

Systems Engineering Revitalization: an Industry Perspective



**DSP Conference
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Chair GEIA G-47***

From Some of Our Customers:



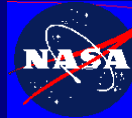
U.S. AIR FORCE

“We Need Better SE”



- **Direction from the SECAF:**
 - *Develop Plan to strengthen Air Force’s systems engineering capabilities*
 - *“Create an Institute for Systems Engineering”*
- **ASECAF (AQ) Policy Memo:**
 - *Incentivize Contractors for Better Systems Engineering*
- **SMC/CC Policy Memo:**
 - *Application of SE related Specs & Standards required on an integral element of SMC acquisition, contracting and program management*

- **Navy**
 - Collaboration on SE process improvements across NAVAIR, NAVSEA, SPAWAR & MARCORPS
 - Broad level System-of-Systems integration
- **FAA**
 - Enterprise-wide Integrated Capability Maturity Model in use for internal performance improvement
- **OMB**
 - Collaborating on an Enterprise Process Improvement Framework for Government
 - Linked to OMB Federal Enterprise Architecture Initiative

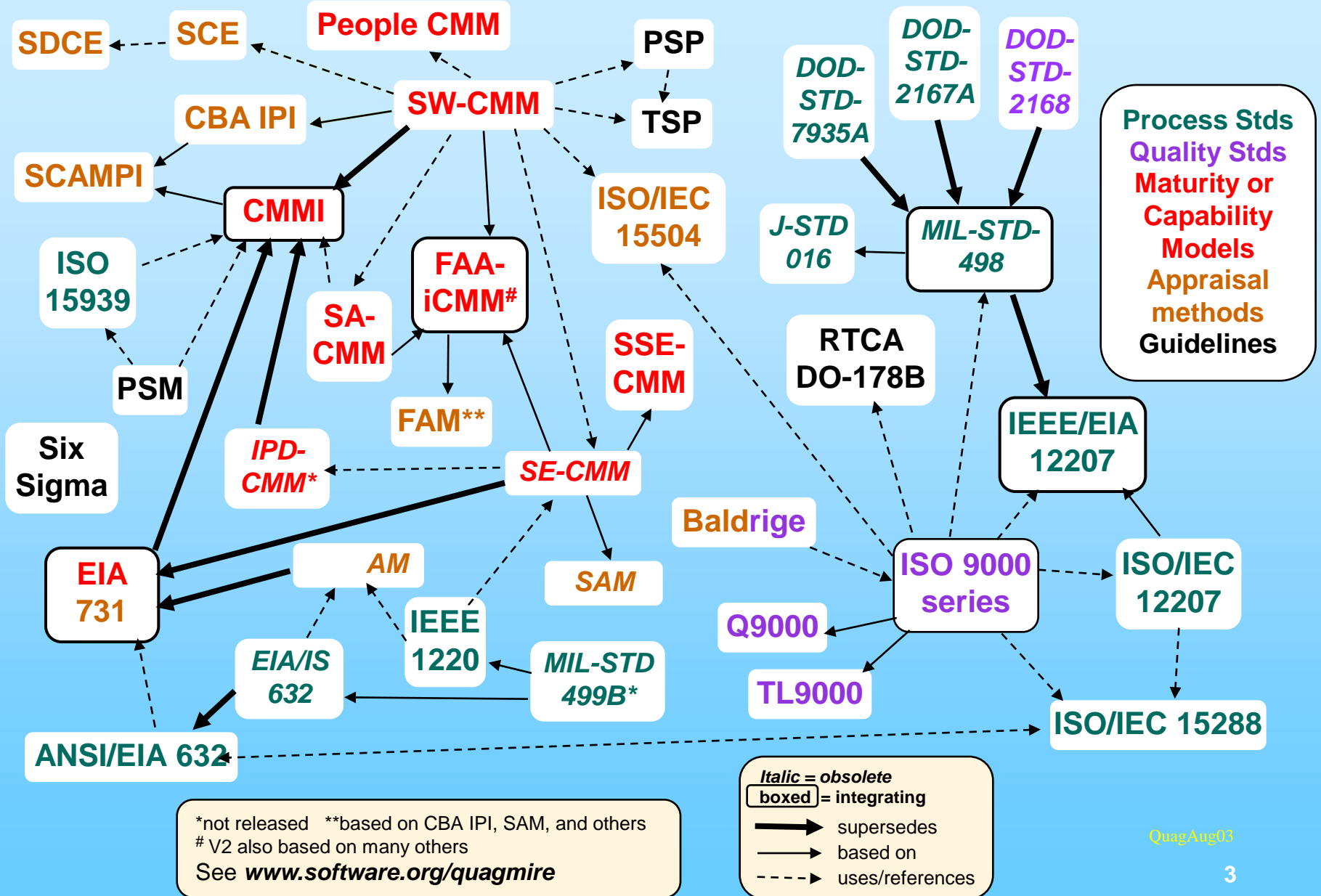


Implementing Strategy #3: Enhance NASA’s core engineering, management, and scientific capabilities and processes to ensure safety and mission success, increase performance, and reduce cost.

“...The complex nature of NASA programs also requires that our systems engineering capability be second to none...”

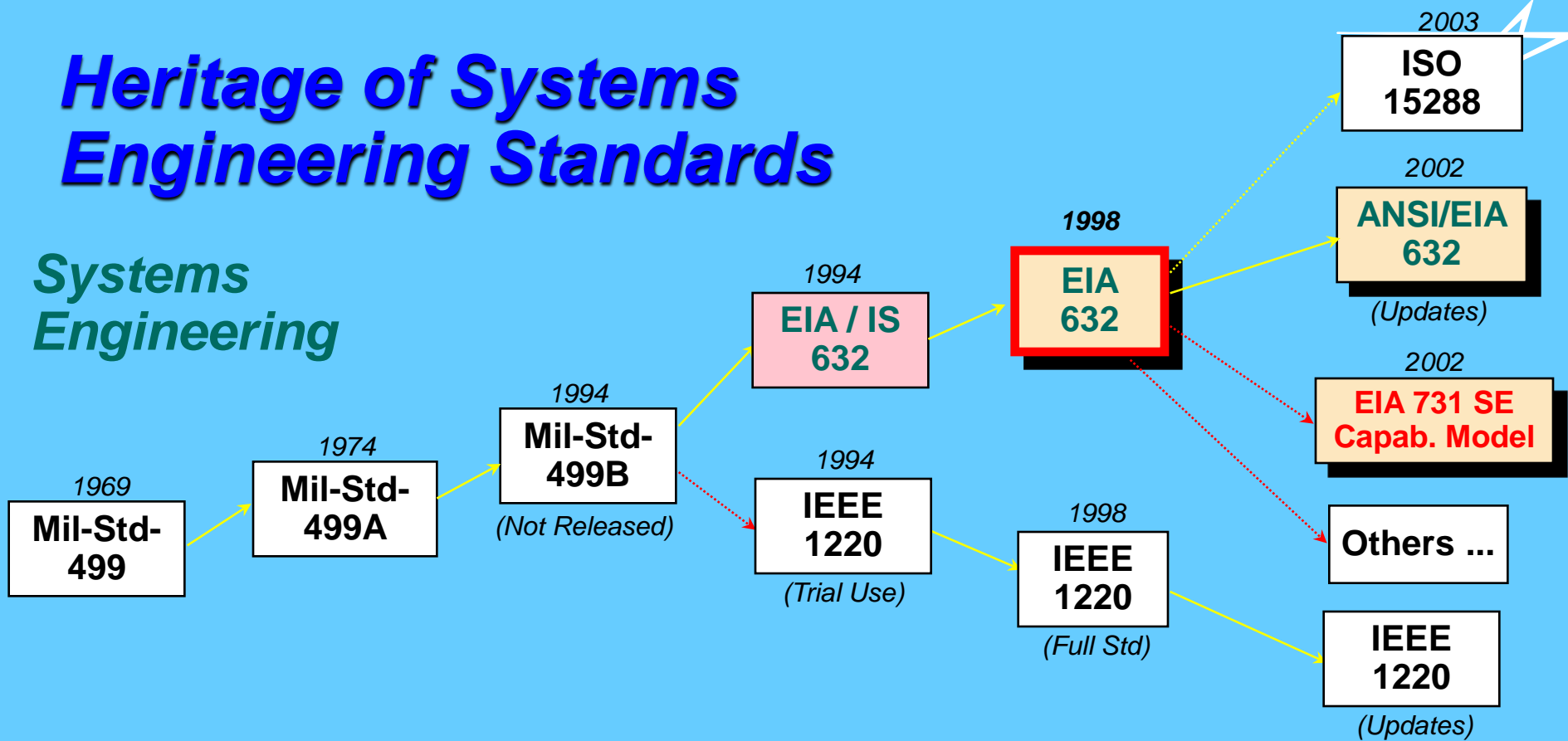
- **To ensure that we achieve success safely and efficiently, NASA will take the following steps:**
 - Implement collaborative engineering capabilities and integrated design solutions to reduce life-cycle cost and technical, cost and schedule risk of major programs;
 - Improve our systems engineering capability and ensure that all NASA programs follow systems engineering best practices throughout their life cycles;

The Frameworks Quagmire

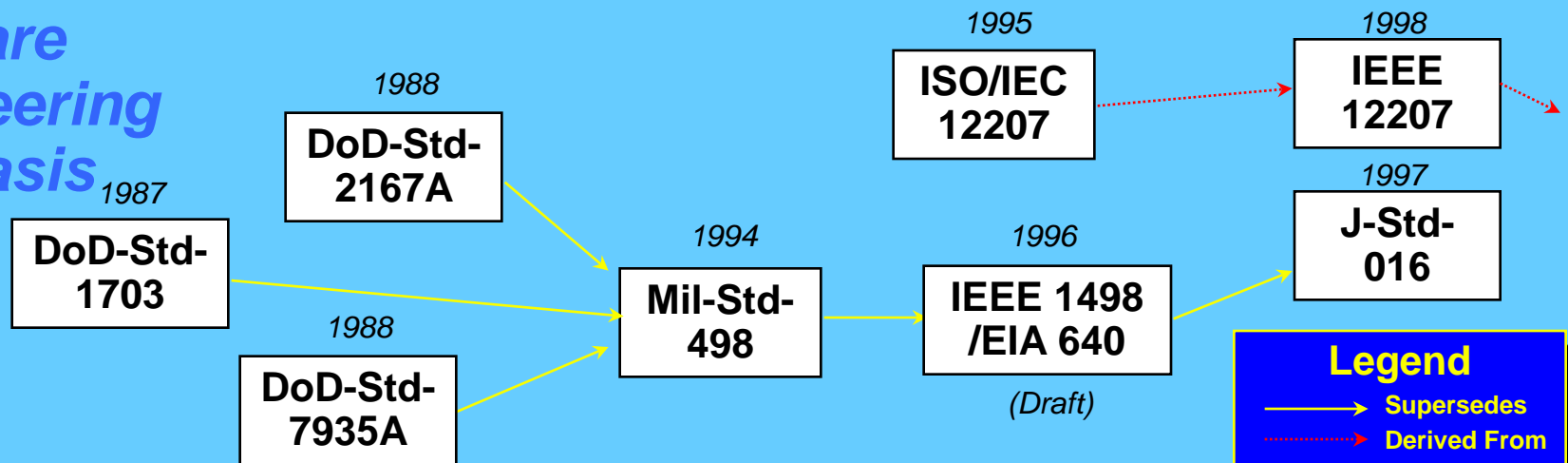


Heritage of Systems Engineering Standards

Systems Engineering



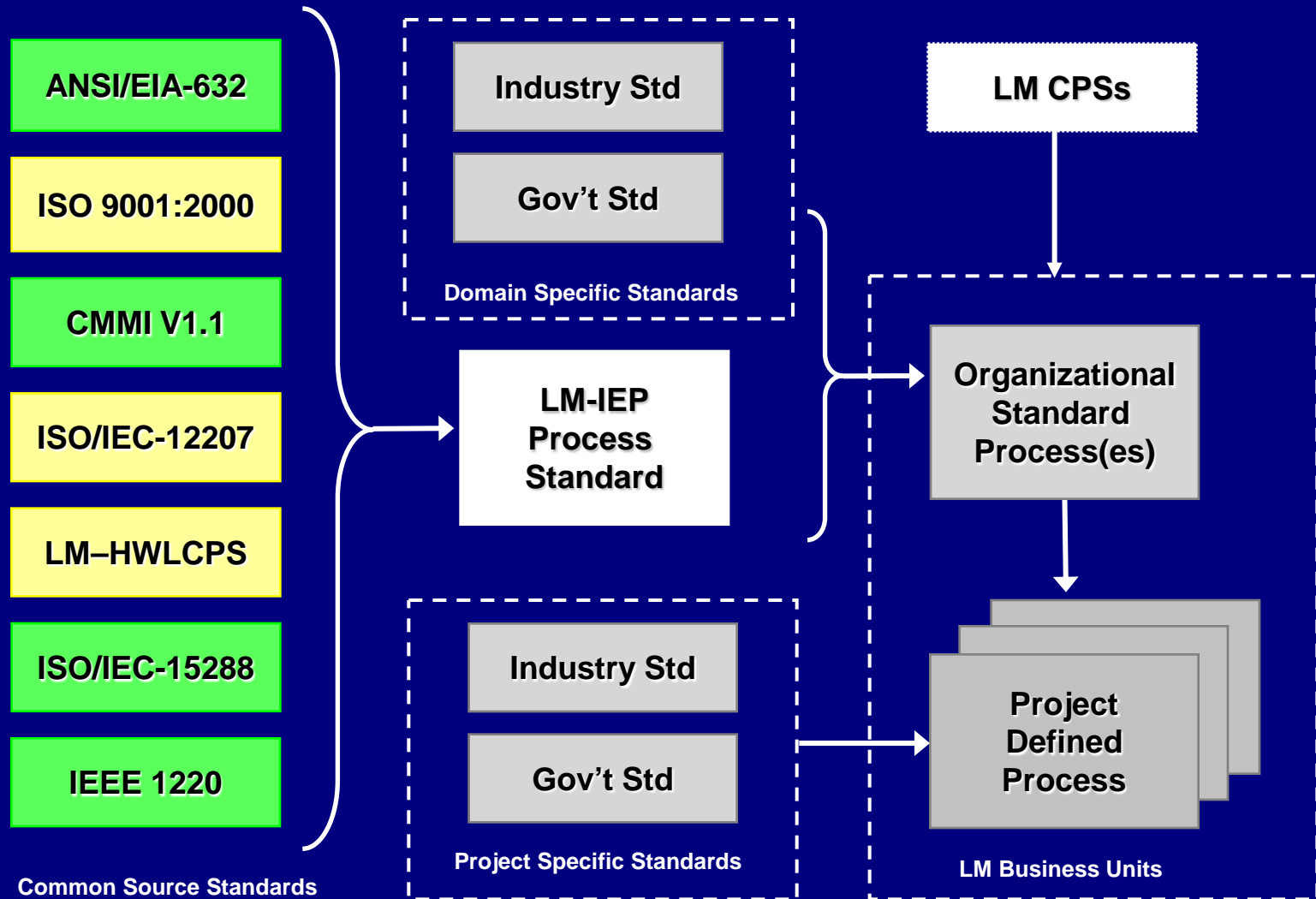
Software Engineering Emphasis



Legend

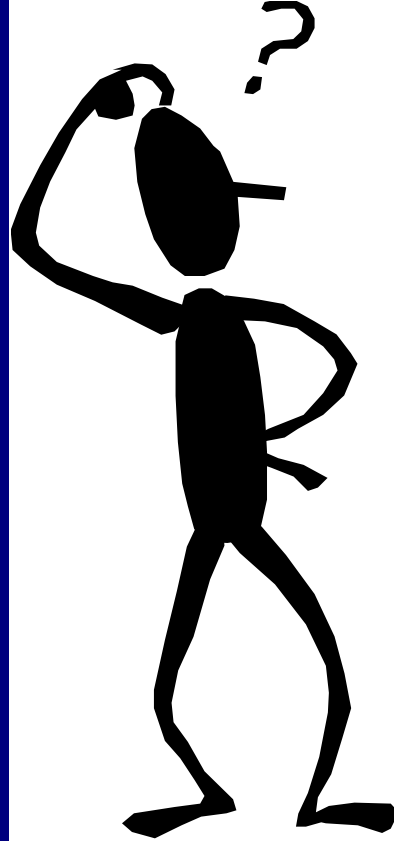
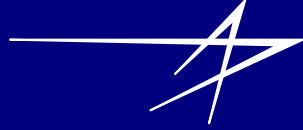
- Supersedes
- Derived From

LM SE Revitalization

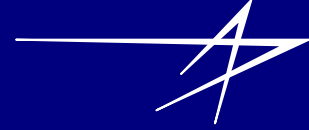


 Indicates Industry SE Standard

How Would You Define SE?



Systems Engineering...



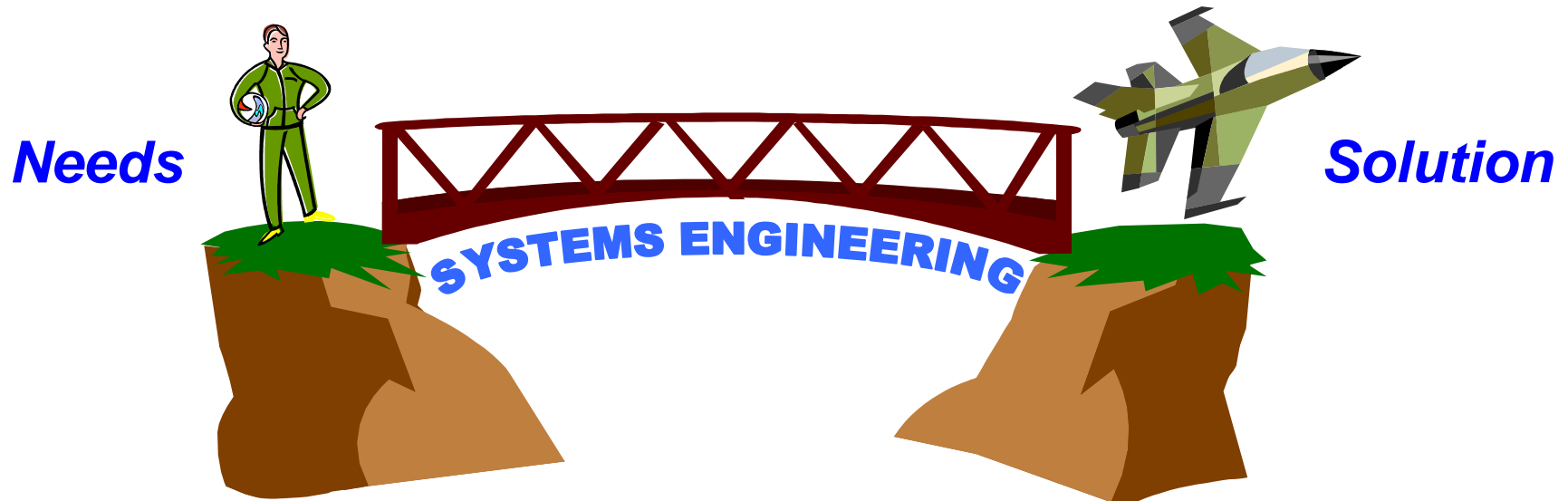
Is a PROCESS – Not an Organization

- Led by systems engineers
- All functions play a role; Integrated via Integrated Process and Product Development (IPPD)
- Must be rigorously applied across program
- The technical "glue" which makes separate design disciplines and subsystems function together to provide an integrated system which performs a specific job.

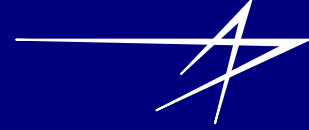
SE is a systematic, interdisciplinary approach that transforms customer needs into a total system solution

Systems Engineering...

...an interdisciplinary approach encompassing the entire set of scientific, technical, and managerial efforts needed to evolve, verify, deploy (or field), and support an integrated and life-cycle balanced set of system solutions that satisfy customer needs.



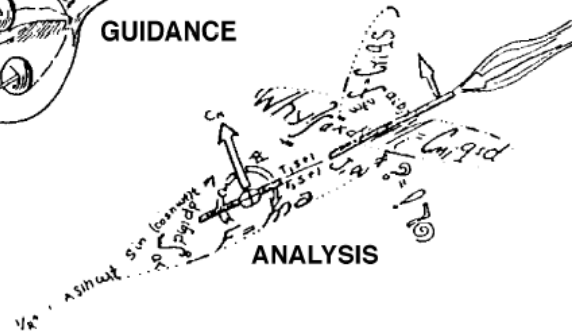
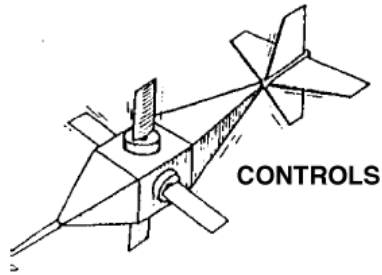
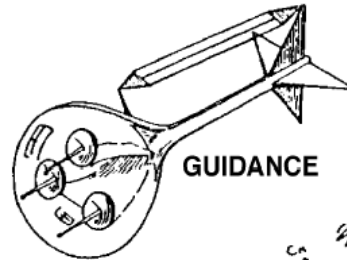
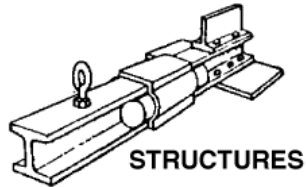
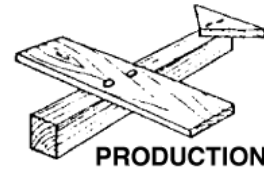
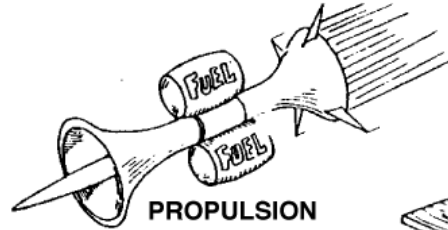
The Systems Viewpoint



- **The Design Engineer has the specialist's viewpoint. Views the system from the inside.**
 - *Concerned with other system elements only as they affect their own design task; but not necessarily how theirs may affect others*
- **The Systems Engineer has the systems viewpoint. Views the system from the outside.**
 - *Concerned with the effect of all system elements as they affect overall system design / performance / cost / schedule*

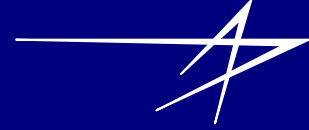
WHY SYSTEM ENGINEERING?

THE IDEAL MISSILE DESIGN FROM THE VIEWPOINT OF VARIOUS SPECIALISTS



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**Systems Engineering must focus on the *entire problem*:
*optimize the whole, not the parts!***

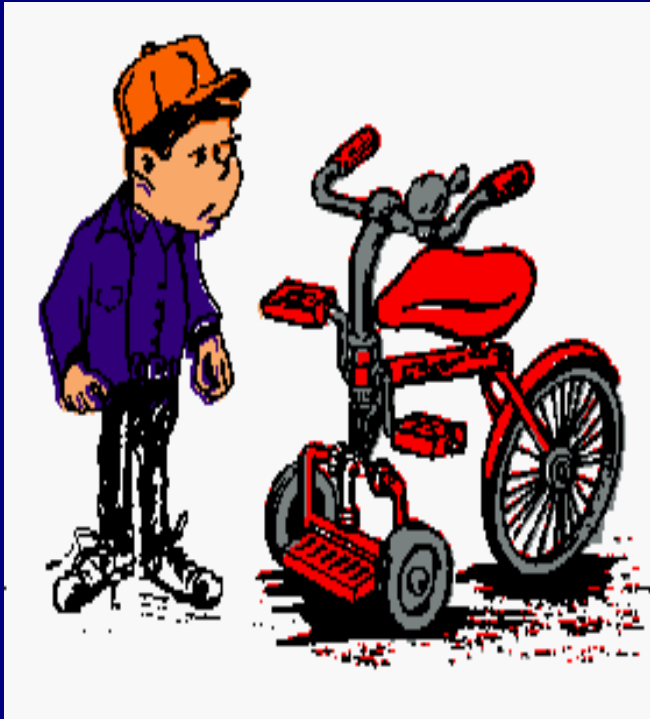


What could we do Better?

- **Requirements should be written better**
 - *Crisp, unambiguous, testable, firm*
- **All Program disciplines work together**
 - *Program management, Engineering disciplines, contracts, bus ops, business development, research*
- **Compromise when necessary**
 - *Tailor Standards & Procedures*
 - *Eliminate desirables / use real needs*

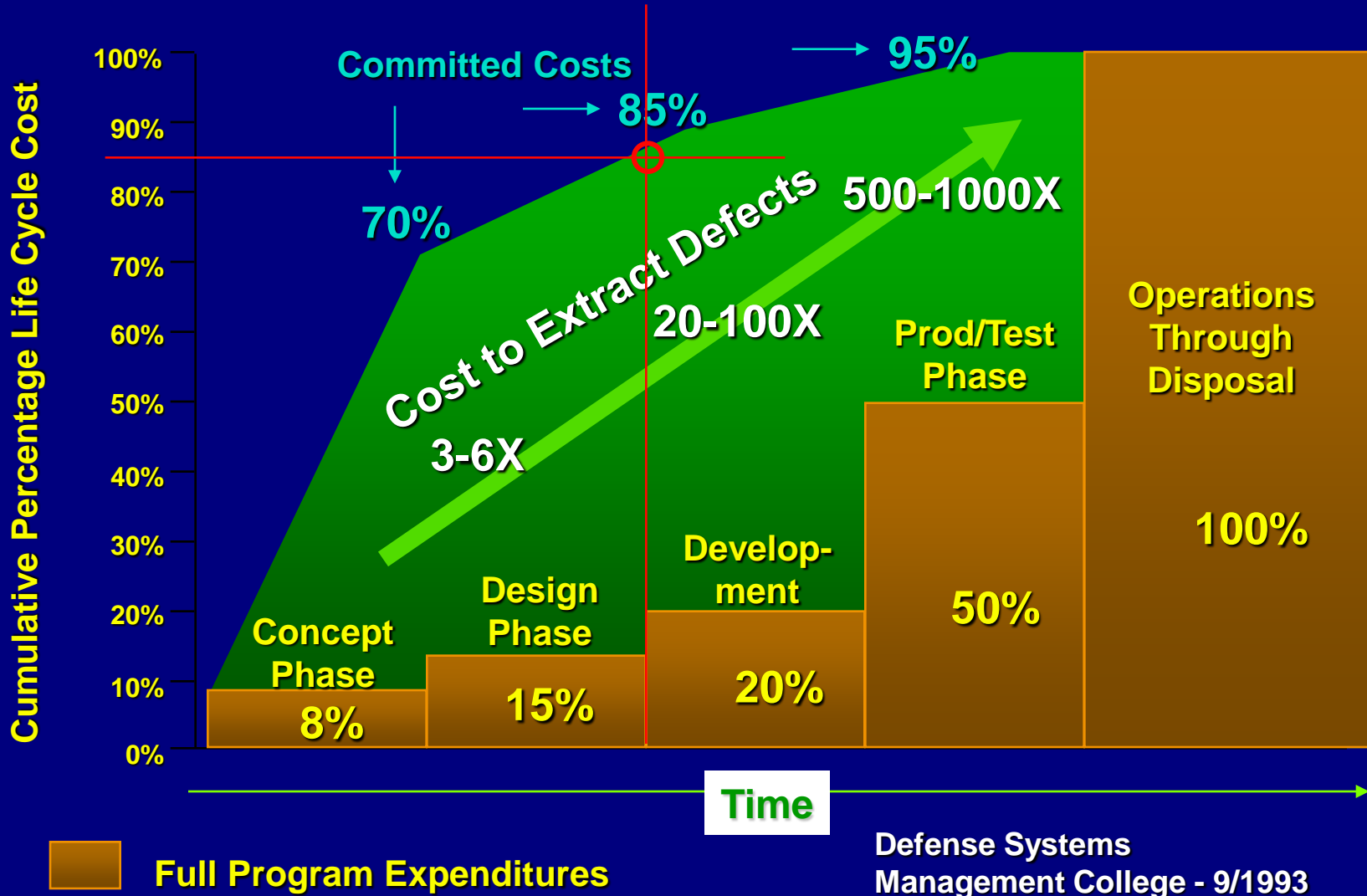
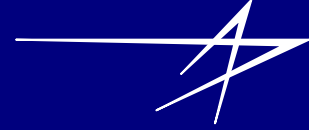
The Value of Systems Integration

- Why is it important??
- The keyword is Integration ... technical integration
- Without it:
 - At best:



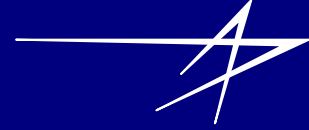
- At worst: **Complete failure**
 - Pile of car parts
 - DIA Baggage Handling

Impact of SE on Program Cost



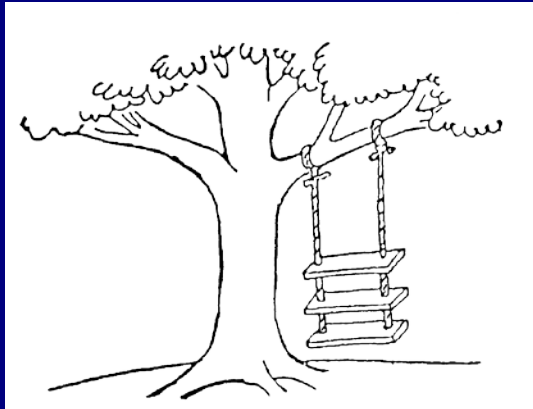
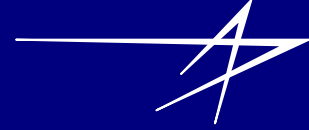
By the time system level design is complete, 85% of the costs have been committed and the cost to extract defects goes up exponentially

Why Is It Important to Manage Requirements?

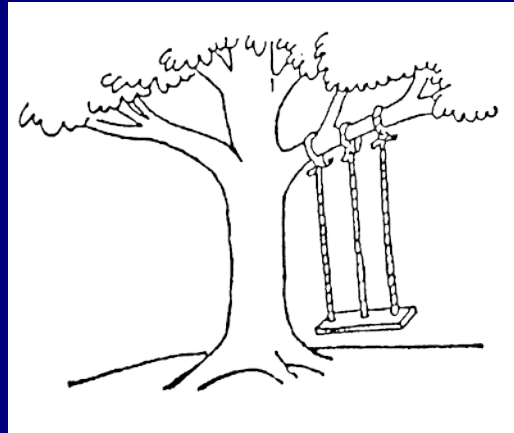


- **To ensure that there is a stable, consistent requirements baseline**
- **To avoid requirements growth**
- **To ensure everyone is working to the same set of requirements**
- **To get appropriate cost impact assessments for proposed changes from all stakeholders**

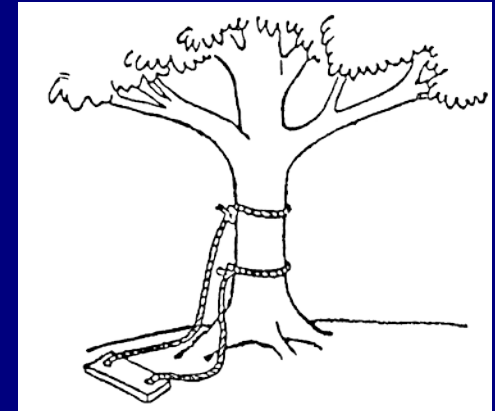
Why are Requirements Important?



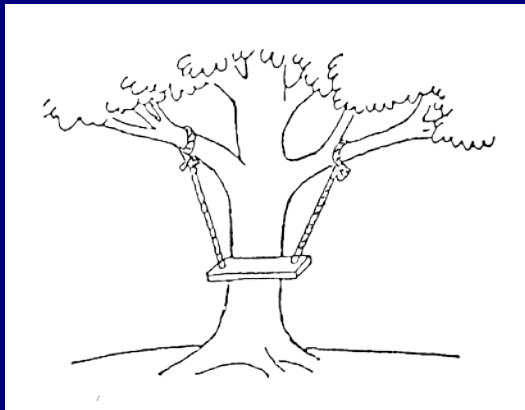
As Contracts Specified It



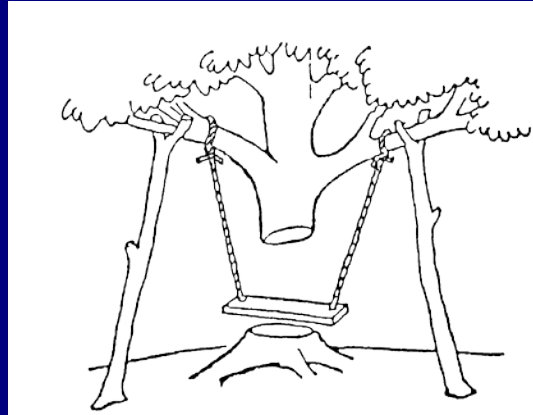
As Engineering Designed It



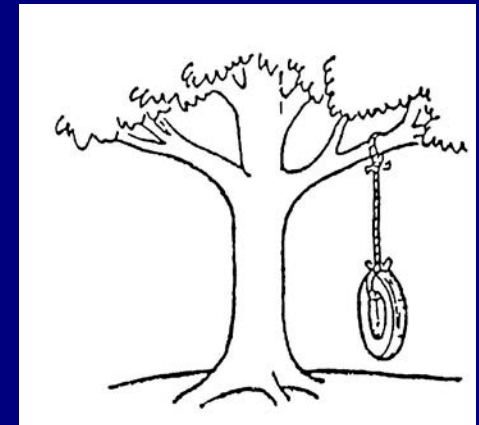
As Materiel Ordered It



As Manufacturing Assembled It



As Test Verified It

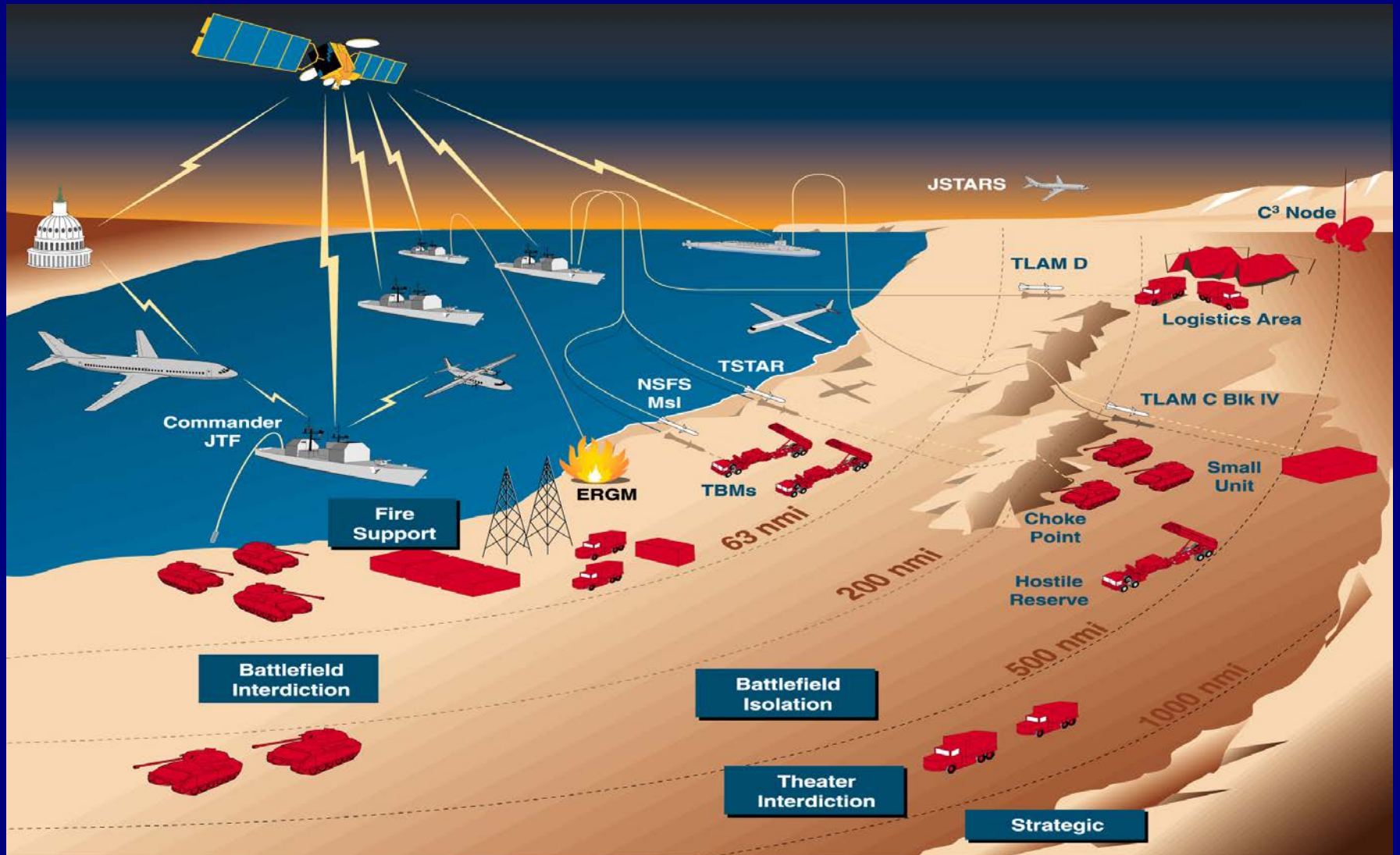


What the Customer Wanted

Clearly Communicating Requirements is Essential

Mission Analysis

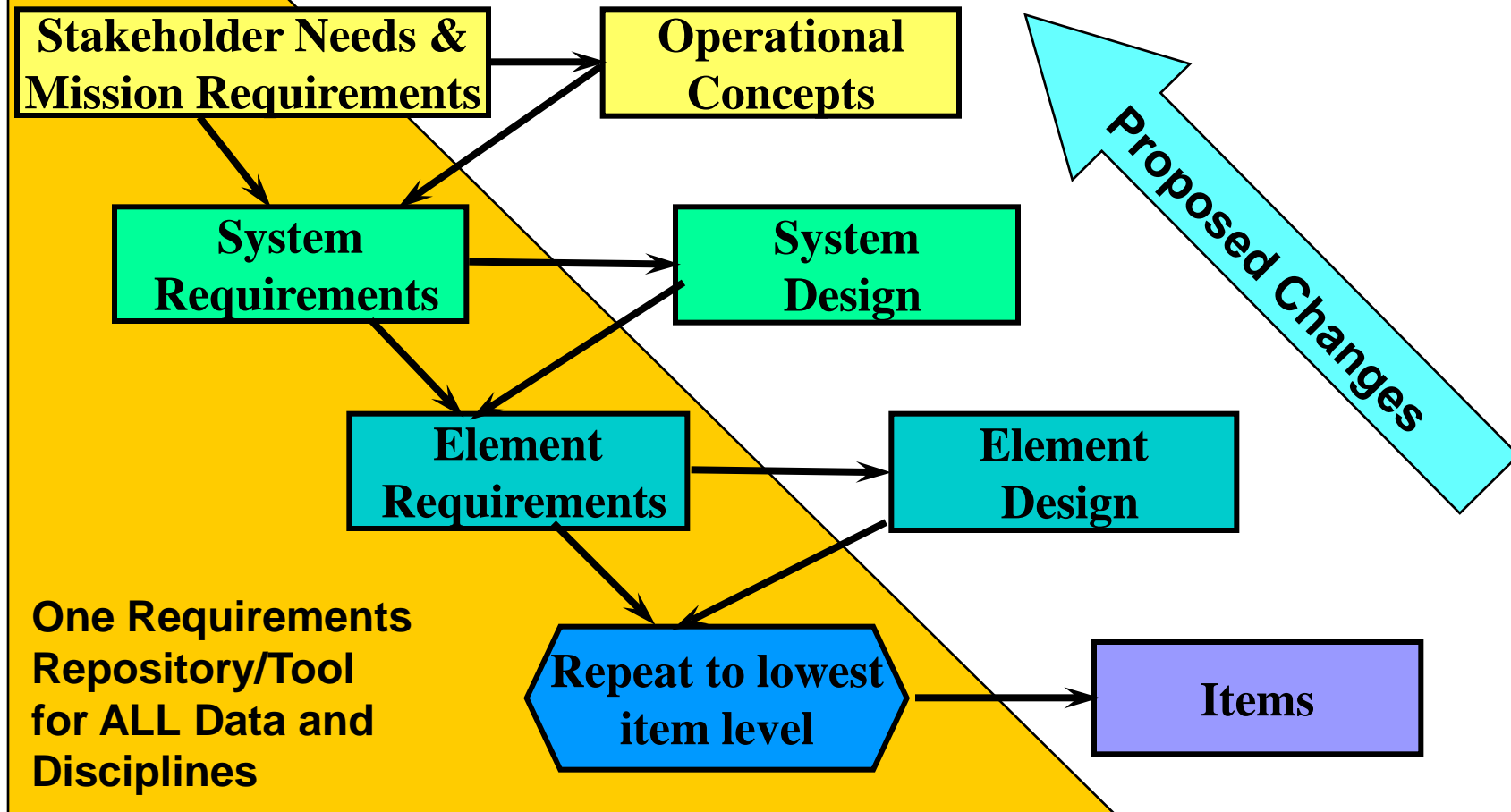
Example -- The Modern Battlefield



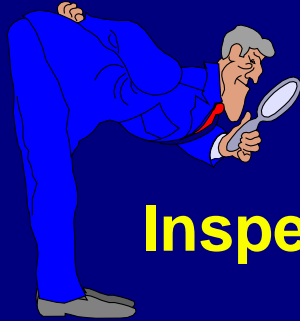
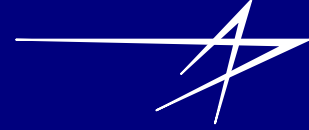
Requirements and Design

Q: Where do requirements end and design begin?

A: There is no dividing line. Design work at one level generates requirements for the next lower level.



What Are the Verification Methods?



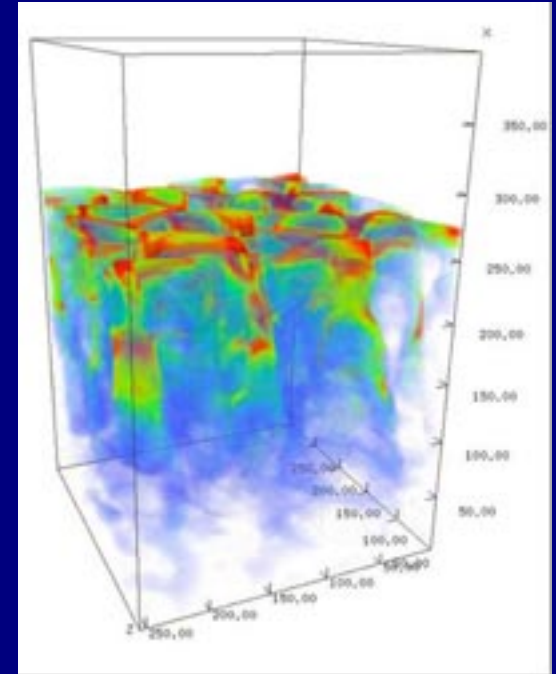
Inspection



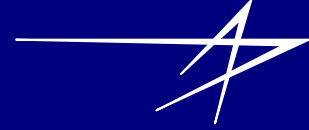
Test



Demonstration



Analysis/Simulation



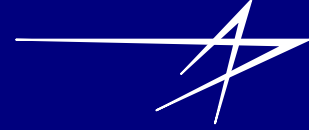
In summary,

The Government / Industry Partnership in Systems Engineering begins with *Standards*

Systems Engineering Revitalization:

- Focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design.***
- Integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation.***
- Considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs.***

Lessons Learned - When to Worry



“That’s history!...We’re going to ‘do it differently this time!’”

“This is all within the state of the art with little design and no development.”

“How could it possibly cost that much ? It wouldn’t cost that much if we didn’t do....”

“We are using COTS hardware - cost risk is low.”

“It’s a tight but achievable schedule.”

“This system has been around for years, all we’re doing is a modification [derivative].”

Lessons Learned - When to Really Worry



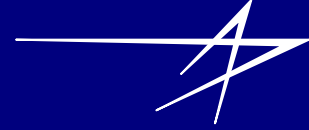
You've carefully thought out all the angles

You've done it a thousand times

It comes naturally to you

*You know what you're doing, its what you've
been trained to do your whole life*

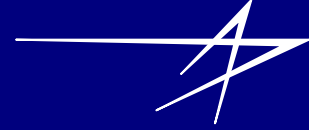
*Nothing could possibly go wrong.... **RIGHT?***



Boy, that looks like an interesting job



***What Process?
I've done this before!***



Think Again!



And Follow Your SE Processes!