ASC Engineering Directorate

Integrity - Service - Excellence

Sound Systems Engineering, Assures Proper/Early Producibility

U.S. AIR FORCE

Dr. Thomas F. Christian,
Richard Stepler, Hamid Akhbari
Aeronautical Systems Center
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Manufacturing & Quality in Systems Engineering

- Why are we here?
  - Are there really deficiencies in our Systems Engineering Process or is there a problem in execution ?
  - What metrics are our critics using to gauge our performance?
    - Failures to make rate, cost, and schedule in production
    - Unresolved engineering issues from the development phase manifest themselves as cost and rate failures detected during LRIP and Production
  - Fixing the root cause of manufacturing problems means including manufacturing as a mandatory discipline in the System Engineer tool set during design and development
- My perspective on the Past, Present, and Future of Manufacturing and Quality involvement in Systems Engineering

Overview

- Where we were ►

- Where we are ►

- Where we are going ►

Where We Were: M&Q in America

- Ahhh…."The Good Old Days"?

  …..Were they as "good" as we remember…
  - Separation of design and manufacturing functions
    - Transition to production always problematic
      - LRIP created to address problem but only addressed symptoms
    - Major redesigns of components required to achieve desired production rates
      - Producibility changes euphemism for "we can't afford to build what you designed"
    - Cost high: low first pass yields and traveled work
    - Schedule fluctuations due to excessive "work in process"
  - Quality by inspection
    - The most expensive and least effective approach
      - Build-test-fix-retest-fix-retest-----who pays for quality

Where We Were: M&Q in America

- Need proof?
  - Back in the 1970s, how long did your domestic car last?
- Corporate commitment to quality and the customer's satisfaction?
  - "What's good for General Motors is good for the country"
- Then came competition from Japan, with help from Deming
- The American auto industry wakes up
  - Recognized Japan's focus on customer satisfaction and quality
- Today: we expect our cars to work every time….all the time
- Toyota is still at the forefront of quality
  - Their "secret" – ***focus on quality and producibility during design***

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Where We Are: M&Q in America

- **FACT**: The American Defense Aerospace Industry has produced, unquestionably, the finest weapon systems in the world
  - But at what cost? How long does it take? How much "cost of quality" have we shifted to operations and maintenance?

"…DoD is simply not positioned to deliver high-quality products in a timely and cost-efficient fashion."

GAO (HASC) Testimony GAO-06-585T "Actions Needed to Get Better Results on Weapons Systems Investments" 5 April 2006

"In 2001, The Average Weapon System Acquisition Program Experienced a 36% Cost Overrun and Schedule Delay of Two Years" – *Dr. Marvin Sambur*

M&Q in the DoD:
Who We Were Then….. and Who We Are Now

- THEN….1975 to 1985
  - M&Q Organization
    - Represented at every acquisition level in DoD
    - Had independent M&Q evaluation of program with veto power
  - Large numbers of experienced people
    - Career field with opportunities
    - Effective Mentoring
  - Tribal knowledge and well documented Specs and Standards

- NOW…..2001 to present
  - Not represented at every acquisition level in DoD
    - No seat and no vote on program readiness
  - Under-represented at most locations
    - No representation at some locations
  - M&Q Specs and Standards cancelled
  - Limited mentoring opportunities and tribal elders retired

GAO Findings: Production Maturity

Program is not taking steps to meet GAO production maturity criteria

Taking steps to meet production maturity criteria

Program demonstrates sufficient production maturity

Program	2003	2004	2005	2006
JPATS		n/a	n/a	n/a
ABL	n/a			n/a
F/A-22				
JSF	n/a	n/a		
Global Hawk	n/a			
JHMCS	n/a		n/a	n/a
Predator B	n/a			
B-2 RMP	n/a			
V-22				

Color ratings based on GAO opinions
Source: GAO Quick Look reports for 2003, 2004, 2005, 2006

n/a = not assessed

Defense Science Board ManTech Study

- DSB was tasked by SAF/AQ to evaluate the ManTech program
- Released report in February 06
- Much of the report pertains specifically to ManTech
- Portion of the report addresses global acquisition manufacturing issues
  - Assessing program readiness for production…..(suggested using the new Manufacturing Readiness Levels (MRLs), more on the MRLs Later)
  - Workforce Expertise – clearly addresses the entire DoD acquisition workforce

Complete DSB report is located at:

http://www.acq.osd.mil/dsb/reports/2006-02_Mantech_Final.pdf

Defense Science Board ManTech Study

Findings:

- Manufacturing talent in the DoD workforce, and its supporting industrial base, has and continues to decline
- Not enough people (both at working level and in leadership positions) understand the processes involved in developing and manufacturing defense systems

Recommendations to correct knowledge deficiency:

- Create policy requiring support for programs such as ManTech
- Implementation of MRLs as part of DoDI 5000.2

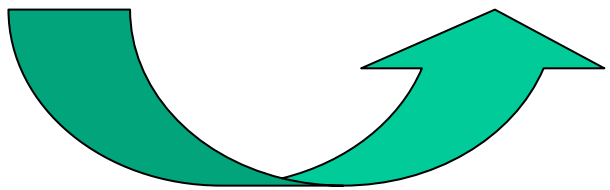
War-fighter Expectations

1. Avoid cost overruns, performance shortfalls, and schedule slips typically manifested during production
2. Improve quality and avoid surprises
3. Ensure affordability and producibility
4. Identify all potential MFG risks during transition from development to production and establish risks mitigation plans
5. Provide rapid response to emerging needs, e.g., readiness (includes combat ops, surge, parts and spares, etc.)

Have you met your customers expectations?

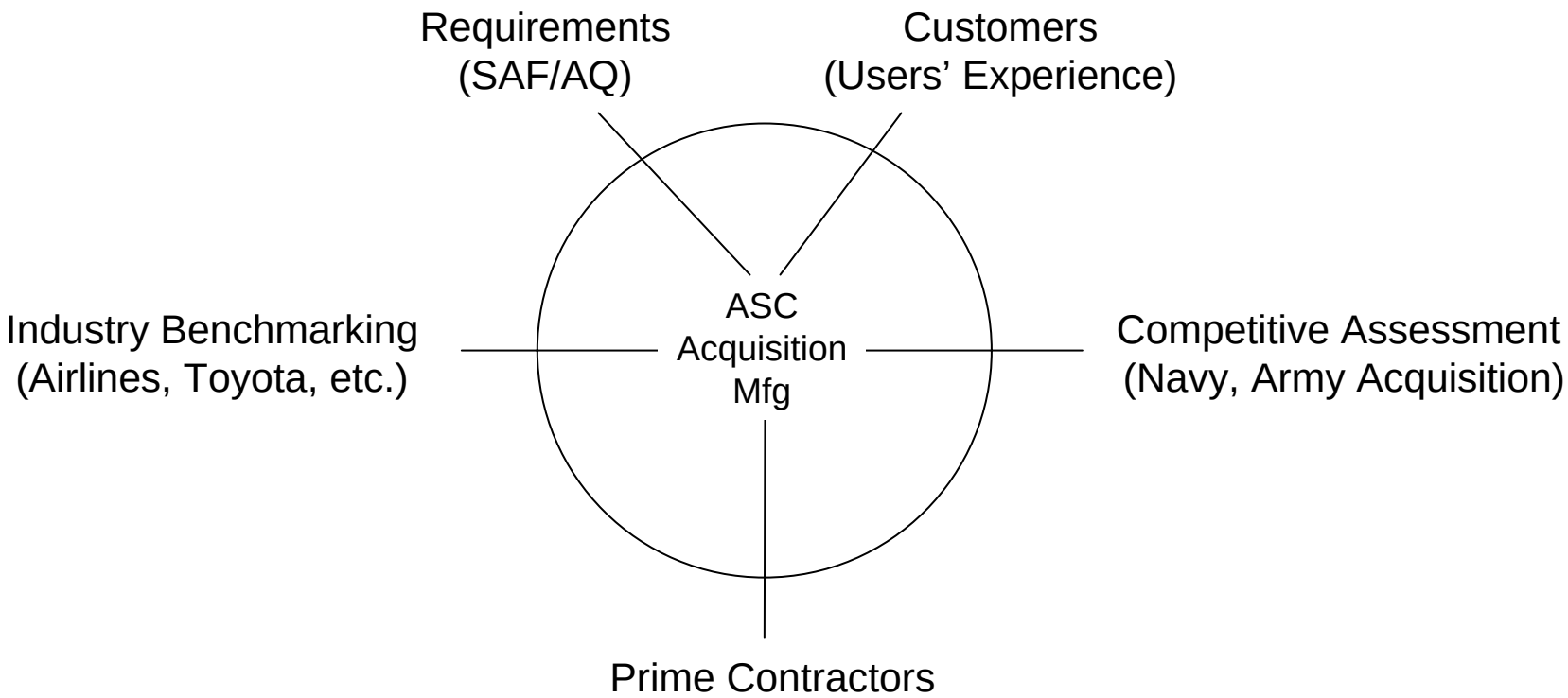
Swinging Pendulum of Acquisition Reform

- Where we were was not cheap….but it was defined
- Where we are is neither cheap nor defined
- The faster..better..cheaper "acquisition reform" pendulum… for us a wrecking ball….left M&Q vulnerable
- We can anticipate the return swing but must not let it drive us back to the old approach.
- Let's tailor the "return trip"



ASC/EN Response to War-Fighter Concerns

- ASC/ENSM plans to conduct a 360^{o} evaluation to identify solutions and best practices



Prime Contractor Messages

1. Government acquisition strategies do not require an in-depth risk analysis for manufacturing during product design.
2. Government does not specify the right deliverables in their contracts.
3. Benchmark other industries to get a better picture on MFG related issues during product development and risk mitigation plans to address them.
4. Assess production readiness in a meaningful way.
5. More emphasis on suppliers during product development.

Prime Contractor Messages

1. Government acquisition strategies do not require an in-depth risk analysis for manufacturing during product design:
   - Establish effective source selection criteria to emphasize producibility and affordability
   - Identify incentives for contractors to focus on producibility and affordability during product development.
   - More MFG/QA emphasis during ASP reviews
   - Strong Government advocate/champion are needed
   - There is a gross lack of knowledge and personnel in this area
   - Hold PMs and chief engineers accountable
   - Educate Government PMs with potential MFG/QA risks and their impacts to the overall system life cycle cost
   - Make long-term decisions thoroughly considering all production risks down the road

Prime Contractor Messages

2. Government does not specify the right deliverables in their contracts:

- Government needs to verify that the contractor has the right processes in place to deliver the right product
- Government does not use the right metrics to measure performance
- Make the contractor demonstrate that they have a solid production plan
- Require the prime to demonstrate control of MFG processes during development
- Specify proper MFG/QA contractual requirements in development contracts

Prime Contractor Messages

3. Benchmark other industries to get a better picture on MFG related issues during product development and risk mitigation plans to address them:

- Consider world-class performers in other industries
- Think outside the box
- Develop lessons learned
- Evaluate commercial programs and practices as well as the FAA
- Consider having budget for “Producibility Improvement Plan” (PIP)

Prime Contractor Messages

4. Assess production readiness in a meaningful way:

- Government needs to develop better MFG transition strategies
- Willoughby templates (Transition from Development to Production) are useful tools
- PRRs are not focusing on the right parameters. Many programs do not conduct full blown PRRs like they once did
- MRLs will be a useful tool once up and running
- Government PMs should be required to develop MFG exit criteria for milestone reviews
- Industry recognizes “Production Plans” once required by the Government for most programs as a useful tool

Prime Contractor Messages

5. More emphasis on suppliers during product development:

- The vast majority of quality related issues come from lower-tier suppliers. Ensure that the prime's processes for management of their suppliers are solid
- Properly manage requirements flow-down to lower-tier suppliers
- Require suppliers participation on IPTs during product development
- Ensure supplier participation in the systems engineering process, in particular MFG processes and procedures
- Develop predictive indicators to assess supplier's "internal health"
- Use of common metrics

Where We Should Be Going

- **The way forward…..**
  - Internally: Manufacturing and Quality must be the responsibility of design engineers and be considered early in the development process
  - Externally: Supplier Management….engineers at primes must partner with suppliers to achieve maximum affordability
  - To help with all of it: The M&Q tool set:
    - Manufacturing Development Guide-Available now
    - Manufacturing Readiness Levels-Draft available now
    - Manufacturing and Quality Integrity Program-Available soon

Systems Engineering – Ensure that design meets requirements and ***is producible***

Mfg/QA helps SE meet producibility, OSS&E, and Airworthiness Design requirements

M&Q Tool Set
Manufacturing Development Guide

Best Practices

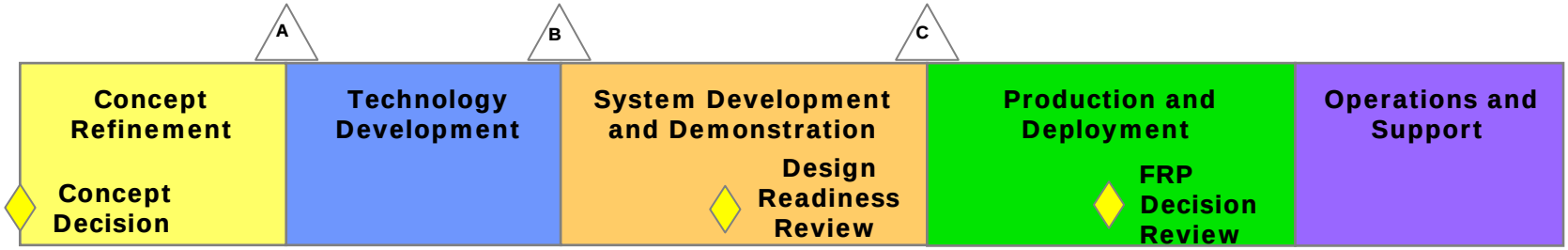
http://engineering.wpafb.af.mil/mdg/mdg.asp

- Mfg Capability/Risk Mgt
- Production Cost Modeling
- Key Suppliers
- Key Characteristics and Processes
- Variability Reduction
- Virtual Mfg
- Design Trade Studies
- Product/Process Validation
- Process Control and Cont Improvement
- Factory Efficiency
- DMSMS

- Developed by a joint industry Government team, improved over the past 10 years
- Recognized aerospace industry guide for describing the role of Manufacturing and Quality in the Systems Engineering process
- Available at:
  http://engineering.wpafb.af.mil/mdg/mdg.asp

M&Q Tool Set
Manufacturing Readiness Levels

Defense Acquisition Life Cycle Framework



Technology Readiness Levels

Manufacturing Readiness Levels

- Parallels Technical Readiness Levels
- OSD planning to make MRL assessments a milestone requirement
- Available at: https://acc.dau.mil/CommunityBrowser.aspx?id=18231

MRLs address topics such as:

Producibility
Key Characteristics
Material Availability
Production Simulation
Process Controls
Tooling

M&Q Tool Set
M&Q Integrity Program

This DRAFT, dated 25 August 2006, prepared by AF-11, has not been approved and is subject to modification.
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(Project SESS-2006-001)

NOT MEASUREMENT SENSITIVE

MIL-HDBK-DRAFT
DATE

DEPARTMENT OF DEFENSE HANDBOOK

MANUFACTURING AND QUALITY INTEGRITY PROGRAM

AMSC XXXX **AREA SESS**

- Contains the practices described in the Manufacturing Development Guide
- Includes suggested contractual and/or Systems Engineering Plan requirements and verifications
- Will be posted on the ASC/EN public Website

Producibility…M&Q's Contribution to Systems Engineering

- America's Defense Aerospace Industry is #1 in the world. However…
  - Are we be able to buy desired quantities?
  - How many B-2s were originally planned? F-22s? JSFs?
- If we can't figure out a way to build better systems cheaper, we will fulfill Norm Augustine's prophecy:
  - *"In the year 2054, the entire defense budget will purchase just one aircraft. This aircraft will have to be shared by the Air Force and Navy 3-1/2 days each per week except for leap year, when it will be made available to the Marines for the extra day."*
- My primary focus is to integrate quality and producibility early in the Systems Engineering process (see the ASC, MDG)

Encouraging Steps Forward

- Tri services committee being formed at the SES level
- NDIA committee on “ Manufacturing & Quality Assurance formed as government/industry forum.
  - If you share my interest in this subject, join me on the committee
- Fixing the root cause of manufacturing problems means including manufacturing as a mandatory discipline in the Systems Engineering tool set during design and development

Summary: We Know We Are There When…..

- The process used to manufacture a part is given equal consideration as the functionality of the part
- Product performance and producibility are equal in the risk analysis trade studies during product development
- The “chiefs” of design, manufacturing and logistics have equal votes on critical design decisions during development
- “Design” executives are held accountable for unit production cost and cost of quality decisions
- M&Q metrics are present in entry and exit criteria for each phase of the acquisition life cycle
- Integrating people, processes, and technology using the System Engineering Process proven effective by world class producers

As good systems engineers, our commitment to M&Q starts in design

Thank you for your time and attention

Thomas.Christian@wpafb.af.mil

Phone: 937-255-1826