Slides From ATI Professional Development Short Course

TOTAL SYSTEMS ENGINEERING DEVELOPMENT AND MANAGEMENT

Instructor:

Jeff Grady

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Who Is Jeff Grady?

CURRENT POSITION

President, JOG System Engineering
System Engineering Assessment, Consulting, and Education Firm

PRIOR EXPERIENCE

U.S. Marines
General Precision, Librascope Div
Customer Training Instructor, SUBROC and ASROC ASW Systems
Teledyne Ryan Aeronautical
Field Engineer, AQM-34 Series Special Purpose Aircraft
Project Engineer, System Engineer, Unmanned Aircraft Systems
General Dynamics Convair Division
System Engineer, Cruise Missile, AGM-129 Advanced Cruise Missile
General Dynamics Space Systems Division
Engineering Department Manager, Systems Development

FORMAL EDUCATION

SDSU, BA Math; UCSD, Certificate in System Engineering; and
USC, MS Systems Management with Information Systems Certificate

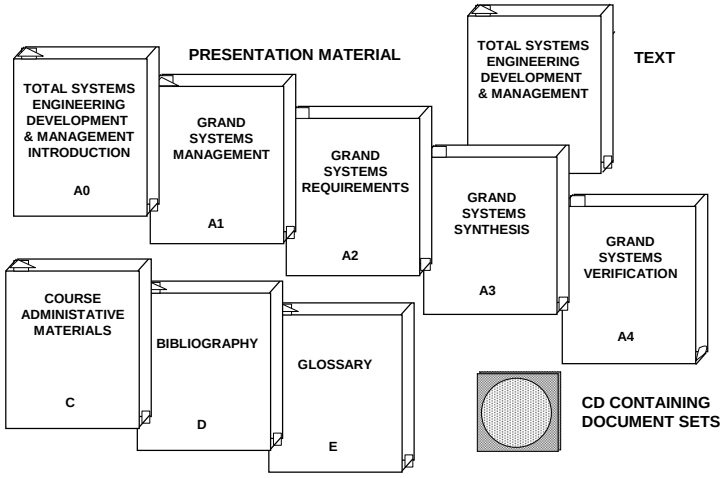
INCOSE First Elected Secretary , Fellow, Founder, ESEP

AUTHOR System Requirements Analysis (1993 & 2006), System Integration, System Validation and Verification, System Engineering Planning and Enterprise Identity, System Engineering Deployment, System Verification (2007), System Synthesis (2010), System Management (2010)

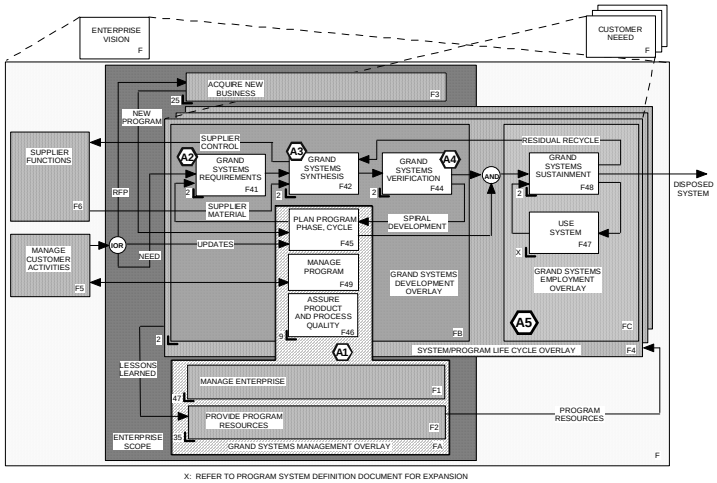
Grand Systems Overview Course
One-Day Management Outline

1.1 Introduction to System Engineering
1.2 Development Process Overview
1.3 Enterprise Re-Engineering
1.4 Program Design
1.5 Program Estimating and Earned Value Systems
1.6 Program Risk Management
1.7 Baselines and Configuration Management
1.8 System Engineering Maturity

Student Materials Map



System Life Cycle



X: REFER TO PROGRAM SYSTEM DEFINITION DOCUMENT FOR EXPANSION

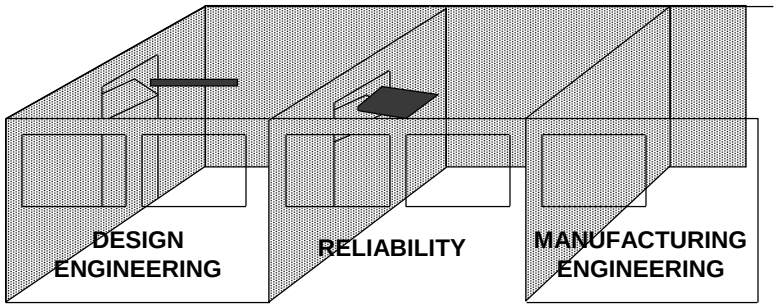
AN EXHIBIT DESIGNATION

Segment Goals

- **Expose a simple foundation for system engineering**
- **Explain the fundamental pathway commonly followed in applying it**
  - **Define the problem**
  - **Solve the problem**
  - **Prove it**
- **Expand, as time permits, methods useful in implementing an effective capability in your product domain of interest**

The Systems Approach Has Not Always Been Properly Applied

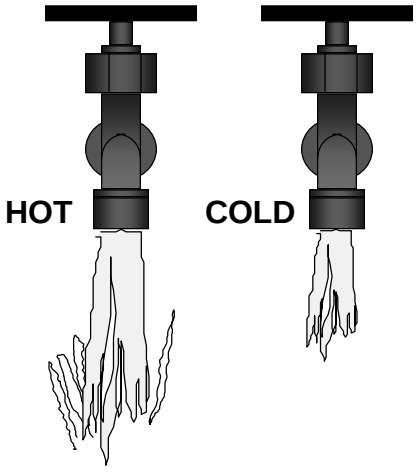
OVER THE TRANSOM ENGINEERING



Other Common Errors In Implementation

- Allowed our methods for organizing knowledge to intrude upon our methods for organizing product
- Failed to understand that we must optimize on both product and product process together
- Given lip service to the systems approach while perpetuating autonomous work performance
- System engineers have been technically shallow and over- energized about rigid rules
- Permitted program managers to conserve program resources early in programs

Order Versus Creativity



EARLY IN PROGRAM

HOT WATER FULL ON
COLD WATER NEARLY OFF

MID-LIFE CRISIS

EVOLVING BALANCE

MATURE PROGRAM

HOT WATER OFF
COLD WATER FULL ON

Crowds of People Are Not Good Enough

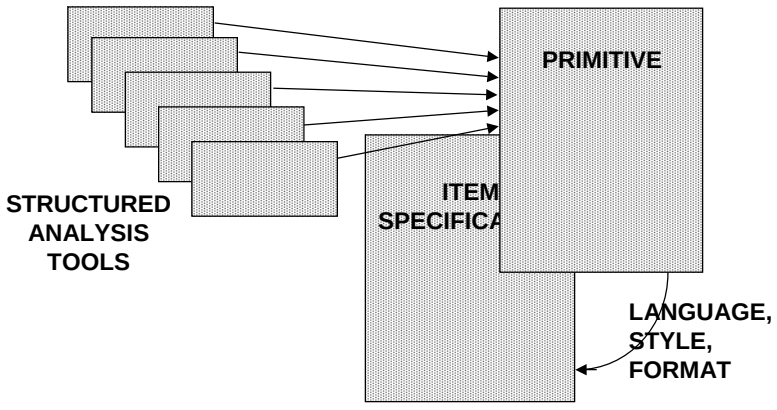
Grand Systems Overview Course
Two-Day Requirements Outline

2.1 Introduction
2.2 Requirements Relationships
2.3 Program Beginnings
2.4 System and Hardware Structured Analysis
2.5 System and Hardware Structured Analysis Variations
2.6 Performance Requirements
2.7 Analysis
2.8 Product Entity Definition Interface Definition and
2.9 Requirements Development Specialty Engineering
2.10 Requirements Analysis Environmental Requirements Analysis
2.11 Computer Software Structured Analysis Intro and Early Methods
2.12 Computer Software Structured Analysis OOA and UML
2.13 Computer Software Structured Analysis DODAF
2.14 Integrated System Definition
2.15 Specification Publishing and Management
2.16 Requirements Risk Management

The Word Requirement, From the Dictionary

- Something wanted or necessary.
- Something essential to the existence or occurrence of something else.
- A necessary character-istic or attribute of some thing (or item).

A Foolproof Search For Subjects



Requirements Quantification Methods

ALLOCATION/FLOWDOWN

Apportionment of parent value in accordance with a mathematical rule

Equivalency - "All items shall be green."

SYNTHESIS VIA MODELS, SIMULATIONS, PARAMETRICS

Appropriate for sets of requirements connected by complex relationships

APPEAL TO AUTHORITY

Customer/Industry/Government Standards

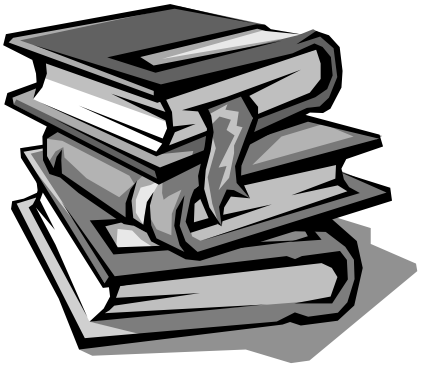
Expert Persons

Sentences of Importance

1	Scope
2	Applicable Documents
3	Requirements
3.1	Functional and Performance Rqmts.
3.1.1	Missions
3.1.2	Threat
3.1.3	Required States and Modes
3.1.4	Entity Capability Requirements
3.1.5	Reliability
3.1.6	Maintainability
3.1.7	Deployability
3.1.8	Availability
3.1.9	Environmental Conditions
3.1.10	Transportability
3.1.11	Materials and Processes
3.1.12	Electromagnetic Radiation
3.1.13	Nameplates and Product Markings
3.1.14	Producibility
3.1.15	Interchangeability
3.1.16	Safety
3.1.17	Human Factors Engineering
3.1.18	Security and Privacy
3.1.19	Computer Resource Requirements
3.1.20	Logistics
3.1.21	Personnel and Training
3.1.22	Requirements Traceability
3.2	Interface Requirements
3.2.1	GFP Interfaces
3.2.2	External Interface Requirements
3.3	Design and Construction
3.3.1	Production Drawings
3.3.2	Software Design
3.3.3	Workmanship
3.3.4	Standards of Manufacture
3.3.5	Process Definition
3.3.6	Material Definition
3.4	Precedence and Criticality of Rqmts.
4	Verification
4.1	Methods of Verification
4.2	Classes of Verification
4.3	Inspections
5	Packaging
6	Notes

MIL-STD-961E Format

What is a Specification?



A specification contains all of the require-ments for a given item.

Sentences of Importance

1	Scope
2	Applicable Documents
3	Requirements
3.1	Functional and Performance Rqmts.
3.1.1	Missions
3.1.2	Threat
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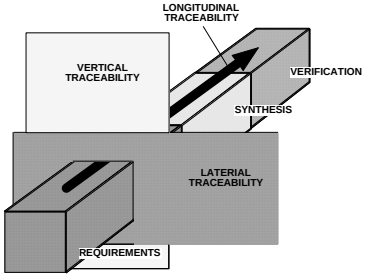
6	Notes

MIL-STD-961E Format

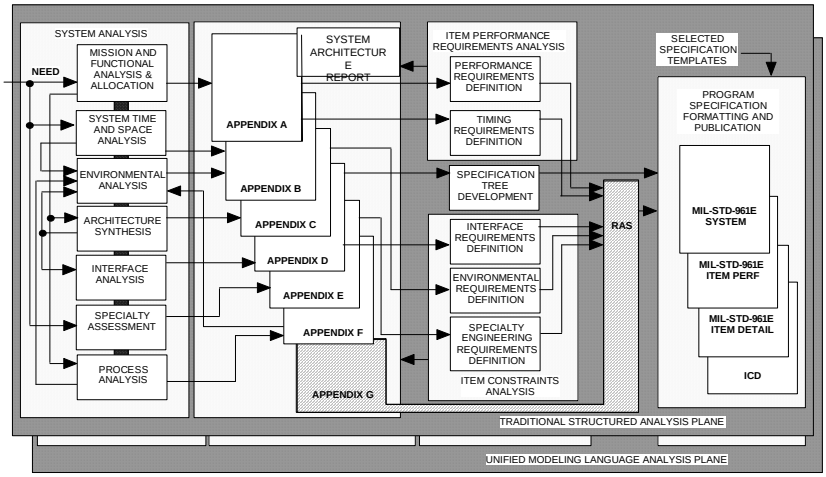
In Writing a Specification, What Is the Target?

Traceability Forms

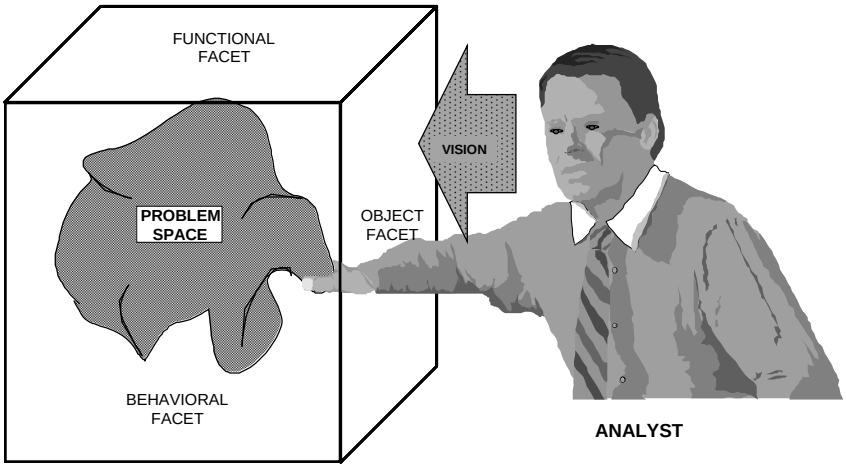
- **Vertical requirements traceability**
  - **Hierarchical or parent-child**
  - **Requirements source traceability**
  - **Requirements rationale traceability**
- **Longitudinal traceability**
  - **Requirements to design and verification**
- **Lateral traceability**
  - **Traceability to method**
- **Applicable document**
  - **Internal integrity**



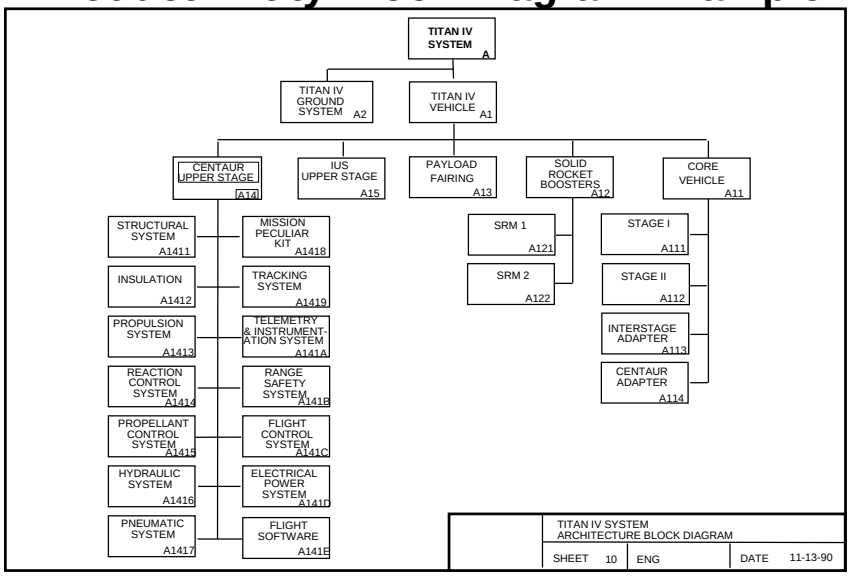
SAR Organization For Traditional Structured Analysis



Structured View of a Problem Space



Product Entity Block Diagram Example



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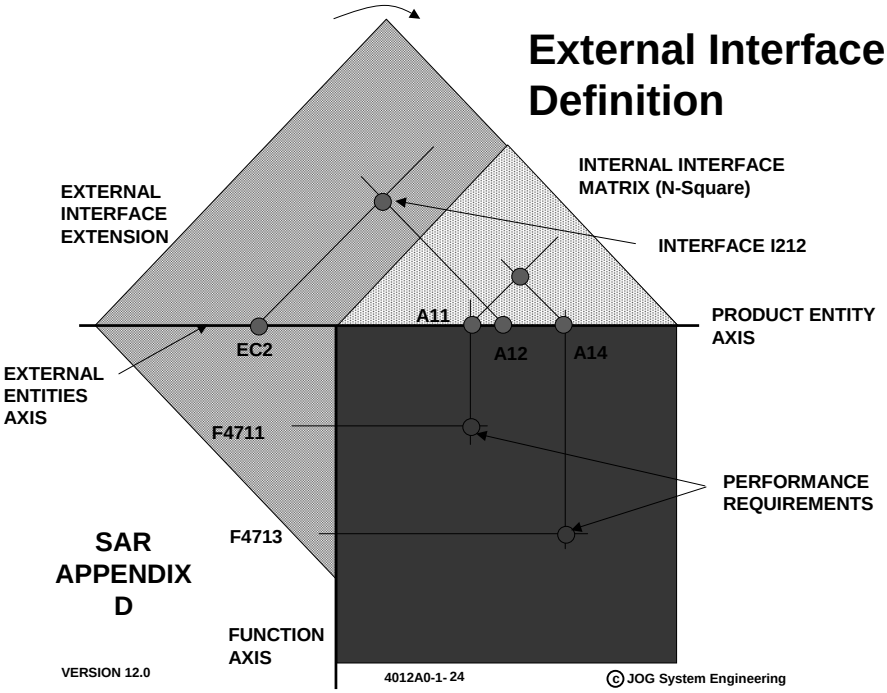
External Interface Definition



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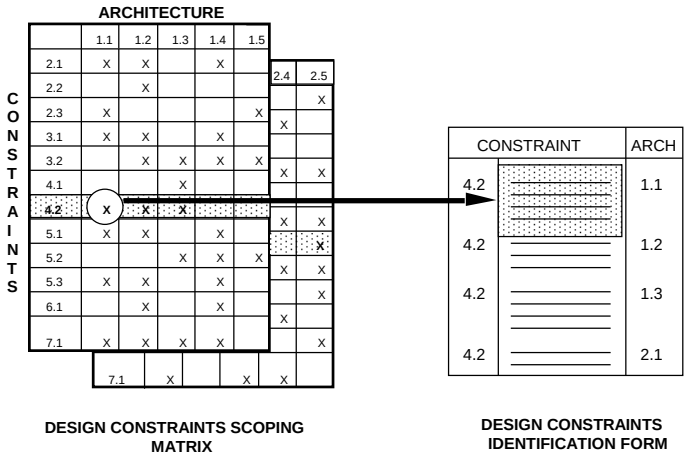
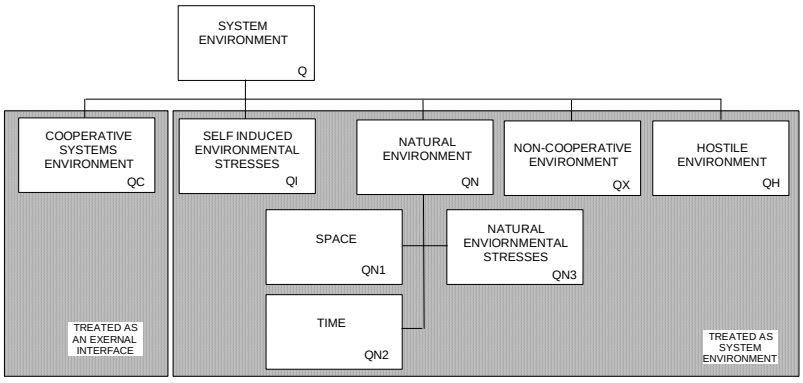
Specialty Engineering Identification of Constraints



DESIGN CONSTRAINTS SCOPING MATRIX

DESIGN CONSTRAINTS IDENTIFICATION FORM

Environment Subsets



Environmental Requirements

- **System**
  - **Identify spaces within which the system will have to function**
  - **Select standards covering those spaces**
  - **For each standard, select parameters that apply**
  - **Tailor the range of selected parameters**
- **End item**
  - **Build three dimensional model of end items, physical processes, and process environments**
  - **Extract item environments**
- **Component**
  - **Zone end item into spaces of common environmental characteristics**
  - **Map components to zones**
  - **Components inherit zone environmental requirements**

Software Analysis Orientations

Process oriented analysis

FLOW CHARTING AND IPO
YOURDON-DEMARCO-CONSTANTINE
HATLEY-PIRBHAI REAL TIME MODELING

Data oriented analysis

DATA TABLE NORMALIZATION
IDEF-1X

Object oriented analysis (OOA)

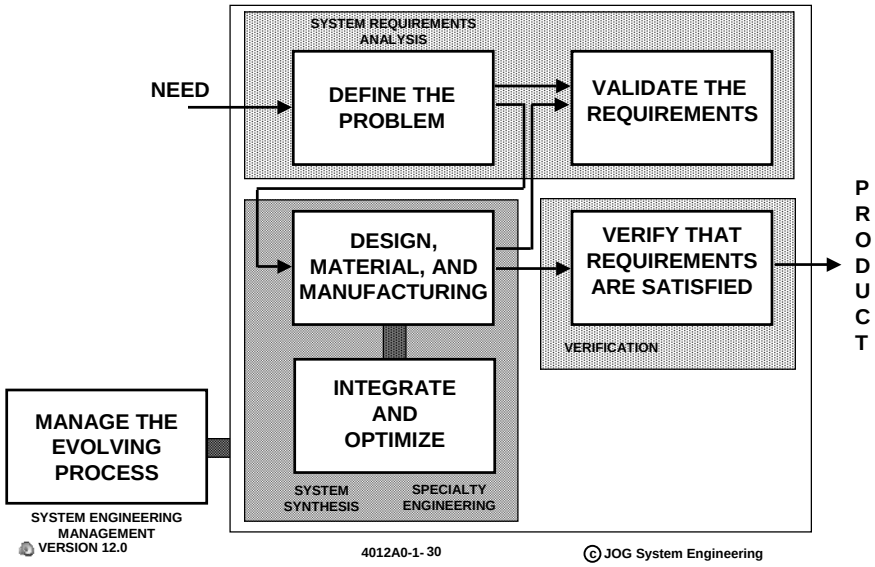
COMBINES PROCESS AND DATA ORIENTATIONS
UML RESTORES SW RESPECT FOR SULLIVAN'S IDEAS

DoDAF

Grand Systems Overview Course
One-Day Synthesis Outline

3.1 Introduction to System Synthesis
3.2 Product Design
3.3 Other Product Sources
3.4 Interface Development
3.5 Interface Development
3.6 Trade Studies and Decision-Making
3.7 Design Reviews
3.8 Manufacturing and Quality

Overall Systems Approach



Design Defined

- To prepare the preliminary sketch or the plan for a work to be executed
- To plan or fashion artistically or skillfully
- To intend for a specific purpose
- To form or conceive in the mind

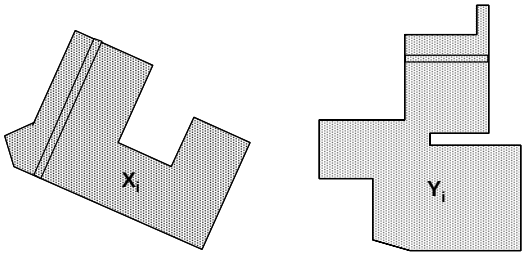
Making Sense of Synthesis

- The combining of the constituent elements of separate material or abstract entities into a single or unified entity (opposite of analysis).
- Because we find it necessary to partition or decompose wholes into parts, to set the problem size to human proportions, we are obligated to synthesize those parts into the whole.
- The design engineer must synthesize the many requirements into a solution that satisfies all of those requirements.

Optimization

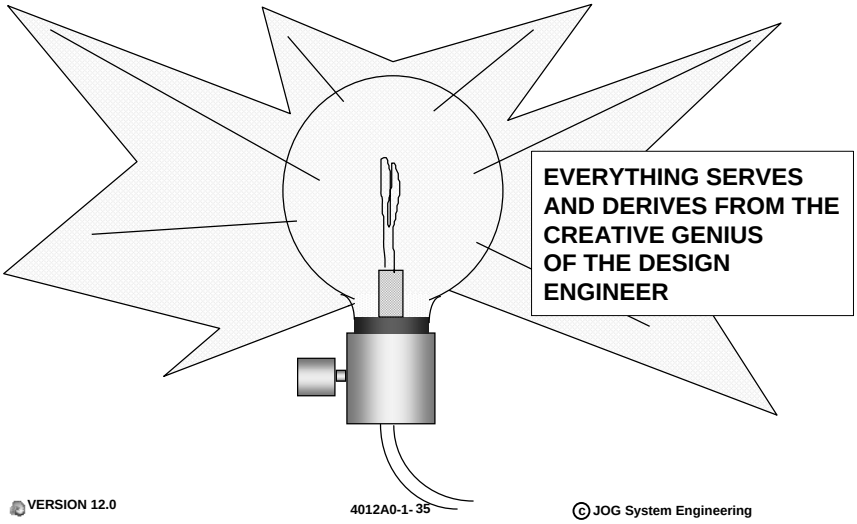
- **Optimize**
  - **To make as effective, perfect, or useful as possible**
  - **To make the best of**
- **Optimum**
  - **The most favorable point, degree, or amount of something for obtaining a given result**
  - **The best result obtainable under specific conditions**
  - **The most favorable or desirable**

What Is It - System Integration?

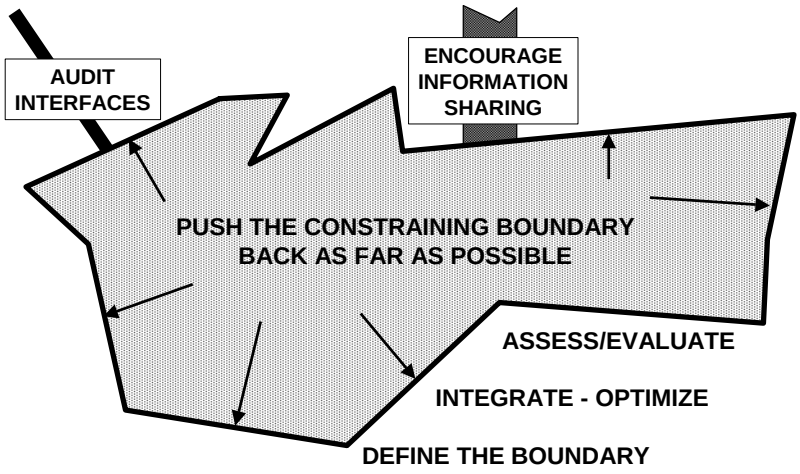


- **The act or process of forming, coordinating, or blending two or more elements into a functioning or unified whole.**
- **Perhaps it can best be described in terms of its parts.**

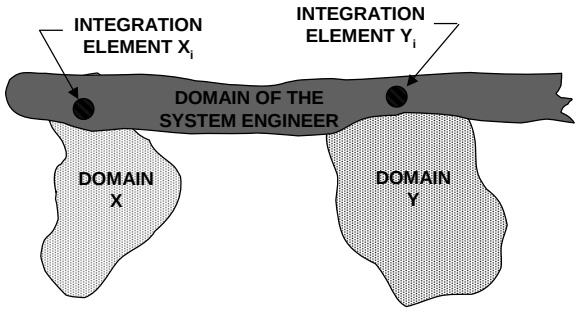
How Do We Turn On the Switch?



System Engineering Services To the Designer



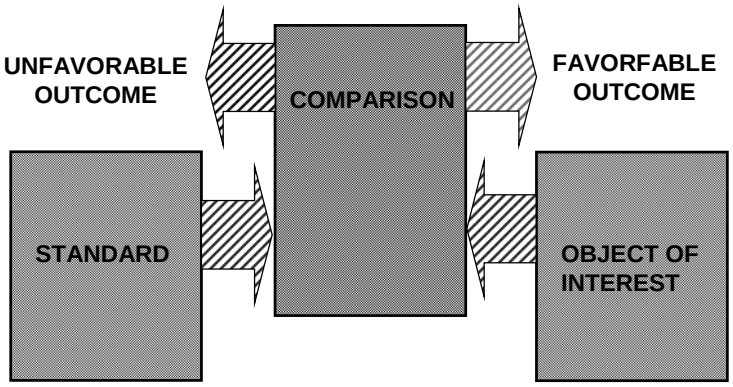
Integration Skills



Grand Systems Overview Course
One-Day Verification Outline

4.1 Introduction to Verification
4.2 Requirements Validation
4.3 Item Qualification Requirements Identification
4.4 Verification Requirements Writing Workshop
4.5 Item Qualification Planning and Documentation
4.6 Top-Down Item Qualification Planning Workshop
4.7 Item Qualification Implementation, Reporting, Management, and Audit
4.8 Item Acceptance and System Test and Evaluation Overview

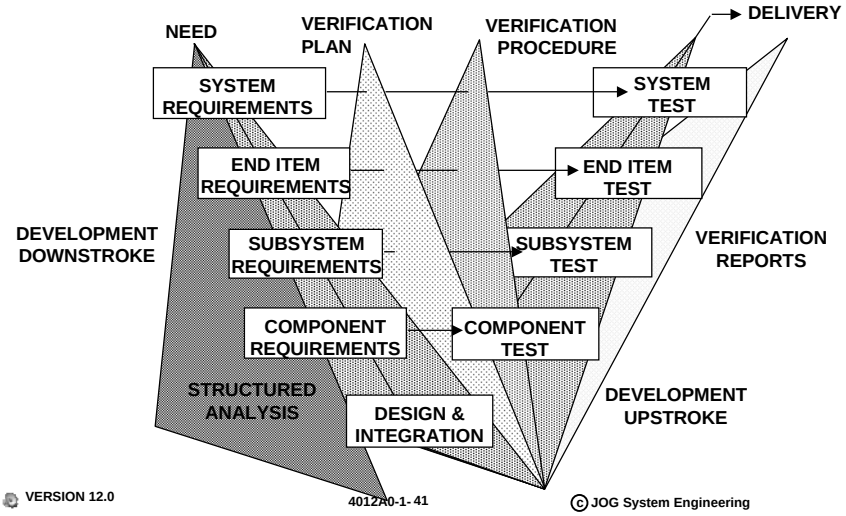
What is Verification?



Verification Purpose and Mechanism

- **Irrefutably establish that the product design satisfies the previously approved requirements**
- **Develop evidence of compliance in test and analysis reports**
- **Verification is the management discipline of coordinating the acquisition, communication, and review of that evidence**
- **Proof of product representations for future use**

The V Model Encourages Good Requirements



Verification Classes

- **Item qualification**
  - **Driven by item performance specifications**
  - **Proves design adequate for the application defined in the specification**
  - **Concluded by an audit called FCA**
- **Item acceptance (first article and recurring)**
  - **Driven by the item detail specification**
  - **Proves the specific product article is acceptable for delivery to customer**
  - **First article acceptance concluded by audit called PCA followed by recurring acceptance**
- **System test and evaluation**
  - **Driven by system specification content**
  - **DT&E**
  - **OT&E**

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