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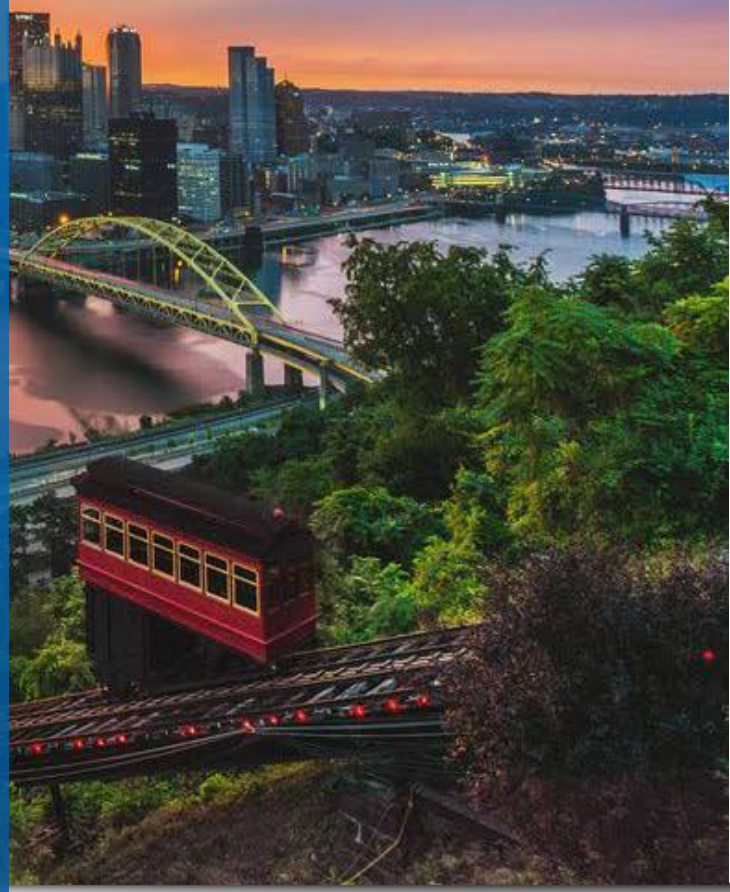
Delusions of Success: Overcoming Optimism Bias in Schedule Forecasting

Jeffrey M. Voth I Maxwell C. Moseley I Ann E. Hawpe



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> We must accelerate innovative research and development, acquire new capabilities faster, and transform the way the U.S. military fights if it is to prevail. This is hardly the first time U.S. national security leaders have felt a sense of urgency and attempted to do so.
>
> Unfortunately, results have been mixed at best, with **absurd acquisition debacles that have set back the country tens of billions of dollars and delayed necessary weapon systems for years.**

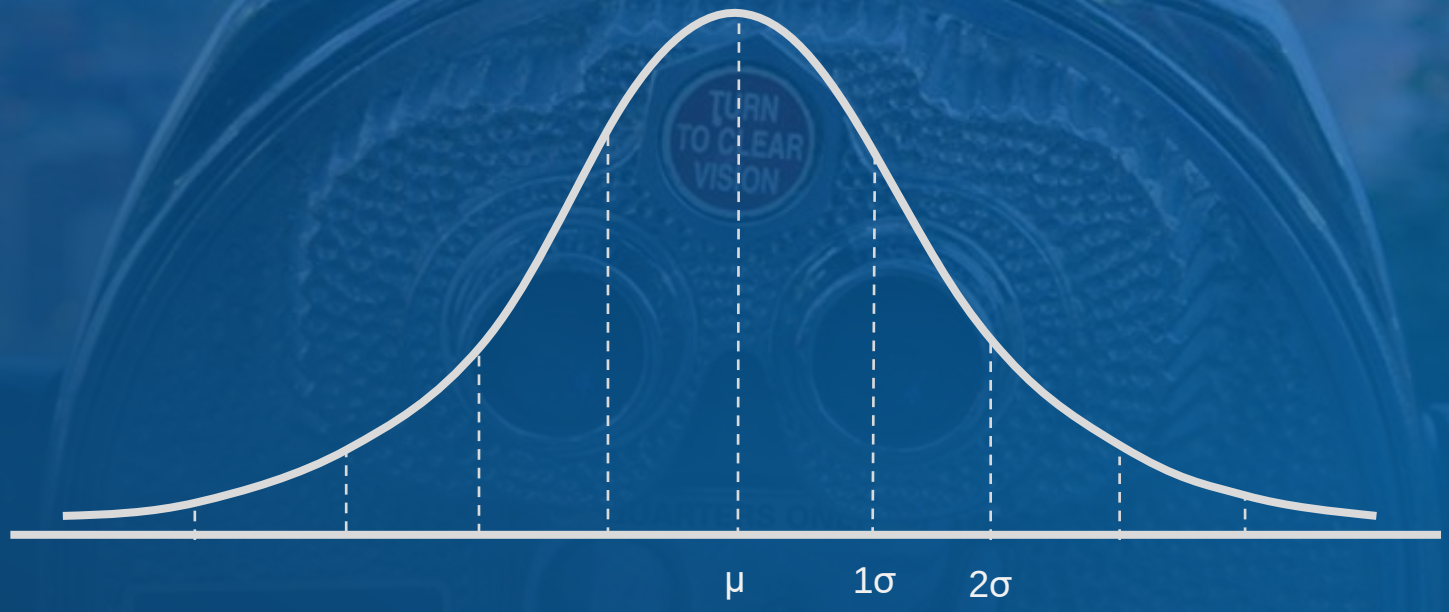
Senators Jim Inhofe (R-Oklahoma) and Jack Reed (D-Rhode Island)
Chairman and Ranking Member of the Senate Armed Services Committee (SASC)
June 26, 2020 USNI Proceedings 146(6) 27-31

> Competition with other programs vying for defense dollars puts pressure on program sponsors to project unprecedented levels of performance (often by counting on unproven technologies) while promising low cost and short schedules.
>
> These incentives, coupled with a marketplace that is characterized by a single buyer (DOD), low volume, and limited number of major sources, create **a culture in weapon system acquisition that encourages undue optimism.**

Paul L. Francis, Managing Director
U.S. Government Accountability Office, Acquisition and Sourcing Management
October 27, 2015 Prepared Statement before the House Armed Services Committee

A Working Definition of Risk

- Risk = Negative uncertainty (downside)
- Uncertainty = More than one possible outcome
  i.e. “more things can happen than will happen”
- Positive uncertainty = Opportunity (upside)



The 3Cs of Risk

Challenges

Causes

Cures

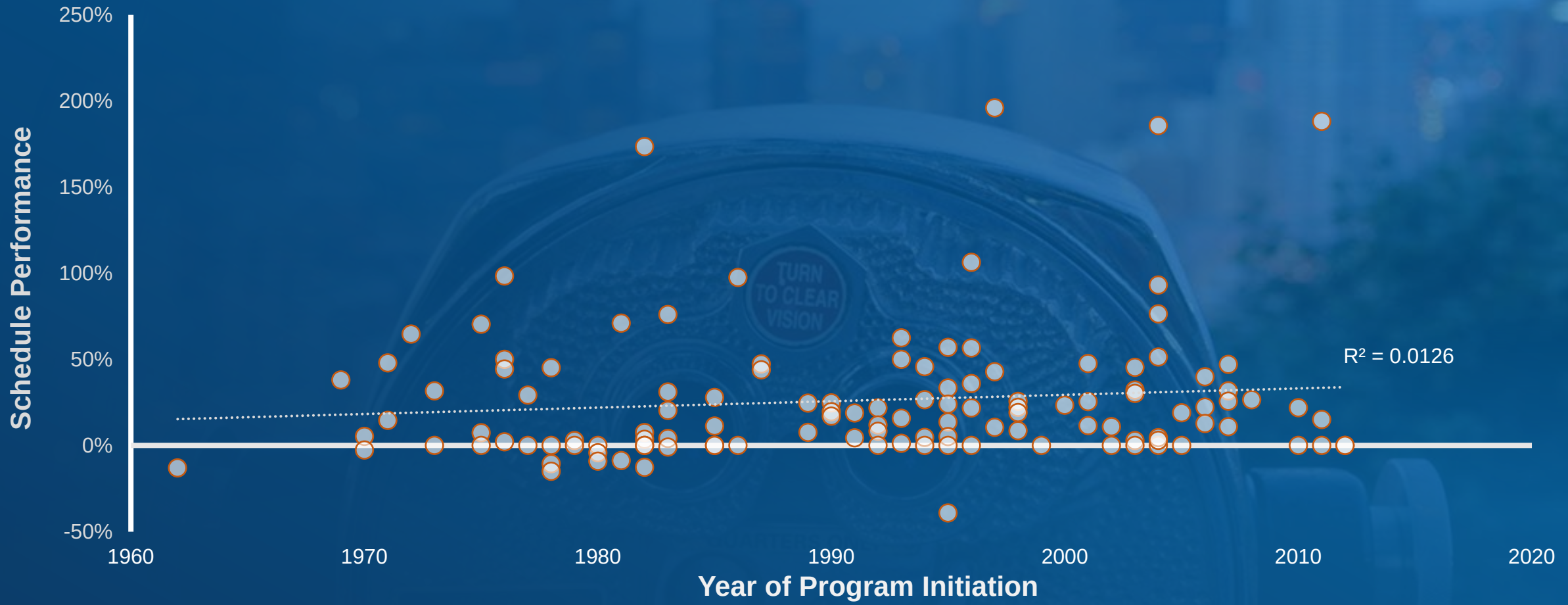
Long implementation phases are extremely costly

"Net stretched-out development and procurement schedules" contributed $2.93 billion in additional cost to DoD programs captured in Selected Acquisition Reports according to GAO (2018)

How do these conclusions fit your experience?

Magnitude of MDAP inaccuracies has not declined over time

Schedule forecasts are likely to be as wrong today as they were 50 years ago



Faster, specially-tailored requirements and acquisition processes are emerging

FUTURE FORCE STRUCTURE

Interim National Security Strategic Guidance (March 2021)

"We will ensure our armed forces are equipped to deter our adversaries, defend our people, interests, and allies, and defeat threats that emerge…"

Sophisticated multi-mission warfare capabilities

- Advanced weapons and sensors required to pace technology, outpace adversaries, and maintain maritime dominance
- Maintain flexibility to rapidly introduce new mission systems

DISRUPTIVE CAPABILITIES

The 3Cs of Risk

Challenges

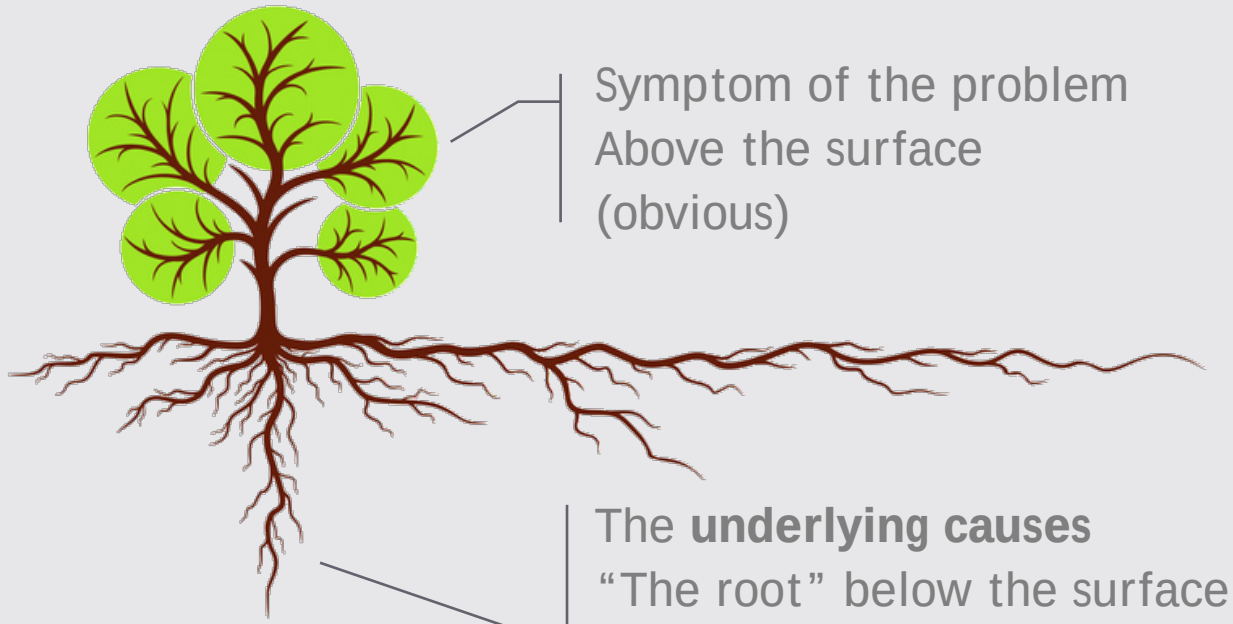
Causes

Cures

Three Types of Explanation

1. **Technical**: Inadequate data and models (Vanston & Vanston)
2. **Psychological**: Optimism Bias (Kahneman, Tversky)
3. **Political-economic**: Strategic misrepresentation (Wachs, Flyvbjerg)

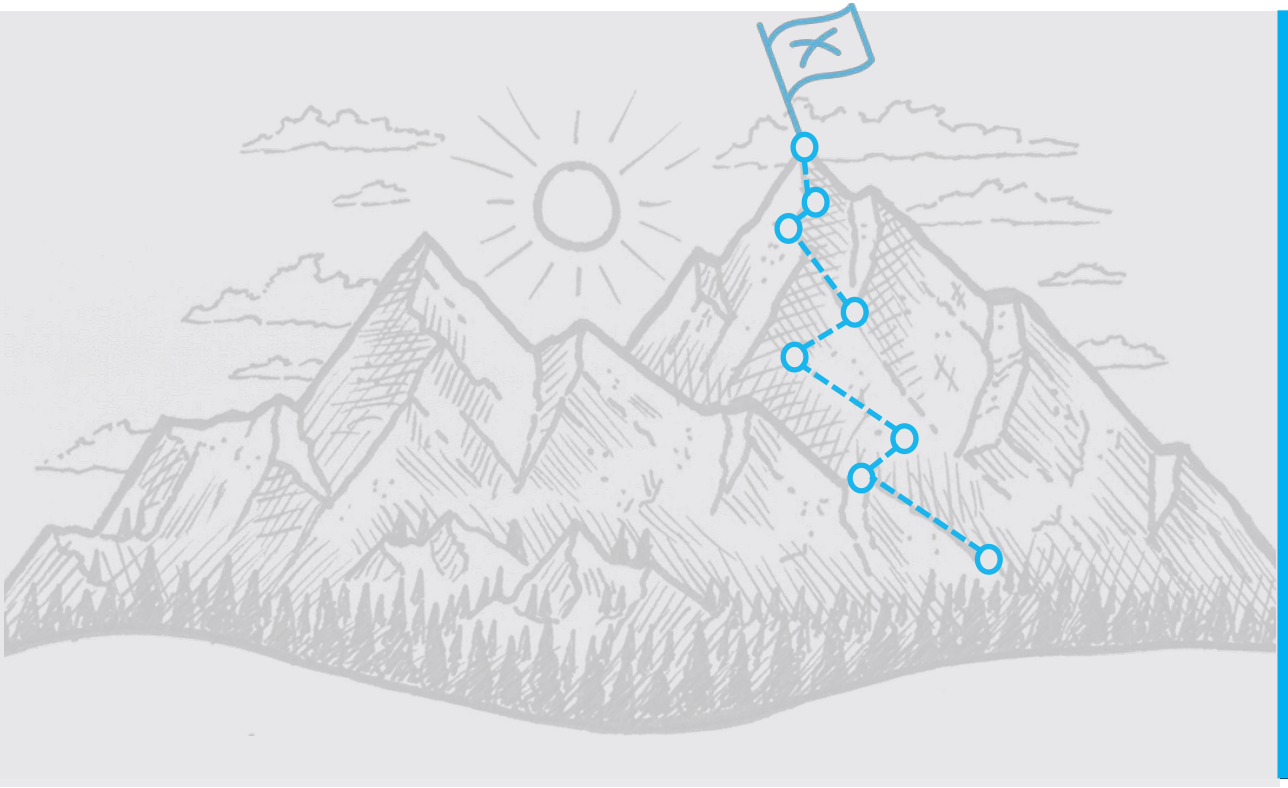
Assessing the risk inherent in MDAPs must address root causes and not simply treat the symptoms



Causes: technical issues, new requirements, increasing levels of complexity, bad data and models, etc.

Root causes: Optimism bias, strategic misrepresentation, risk

People frequently overestimate the likelihood of positive events while underestimating the likelihood of negative events



Optimism bias is the systematic tendency for people to be overly optimistic about the outcome of planned actions

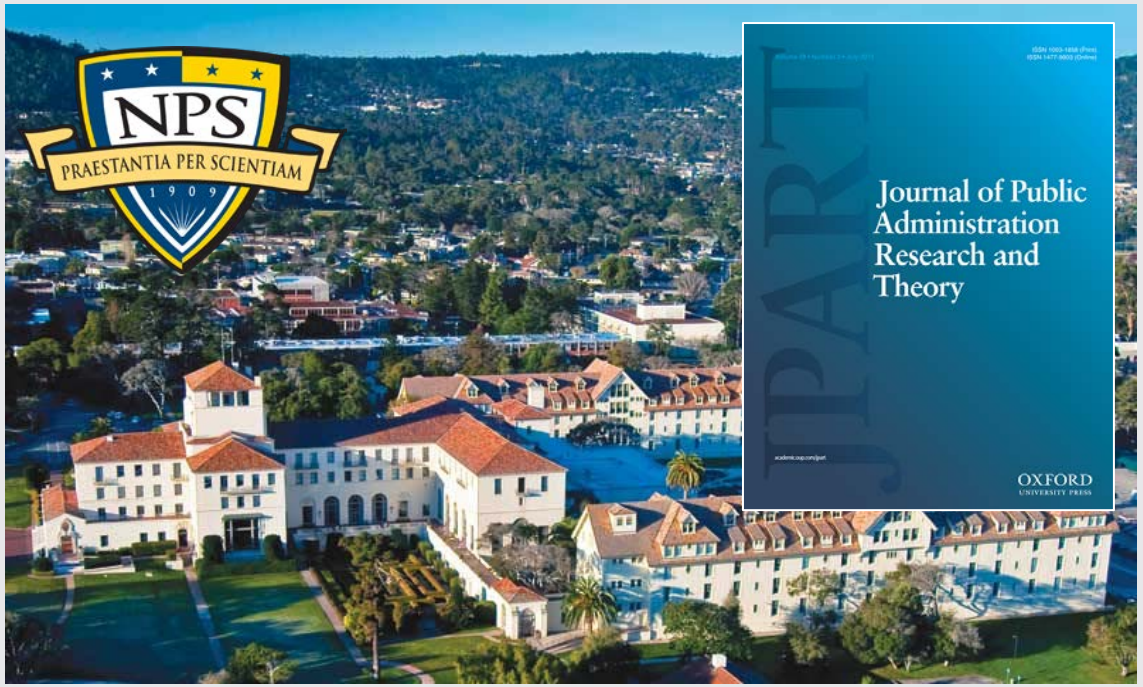
Case Study: The Sydney Opera House was expected to be completed in 1963 at a cost of $7M. A scaled-down version opened in 1973 at a cost of $102M

When making a decision, use all available distributional information about outcomes to more accurately forecast

“This may be considered the single most important piece of advice regarding how to increase accuracy in forecasting”

(Thinking Fast and Slow, 2011: 251)

Strategic misrepresentation is a predictable response to misaligned incentive structures



"Strategic misrepresentation is the planned, systematic distortion or misstatement of fact – lying – in response to incentives in the budget process."

(Jones and Euske,1991:437)

Main Risk is Internal, Not External

Conventional wisdom sees causes of risk as mainly **external** to programs

The root cause of risk is **internal**. It consists of the way program and engineering teams systematically misconceive risk

The 3Cs of Risk

Challenges

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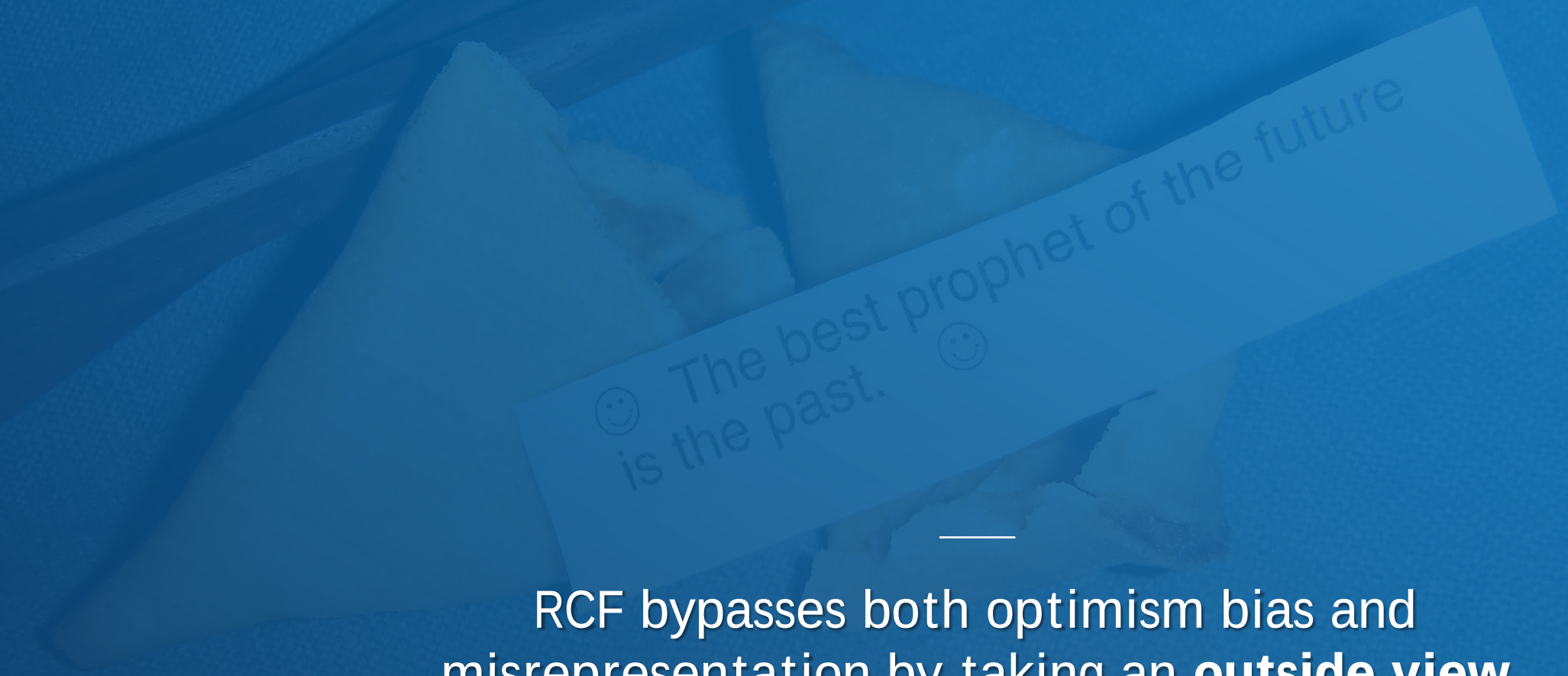
A Reference Class Forecast (RCF) predicts the outcome of a planned action based on actual outcomes in a reference class of similar actions to that being forecasted



RCF bypasses both optimism bias and misrepresentation by taking an **outside view**

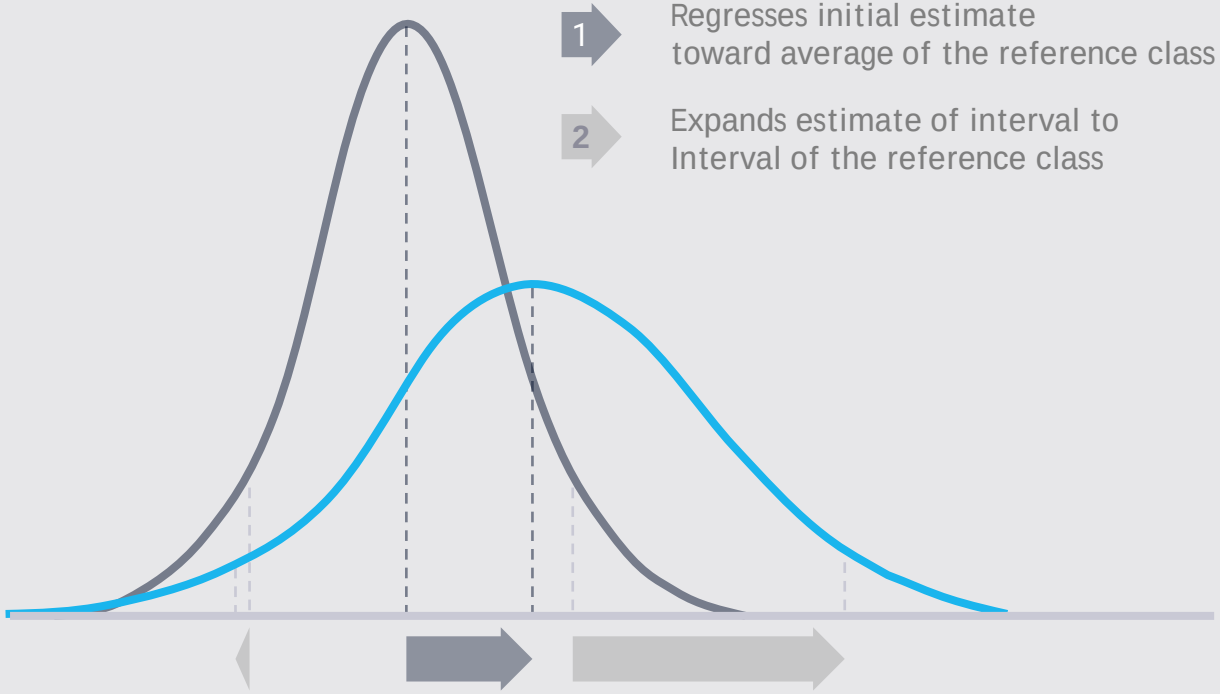
Reference Class Forecasting (RCF) is designed to overcome the planning fallacy that plagues most major programs

RCF is a method for systematically taking the outside view to overcome "planning fallacy"

Cause: "Inside view" focusing on the elements of the specific planned action, seeing this action as unique

Cure: "Outside view" focusing on the outcomes of similar actions that have already been completed

Reference Class Forecasting (RCF) developed as a practical tool, not purely an academic exercise



RCF is now a **government standard** across all major UK programs

1. Identify relevant **reference class** of past, similar projects (min 15 projects)
2. Establish **probability distribution** for the selected reference class
3. Compare specific program with distribution, in order to establish the **most likely outcome**

Schedule data in Selected Acquisition Reports (SARs) can build reference classes for MDAPs

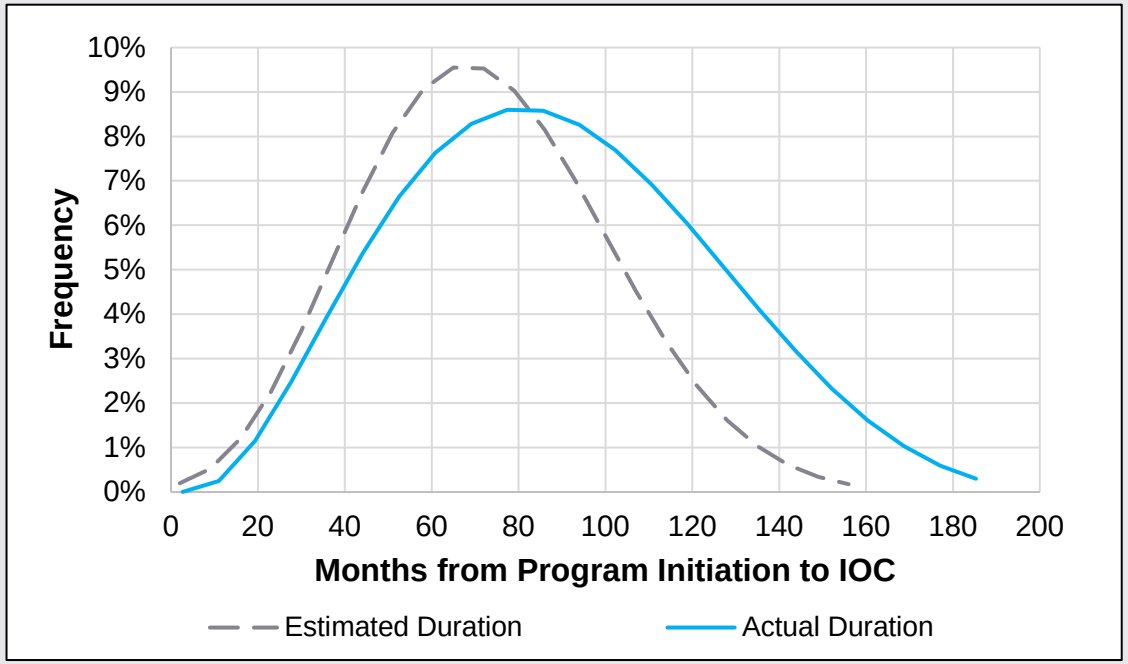
Commodity Class		Median (months)	Mean (months)	Count (n)	IQR (months)	Standard Deviation (months)	CV	Min (months)	Max (months)
Ship	**Planned**	86.0	78.8	17	47.5	26.8	0.34	42	126
	Actual	89.0	94.7	17	61.0	33.0	0.35	49	147
Missile	**Planned**	75.0	69.4	23	25.0	17.1	0.25	38	92
	Actual	88.0	92.1	23	43.0	28.1	0.31	46	158
C5I	**Planned**	68.0	68.3	29	55.0	31.9	0.47	16	140
	Actual	86.0	84.5	29	39.5	35.0	0.41	16	159
Vehicle	**Planned**	57.0	62.3	7	22.0	23.3	0.37	30	106
	Actual	82.0	75.6	7	55.0	26.4	0.35	37	106
Fixed Wing	**Planned**	63.5	66.6	26	61.8	35.3	0.53	16	149
	Actual	72.0	77.1	26	72.0	43.3	0.56	24	177
Rotary	**Planned**	72.0	65.4	14	26.5	25.4	0.39	9	106
	Actual	81.0	82.4	14	65.5	40.1	0.49	11	151

This study compares durations from program initiation to the **planned and actual dates of Initial Operational Capability (IOC)** for 116 MDAPs

General trends observed across six commodity classes:

- The mean actual duration is **longer** than the mean planned duration
- Interquartile range (IQR) is **wider** for actual durations than for planned durations (except for C5I programs)
- Coefficients of variation (CVs) tend to be **higher** for actual durations, reflecting real-world uncertainties

Fitting Beta distributions to the estimated and actual initiation-to-IOC durations confirms expectations



Collectively, the 116 MDAPs experience **longer, more varied schedules** than estimated

This pattern emphasizes the inherent uncertainty in complex MDAPs, regardless of commodity class or year of initiation

First deployed in 2013, the Navy plans to evolve the SM-6 design and buy 1,800 through 2026 at a total cost of $6.4B

ANTI-AIR WARFARE

ANTI-SURFACE WARFARE

SEA-BASED TERMINAL BMD

Using RCF captures the full range of past outcomes and avoids subjectivity in selecting individual analogies

Program	Year of Initiating Milestone	Initiation to Est. IOC (months)	Initiation to Actual IOC (months)	Delta (months)	Percent Overrun
Program A	1982	49	134	85	173.5%
Program B	1976	58	115	57	98.3%
Program C	1986	80	158	78	97.5%
Program D	1972	65	107	42	64.6%
Program E	1978	40	58	18	45.0%
Program F	1976	88	127	39	44.3%
Program G	1973	38	50	12	31.6%
Program H	1977	65	84	19	29.2%
Program I	1998	47	59	12	25.5%
Program J	1996	69	84	15	21.7%
Program K	1990	77	92	15	19.5%
Program L	1971	83	95	12	14.5%
Program M	1992	74	80	6	8.1%
Program N	1989	79	85	6	7.6%
Program O	1983	75	78	3	4.0%
Program P	1994	92	92	0	0.0%
Program Q	1979	88	88	0	0.0%
Program R	1978	80	68	-12	-15.0%

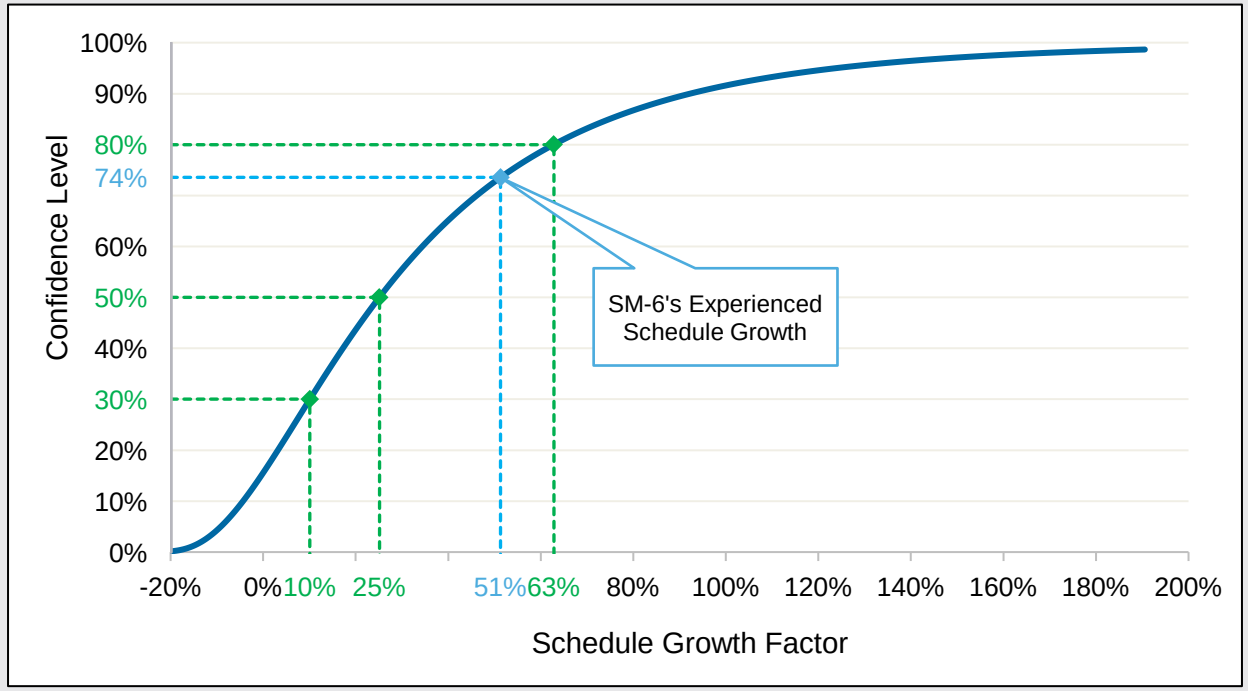
For example, at least **18 past missile MDAPs** had reached IOC prior to SM-6 Blk 1's initiation in June 2004

Of these 18 programs:

- 15 experienced a schedule overrun
- 2 finished on time
- 1 finished early

These programs averaged a **37.2% schedule delay**

Applying a Lognormal distribution to the reference class would allow the program to plan to specific confidence levels



The 80% confidence level is the **"conservative estimate"**

The 50% confidence level is the **"most likely estimate"**

The 30% confidence level is the **"optimistic estimate"**

Given the increasingly dynamic nature of MDAPs, it is time to move away from the traditional mindset about risk…

Conventional risk management methods increase risk by underestimating variance

Better methods exist to reduce schedule variance by incorporating an outside view of each program

These methods must go hand-in-hand with better incentive alignment, including through portfolio management

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Authors

Jeffrey M. Voth
Herren Associates, Inc.
T +1 703 338 5772
Jeff.Voth@jlha.com

Maxwell C. Moseley
Herren Associates, Inc.
T +1 202 400 3473
Maxwell.Moseley@jlha.com

Ann E. Hawpe
Herren Associates, Inc.
T +1 202 441 3654
Ann.Hawpe@jlha.com

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