Making Time from Data: Toward Realistic Acquisition Schedule Estimates

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WHY SCHEDULE?

- Because Schedules are Still Regularly overrun

- Because Schedule is often ignored at the expense of cost and performance

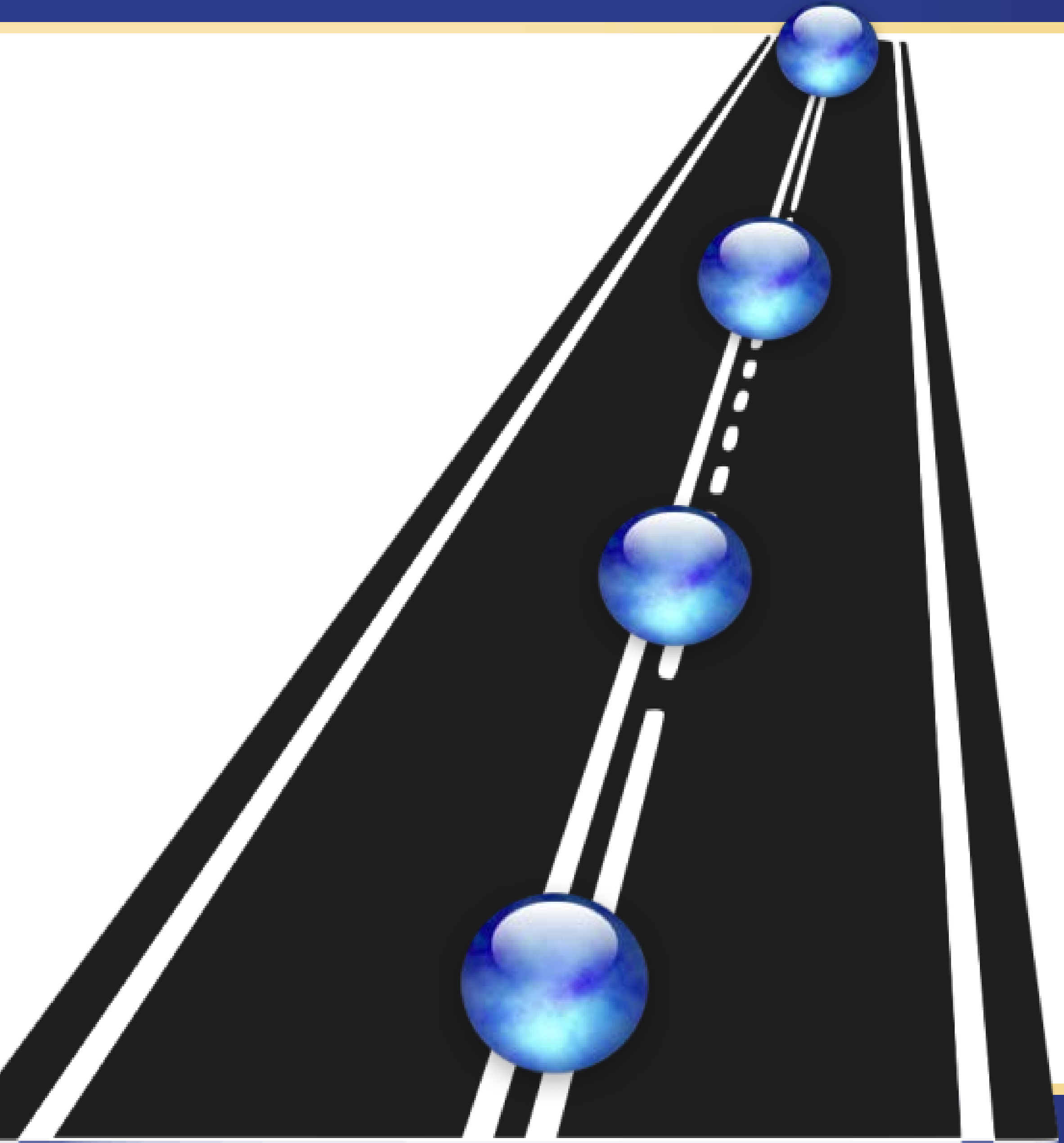
WHY IS THIS HAPPENING?

- Because the Scheduling process is part of a **system**
- Because people don't always recognize systems—although weapons development programs are **systems**
- And…Because people don't recognize the **dynamics of systems**

Agenda

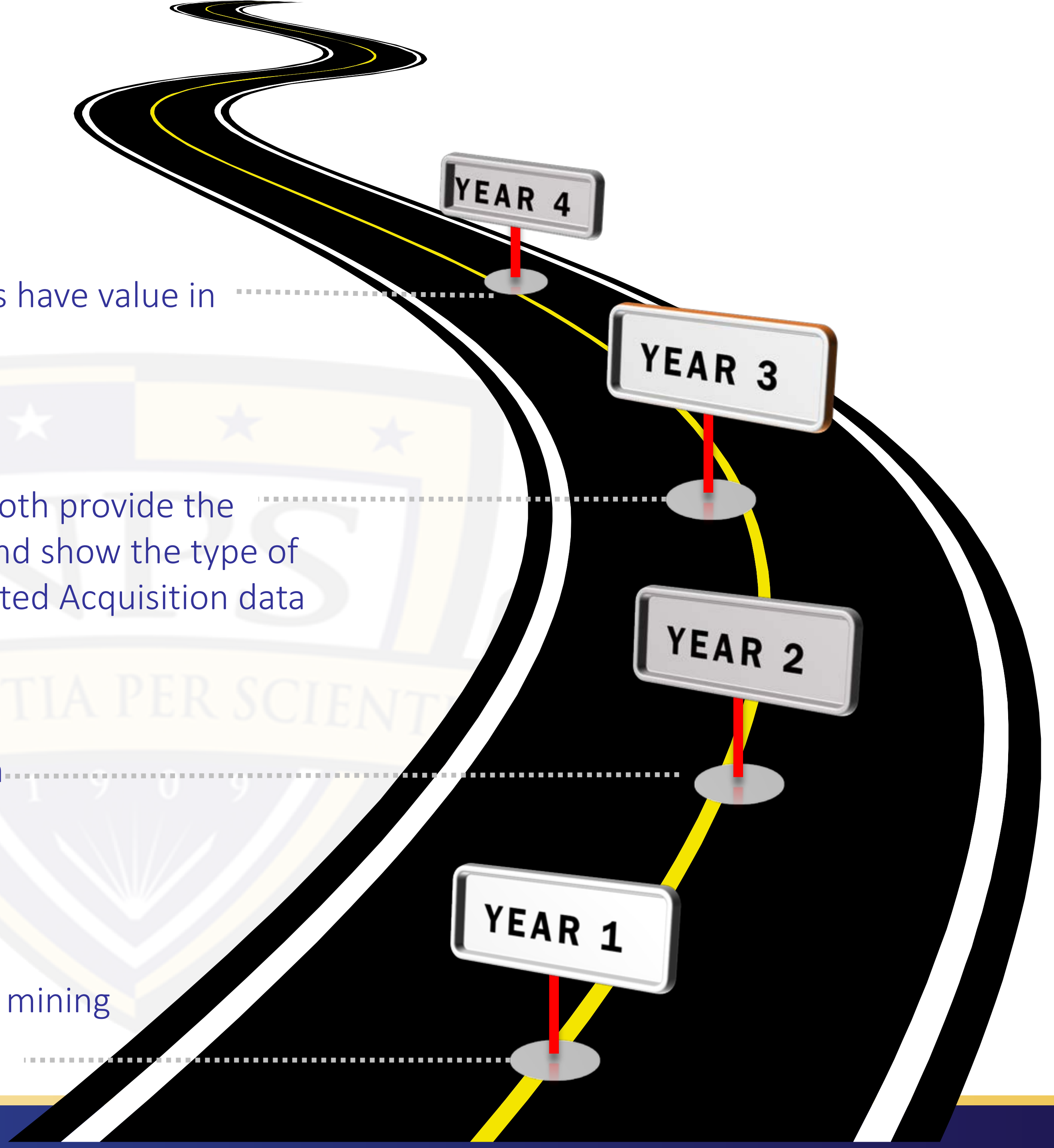
- Overall Research Agenda
- Progress to Date
- 2019 Research Focus
- System View of Acquisition
- Schedule Analysis Methodology
- Complexity
- Decision Dynamics
- Applying The Methodology
- F-35 Case Study

Multi-Year Inquiry asking…



- Can operational performance metrics better capture contemporary operations (and thus enable better schedule estimation relationships)?
- What model(s) best capture the trade-offs among program cost and schedule, as well as operational capability of fielded equipment?
- Can those models give insight into “troubled programs,” with difficulties in cost, schedule, and performance?
- Analyze previous case studies for insights into program schedule drivers.
- What estimating relationships best capture time to field new hardware? What schedule drivers are generally most important?
- How useful are they in predicting actual program schedules (empirical assessments)?
- Can prediction markets for cost and schedule identify problems?

Some Interim Findings…

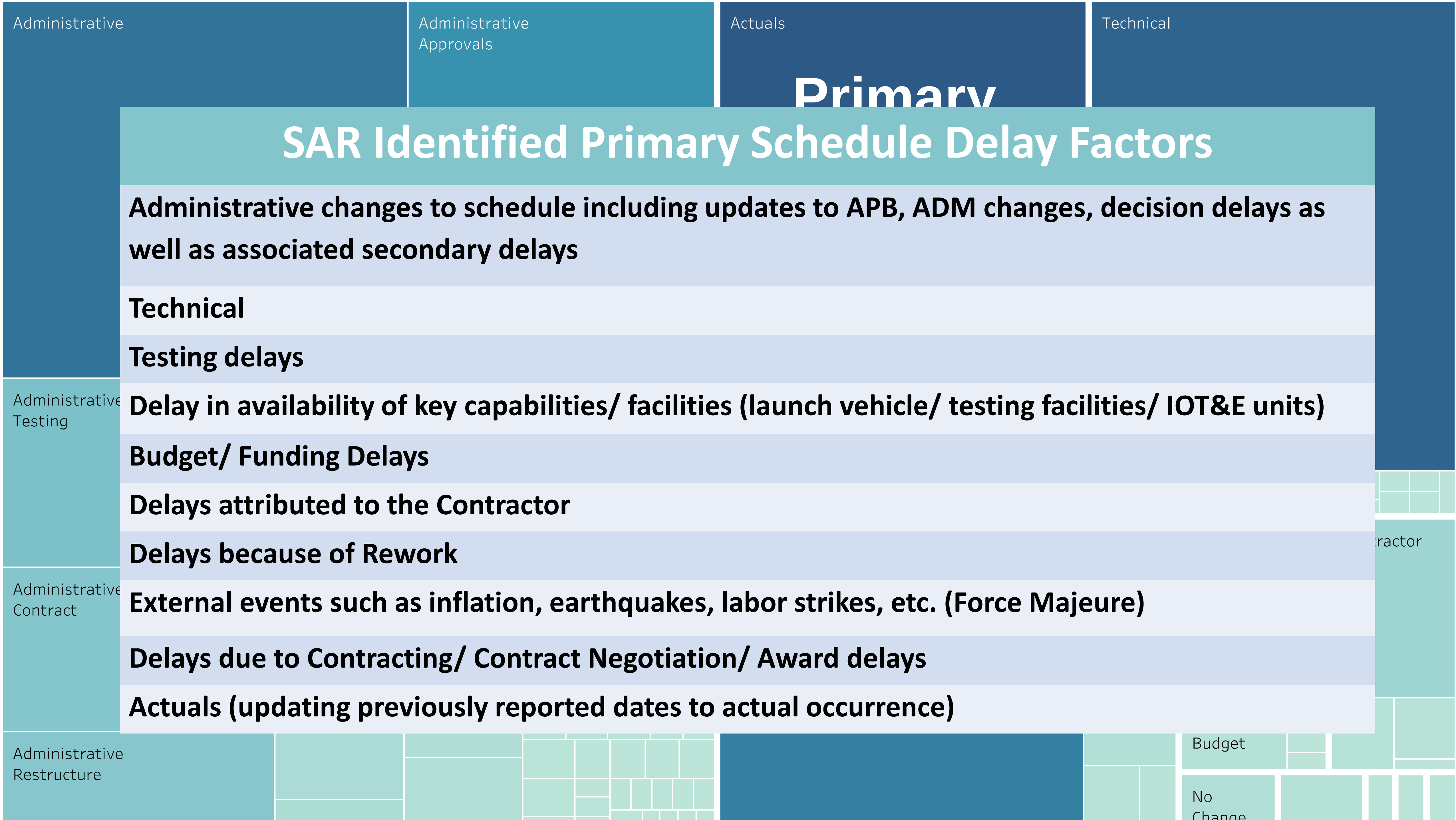


Systems Dynamics and other network models have value in explaining the nature of schedule delays

Data science, analysis and empirical models both provide the critical data necessary for schedule analysis and show the type of analysis that can be accomplished using Selected Acquisition data

Sophisticated mathematical models (based on EV) can interpret the causal structure associated with program schedule achievement but need more work

Schedule delays and causes can be identified through mining and analysis of acquisition data

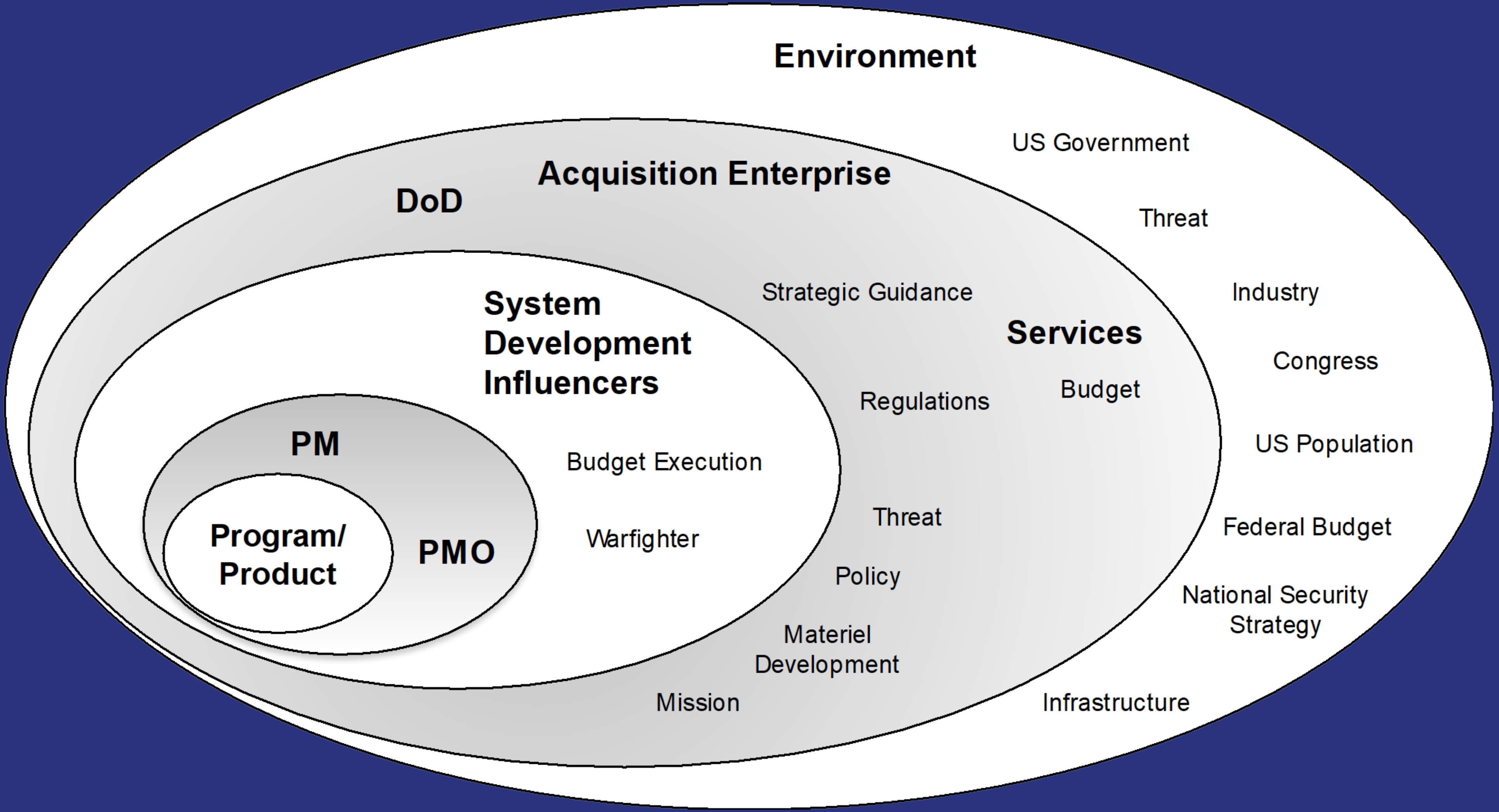


SAR Identified Primary Schedule Delay Factors
Administrative changes to schedule including updates to APB, ADM changes, decision delays as well as associated secondary delays
Technical
Testing delays
Delay in availability of key capabilities/ facilities (launch vehicle/ testing facilities/ IOT&E units)
Budget/ Funding Delays
Delays attributed to the Contractor
Delays because of Rework
External events such as inflation, earthquakes, labor strikes, etc. (Force Majeure)
Delays due to Contracting/ Contract Negotiation/ Award delays
Actuals (updating previously reported dates to actual occurrence)

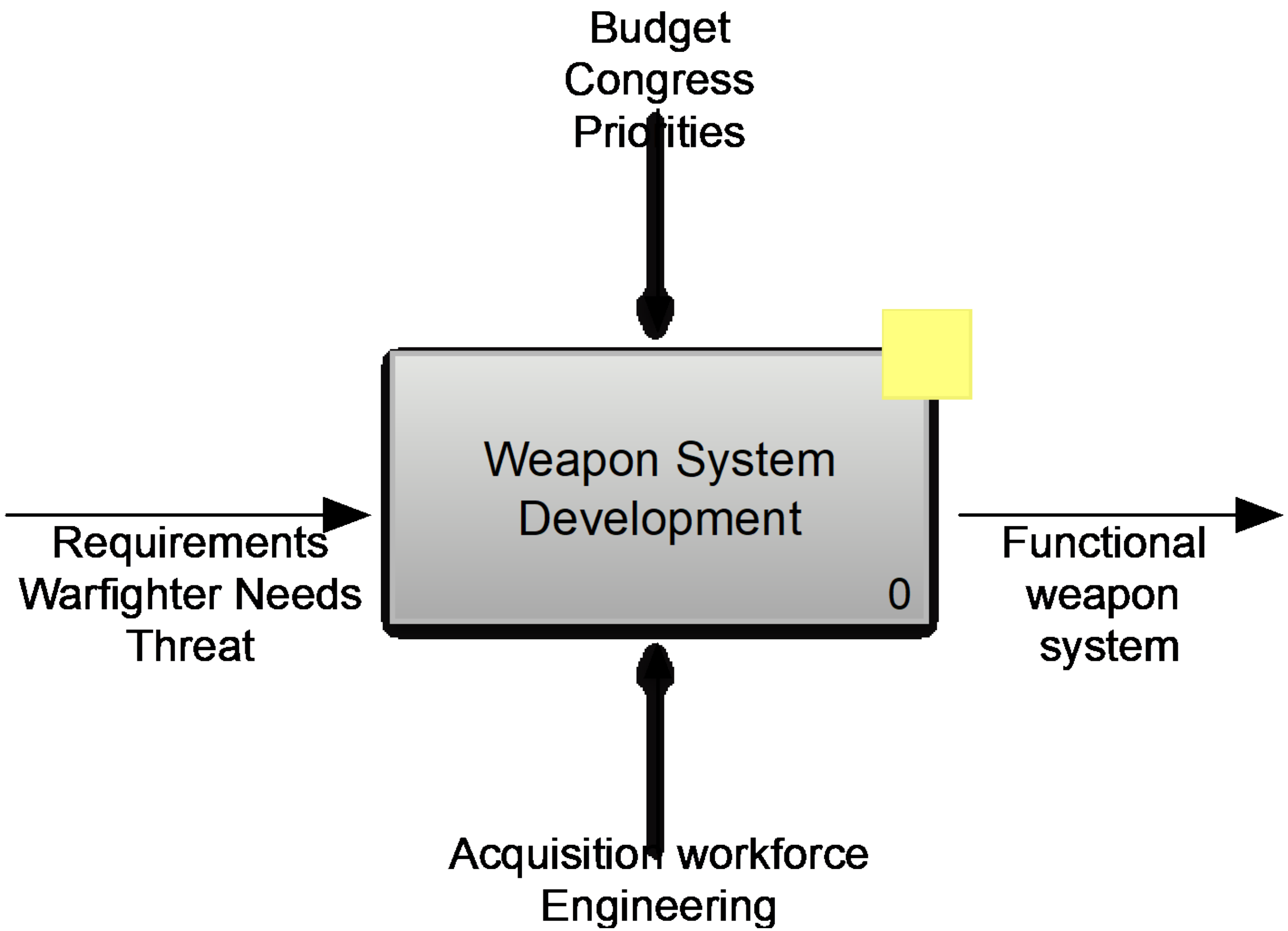
2019 Research Focus

- Research Question
  - *What analytical techniques and approaches can be applied to schedule analysis to increase the efficiency and effectiveness of schedule estimating and execution?*
- 2019 develops a theoretical framework to examine schedule delays using F-35 Case Studies
- We continue our exploration of schedule dynamics with an examination using a dynamic-focused framework and complexity informed by data

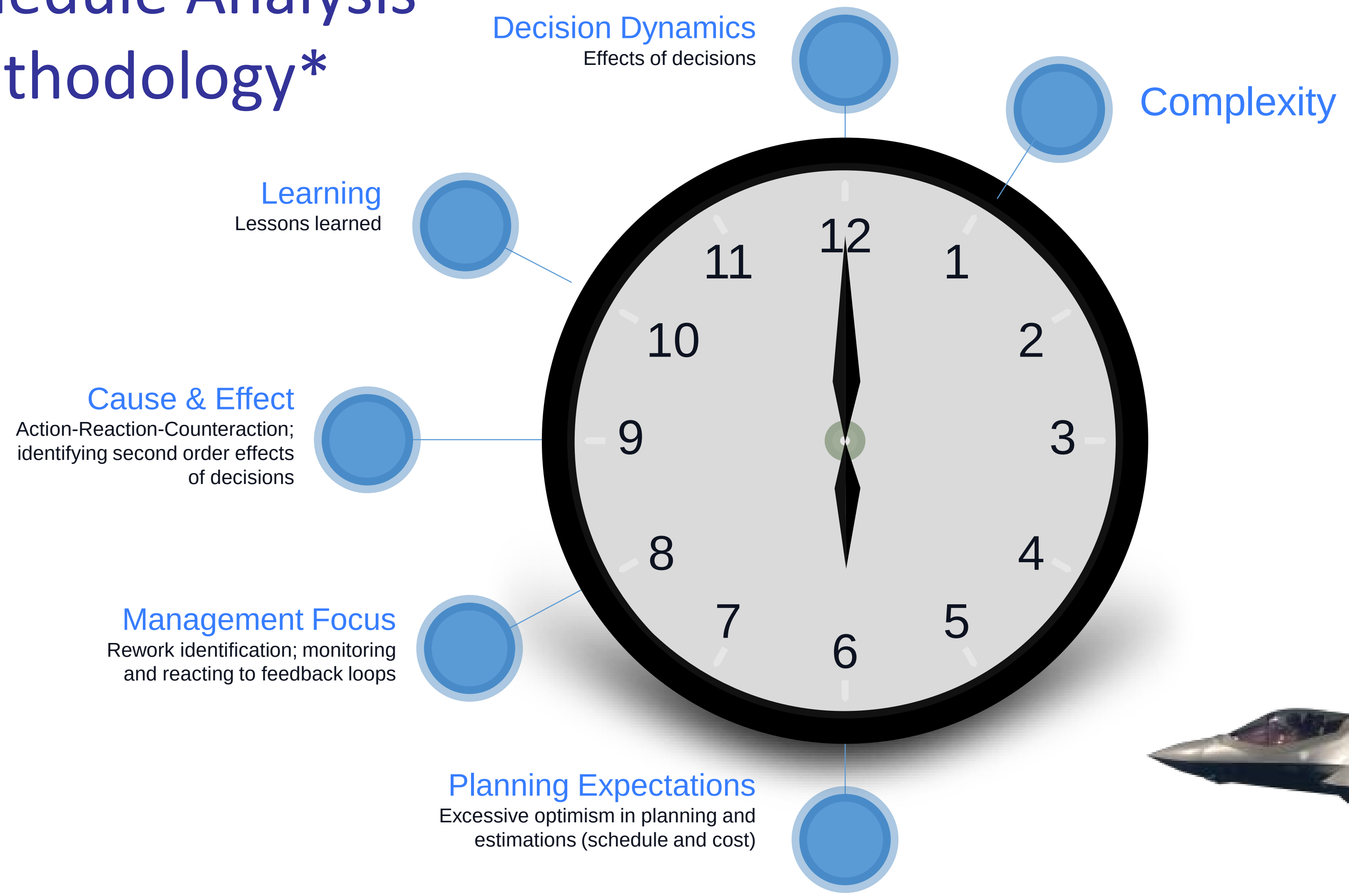
The “Weapon System Development” Environment



Development as System

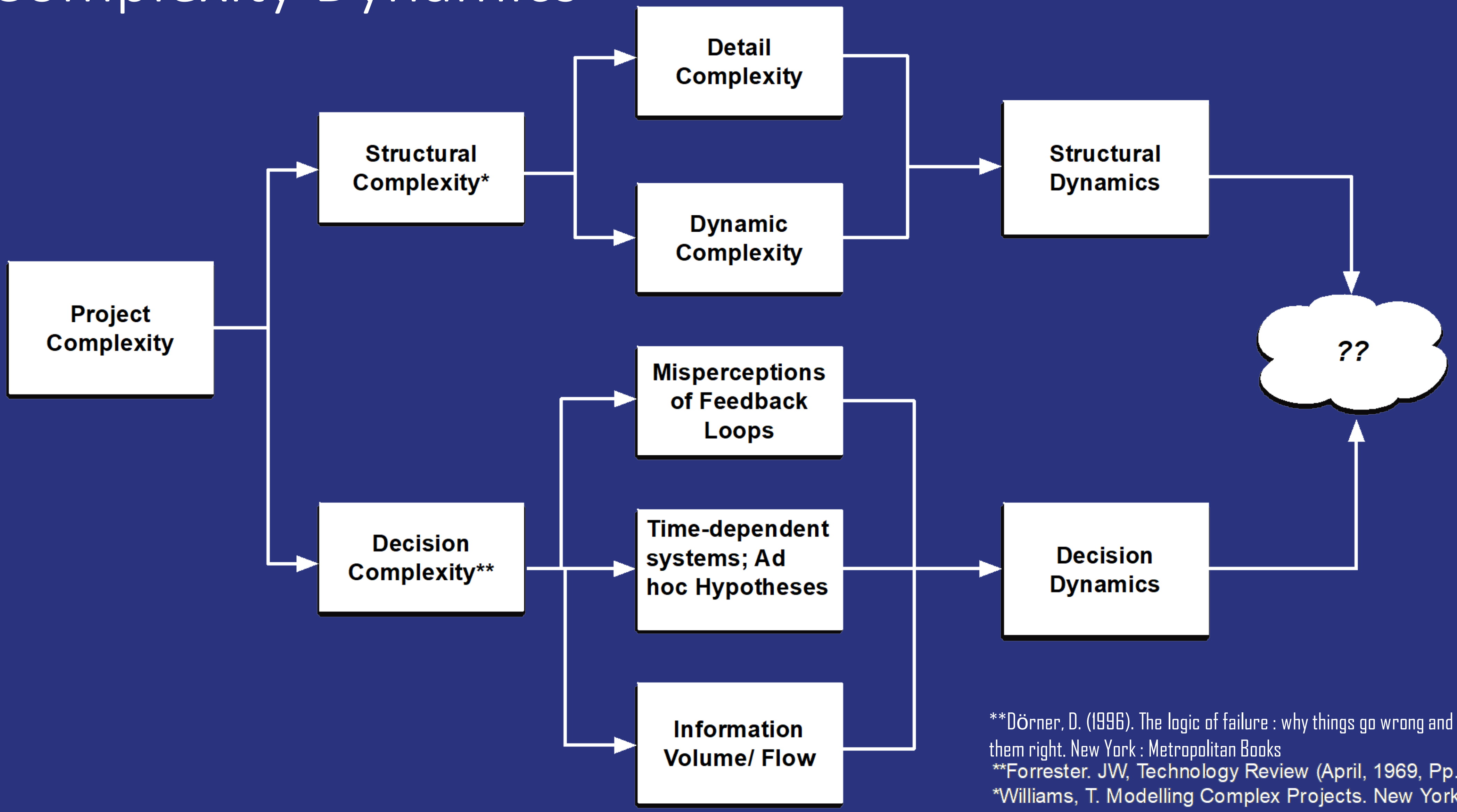


Schedule Analysis Methodology*



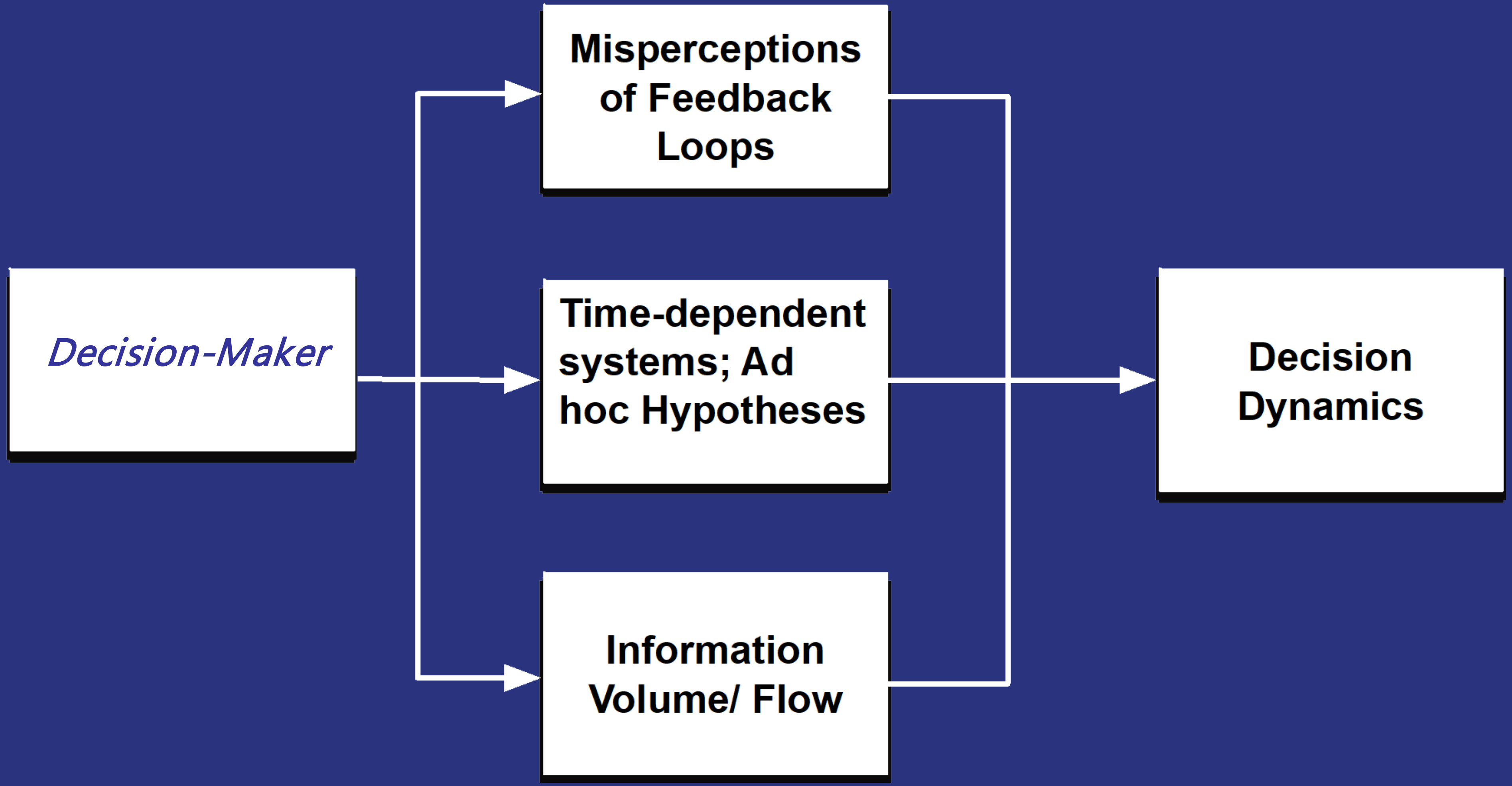
*After Cooper, K. G. (1998). Four Failures in Project Management. In *The Project Management Institute Project Management Handbook* (Jossey-Bass Business & Management Series). Jossey-Bass.

Complexity Dynamics



**Dörner, D. (1996). The logic of failure : why things go wrong and what we can do to make them right. New York : Metropolitan Books
**Forrester. JW, Technology Review (April, 1969, Pp. 21-31
*Williams, T. Modelling Complex Projects. New York, NY; Wiley

Decision Dynamics



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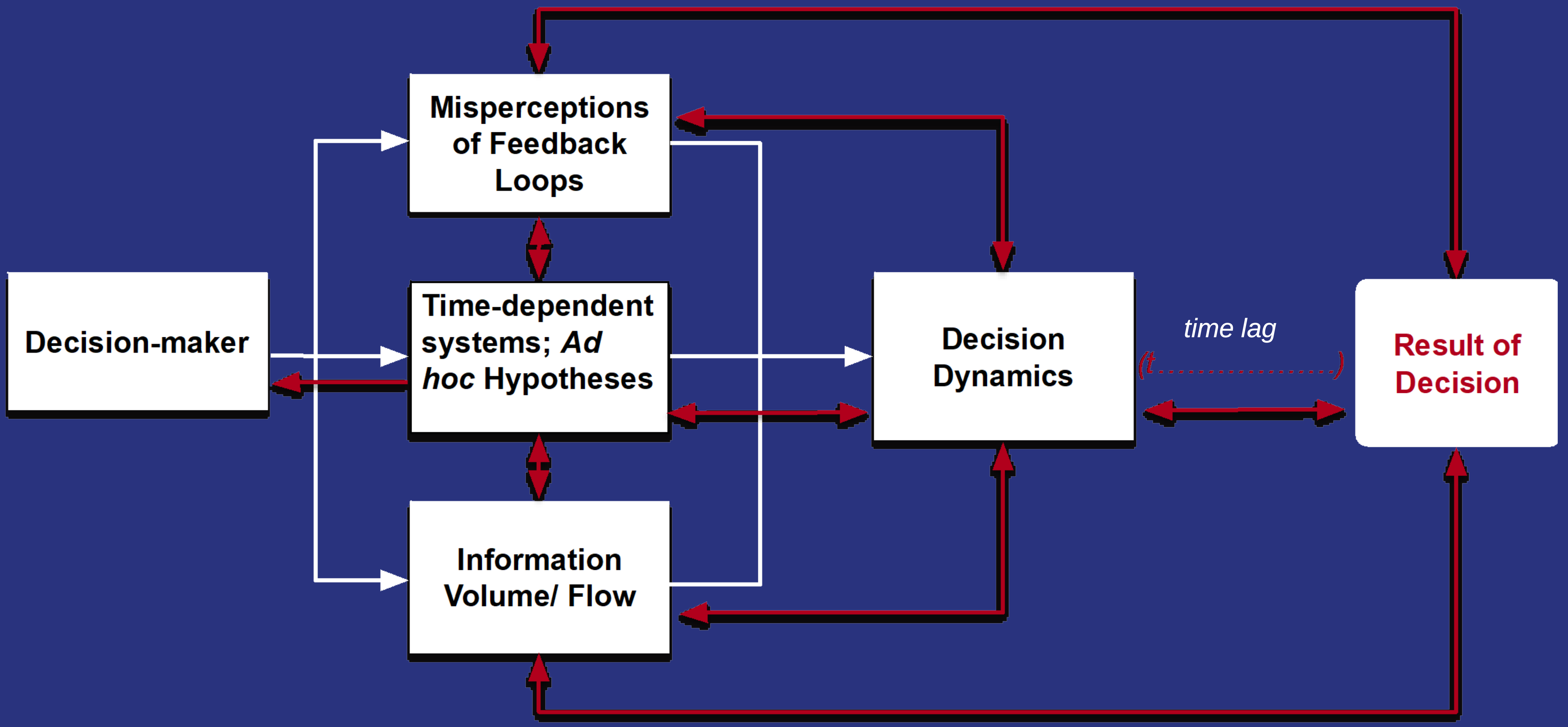
Decision Dynamics



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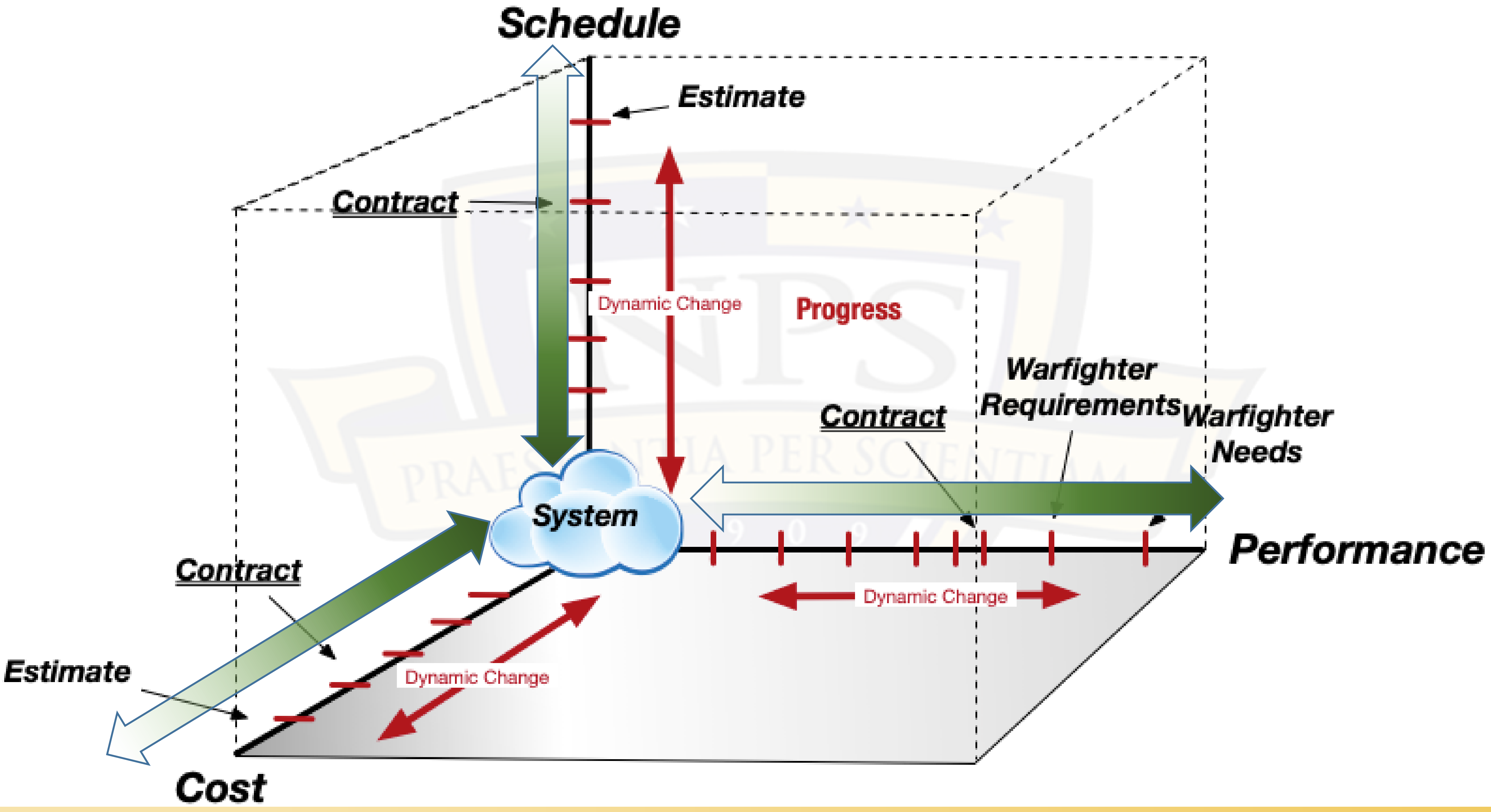
Notional Dynamic Environment



Analysis Framework

Events	Failure Modes			
	Planning Expectations	Management Focus	Cause & Effect	Learning
X-35 Prototype Assumption	D			D
Def Acquisition Reform Benefits	S			
Success-based Development Strategy	S		S	
Cost-reduction exercise		D	S,D	D
Estimation Methods		S		S
Weight Reduction Exercise		S,D	S,D	
F135 to F119 evolution		D	S,D	

D-Decision Dynamics; S-Structural Complexity

F-35 Weight Reduction Exercise (2004)

Previous Expectation (a root cause)	X-35 was close to a producible design (a “framing assumption”).
Early Execution	Pursuit of cost savings (“affordability”), with weight increases accepted. Reliance on previous weight-estimation methods.
Complexity	Old methods of weight prediction not accurate for 5^{th}-gen fighters. Emerging “bottom up” weight growth jeopardizes attaining KPPs.
Decision Dynamics	Stop everything and cut weight (April 2004) – with a high degree of emphasis (perhaps to the point of single-minded focus).
Effects	First-order effects included 18-month schedule stretch, $6B development cost increase. Less munitions carriage (B model). Reductions in commonality.
Future Problems	Long-term effects included greater manufacturing expense and structural issues.
Learning	Not clear. Record indicates that LM found a one-off problem and solved it.

Understanding how people deal with the dynamics present in every system is critical to the understanding of Schedule