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27 Oct 11

IEDs ON THE ROAD TO ACQUISITION AND SUSTAINMENT OF WEAPON SYSTEMS

OUTLINE

- IEDs
  1. Development of the Configuration Baselines
  2. Converting “Customer Needs” Into “Technical Requirements”
  3. Reducing the Cost of Programs
  4. The Need for More Systems Engineers
- Summary

Development of the Configuration Baselines

IED - #1

IED - #1

- **Development of the Configuration Baselines**
  - **DoDI 5000.02**
    - **Capabilities Development Document (CDD) *not finalized* until Milestone B**
    - **Enclosure 12 directs programs to *take control* of the Initial Product Baseline after CDR**
  - **WSARA**
    - **Requires all ACAT I programs to conduct PDR *before* Milestone B**
  - **System Requirements Document (SRD) Handbook**
    - **Use SRD in RFP**
    - ***Replaced* by Systems Specification at contract award**

IED - #1

- **Impact**
  - **CDD not finalized until Milestone B**
    - **Can't** correctly translate customer needs into system level performance requirements
    - **Can't** write a system specification
    - **Can't** functionally decompose system level performance requirements into lower level performance requirements
    - **Can't** write performance specifications for system pieces

Bottom Line: Program risk not reduced – faulty requirements

IED - #1

- **Impact**
  - **Taking control of Initial Product Baseline after CDR**
    - Taking control of an **immature** baseline
    - We know there will be many **design changes**
    - Most of the **software** has not been coded at this point
    - Will have to write and disposition many **ECPs**
    - Past track record shows this leads to many **undefinitized contract modifications** – can't process ECPs fast enough

Bottom Line: Most programs will likely experience a Nunn-McCurdy breach before reaching Milestone C

IED - #1

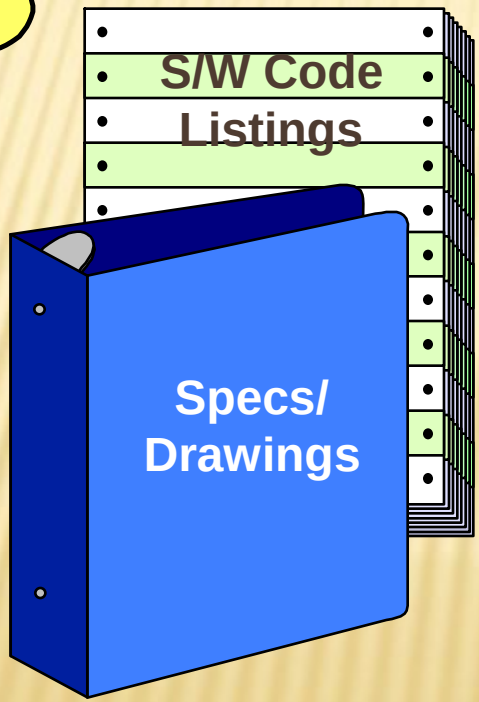
- **Impact**
  - **Replacing the SRD with the System Specification at contract award**
    - **Immature** baseline put on contract
    - **Negates** the purpose for conducting ASR,SRR, and SFR
    - Don't believe contractor will conduct **adequate engineering** analysis, modeling, and prototyping without contract award
    - We know there will be **requirement changes**
    - Makes the gov't the **approval authority** for all

Bottom Line: Again, program risk not reduced – faulty requirements

CONFIGURATION BASELINES

Config Baselines

Products / Processes



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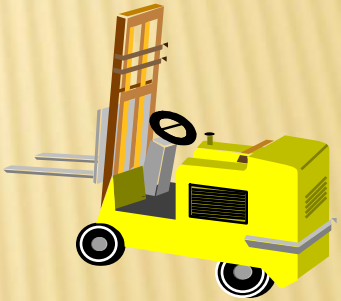
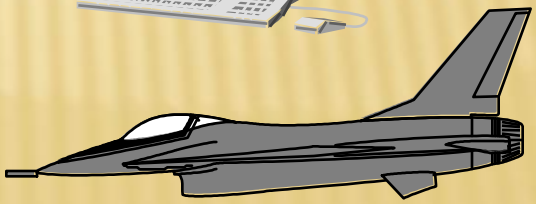




CONFIGURATION BASELINES

System

FUNCTIONAL (PERFORMANCE) BASELINE

1. Performance Requirements – System
2. Verification Methods (Qualification) – System

ALLOCATED (AS-DESIGNED) BASELINE

1. Performance Requirements – System Pieces
2. Verification Methods (Qualification) – System Pieces

Each System Piece

PRODUCT (AS-BUILT) BASELINE

1. Design solutions (dwgs, s/w code listings) – System Pieces
2. 1st Article Reqts – System Pieces
3. Lot / Acceptance & Inspection Reqts – System Pieces
4. Verification Methods (1st Article, Lot / Acceptance) – System Pieces

CONFIGURATION BASELINES

- **Only the technical requirements that must be managed and controlled are put into the configuration baselines**
- **Everything else is put in the "best commercial practices" bucket**
- **AIM Parachute example**
  - **Needed process spec for stretch fabric par**
  - **Didn't need process spec for nylon panels**

Irvin Industries LTD, Canada

TECHNICAL REVIEWS

- Alternative Systems Review (ASR)
- System Requirements Review (SRR)
- System Functional Review (SFR) *(Note – Formerly SDR)*
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)
- System Verification Review (SVR)
  - Functional Configuration Audit (FCA)
  - Production Readiness Review (PRR)
- Physical Configuration Audit (PCA)

{ *Added – Provide PM with technical recommendation for production decision*

TECHNICAL REVIEWS

- ASR – Identify preferred system concept
- SRR – Ensure progress made defining system level technical requirements
- SFR – Identify system level performance requirements
- PDR – Identify performance requirements of system pieces
- CDR – Identify design solution for system pieces
- SVR – Ensure system technically ready to begin production
- PCA – Ensure product baseline documentation matches product being produced / acceptance procedures adequate

FBL

ABL

PBL

– Originally, government would take control of a configuration baseline

TECHNICAL REVIEWS – CAID

- ***Clear Accountability In Design (CAID)***

  - **Don't take control of CM baseline documents until they are sufficiently mature**
  - **Only take control of those CM baseline documents needed to support the weapon system, i.e. to execute program acquisition and sustainment strategies**

TECHNICAL REVIEWS – CAID

- **SFR:** Identify system level performance requirements
  - Take control of system specification

FBL

Milestone B

- **PDR**: Identify performance requirements of system pieces
  - Take control of performance specifications of key system pieces

ABL

- **SVR:** Ensure system qualified and ready to begin production
  - Take control of performance specifications for remaining system pieces as needed to execute program

ABL

Milestone C

PBL

- **PCA:** Ensure product design documentation matches product being produced / acceptance procedures adequate

TECHNICAL REVIEWS – 5000.02

Milestone A

- **SFR:** Identify system level performance requirements
  - Take control of system specification

FBL

- **PDR:** Identify performance requirements of system pieces
  - Take control of performance specifications of system pieces

ABL

Milestone B

- **CDR:** Identify design solution of system pieces
  - ***Take control of design*** information (design specifications, drawings, s/w code listings) of system pieces

PBL

ABL must be defined before taking control of PBL

IED - #1

- **Counter Measures**
  - **Finalize CDD shortly after Milestone A**
  - **Follow CAID practice when technical reviews held**
  - **Change the wording in DoDI 5000.02 Enclosure 12**
    - **FBL Only:** Programs shall take control of the Functional Baseline after successfully completing SFR.
    - **FBL and ABL:** Programs shall take control of the Functional Baseline after successfully completing SFR and shall take control of key Allocated Baseline specifications after successfully completing PDR. Programs shall take control of the remaining Allocated Baseline specifications needed to execute their acquisition and sustainment strategies after successfully completing SVR.

IED - #1

- **Counter Measures**
  - **Replace the contract SRD with the System Specification after successfully completing SFR**
  - **EMD RFPs should not contain SRDs**
    - **Should contain Functional and/or Allocated Baseline specifications as appropriate**
    - **Key Allocated Baseline specifications could be lower than third tier**
    - **Must be contractually binding or risk compromising pre-MS B engineering efforts**

Programs should never skip milestones – system level technical requirements matured between MS A and MS B – lower lever technical requirements matured between MS B and MS C

Converting “Customer Needs” into “Technical Requirements”

IED - #2

IED - #2

- **Converting "customer needs" into "technical requirements"**
  - **In some ways, like converting "art" to "science"**
  - **Many needs and requirements must be derived**
  - **Cheeseburger Example**
    - **What do you like?**
      - **Easy part – lettuce, tomato, american cheese**
      - **Hard part – Wendy's, Burger King, Smashburger, etc**

rms

One of the "most" difficult systems engineering tasks

IED - #2

- Impact
  - Converting “art” to “science”
    - Poor upfront requirements identified as a “root cause” as to why programs fail
    - Major reason why programs can pass DT&E but fail OT&E
      - DT&E involves compliance with contract specifications
      - OT&E is conducted by the “customer”

Desired OT&E changes most likely requires contract modifications

IED - #2

- **Counter Measures**
  - **Customer must be involved early and often**
  - **Take advantage of prototyping whenever feasible at all levels of indenture**
    - **Maximize the use of software rapid prototyping principles**
  - **Technical requirements must be expressed in verifiable terms**
    - **Analysis**
    - **Examination**
    - **Demonstration**
    - **Test**

Reducing the Cost of Programs

IED - #3

IED - #3

- **Reducing the cost of programs**
  - **Life cycle costs never go down**
    - **Really trying to reduce the growth rate of life cycle costs**
  - **Most new technology comes along in "inch stones" not "milestones"**
  - **New laws and policy are increasing development costs**
    - **Competitive prototyping**
    - **Demonstrating reliability**
  - **DoD and Service policies aren't integrated as well as they should be**
    - **Performance based acquisition vs reducing logistics footprint**
    - **Acquisition vs Sustainment**

IED - #3

- Impact
  - Life cycle costs
    - Designs that reduce life cycle costs often increase unit costs – can't get past unit costs
    - Belief in benefits and projected savings is a hard sell
  - New technology
    - "Inch stones" seldom make it above the funding line
    - Many opportunities to reduce costs and to improve reliability being missed
  - New laws and policy
    - Competitive prototyping will 2X resource

DEMONSTRATED RELIABILITY TESTS

Failures / Reliability	0	1	2	3	4	5
.999	2303	3890	5322	6681	7994	9275
.98	115	194	266	334	400	464
.90	23	39	53	67	80	93
.85	15	26	35	45	53	62
.80	12	19	27	33	40	46

CONFIDENCE: 90% **SOURCE: QUALITY-ONE INTERNATIONAL**

IED - #3

- Impact
  - Policies Not Integrated
    - Performance based acquisition doesn't drive parts standardization
      - Result – logistics footprint goes up
      - Implementing performance based acquisition and parts management on the same program is like trying to mix oil and water
    - Program management responsibilities include sustainment
      - When did Logistics Support become synonymous with Program Mgmt?
      - It's lust-to-dust, not lust-to-gravel with gravel-to-dust being sustainment
  - Not Doing Important Tasks
    - Typical rationale – can't afford it / need it faster
    - Like laws of nature, programs have a cost they must pay

AIR FORCE AUDIT AGENCY (AFAA)

- **Audit Findings (FY 94-95) – MODs**
  - **Lack of CM a major contributor to MOD schedule delays and cost increases.**
    - **2 to 6 years per MOD**
    - **$65 to $217 million per MOD**
  - **Programs failed to establish adequate configuration status accounting systems**
    - **Could not effectively track and control baseline changes**
- **Unwilling to spend $50M (est) to keep CM baseline data current – willing to spend $200M extra per MOD**
  - **Passed audit results to all AF program managers**
  - **Received zero feedback – no interest in saving**

IED - #3

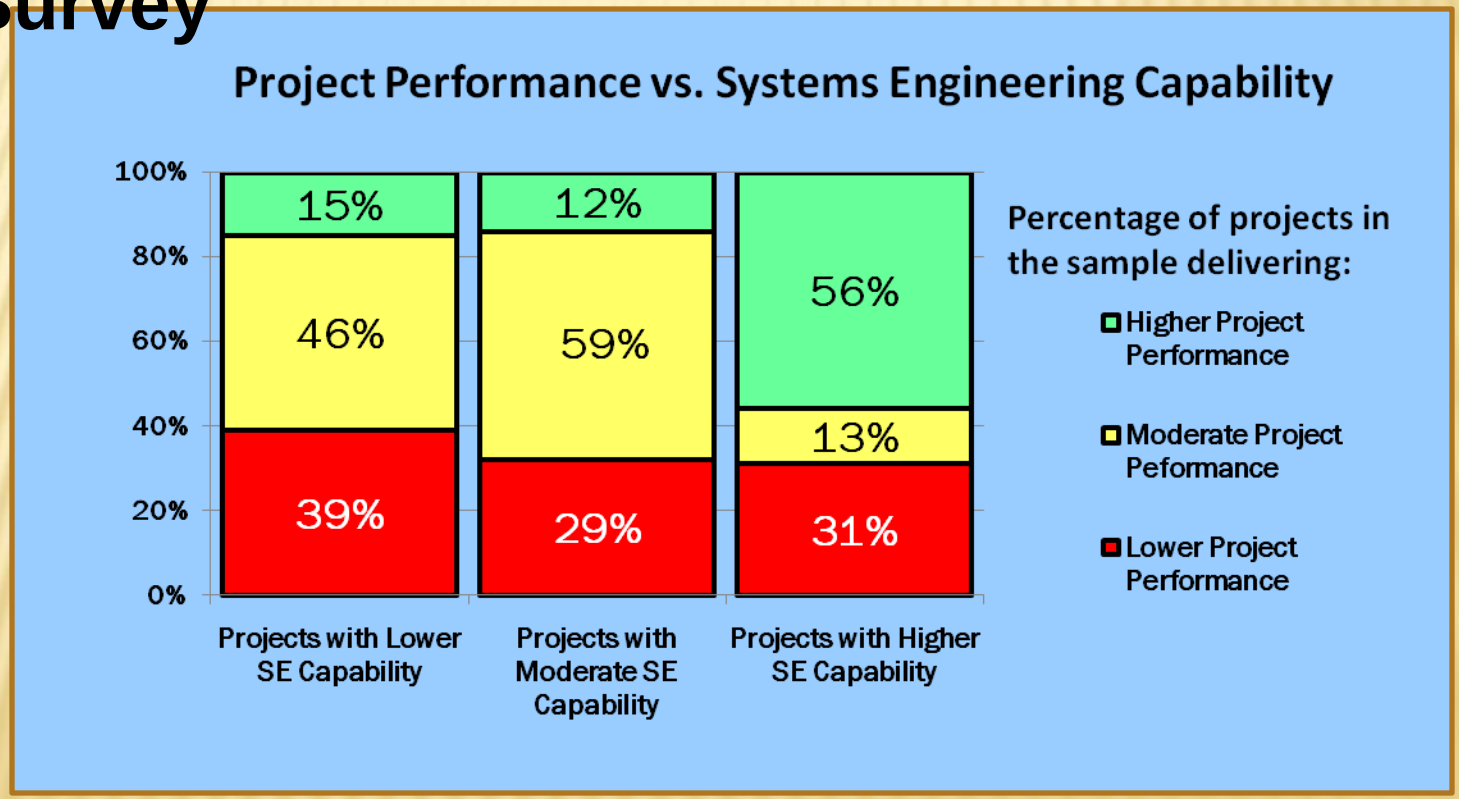
- **Counter Measures**
  - **Must be willing to pay the upfront cost – nothing's free**
    - **Should always be looking for ways to accomplish tasks more effectively and better**
    - **Model based systems engineering a good start**
  - **Strike a balance between "milestone" and "inch stone" technology upgrades – can't be all "milestone"**
    - **Need to budget for upgrades**
    - **Funding upgrades via a surcharge on parts sales is inadequate**
  - **Need integrated decisions based on long term goals**
    - **Develop road map of near term tasks to achieve long term**

IED - #3

- **Counter Measures**
  - **Need integrated policies**
    - **Like programs, policies need a "system" focus**
    - **Too often we are sub-optimizing based on "special interests" areas**
    - **Decisions made open some doors and close others**
      - **Can't buy spare parts competitively with just a system spec under program control**
  - **Run the Systems Engineering process correctly**
    - **Not just about getting the right solution**
    - **It provides programs with the best chance to be right the 1st time**
    - **This provides legitimate speed and reduces program costs**
    - **SE metrics will truly have meaning**

IED - #3

- **Counter Measures**
  - **NDIA Systems Engineering Effectiveness Survey**



The Need for More Systems Engineers

IED - #4

IED #4

- **The Need for More Systems Engineers**
  - **Requirements are growing more complex**
  - **Business teaming arrangements have become more sophisticated and global in nature**
  - **Poor decisions are more costly and time consuming**
  - **Do we need new processes as well?**
    - **Enterprises**
    - **System of Systems**
    - **Sustainment**

IED #4

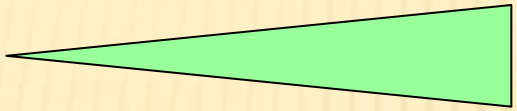
- **Impact**
  - **More Systems Engineers**
    - **What engineering responsibility would a Systems Engineer have that isn't already the responsibility of the Chief Engineer?**
      - **Answer – None!**
    - **We're being asked to design systems that can be readily adapted to future needs, but ….**
      - **Can't design for unknown conditions**
      - **Must assume a value**
    - **The real challenge is to be able to apply a growing number of new and different technologies**

ELEMENTS OF SE

- **Systems Engineering Process**
  - **A set of technical processes used to develop, produce, and maintain integrated, balanced solutions that meet customer needs**
    - **Balanced as it relates to satisfying cost, schedule, and performance requirements**
- **Domain Knowledge**
  - **Detailed technical knowledge related to a specific enterprise, system of systems, family of systems, product, engineering discipline, and/or process**
- **Systems Engineer**
  - **A lead technical authority responsible for executing the systems engineering process and ensuring the required domain knowledge gets applied**

SYSTEMS ENGINEERS

- **Organizational Constructs**

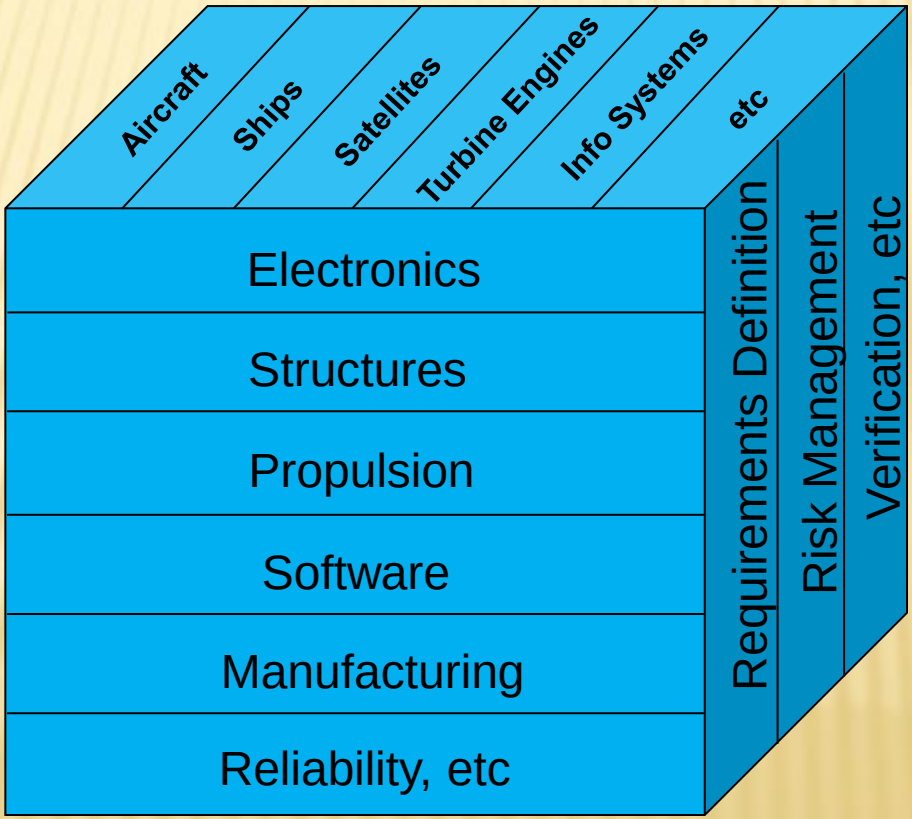
One systems engineer  **Many systems engineers**

- **Need exists for entry, journeyman, and expert level systems engineers**
  - **Chief and Lead Engineers are examples of systems engineers**

- **Factors that influence numbers and experience levels required**
  - **Program complexity**
  - **Domain knowledge required**

DOMAIN KNOWLEDGE

Enterprises, SoS, FoS, Products



Engineering Disciplines

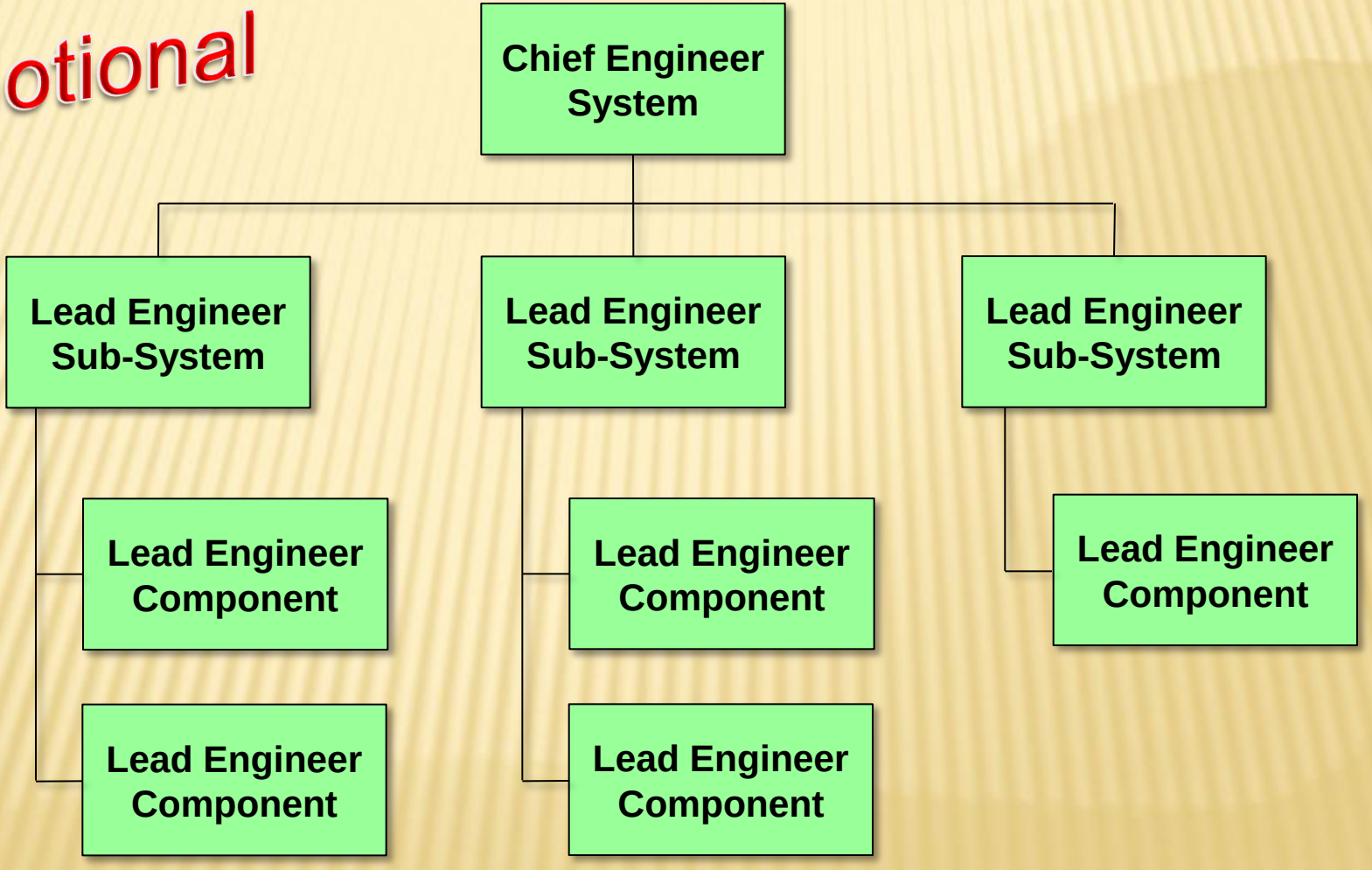
Systems Engineering Processes

IED #4

- **Counter Measures**
  - We need systems engineers who understand the "theory"
    - We don't need new systems engineering processes
  - We need to increase the domain knowledge available to the Chief and Lead Engineers
  - Even "enterprises" and "systems-of-systems" need a single decision authority at the top
    - Shared leadership with no accountability to each other won't work
  - Resourcing "enterprises" and "systems-of-systems" needs to be integrated as well
    - Funding
    - Personnel

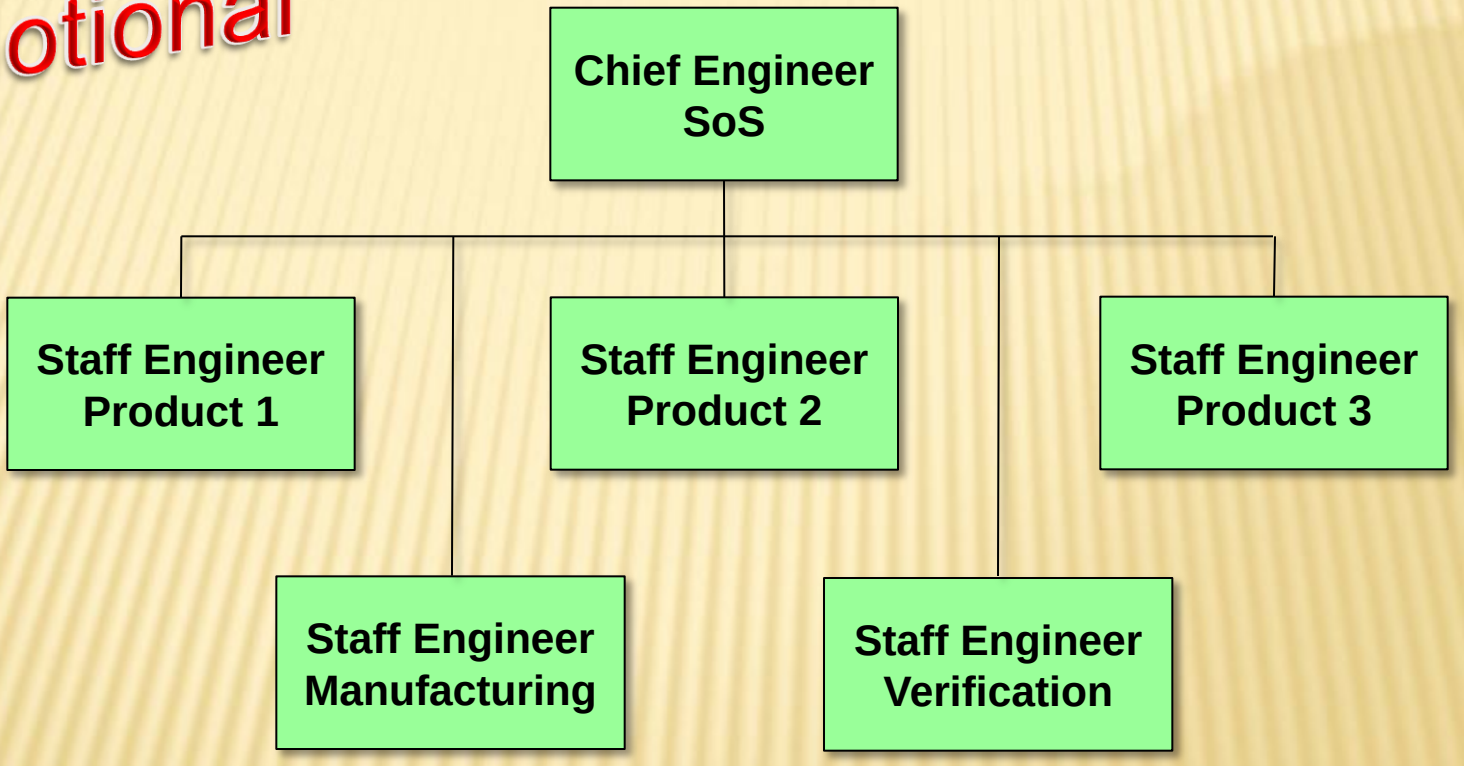
PRODUCT

Notional



SYSTEM OF SYSTEMS

Notional



Note: Staff Engineer could be a Product Chief Engineer

IED #4

- **Counter Measures**
  - **What do we want to know?**
    - **How we're going to use our systems in the future**
  - **What's our contracting strategy for EMD?**
    - **Firm Fixed Price**
  - **What do we need to know for accurate pricing?**
    - **The number of design changes that will be made**
    - **The number of lines of code that will be written**
  - **So what do we really need????**

PSYCHIC Engineers !!!!

SUMMARY

SUMMARY

- We need people that understand the theory and can tailor it to the meet the specific needs of the program
- We need to apply more domain knowledge to our programs
- We need people who make good decisions
- Just run the “damn” SE process

QUESTIONS?