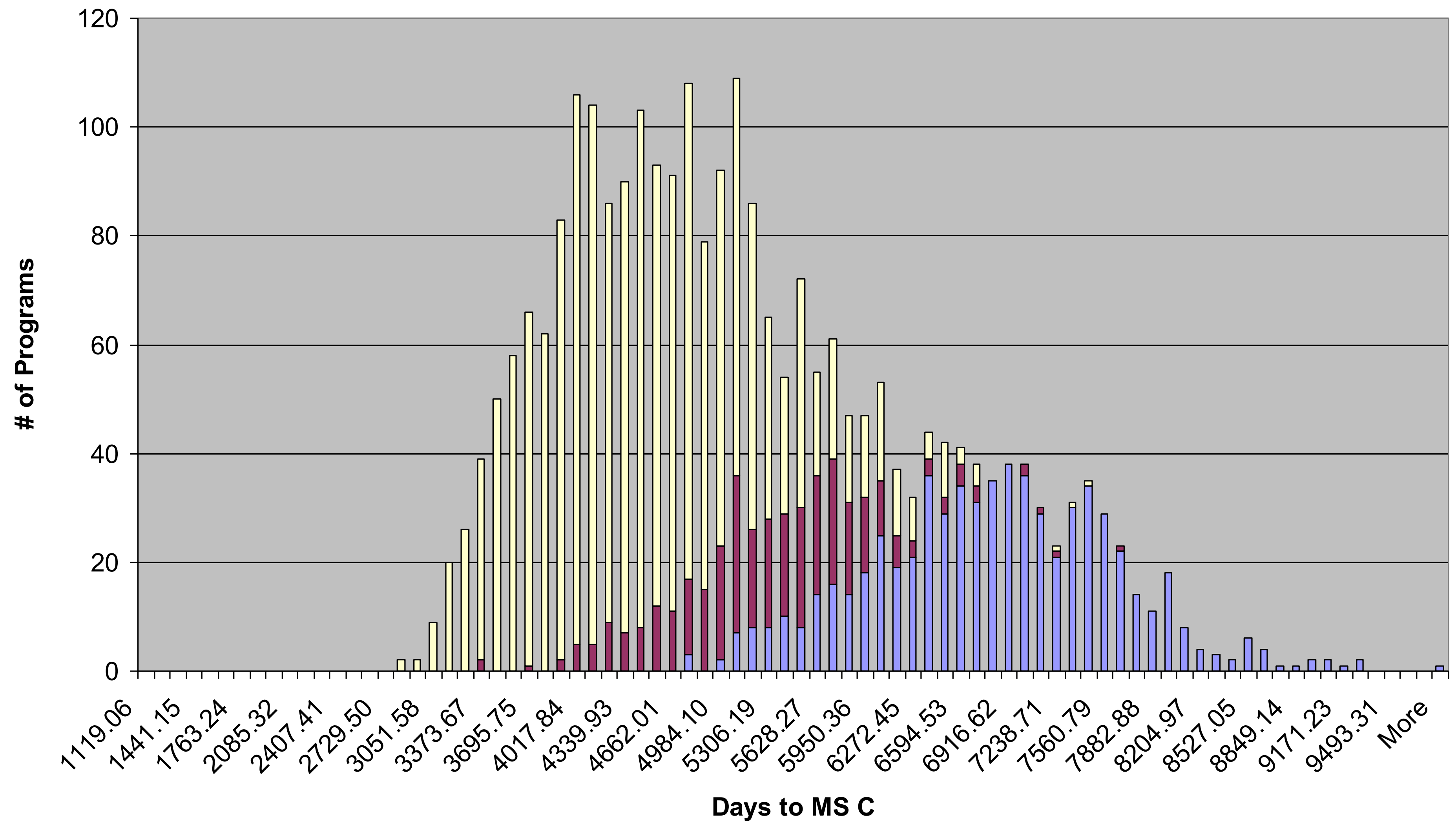
Histogram of programs within the formal process



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Experimental Interventions Completed

- JCIDS Interventions
- PPBE Interventions
- Acquisition Interventions
  - Systems Engineering
  - Acquisition Management
- Combinations of interventions

Different process and policy intervention results

- **Example intervention:**
  - Intervention: Test effect of improving "Funding Instability" by eliminating source of funding instability in the model
  - Results compared to the baseline:
    - Mean/median of outcomes reduced by about 4%
- **Many other interventions tried—(20 total)**
  - Results were similar—no silver bullet solution

"Do Everything" — combination of all separate interventions (13) resulted in schedule reduction of 19% from baseline

Most Effective Interventions – but three different objectives?

- Reducing total program time to MS C: ~10% gain
  - Multiple interventions most effective (e.g. improving Systems Engineering across lifecycle)
- Increasing program "predictability" (or minimize program variances): ~10% gain (but 20% reduction in the outlier spread)
  - Focus on "quality" initiatives such as improvements to systems engineering, increased technical confidence or maturity, minimize funding turbulence
- Control process "throughput" or capacity: ~10% gain
  - e.g. Increase program termination probability at major reviews

Qualitative Observations (in no order of importance)

- **#1: Many participants in the system do not understand the workings of one segment from another beyond their immediate associations.**
  - **The segments are indeed coupled, but the understanding of how they are coupled is not well understood.**
- **#2: The acquisition system is operating beyond its capacity and does not have the numbers or the skilled personnel necessary to handle the workload.**
  - **Additionally, other resources, including money, are constrained. These conditions lead to classic firefighting behaviors as reported in the *product development literature*.**

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Qualitative Observations

- **#3: The conflict oriented nature of the resource allocation process is a liability to acquisition program success.**
- **#4: A lack of understanding regarding the interdependencies between programs**

Qualitative Observations

- **#5: Decisions are deferred across the overall Acquisition system in order to achieve consensus.**

- **#6: The amount of documentation required by the overall system is staggering and can be the driving force behind program delays.**

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Key Qualitative Conclusion

The overall Acquisition system incentivizes personnel to not follow existing processes and go around it.

- **Some of the evidence in this regard is the proliferation of new programs, prototypes and rapid reaction programs that operate on the fringes of the current system.**

Quantitative Findings (in no order of importance)

#1: An unexpectedly large number of projects actually circumvent portions of the traditional acquisition system

- Especially in context of traditionally recognized new product development best practices and their associated processes.

#2: The greatest expected improvement possible in the model was about a 20% improvement to the mean program duration and that only after combining ALL potential interventions.

Quantitative Findings

#3: The most improvement a single intervention makes on the system is approximately a 9% reduction to the average elapsed time of a program to Milestone C.

- **This particular intervention speaks to the authority and accountability of acquisition leaders.**

#4: The top interventions, across any measure, are all combinations of differing interventions.

- **This suggests that <u>incremental continuous improvement has not exhausted all options or reached its limits</u>**
  - **Although the evidence may suggest that these incremental improvements are becoming more costly as the "low hanging fruit" has already been implemented.**

Key Quantitative Findings

The sheer complexity of the system complicates the testing and measurement of proposed interventions.

- Real world interventions are rarely understood because years must transpire before steady-state results relating to that intervention are seen.

The most effective interventions are those that address the "quality" of system processes or attack sources of variability in the system.

- For example: Improving systems engineering processes and reducing technical and funding uncertainties cause programs to execute less randomly

Overarching Conclusion #1

The Acquisition "Enterprise" system is designed for flexibility, transparency, and performance at the expense of cost and schedule

- **It is not just about cost, schedule, and performance. Instead of three major considerations, there are five that are in play**
  - **A good rule of thumb? "Pick three at the expense of two"**

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Overarching Conclusion #2

The idea that problems in the acquisition system are the problem of acquisition alone is not correct.

- **These problems are the result of emergent behaviors of the overall system. Indeed, ALL of the evidence gathered and presented in this work suggests it is a *systems problem*.**

There is no silver bullet.

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Implications

- **Changing Acquisition System outcomes will require a multi-community effort (i.e., users, requirements, PPBE, acquisition, contractors, etc.)**
- **Model new or changed system processes, procedures, and policies <u>*before*</u> implementation**
  - **Eliminating unnecessary or duplicative processes and decisions will reduce program development time and cost.**
- **Stay the course/accelerate CPI efforts, especially toward reducing variability in inputs**
- **Acknowledge system-level issues and set appropriate goals**
  - **Significant effort over many years will be required for system-wide change**

An Enterprise perspective on Acquisition yields new insights into individual program execution issues and overall system improvement strategies

Continuing the Research

- Much, much, more to do….
- Create a predictive option within the model
  - From snapshot in time of a given program
- Adaptation/verification of model to a "community-specific" implementation
- Migrate model from proprietary implementation to open-standards and/or Microsoft products (e.g. Visio, etc.)

AFIT offers in-residence and distance-learning graduate Systems Engineering Degrees and (for managers) Research and Development Management degree

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Questions?

- **Thank you for your time and attention**
- **My contact information:**

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Backup

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Original Contributions

- **Model and Methodology shed new insight into overall system**
  - **Provides a different mechanism to look at the behaviors of the overall system**
- **Provides an opportunity to:**
  - **Selectively test different interventions**
  - **Analyze those outcomes**
- **Can be applied to very complex and dynamic socio-technological systems**

My Current Status

Assistant Professor of Engineering Systems

- Air Force Institute of Technology, WPAFB, OH
  - Teaching Responsibilities
    - R&D Management program (13 students, all 63A AFSC)
    - Systems Engineering program (27 students, all AFSCs)
  - Research
    - Advising 4 students; member of 2 other thesis committees
    - Starting effort to further the PhD research stream
  - "Visiting Faculty" in Air Force Center for Systems Engineering
    - Disseminate SE research through AF CSE products
  - "LAI guy"

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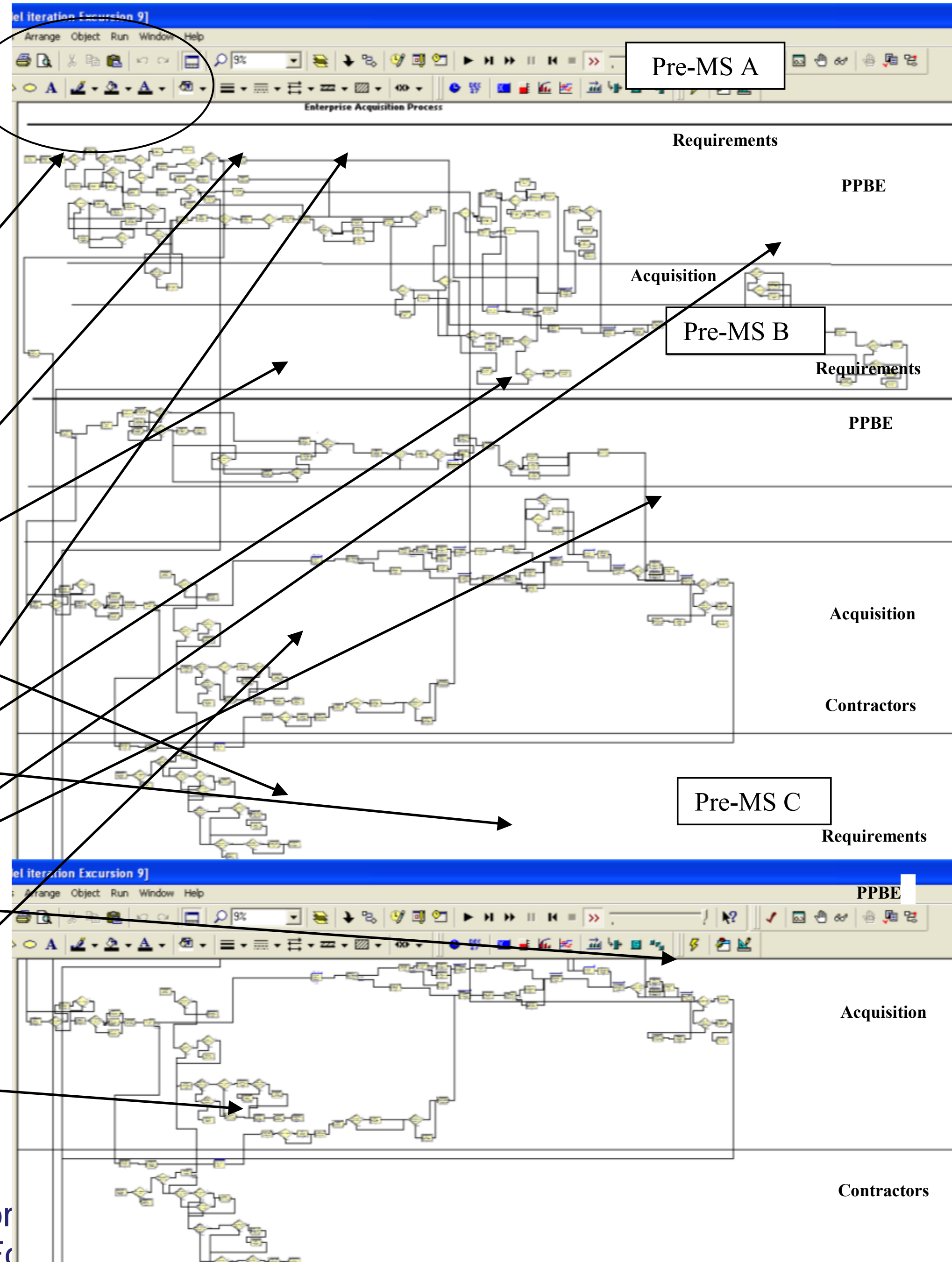
- Informal entry processes and screening
- Requirements approvals (MAJCOM)
- Joint requirement approvals
- Acquisition Panels
- Systems Engineering reviews and testing



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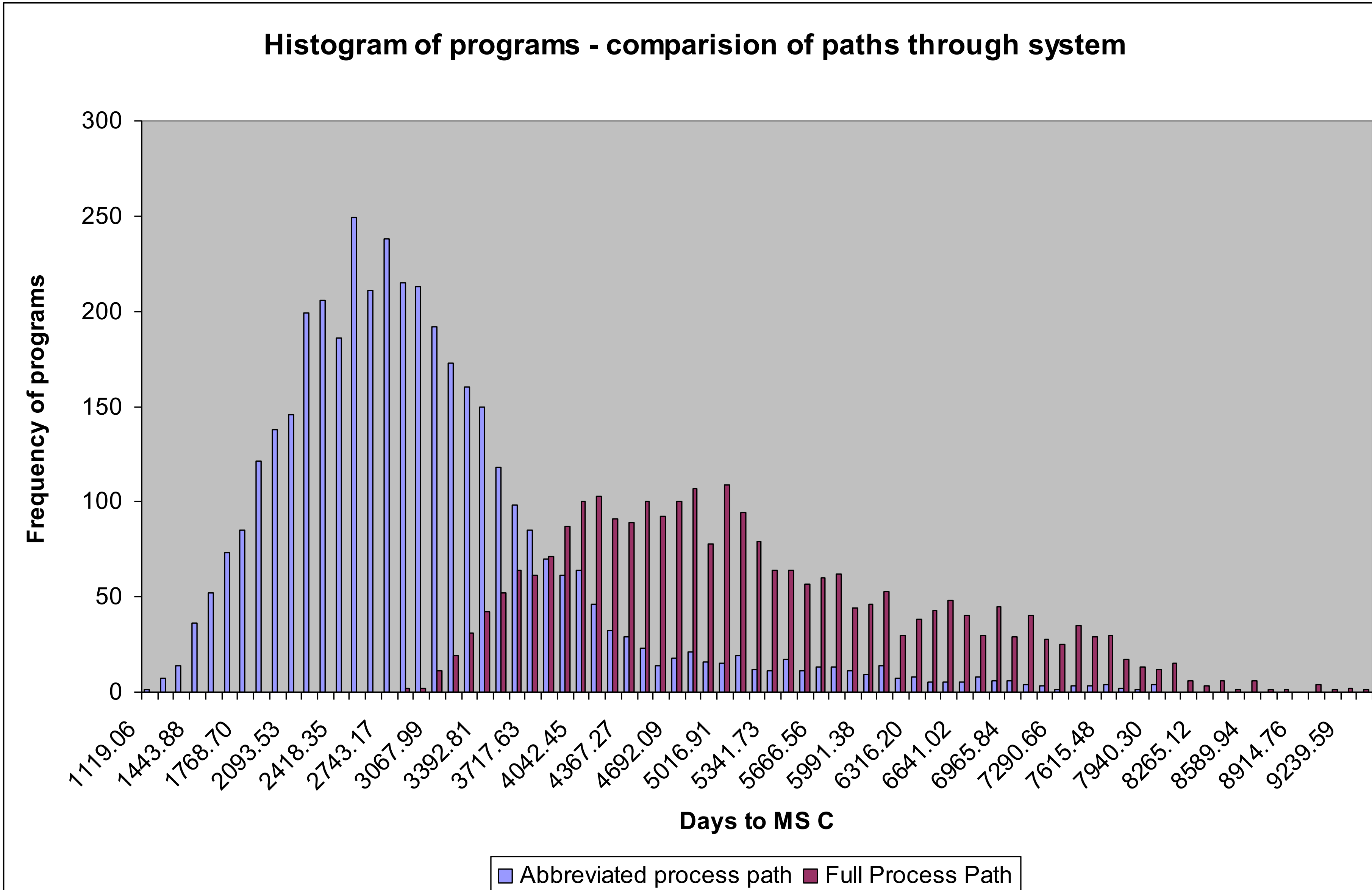

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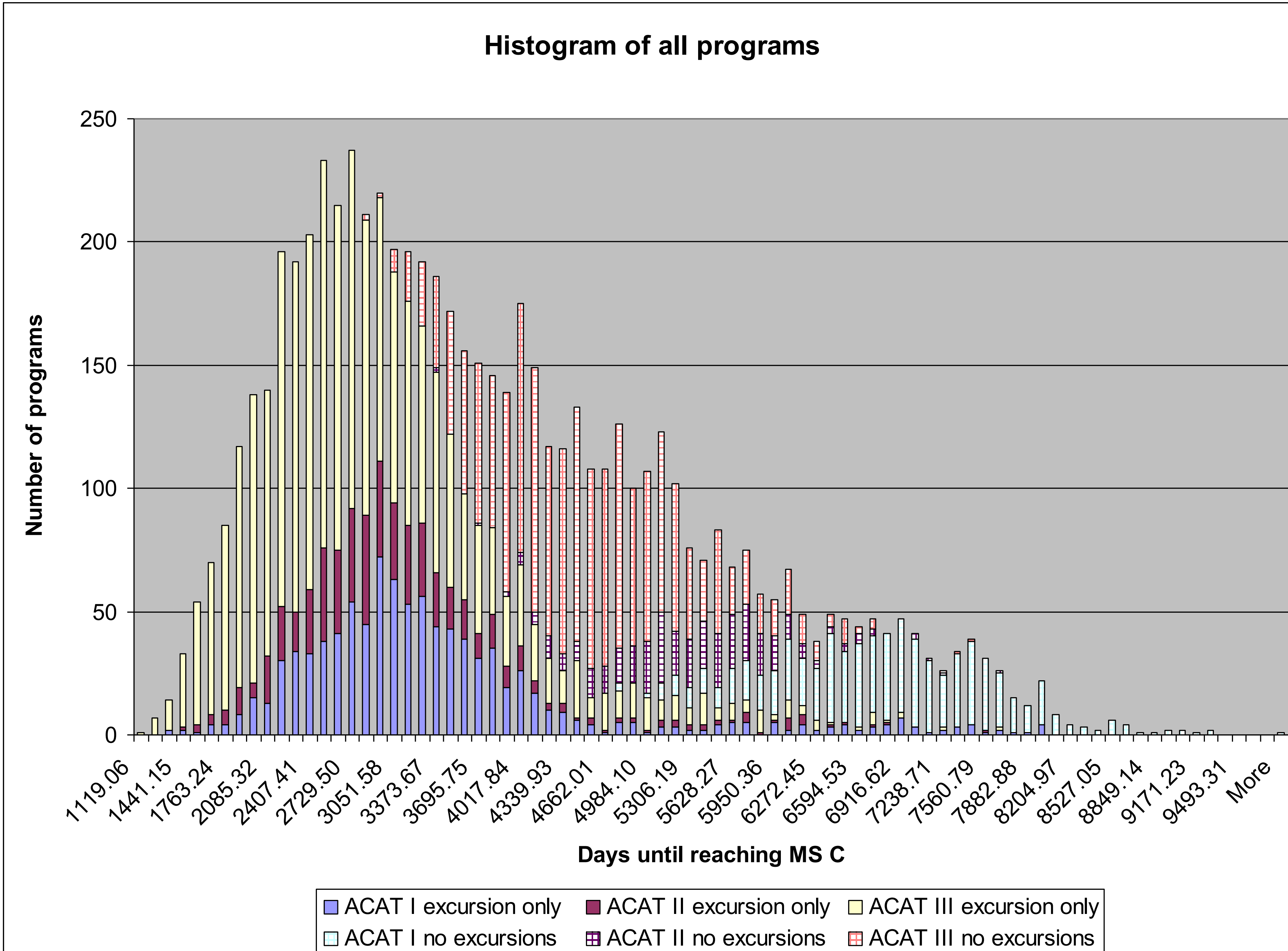

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Cost Growth in selected industries

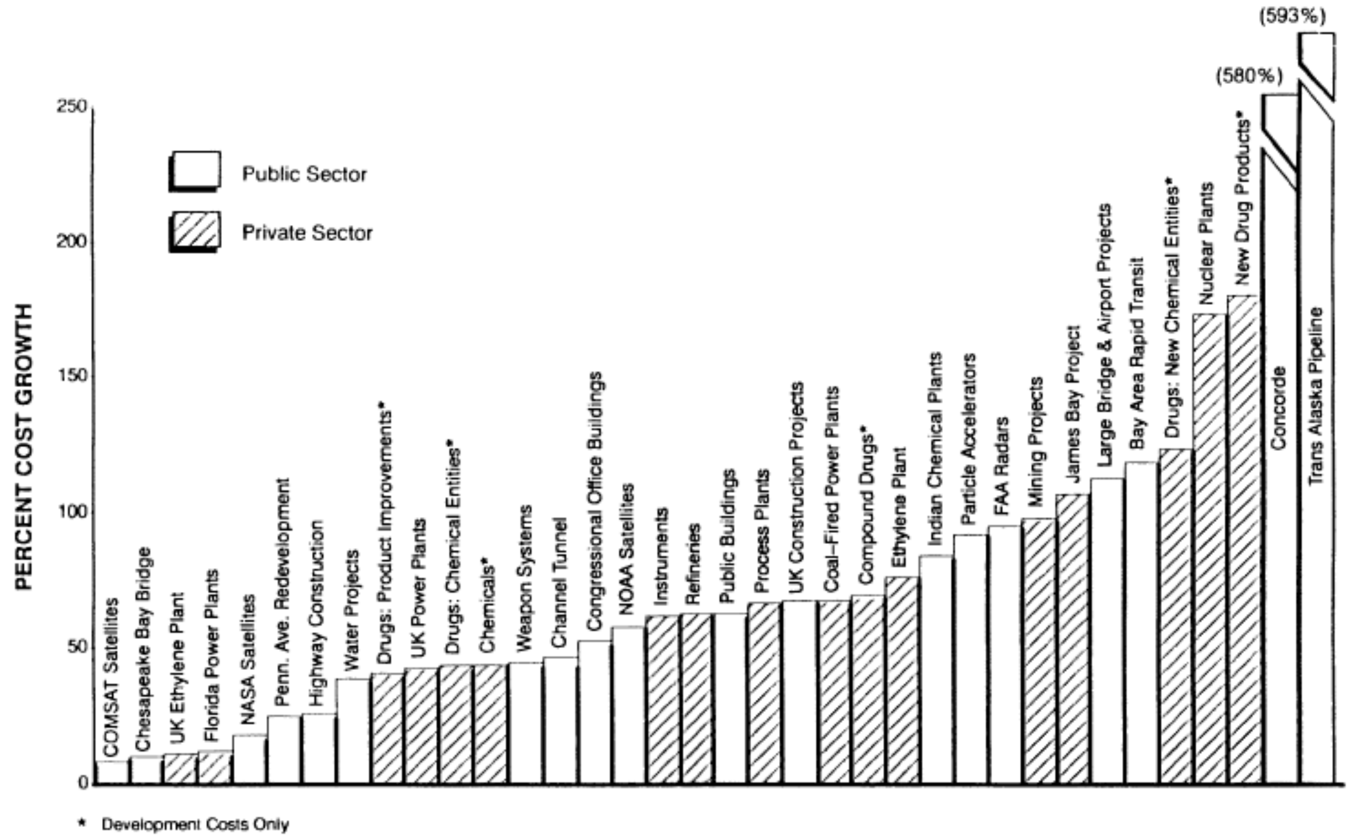

Figure 1. Public- and private-sector cost growth.

Source: Biery, Frederick P., "The Effectiveness of Weapon System Acquisition Reform Efforts." *Journal of Policy Analysis and Management*, Vol 11, No. 4, 1992

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Schedule Growth in selected industries

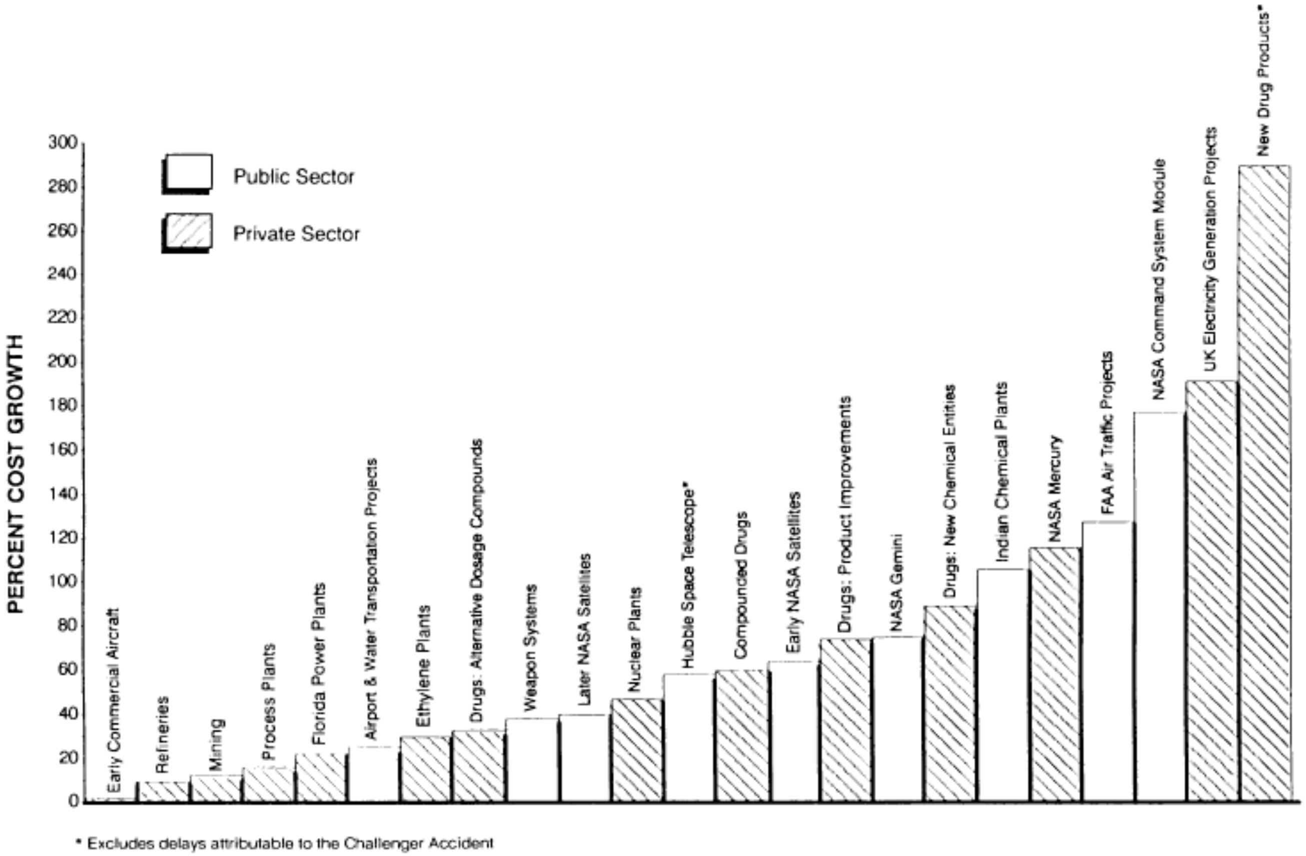

Figure 2. Public- and private-sector schedule growth.

Source: Biery, Frederick P., "The Effectiveness of Weapon System Acquisition Reform Efforts." ***Journal of Policy Analysis and Management*, Vol 11, No. 4, 1992**

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Potential Future Work

- #1: Identify and develop enterprise risk measures
- #2: Adapt the model to test different items such as Technology Readiness Levels or the “novelty” vs. cost or complexity of the program
- #3: Investigate other circumvention options
- #4: Add cost data to the model, both in terms of the actual program, but also the “costs” of individual process steps and decision points
- #5: Add a more explicit modeling of the PPBE to this model
  - Explore if such a model is more appropriate in demonstrating systems behaviors

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Future Work

- #6: Explore why certain interventions, such as funding stability, technical uncertainty, test trades, and other individual SE reviews did not have a greater impact on program outcomes vs. the baseline case
- #7: Add more fidelity to the model and the model construction
  - Provide a better understanding of interactions
- #8: Extend the model to the enterprise
  - Study how multiple systems in development coexist and how their interactions would drive and affect one another
- #9: Extend the model to be predictive for future program execution
  - Take the current state of an existing program and plug it into the model at the appropriate place and propagate its execution forward

Looking for answers in the wrong places?

- GAO and others* suggest better:

Risk Management and Controls
AND
Product Portfolio Management

will improve acquisition system performance outcomes

*(GAO 05-391, 04-53, 06-110,06-257T,06-368, 06-391, 06-585T, DAPA 2006, PMIBOK, DSMC Risk Management Guide Book, Browning, T. R. and E. F. H. Negele (2006). Lambert, J. H., R. K. Jennings, et al. (2006). Lévárdy, V. and T. R. Browning (2005), Cooper 2001, Cusumano & Nobeoka 1998, RAND MG-271, MG-360, MG-415, TR-262)

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Survey "State of the Practice" Risk & Portfolio Management

- Product Center at AFB - test location
  - 75% of Wing Commanders (Highest Tier) interviewed
  - 36% of Group Commanders (2nd tier) interviewed
  - 11% of Squadron Commanders (3rd tier) interviewed

- Portfolios & Risk were discussed in terms of project outcomes:
  - Performance (requirements), cost (resources), and schedule (time).

Details of second study

- **Purpose: Characterize other elements of enterprise**
  - **Interview key players in processes outside of acquisition**
- **25+ professionals outside of acquisition interviewed**
  - **Represented "Requirements" Community (5)*, "User" Community (7)*, "Budgeting, Programming, and Execution" Communities (13)**
    - **Within SAF/AQX, ACC/A5, ACC/A8, AF/XORD, AF/A5, JFCOM, ASCISR2, AF/A35 organizations (Norfolk Naval Base, Langley AFB, Pentagon, Crystal City, Roslyn, etc.), and others**
    - ***Leveraged work previously done for Masters' degree (2000)**

Risk

- Affirmed its use as important
- 75% of those interviewed used traditional risk tools (e.g. risk cubes, mitigation plans) for individual programs.
- 50% used program-level metrics to help make portfolio decisions
- 42% used ‘high-level’ reviews to discuss risks of multiple projects – but without a structured process or integration of risks between projects

Portfolio Management

- **92% of all those interviewed felt Portfolio Management was an ‘art’.**
- **42% acknowledged having no portfolio-level vision or strategy although another 33% claimed to have a vision or strategy.**

Portfolio measures

- **33% of those interviewed want portfolio-level measures, while acknowledging difficulty in obtaining such measures.**
- **Representative quote**
  - **"For me, it's done, it's really done as 'contentment' among the portfolio...and if I have that good feeling, I'm satisfied with the direction of the entire portfolio". Squadron commander (Level III leader)**

Portfolio Risk

- Challenging concept for many.
  - Almost all interviewees had a different definition and understanding of portfolio risk and what it meant for them.
- 25% of those interviewed claimed to have a set of portfolio risks
  - One leader had an integrating contractor managing those risks*
- 42% said limited manpower prevented the use of portfolio risk management
- 33% felt that the structure of their organization inhibited portfolio risk management.

* The contractor was also interviewed. Although they had accepted the task of managing portfolio risks, determining those risks was proving to be very difficult & at the time of the interview, and after several months of effort, they did not yet have any portfolio risks enumerated.

How do you manage a project portfolio efficiently?

It depends on the objective

- **Meet the portfolio objectives OR achieve "operational" status for as many projects as possible**
- **What actions are effective?**
  - **Meet Portfolio objectives**
    - **Staffing uncertain projects**
    - **Number of projects kept low**
    - **Keep slack capacity in processes, money, and people**
  - **Achieve "operational" status of maximum projects**
    - **Resource planning (minimize projects in pipeline)**
    - **Review portfolio projects often (quarterly)**
    - **Re-allocate resources – keep schedule as much as possible**

McDonough Iii, E. F., & Spital, F. C. (2003). MANAGING PROJECT PORTFOLIOS. *Research Technology Management, 46*(3), 40.

Pathologies of Current AF Acquisition Portfolio Outcomes

Evidence:

- Cost, schedule, and performance instability
- Mismatches between program execution and portfolio emphasis
- Cacophony of stakeholder voices dilute portfolio focus and vision

Result:

- Emphasis on maintaining dollars & personnel

High-level DSM

		Pre-MS A requirements	Pre-MS A PPBES	Pre-MS A acquisition	Pre-MS A contractor	Pre-MS B requirements	Pre-MS B PPBES	Pre-MS B acquisition	Pre-MS B contractor	Pre-MS C requirements	Pre-MS C PPBES	Pre-MS C acquisition	Pre-MS C contractor
		1	2	3	4	5	6	7	8	9	10	11	12
Pre-MS A requirements	1	1	1	1									
Pre-MS A PPBES	2		2	1									
Pre-MS A acquisition	3	1	1	3	1								
Pre-MS A contractor	4			1	4								
Pre-MS B requirements	5	1				5	1	1					
Pre-MS B PPBES	6		1				6	1					
Pre-MS B acquisition	7	1		1		1	1	7	1				
Pre-MS B contractor	8							1	8				
Pre-MS C requirements	9	1				1				9	1	1	
Pre-MS C PPBES	10						1				10	1	
Pre-MS C acquisition	11	1				1		1		1	1	11	1
Pre-MS C contractor	12											1	12

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DSM Analysis

- High-level DSM
  - Shows 3 distinct communities involved in a complex process
- More detailed DSM required
  - Most tools have difficulty representing complex systems with more than 250 elements
  - Produced three distinct DSMs
    - One for each phase in the Acquisition process
      - Pre-A is 89x89
      - Pre-B is 104x104
      - Pre-C is 132x132

- **Differences in percentages between 10000 and 48500 iterations are less than 1%**

summary of 10000 trials

	B	C	D	F	G	I	J
1	**Reason for program termination**	**Number at end poi**	**Percentage of total ru**	**Number at end poi**	**Percentage of total ru**	**Number at end poi**	**Percentage of total runs**
2	**Number of samples**	**10000**		**3802**		**1911**	
4	**Name of Ending Point**						
5	Early end; in scope of existing document; outright rejection	3444	34.440%	excluded	excluded	excluded	excluded
6	new concepts after waiting period; rejected	2754	27.540%	excluded	excluded	excluded	excluded
7	remain in acq	1891	18.910%	1891	49.74%	excluded	excluded
8	arrive at MS C	1394	13.940%	1394	36.66%	1394	72.95%
9	independent document PreC	89	0.890%	89	2.34%	89	4.66%
10	2nd time requirements path	57	0.570%	57	1.50%	57	2.98%
11	independent document preA	67	0.670%	67	1.76%	67	3.51%
12	independent document PreB	50	0.500%	50	1.32%	50	2.62%
13	joint interest preC	39	0.390%	39	1.03%	39	2.04%
14	1st time requirements path	33	0.330%	33	0.87%	33	1.73%
15	1st time requirements path preC	27	0.270%	27	0.71%	27	1.41%
16	joint interest PreB	18	0.180%	18	0.47%	18	0.94%
17	joint integration PreC	12	0.120%	12	0.32%	12	0.63%
18	joint interest preA	17	0.170%	17	0.45%	17	0.89%
19	2nd time requirements preB	19	0.190%	19	0.50%	19	0.99%
20	1st time requirements PreB	12	0.120%	12	0.32%	12	0.63%
21	2nd time requirements path preC	16	0.160%	16	0.42%	16	0.84%
22	kill at MS C	20	0.200%	20	0.53%	20	1.05%
23	joint integration preB	11	0.110%	11	0.29%	11	0.58%
24	Joint Integration PreA	18	0.180%	18	0.47%	18	0.94%
25	end at COA	7	0.070%	7	0.18%	7	0.37%
26	no AoA	3	0.030%	3	0.08%	3	0.16%
27	kill at CDR	1	0.010%	1	0.03%	1	0.05%
28	stop MS B	1	0.010%	1	0.03%	1	0.05%
29	pre-MS C begin	0	0.000%	0	0.00%	0	0.00%
30	kill at MS B	0	0.000%	0	0.00%	0	0.00%
31	kill at PDR	0	0.000%	0	0.00%	0	0.00%
32	concept selection	0	0.000%	0	0.00%	0	0.00%
33	2nd try ms A	0	0.000%	0	0.00%	0	0.00%
35	**Totals**	**10000**	**100%**	**3802**	**100.00%**	**1911**	**100.00%**

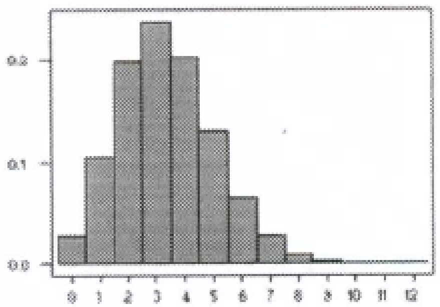
Sheet1 / Sheet2

summary of 48500 trials

	B	C	D	F	G	I	J
1	**Reason for program termination**	**Number at end poi**	**Percentage of total ru**	**Number at end poi**	**Percentage of total ru**	**Number at end poi**	**Percentage of total runs**
2	**Number of samples**	**48500**		**18406**		**9023**	
4	**Name of Ending Point**						
5	Early end; in scope of existing document; outright rejection	16982	35.015%	excluded	excluded	excluded	excluded
6	new concepts after waiting period; rejected	13111	27.034%	excluded	excluded	excluded	excluded
7	remain in acq	9383	19.347%	9383	50.98%	excluded	excluded
8	arrive at MS C	6601	13.611%	6601	35.86%	6601	73.16%
9	independent document PreC	437	0.901%	437	2.37%	437	4.84%
10	2nd time requirements path	259	0.534%	259	1.41%	259	2.87%
11	independent document preA	241	0.497%	241	1.31%	241	2.67%
12	independent document PreB	239	0.493%	239	1.30%	239	2.65%
13	joint interest preC	182	0.375%	182	0.99%	182	2.02%
14	1st time requirements path	172	0.355%	172	0.93%	172	1.91%
15	1st time requirements path preC	141	0.291%	141	0.77%	141	1.56%
16	joint interest PreB	101	0.208%	101	0.55%	101	1.12%
17	joint integration PreC	92	0.190%	92	0.50%	92	1.02%
18	joint interest preA	87	0.179%	87	0.47%	87	0.96%
19	2nd time requirements preB	83	0.171%	83	0.45%	83	0.92%
20	1st time requirements PreB	76	0.157%	76	0.41%	76	0.84%
21	2nd time requirements path preC	72	0.148%	72	0.39%	72	0.80%
22	kill at MS C	64	0.132%	64	0.35%	64	0.71%
23	joint integration preB	59	0.122%	59	0.32%	59	0.65%
24	Joint Integration PreA	47	0.097%	47	0.26%	47	0.52%
25	end at COA	45	0.093%	45	0.24%	45	0.50%
26	no AoA	13	0.027%	13	0.07%	13	0.14%
27	kill at CDR	4	0.008%	4	0.02%	4	0.04%
28	stop MS B	3	0.006%	3	0.02%	3	0.03%
29	pre-MS C begin	3	0.006%	3	0.02%	3	0.03%
30	kill at MS B	1	0.002%	1	0.01%	1	0.01%
31	kill at PDR	1	0.002%	1	0.01%	1	0.01%
32	concept selection	0	0.000%	0	0.00%	0	0.00%
33	2nd try ms A	0	0.000%	0	0.00%	0	0.00%
35	**Totals**	**48499**	**100%**	**18406**	**100.00%**	**9023**	**100.00%**

Feedback example

Process task/decision point: Testing times

	ACAT I	ACAT II	ACAT III
Time Distribution			
Distribution shape (example): 	1) 15-20% 2) 25% 3) 10%	hard to do	10% 15% 10%

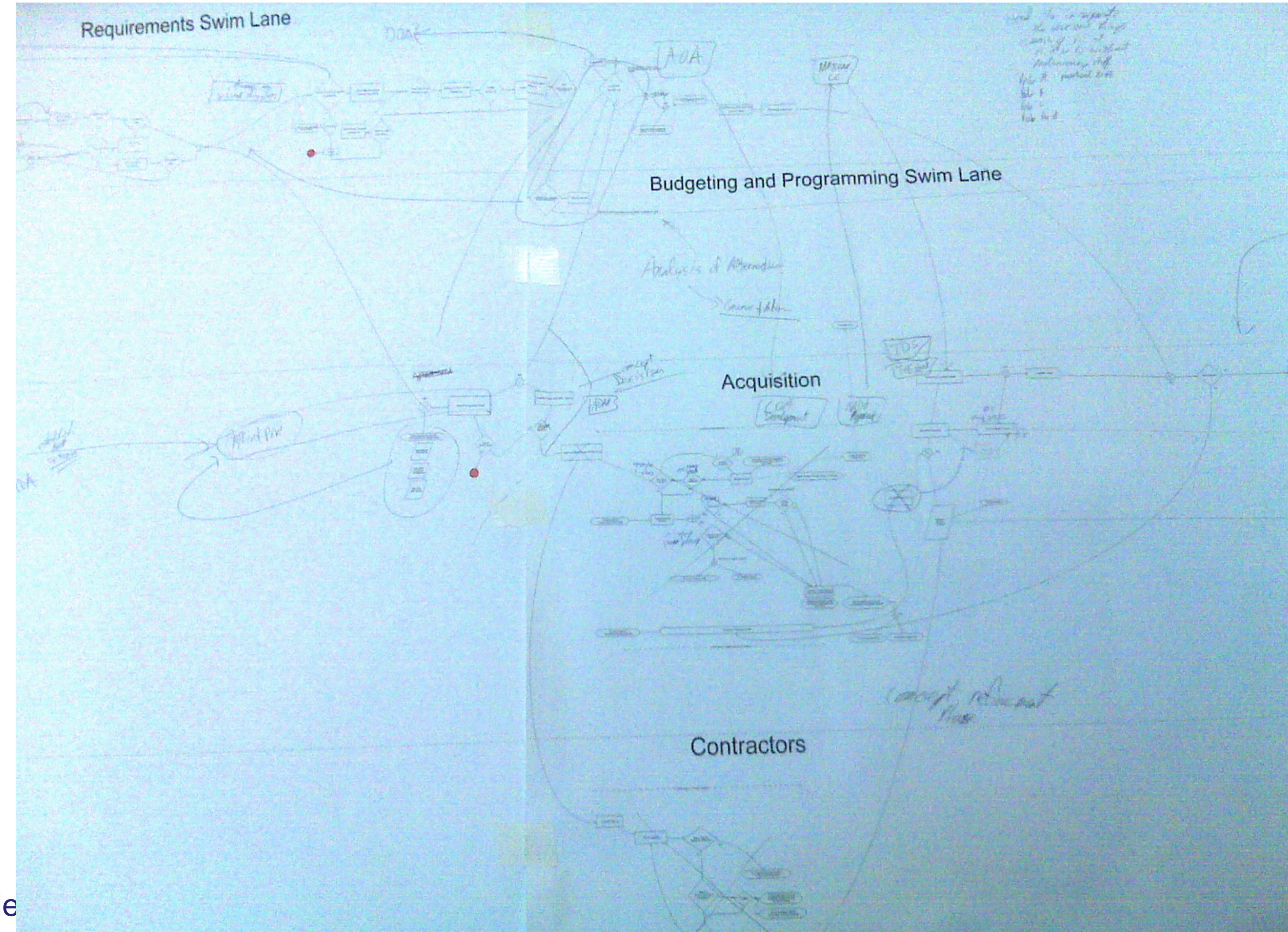
Notes:

Complete process of checking model by hand

- **Completed**
  - **Many trials by hand**
    - **Example: 4th trial reached Milestone A at 1410 days**
    - **Each hand trial required 15 to 300 individual roles of the dice, plus calculation of time elapsed based on triangular distributions and probabilities of different paths to take**

	Hand model #1	Hand model #2	Hand model #3	Hand model #4
Ending point	Stay in Sustainment system	Stay in sustainment system	Stay in sustainment system	Milestone A
Number of process steps	7	7	7	192
Final days	439	959	785	1222

Obtain expert's feedback on model



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Expert feedback was helpful

- All agreed the model approach was understandable
- All had inputs on model improvements
  - The majority of inputs were on interactions between the processes that are not well documented
- All task durations and decision probabilities were re-verified and validated

Data Sources used to obtain verifiable data

- **SMART (System Metric and Reporting Tool) data access**
  - **MAR scores (all programs of record; some since 1990s)**
  - **PoPS scores (all programs of record since 2006)**
- **DAMIR (Defense Acquisition Management Information Retrieval) data access**
  - **SAR data (archives; current; preliminary); APBs, etc**
- **AF Financial data access**
  - **PEM assignments; PE to program mapping; P & R docs, archives, etc.**
- **AF Systems Library access**
  - **PEO system groupings; ACAT levels for programs; PMs; locations**
- **OSD Acquisition Management data access**
  - **All PMDs since 1989**
- **SACOM data access**
  - **Acquisition manning data (requested/desired and allocated)**

Records of existing programs; past and current

Program Name	Initial ACAT Level	Initial Start Date	Source	Initial Milestone of Entry	Projected Milestone Dates			Source	Actual Milestone Dates			Source	Initial Analysis of Schedule		
					A	B	C		A	B	C		Projected B to C	Actual B to C	% change
B-2 RMP	I	17 Aug 2004	SMART Schedule	B	-	Jul 2004, Sep 2004	Feb 2007, Sep 2008	Jan 2009 APB	-	17 Aug 2004	4 Sep 2008	SMART Schedule	30 months	49 months	63%
C-5 RERP	I	1 Feb 2000	SMART Schedule	B	-	Nov 2001	Dec 2006, Mar 2007, Mar 2008	Jun 2008 APB	-	5 Nov 2001	25 Mar 08	SMART Schedule	61 months	88 months	44%
JDAM	I	11 Sep 2000	SMART Schedule	A	Oct 1993	Oct 1995, Sep 1995	Jul 1999, Apr 1998, Feb 1999, Nov 1999, Nov 2000	Oct 2002 APB	1 Oct 1993	1 Sep 1995	1 Mar 2001	SMART Schedule	34 months	66 months	94%
F-22	I	1 Oct 1986	SMART Schedule	A	Oct 1986	Jun 1991	Dec 1999, Jul 2001, Mar 2002, Sep 2002, Jul 2003, Mar 2004, Sep 2004	May 2007 APB	1 Oct 1986	1 Jun 1991	1 Mar 2005	SMART Schedule	102 months	165 months	62%
JPATS	I	1 Jan 1993	SMART Schedule	A	Jan 1993	Jun 1994, Feb 1995, Aug 1995	Jun 1998, Jan 1999, Sep 1999, Dec 1999, Nov 2000, Nov 2001	Sep 2007 APB	1 Jan 1993	1 Aug 1995	1 Nov 2001	SMART Schedule	34 months	75 months	120%
AMRAAM	I	1 Nov 1978	SMART Schedule	A	Nov 1978	Nov 1982, Sep 1982	Jun 1987	May 2008 APB	1 Nov 1978	1 Sep 1982	1 Jun 1987	SMART Schedule	45 months	45 months	0%
B-2 EHF Increment 1	I	22 Feb 2007	SMART Schedule	B	-	Feb 2007	Jul 2011	May 2007 APB	-	22 Feb 2007	*31 Jul 2011*	SMART Schedule	52 months	52 months	0%
C-130 AMP	I	1 Nov 2005	SMART Schedule	B	-	Jul 2007	Jun 2008	Feb 2008 APB	-	31 Jul 2007	*30 Jun 2009*	SMART Schedule	11 months	23 months	109%

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of the United States Air Force, the Department of Defense (DoD), or the U.S. Government.

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Actual model results

- **Samples are statistically similar between MS B and MS C**

t-Test: Two-Sample Assuming Unequal Variances

	Simulated Data	*Actual Data*
Mean	1859.04	1644.55
Variance	277970.02	1066656.89
Observations	546.00	20.00
Hypothesized Mean Difference	0.00	
df	19.00	
t Stat	0.92	
P(T<=t) one-tail	0.18	
t Critical one-tail	1.73	
P(T<=t) two-tail	0.37	
t Critical two-tail	2.09	

Since the null hypothesis is that the mean difference is zero, this is a two-sided test. Since the t-statistic < t critical (0.92 < 2.09) and p value > alpha (0.37 > 0.05), the null hypothesis is not rejected at the 95% confidence level.