



## Acquisition Research Program: Creating Synergy for Informed Change

# Systems Engineering Applied Leading Indicators

**Enabling Assessment of Acquisition Technical Performance**

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# ALI - Applied Leading Indicators (Part 1 of 2)

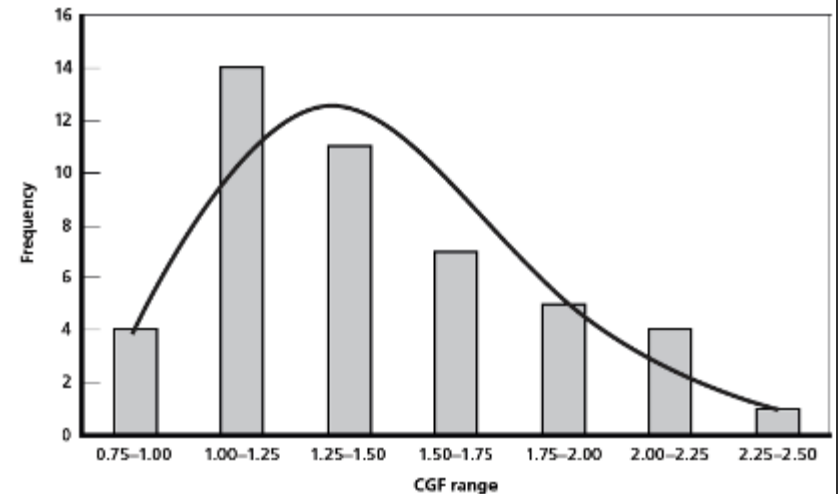
- What problem are we trying to solve?
- How do ALIs integrate into current management practices?
- How can ALIs benefit programs?



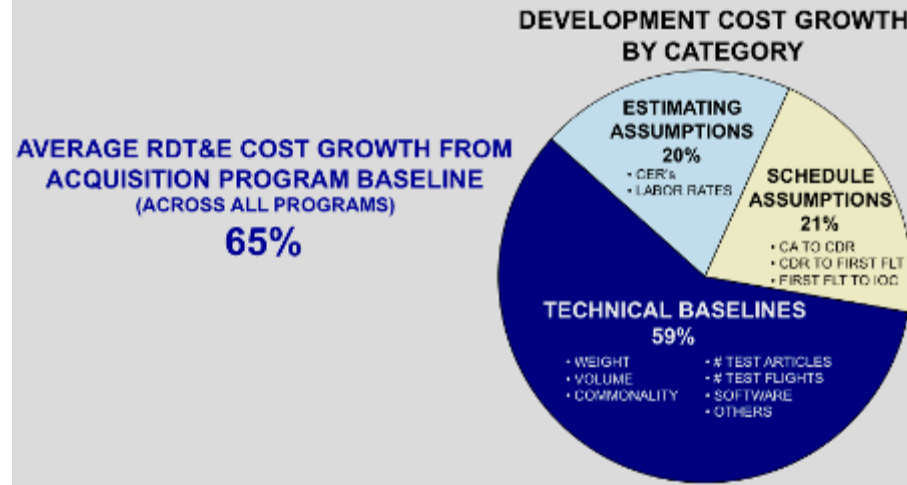
# What is the Problem?

- Cost
- Complexity
- Risk Control
- Integration
- Predictability
- Acceptability

Figure S.1  
Distribution of Total Cost Growth from MS II Adjusted for Procurement Quantity Changes



RAND TR266-S.1



# The SE – ALI Challenge

- Can we provide a **quantitative projection** of how varied and interrelated technical factors are impacting overall program performance?
- Can we provide **current and projected** program performance?
- Can we **fill a gap** that currently exists between technical measures and overall program performance measures?
- Can we **augment** current program health and status methods and tools with supporting and parallel technical methods?

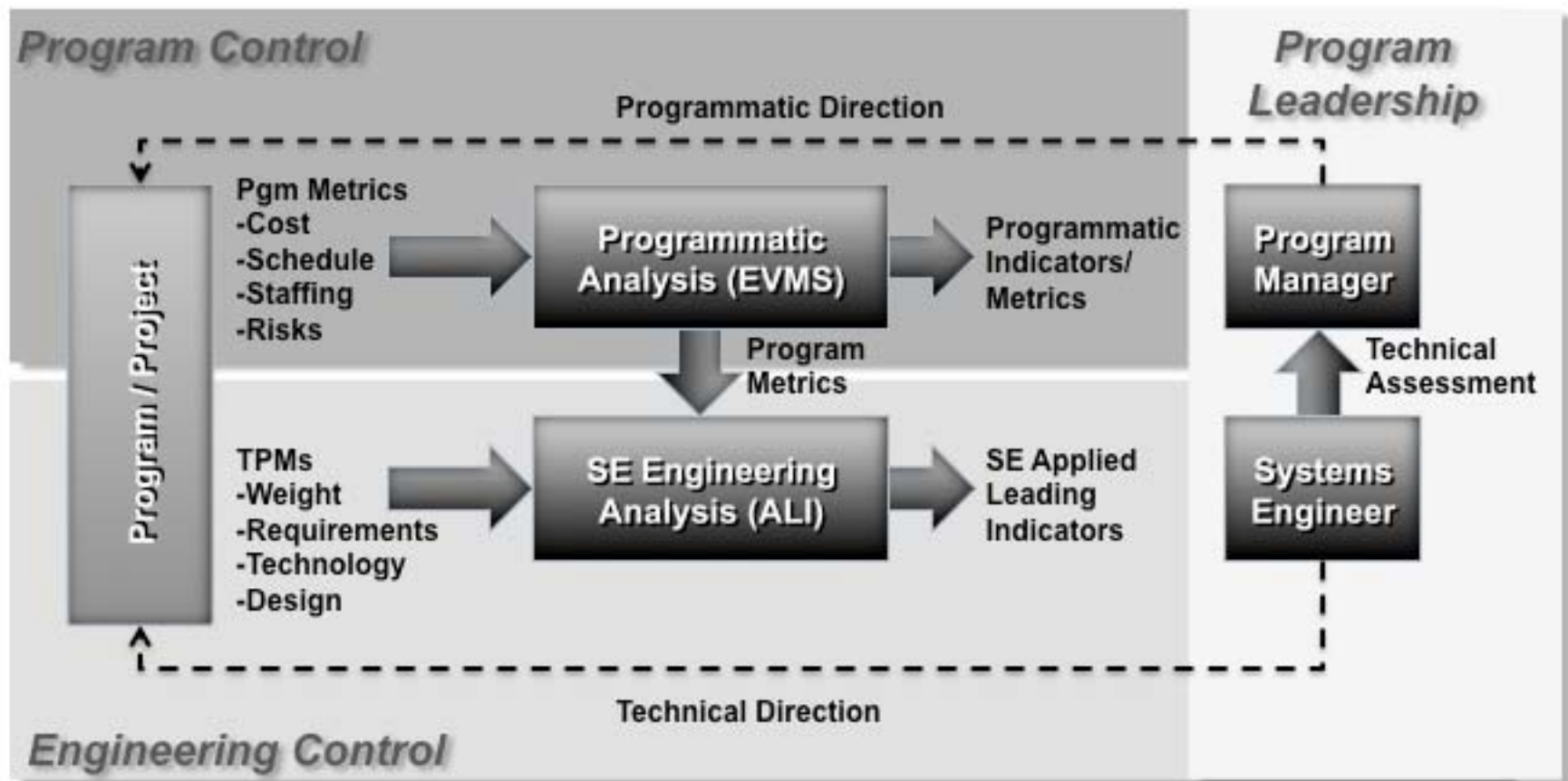


# ALI – Augments Program Management Processes

- **Program Metrics**
  - **Cost & Schedule** – based (EVM)
  - Focused upon actuals vs. planned data
  - Largely measures **now vs. past**
  - Projecting \$/time-to-complete based upon current trajectories
- **Risk Management**
  - Cost, schedule, and performance
  - Assessments heavily based on history, experience, and judgment
  - **Risk/issue** updates are based on **now**
  - Root cause analysis based on past performance and helps suggest course changes
- **SE Advanced Leading Indicators**
  - Collaborative with Program and Risk metrics
  - **Future**-focused (prognostic)
  - **Performance/technical**-focused (vice cost/schedule)
  - Provides needed SE insight of **technical interactions and dependencies** not readily apparent through other metrics



# ALI Augments Program Management





# SE Leading Indicators Examples

- Requirements volatility
- Design definition maturity / complexity
- Interface maturity/ complexity
- Verification & validation trends
- Technical review resolution trends
- Technical risks trends
- Technology maturity & adoption
- SE staffing & skills
- SE process compliance
- NAVAIR-unique
  - Aircraft weight trends
  - ...(TBD)

*Note: Some of these are currently measured as program TPMs but not used to develop prognostic technical indicators*



# ALI - Possible Value-Added Examples

- **EVM validation**
  - Your program looks good from cost, schedule, and milestone achievement. How does your program *technical* health compare to those who have gone before you with similar EVM assessments?
- **Integrated technical assessment**
  - You have recently re-baselined. How do the *complexity* of your design and recent *requirements volatility* impact your probability of meeting program and performance objectives?
- **Risk amplification**
  - Root cause analysis suggest several course corrections for your technical approach. What SE leading indicators help select a path?



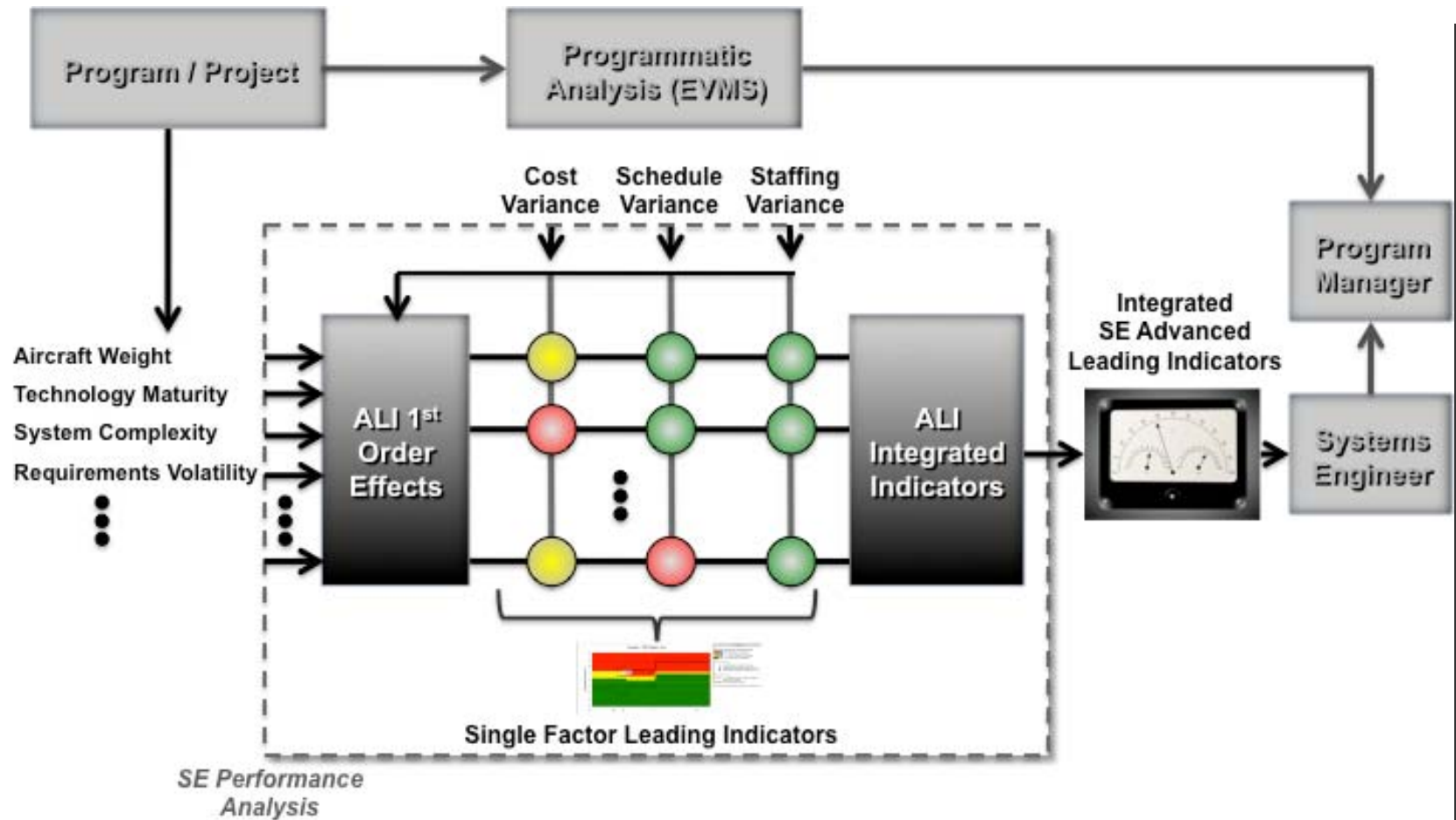


# ALI - Applied Leading Indicators (Part 2 of 2)

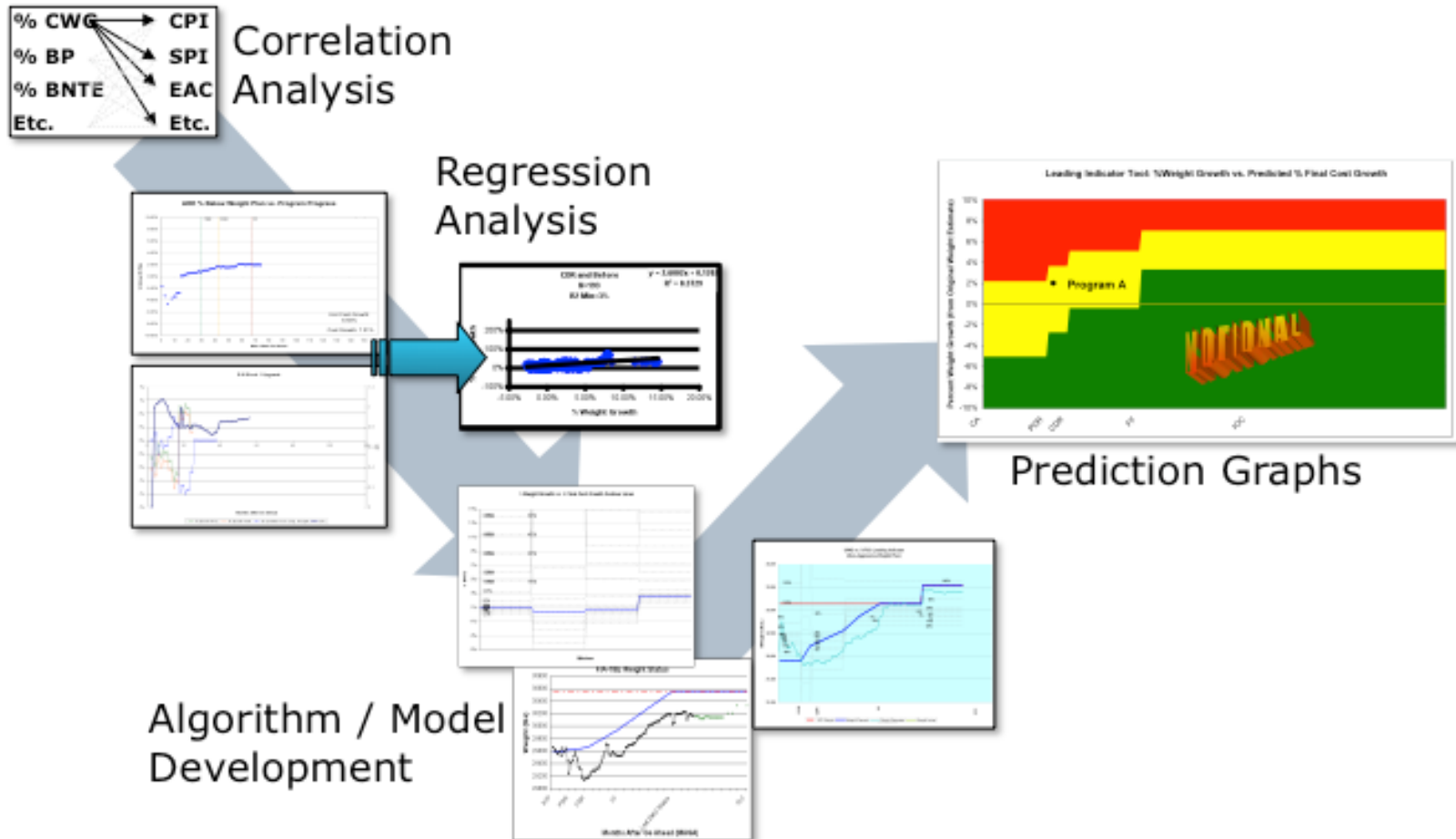
- How are we building ALIs?
- What have we learned?
- Where do we go from here?



# SE ALI Process Summary

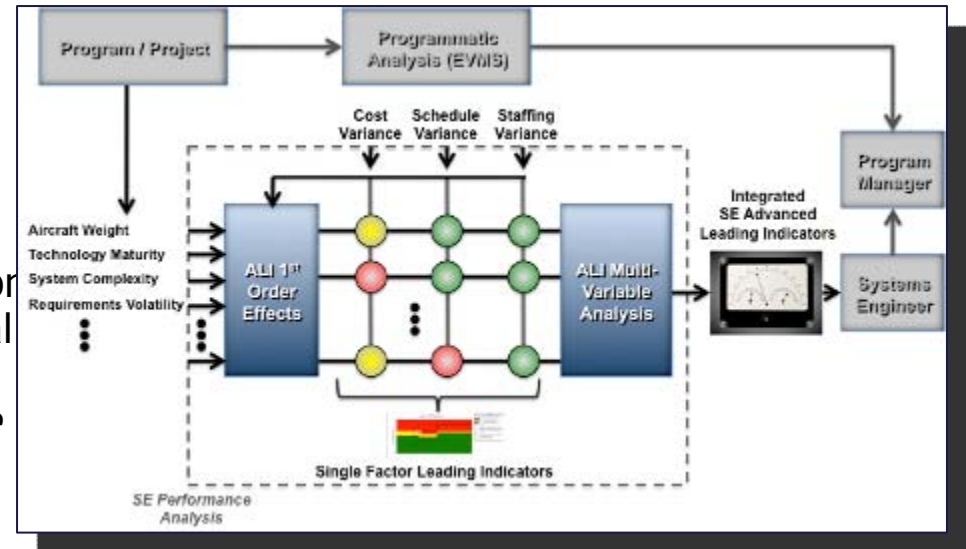


# ALI Analysis Method



# The SE-ALI Challenge (Progressing from Single to Multiple Variable Analysis)

- **Program performance**
  - Can we provide current and projected program performance using SE-based metrics? (*ALI single factor process– to date*)
- **Explaining inter-relationships**
  - Can we provide a quantitative projection of how varied and interrelated technical factors are impacting overall program performance? (*emerging Multi-Variable process*)
- **Enhance current metrics**
  - Can we fill gaps that currently exist between technical measures and overall program performance measures?
- **Supporting current methods**
  - Can we augment current program health and status methods and tools with supporting and parallel technical methods?



ALI Single Variable Analysis      ALI Multi-Variable Analysis





# Conclusions & Lessons-Learned: Data

- Data can be inconsistent and incongruent.
- Retention of data from various programs is sometimes incomplete leading to statistical analysis of sparse data.
- ALI metrics will emerge that can be recommended to be inculcated into the acquisitions to enable greater future ALI fidelity, granularity, and reliability.





# Conclusions & Lessons-Learned: Single Factor ALI

- Single factor ALI analysis
  - Development method was valid
  - Provided a basis for ALI tool prototyping
  - Obtained preliminary user acceptance, understanding, suggested improvements
  - Identified ALI concept shortfalls.
  - Users demand multi-factor ALI methods



# Conclusions & Lessons-Learned: Multi-Factor Analysis

- In very early stages.
- Leveraging single-factor analysis lessons-learned
- Applying multivariate statistical methods
- New GUI concepts
- Next steps will expand to other ALI factors, include actual data, validate multivariate models, and prototype a tool to obtain user acceptance feedback



# Conclusions & Lessons-Learned: User Acceptance

- Users recognize the need for ALIs
- They do not, however, want ALI to replicate EVM-based metrics and methods.
- They desire ALI methods to incorporate prediction inferences and judgments of the project engineering and management team to influence analytical output
- ALIs need to reveal mutual coupling of the multiple ALI factors, the overall impact to the program, and insights into how to respond, technically.



# Next Steps

- Multi-factor ALIs
- “Sea change” underway toward Total Ownership Cost (TOC) control at NAVAIR.
  - What are the salient TOC assessment goals and objectives?
  - What are the ALI metrics most relevant to TOC assessment?
  - What TOC ALI human interaction interfaces would be most useful to users?

