A Systems Engineering Perspective on Parts Management: Ideas for Future Initiatives

October 25, 2010
Presented to the
Parts Standardization and Management Committee Fall Conference

Outline

- **What's going on in the Systems Engineering Office**
- **Systems Engineering Design Considerations and Parts Management**
- **Rational Sourcing and Parts Management**
- **Conclusion**

Overarching Guidance (1 of 3)

- **Quadrennial Defense Review Executive Summary, February 2010**
  - ***Further rebalance the capabilities of America's Armed Forces to prevail in today's wars, while building the capabilities needed to deal with future threats***
  - ***Further reform the Department's institutions and processes to better support the current needs of the warfighter; buy weapons that are usable, affordable and truly needed; and ensure that taxpayer dollars are spent wisely and responsibly***
  - ***Preserve and enhance the All-Volunteer Force***
  - ***Improve how it matches requirements with mature technologies, maintains disciplined systems engineering approaches, institutionalizes rapid acquisition capabilities, and implements more comprehensive testing***
- **Quadrennial Defense Review Report Preface Secretary of Defense Robert M. Gates, February 2010**
  - ***United States needs a broad portfolio of military capabilities with maximum versatility across the widest possible spectrum of conflict***

Overarching Guidance (2 of 3)

"… as a matter of principle and political reality, the Department of Defense cannot go to the America's elected representatives and ask for increases each year unless we have done everything possible to make every dollar count. Unless there is real reform in the way this department does its business and spends taxpayer dollars."

Excerpt from remarks delivered by Secretary of Defense Robert M. Gates, Abilene, Kansas, on the 65th anniversary of the allied victory in Europe, May 8, 2010

"The department has set a goal of finding more than $100 billion in overhead savings over the next five fiscal years, starting in FY '12. As a matter of principle and political reality, we must do everything possible to make every taxpayer dollar count."

Excerpt from remarks delivered by Secretary of Defense Robert M. Gates, DoD News Briefing at the Pentagon, June 28, 2010

Overarching Guidance (3 of 3)

"On June 28, I wrote to you describing a mandate to deliver better value to the taxpayer and warfighter by improving the way the Department does business. I emphasized that, next to supporting our forces at war on an urgent basis, this was President's Obama's and Secretary Gates' highest priority for the Department's acquisition professionals. To put it bluntly; we have a continuing responsibility to procure the critical goods and services our forces need in the years ahead, but we will not have ever-increasing budgets to play for them. We must therefore strive to achieve what economists call productivity growth; in simple terms, to DO MORE WITHOUT MORE. ..."

Excerpt from Under Secretary of Defense (Acquisition, Technology and Logistics), Ashton B. Carter, MEMORANDUM FOR ACQUISITION PROFESSIONS, Subject: Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending, Sept 14, 2010

Systems Engineering Mission

Develop and grow the Systems Engineering capability of the Department of Defense – through engineering policy, continuous engagement with Component Systems Engineering organizations and through substantive technical engagement throughout the acquisition life cycle with major and selected acquisition program offices.

A robust Systems Engineering capability across DoD requires attention to Policy, People and Practice.

Apply best engineering practices to:

- **Support and advocate for DoD Component initiatives**
- **Help program managers identify and mitigate risks**
- **Shape technical planning and management**
- **Provide technical insight to OSD stakeholders**
- **Identify systemic issues for resolution above the program level**

Systems Engineering Organization

Director, Systems Engineering
Steve Welby

Vacant, Principal Deputy

Systems Analysis
Kristen Baldwin

Addressing Emerging Challenges on the Frontiers of Systems Engineering

- Analysis of Complex Systems/Systems of Systems
- Development Planning/Early SE
- Program Protection/Acquisition Cyber Security
- University and Industrial Engineering Research
- Modeling & Simulation Coordination

Major Program Support
James Thompson

Supporting USD(AT&L) Decisions with Independent Engineering Expertise

- Engineering Assessment / Mentoring of Major Defense Programs
- Program Support Reviews
- OIPT / DAB / ITAB Support
- Systems Engineering Plans
- Systemic Root Cause Analysis

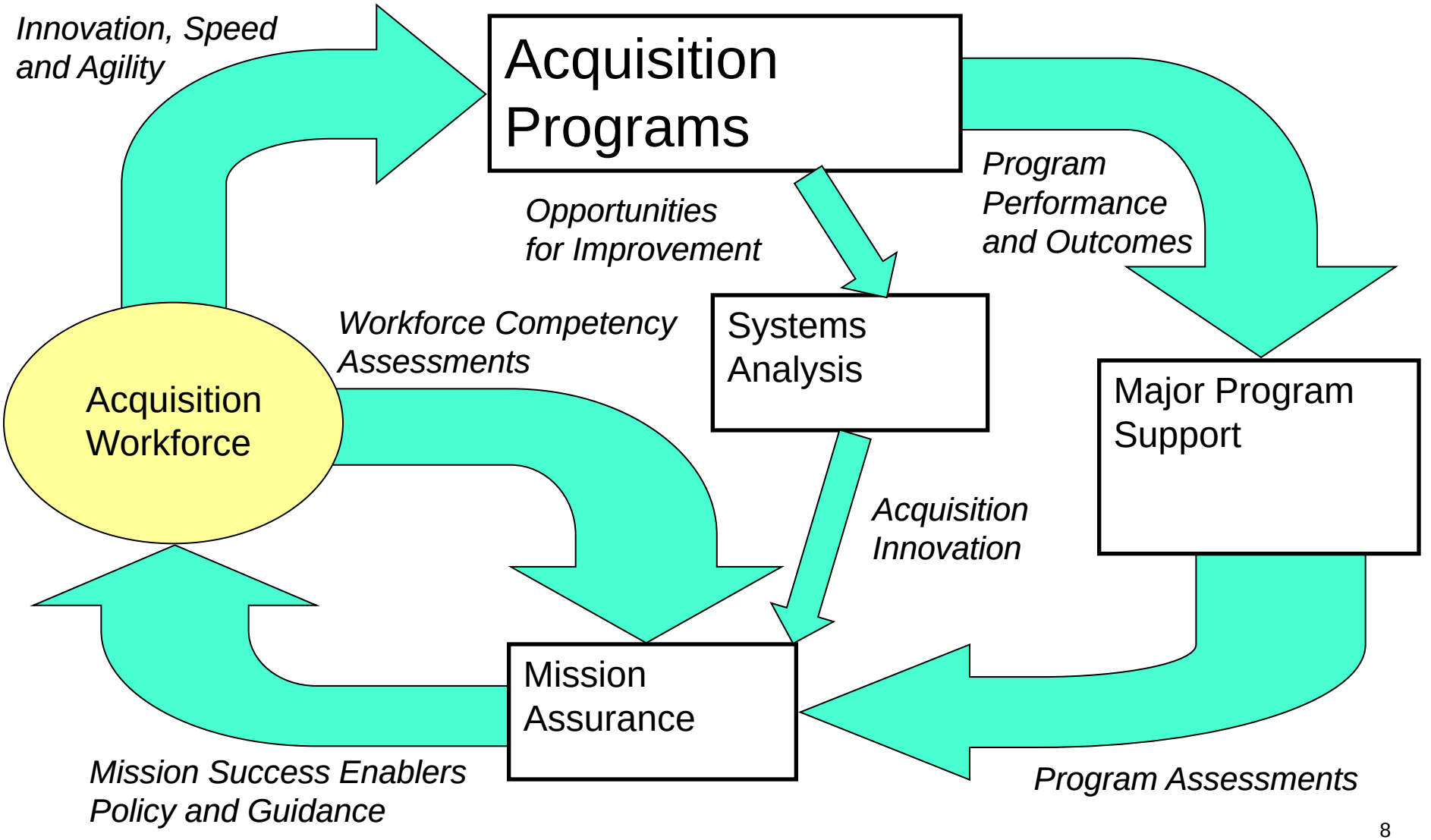
Mission Assurance
Nicholas Torelli

Leading Systems Engineering Practice in DoD and Industry

- Systems Engineering Policy & Guidance
- Specialty Engineering (System Safety, Reliability / Availability / Maintainability, Quality, Manufacturing, Producibility, Human Systems Integration (HSI))
- Technical Workforce Development
- Standardization

Providing technical support and systems engineering leadership and oversight to USD(AT&L) in support of planned and ongoing acquisition programs

Systems Engineering Organization Designed to Improve Acquisition Program Performance



Components of Affordability from a Parts Management Perspective

- **Develop designs that minimize the number of unique or specialized parts used in a system to**
  - **Reduce logistics footprint**
  - **Lower total ownership cost**

  by streamlining the selection of preferred or commonly used parts typically described by non government standards, military standards, or parts already in use
- **Flow down parts requirements to suppliers to assure quality and manage obsolescence**

Affordability emphasis derived from overarching guidance

SE Goals for Parts Management

- **Ensure parts management is adequately reflected in SE policy and guidance**
- **Exploit parts management contributions to manufacturing readiness**
- **Build on the parts management relationship to RAM**
- **Conduct outreach on the importance and benefits of a proactive parts management approach**

SE Goals for Parts Management Align with Affordability Perspectives

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Each of the SE goals for parts management impacts parts management's contributions to affordability

Outline

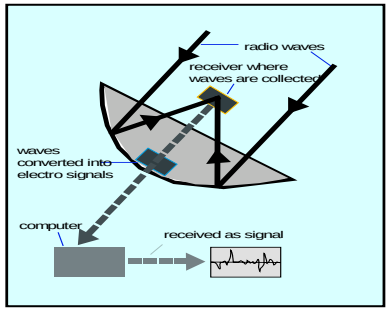
- What's going on in the Systems Engineering Office
- Systems Engineering Design Considerations and Parts Management
- Rational Sourcing and Parts Management
- Conclusion

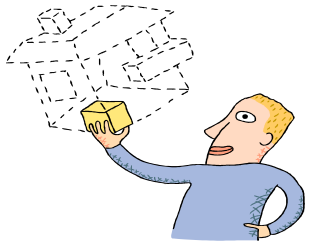
What Is a Design Consideration

Design Specifications

Desired Capabilities

System Characteristics





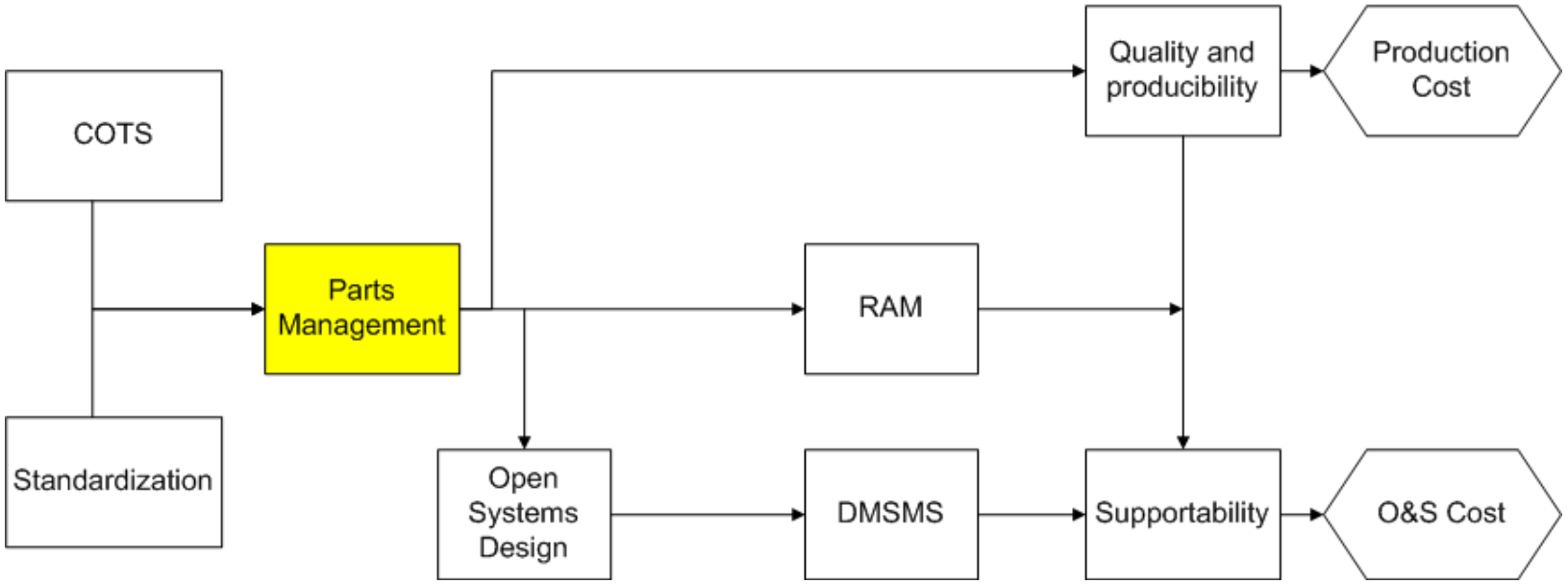
Design Considerations

Design considerations are used to translate system characteristics into design specifications. They specify constraints and enable tradeoffs.

Defense Acquisition Guidebook SE Design Considerations in Alphabetical Order

- Accessibility
- COTS
- Corrosion prevention and control
- Disposal and demilitarization
- DMSMS
- ESOH
- HSI
- Insensitive munitions
- Interoperability
- Open system design
- Parts management
- Program protection and system assurance
- Quality and producibility
- Reliability, availability and maintainability
- Software
- Spectrum management
- Standardization
- Supportability
- Survivability and susceptibility
- Universal identification of items

A Parts Management-Centric View of Systems Engineering Design Considerations



An Idea on How to Evolve this Situation

- **Trends in commercial electronics are limiting the ability of parts management to accomplish its objectives**
  - **Parts management is necessary but may not be sufficient because the same part may be produced from different materials and processes**
  - **Example: lead free solder**
    - **Solder joints more brittle**
    - **Prevalence for tin whiskers**
    - **Higher melting temperature affects the board**
    - **Suppliers do not change part number when different solders used**
- **Materials and process management should also become a design consideration to work in conjunction with parts management**

Benefits

- **Risks to defense systems can be better managed**
- **Designs can compensate when critical parts cannot be guaranteed to be lead free**
- **Parts quality and reliability can be improved**
- **Procurement can compensate for the prevalence of lead-free parts on the market**
- **Maintenance procedures can be developed to deal with the various materials that may be found in the market**
- **Inventory can be screened to reject lead-free critical parts**

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What Is Rational Sourcing

- Emerging commercial trend
- Requires a rational part family hardware design
  - Can be fully described by attributes some of which (termed features) can be turned on or off
  - Some attributes may be standardized in defining a family
  - Family of parts usually represented by single design drawing
- Uses a parametric cost model to buy hardware
  - Cost defined as a function of the attributes (and volume)
- Lowers costs for buyers, increases profit for suppliers

Enables parts management to be carried out for families of parts

Rational Hardware Design Example

Bolts

- **Bolt attributes**
  - **Thread size**
  - **Length**
    - **Overall**
    - **Head**
    - **Threaded and non-threaded portions**
    - **Tapers**
  - **Diameter**
  - **Material**
  - **Wrenching configuration (what the bolt head looks like)**

Description of a Design Drawing for a Family of Parts

- **Picture of the part, labeling all of the attributes and features**
- **Matrix defining all possible combinations**
  - **Rows represent the parts in the family (labeled by part number)**
  - **Columns represent the attributes**
  - **Cells contain the possible values of the attributes**
- **Quality requirements**
- **Values of the standardized attributes**

Techniques for Developing a Parametric Cost Model for a Family of Parts (1 of 7)

Fuel Manifold

Cost = -4083 + (349 * Weight) + (785 * Style/Material) + (82923 * Fuel Rail Wall Thickness)

Tube-Hoses

Mature (100th) Hose Price = 186* Assembly Weight + 88.4* Number of Welds + 249

Small Inco 625 Sheet Metal Brackets

Mature Cost = 6.43 + 5.21 Welds + 1.26 Holes + 9.29 Spring Clip + 5.66 Spacer + 0.609 Area

321 Stainless Steel Tubes

100th Part Cost = $10.9 + $178*non-std fittings + $94 (if .035 wall vs .028) + $44*# welds + $20* # brazes

Titanium Tubes

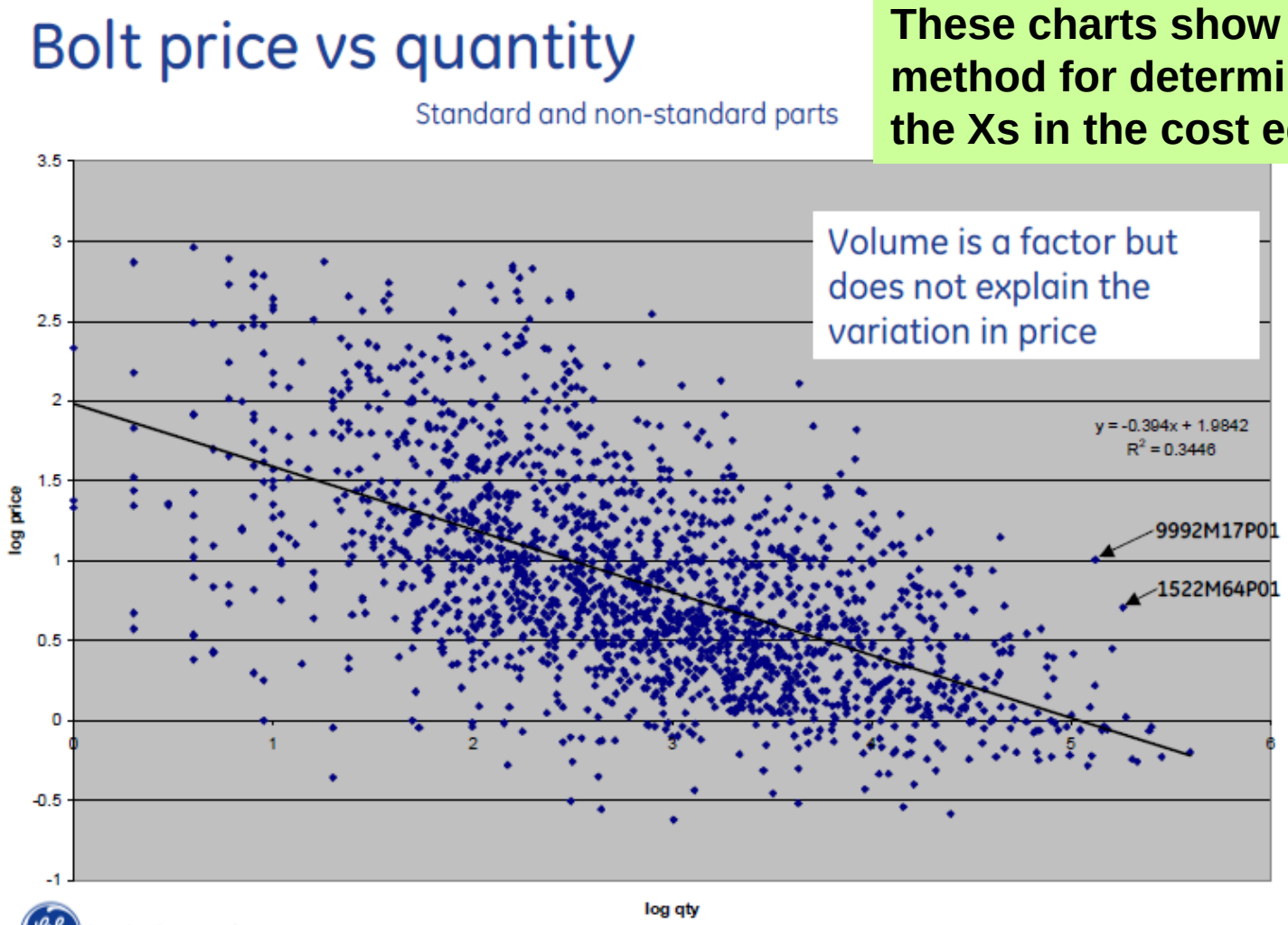
Mature Tube Cost = - 292 + 765 *Tube Diameter + 163 *bolted flanges + 176 *fittings + 333 *specialty Fittings

The end product is a parametric part family cost equation

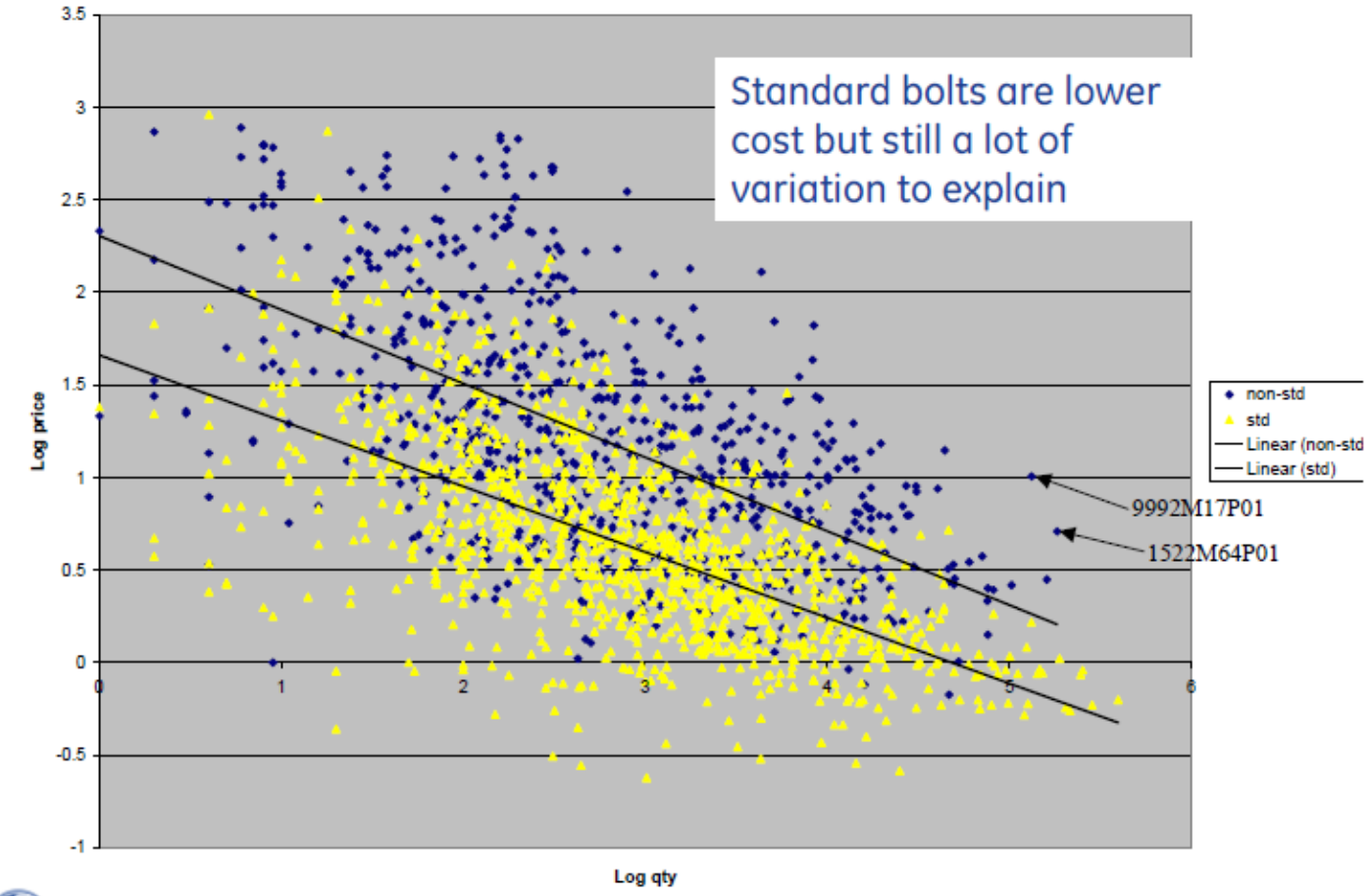
imagination at work

Techniques for Developing a Parametric Cost Model for a Family of Parts (2 of 7)

These charts show one method for determining the Xs in the cost equation



Techniques for Developing a Parametric Cost Model for a Family of Parts (3 of 7)



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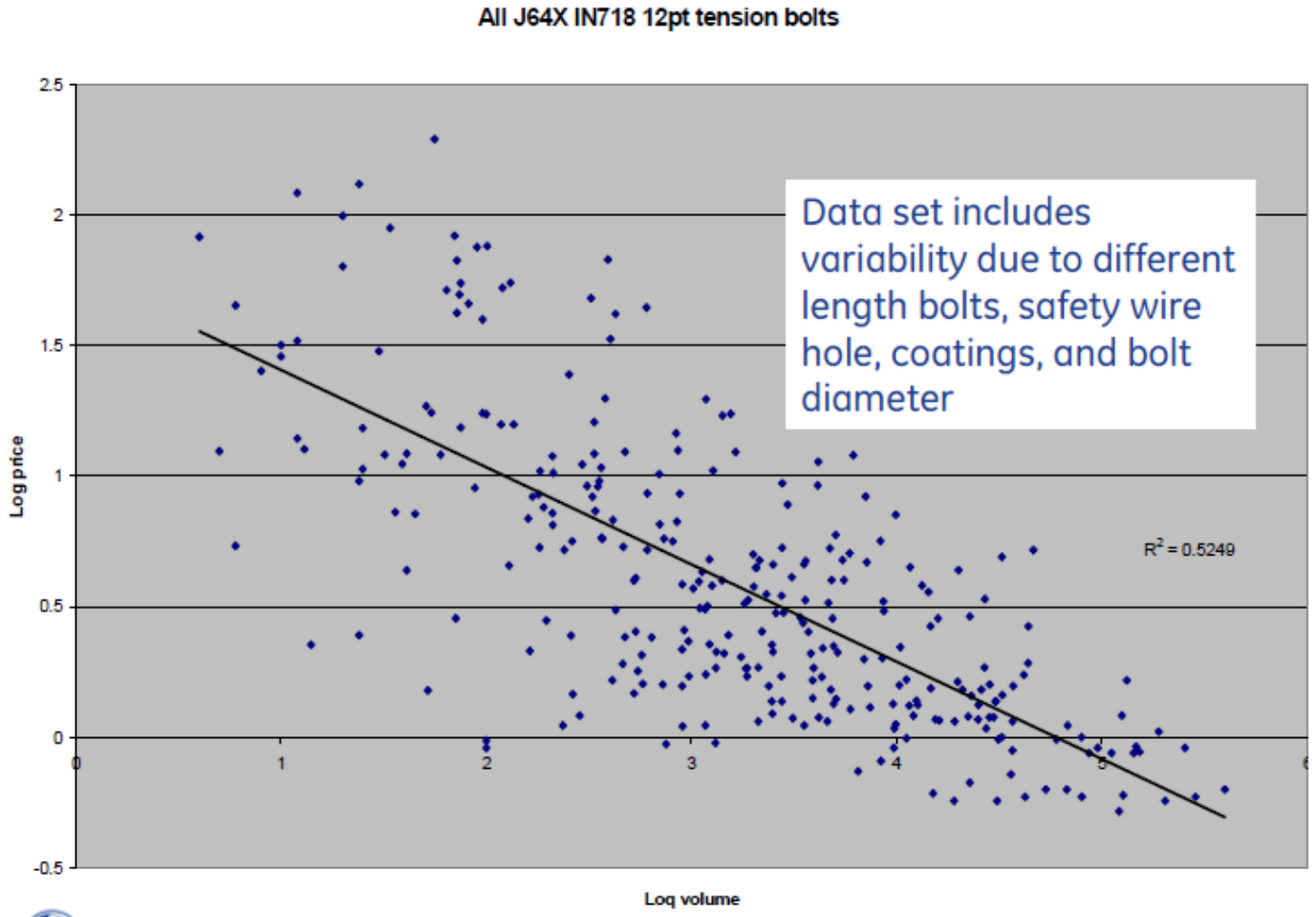
Techniques for Developing a Parametric Cost Model for a Family of Parts (4 of 7)



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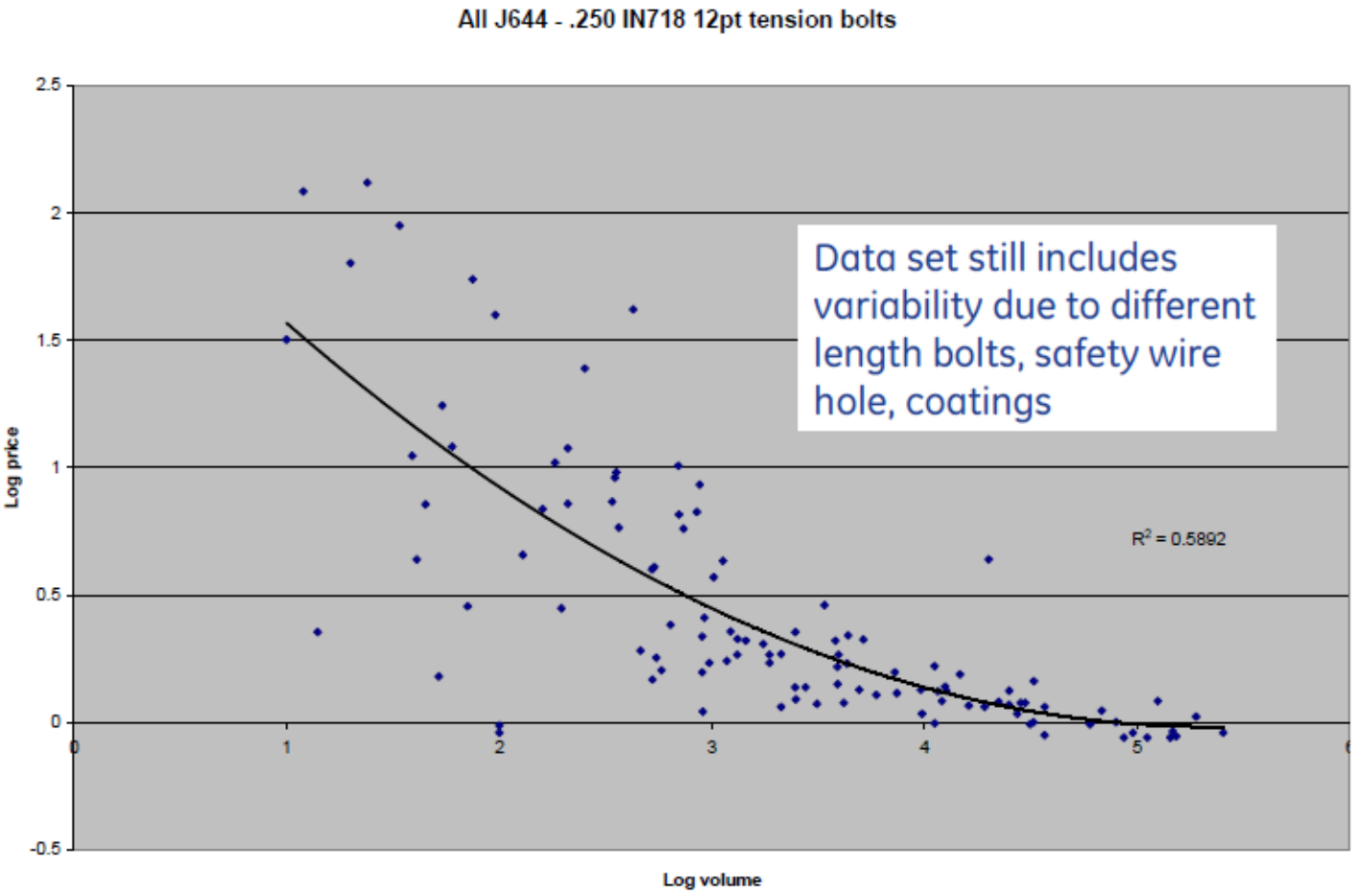
Techniques for Developing a Parametric Cost Model for a Family of Parts (5 of 7)



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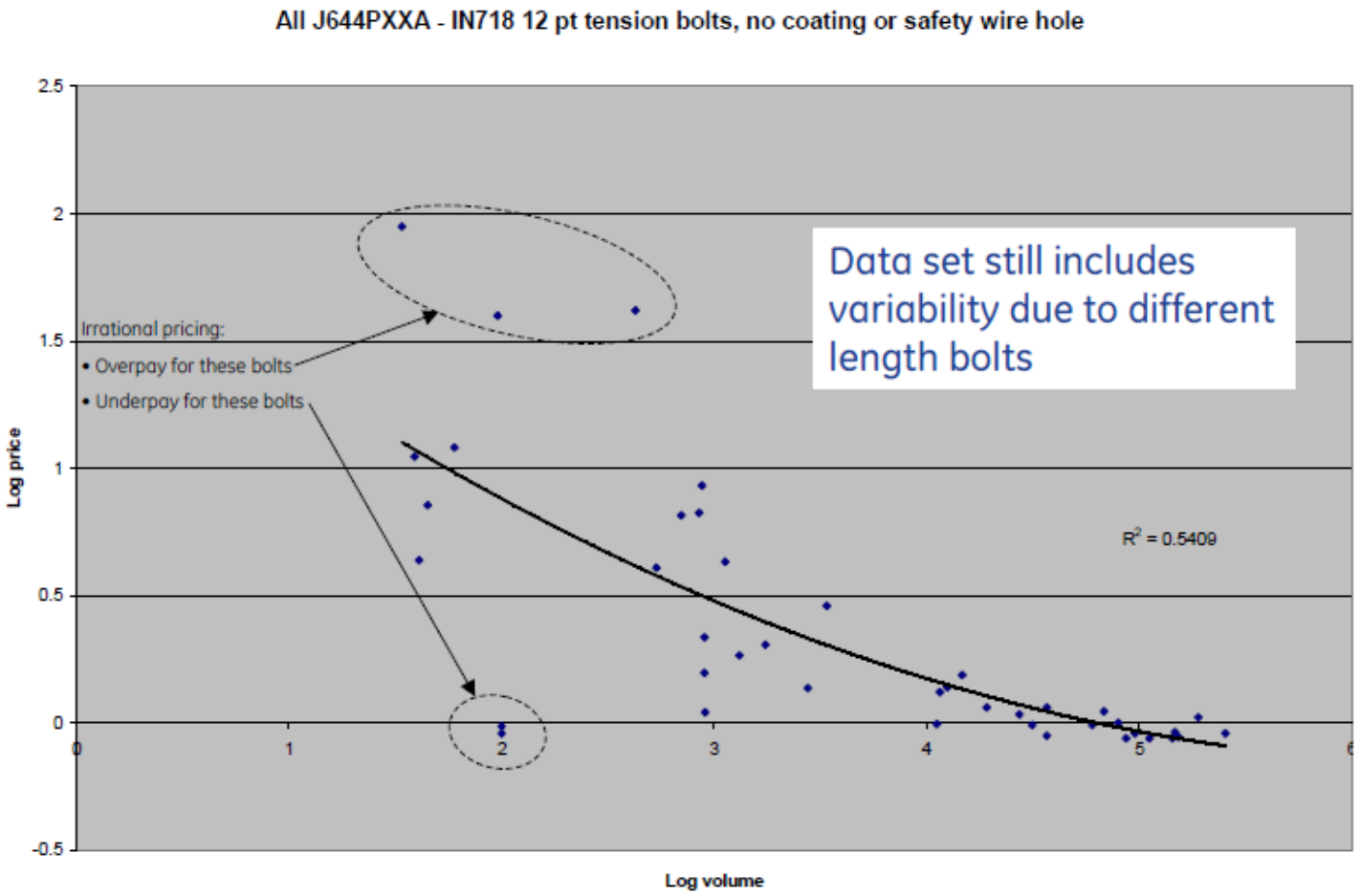
Techniques for Developing a Parametric Cost Model for a Family of Parts (6 of 7)



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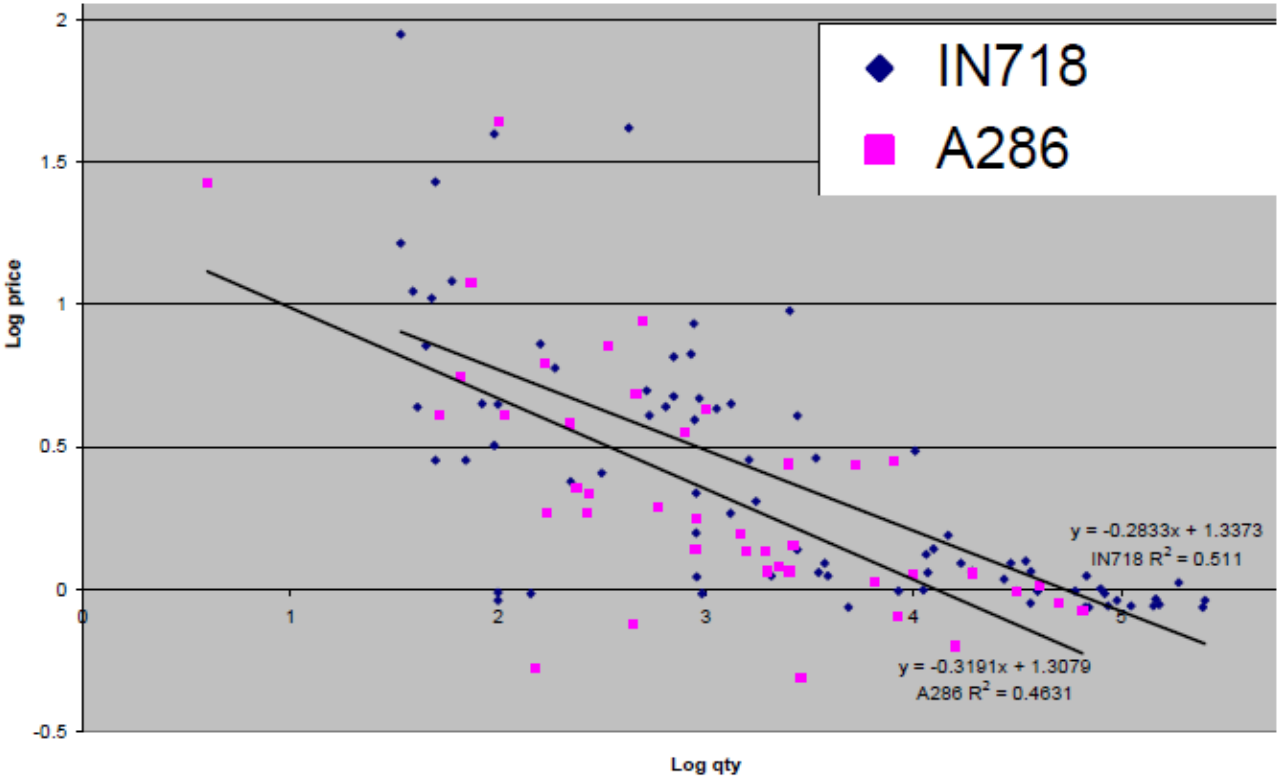
Techniques for Developing a Parametric Cost Model for a Family of Parts (7 of 7)

Once the key Xs are determined you can develop a strawman cost equation

Does Material Matter?

¼" Tension bolts



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An Approach for Implementation

- Determine the attributes to be standardized (define the family)
- Determine which attributes are always present as independent variables in the cost model (base design attributes)
- Determine which attributes can be turned on or off (features)
- Create a design of experiments (parts, quantities to quote) to enable the development of a cost equation
  - Only do this if there are a large number of combinations, otherwise get a quote on all parts in the matrix
- Issue the RFP
- Receive bids
- Build cost equation for base design attributes and feature add-ons
- Negotiate final cost model with selected suppliers

Benefits

- Engineers can improve cost-performance trade-offs by integrating the parametric cost models with their design tools
- Preferred parts lists attain greater flexibility since the table in the design drawing can be easily expanded with another row
- DoD will pay lower prices for preferred parts because suppliers costs are less
  - Economies of scale apply to multiple parts
  - Creates efficiencies for scheduling and tooling
  - No need to re-cost for every buy, the prices are pre-negotiated
  - Increases opportunities for sales
- DoD parts procurement overhead will be reduced by using a single RFP for multiple parts

Applicable to expensive parts (e.g., engine disks) as long as part differences are mostly scale and material

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Conclusions

- **The systems engineering process determines the best parts to be used in a system in a way that balances other factors that may affect program outcome**
- **Parts management today is designed to support systems engineering and affordability and is organizationally placed and structured to make this support effective and efficient**
- **There are some new systems engineering challenges and opportunities that affect parts management**
  - **Lead-free soldering in commercial electronics**
  - **Rational sourcing enabled by rational design**
- **The parts management community needs to continue its forward looking approach to promoting affordability by meeting these challenges**

Potential Actions for the Parts Management Community

- **Updates to Parts Management Guide (SD 19) and MIL-STD-3018 to reflect**
  - **Interactions with materials and process management**
  - **Extension of parts management principles to families of parts**
- **Amplified guidance for industry practices, e.g., Preferred Parts List development, subcontractor management, …**