INCOSE 2011
SYMPOSIUM

Is System Engineering Overdue For a Fix?

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Systems Engineering Criticism

- Some have criticized the systems engineering process as being ineffective, costly,...
- The final straw for me was Av Week November 1/8 2010
- There is a counter argument we should pursue as a prerequisite to wholesale change to the process
- That counter argument is that perhaps we should try to follow the process we have described in the development of new systems
- An enterprise that develops systems should have good management that improves over time and insists that the process employed does as well

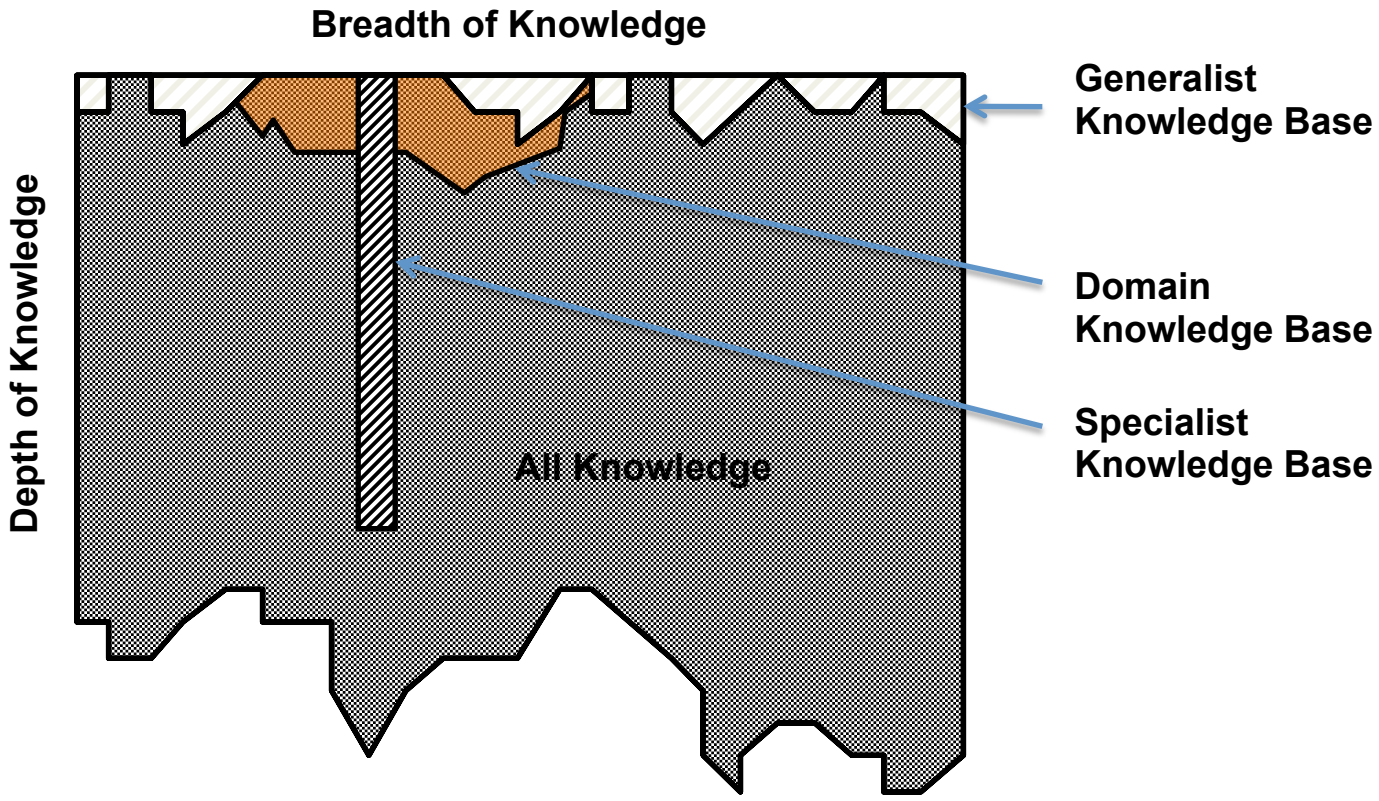
Five Foundations

- Development requires knowledge and knowledge is distributed
- We must organize knowledge in some way
- There is a preferred order of development
- An effective process has been defined
  - Define the problem
  - Solve the problem (design, material, manufacture)
  - Prove that the design satisfies the definition (verify)
  - Manage well across the development effort
- Modeling is an effective beginning

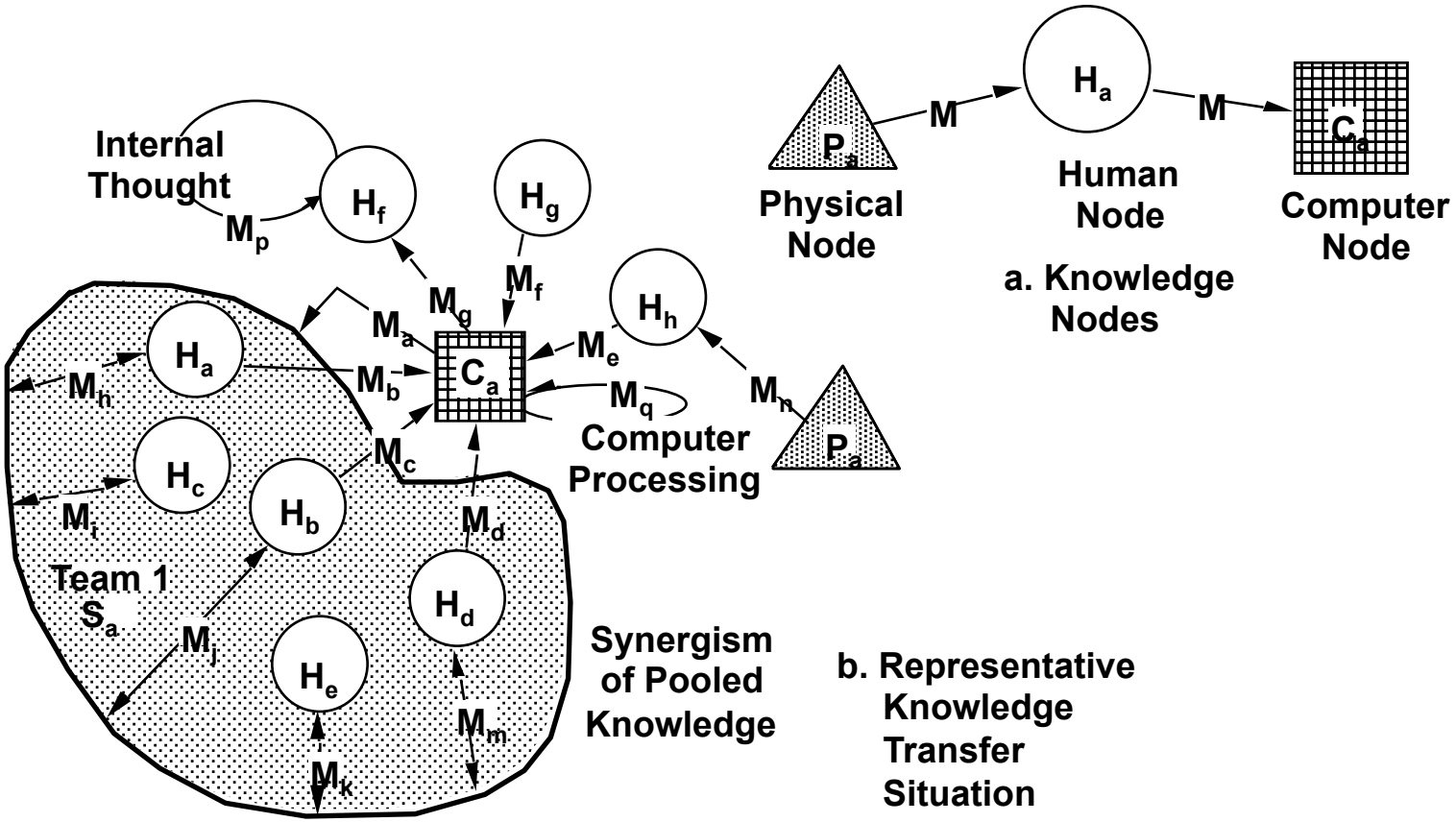
The Knowledge Situation

- At one time on planet Earth every person could know everything mankind knew
- Man progressed in his knowledge through experience
- Eventually the amount of knowledge available was greater than the capacity of a single human mind
- People had to specialize
- Now knowledge must be partitioned into many specialties

Knowledge is Distributed



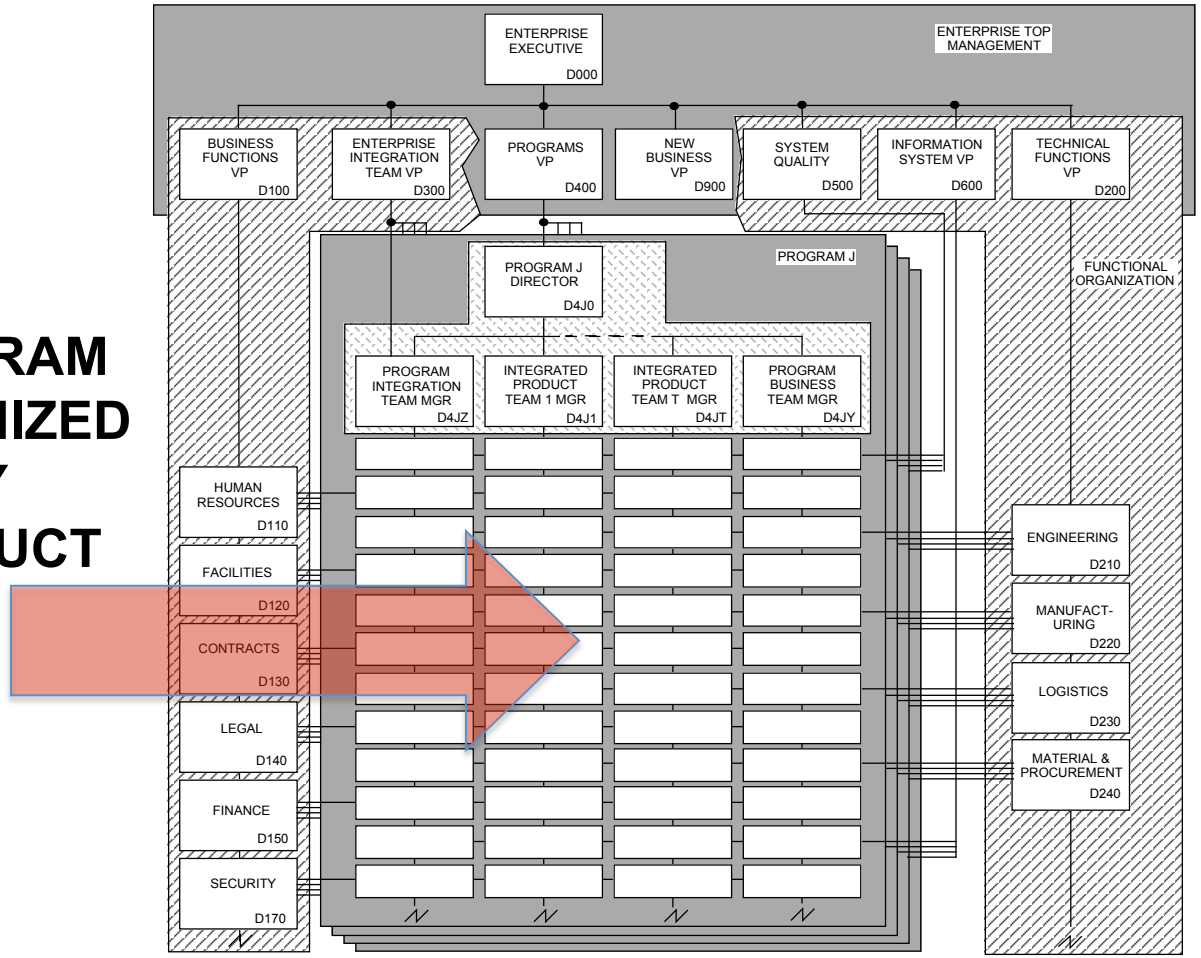
Knowledge Repositories



The role of the system engineer is to cause a collection of people to appear to possess a single great mind.

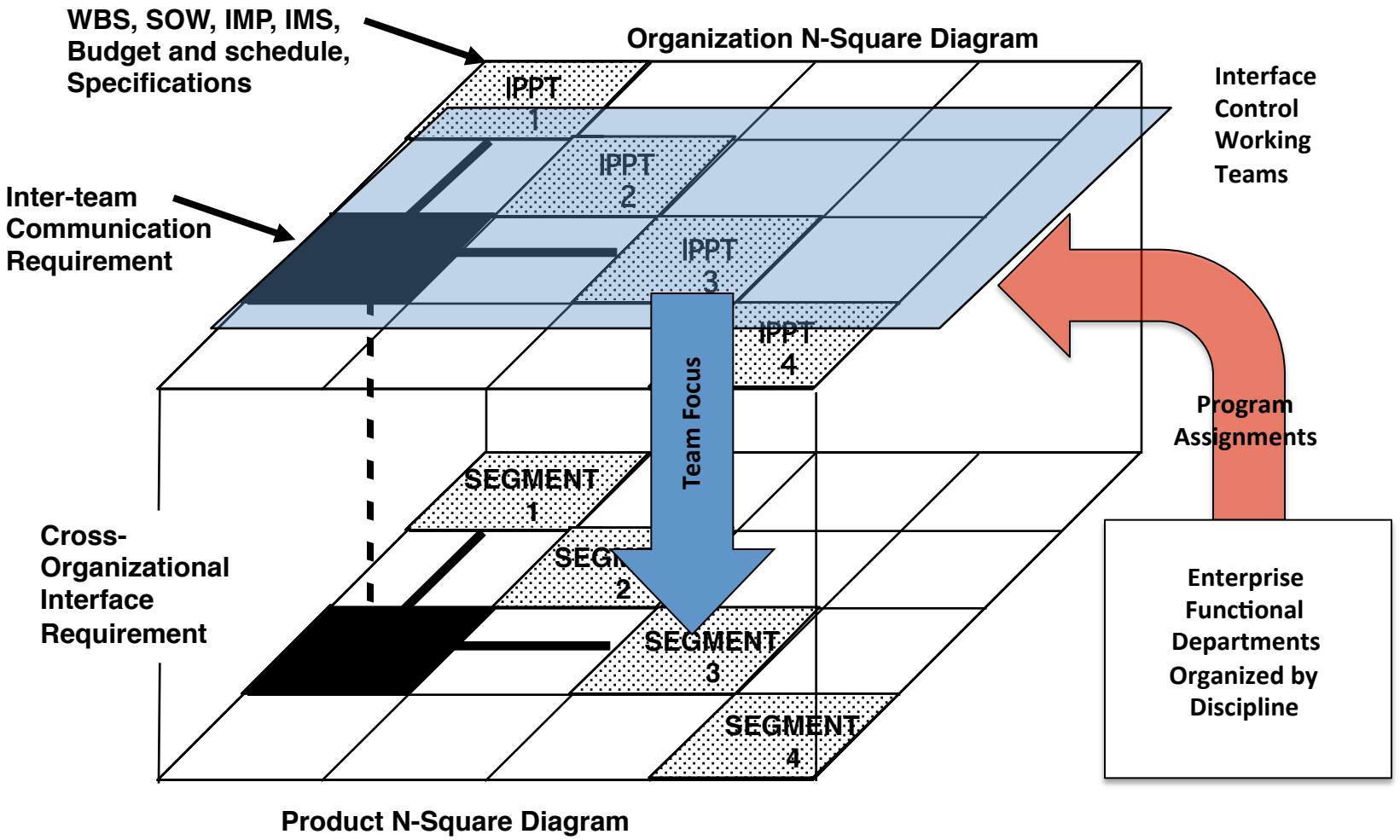
An Effective Organizational Scheme

PROGRAM ORGANIZED BY PRODUCT



ENTERPRISE ORGANIZED BY KNOWLEDGE

Knowledge Applied to a Program



Order of Development

- Define the problem as a prerequisite to solving it
- First determine what the system must do and how well
- Then determine what the system will have to consist of in order to do so
- Follow the advise of Louis Sullivan – "Form ever follows function"
- Note that object oriented analysis did not survive because it called for us to determine what the system consisted of as a prerequisite to determining what those "objects" must do.

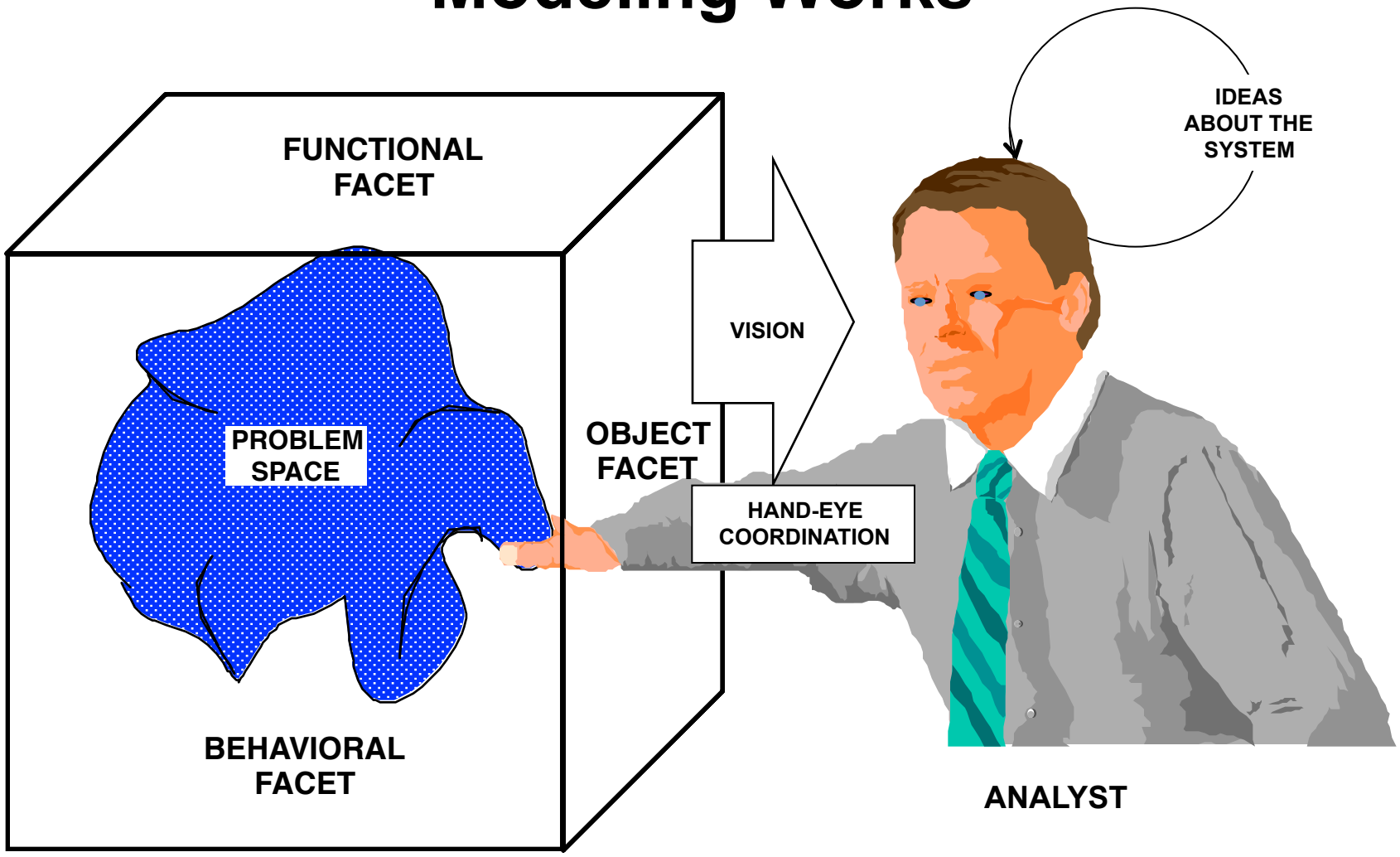
In the Remaining Time

- Permit me to focus on the first order of business in system development because if it is not done well and affordably then all else is for not
- Today there are many enterprises that have not yet figured out how to do this work well
- You should possess a specification template coordinated with department responsibilities, models to be employed, and location of modeling artifacts
- You should define the problem to be solved through modeling using a comprehensive model

Use a Specification Template Coordinated With Departments, Models, and SAR Appendices

PARA	TITLE	DEPT	MODEL TO BE APPLIED	SAR
3.2	System Capabilities	D216-2	Functional Analysis	A
3.2.m	Capability m	D216-2	Functional Analysis	A
3.2.m.n	Performance Requirement n	D216-2	Performance Requirements Analysis	
3.3	Interface Requirements	D216-2	Interface Requirements Analysis	D
3.3.1	Crossface Requirements	D216-2	Schematic Block Diagram	D
3.3.2	Innerface Requirements	D216-2	Schematic Block Diagram	D
3.3.3	Outerface Requirements	D216-2	Schematic Block Diagram	D
3.3.4	Government-Furnished Property (GFP) Interfaces	D216-2	N-Square Analysis	D
3.4	Specialty Engineering Requirements	D216-2	Specialty Engineering Modeling	E
3.4.1	Reliability	D216-4	Reliability Modeling	E
3.4.2	Maintainability	D216-4	Maintainability Modeling	E
3.4.3	Availability	D216-4	RAM Modeling	E
3.5	Environmental Requirements	D216-2	Environmental Requirements Analysis	B

Modeling Works



But What Model?

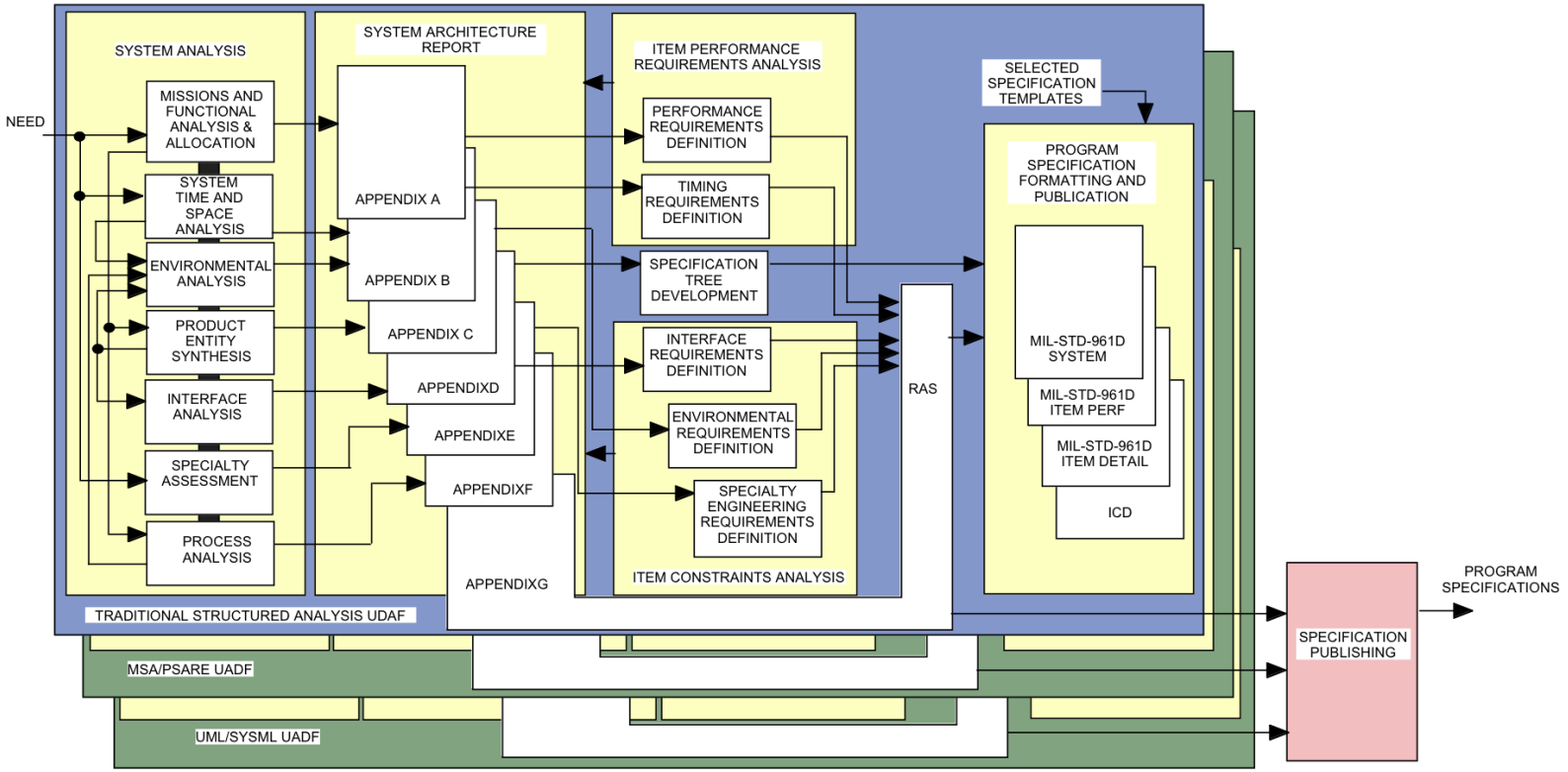
- Use a comprehensive model that is effective no matter how you decide to implement the design in hardware, software, or people doing things
- Three such universal architecture description frameworks (UADF) are available
  - Traditional structured analysis using functional analysis combined with constraints analysis (interface, specialty engineering, and environmental modeling)
  - MSA-PSARE augmented with constraints analysis
  - UML-SysML augmented with constraints analysis

Capture the Modeling Results in a RAS Implemented in a Database From Which Specifications Can be Printed

MODEL ENTITY		REQUIREMENT ENTITY		PRODUCT ENTITY		DOCUMENT ENTITY	
MID	MODEL ENTITY NAME	RID	REQUIREMENT	PID	ITEM NAME	PARA	TITLE
F47	Use System			A	Product System		
F471	Deployment Ship Operations			A	Product System		
F4711	Store Array Operationally	XR67	Storage Volume < 10 ISO Vans	A1	Sensor Subsystem		
H	Specialty Engineering Disciplines			A	Product System		
H1	Reliability	EW34	Failure Rate < 10 x 10-6	A1	Sensor Subsystem	3.1.5	Reliability
H11	Reliability	RG31	Failure Rate < 3 x 10-6	A11	Cable	3.1.5	Reliability
H11	Reliability	FYH4	Failure Rate < 5 x 10-6	A12	Sensor Element	3.1.5	Reliability
H11	Reliability	G8R4	Failure Rate < 2 x 10-6	A13	Pressure Vessel	3.1.5	Reliability
H12	Maintainability	8GHU	Mean Time to Repair < 0.2 Hours	A1	Sensor Subsystem	3.1.6	Maintainability
H12	Maintainability	U9R4	Mean Time to Repair < 0.4 Hours	A11	Cable	3.1.6	Maintainability
H12	Maintainability	J897	Mean Time to Repair < 0.2 Hours	A12	Sensor Element	3.1.6	Maintainability
H12	Maintainability	9D7H	Mean Time to Repair < 0.1 Hours	A13	Pressure Vessel	3.1.6	Maintainability
I	System Interface			A	Product System		
I1	Internal Interface			A	Product System		
I11	Sensor Subsystem Innerface			A1			
I181	Aggregate Signal Feed Source Impedance	E37H	Aggregate Signal Feed Source Impedance= 52 ohms +-2 ohms	A1	Sensor Subsystem		
I181	Aggregate Signal Feed Load Impedance	E37I	Aggregate Signal Feed Load Impedance= 52 ohms +-2 ohms	A4	Analysis and Reporting Subsystem		
I2	System External Interface			A	Product System		
Q	System Environment			A	Product System		
QH	Hostile Environment			A	Product System		
QI	Self-Induced Environmental Stresses			A	Product System		
QN	Natural Environment			A	Product System		
QN1	Temperature	6D74	-40 degrees F <= Temperature <= +140 degrees F	A	Product System		
QX	Non-Cooperative Environmental Stresses			A	Product System		

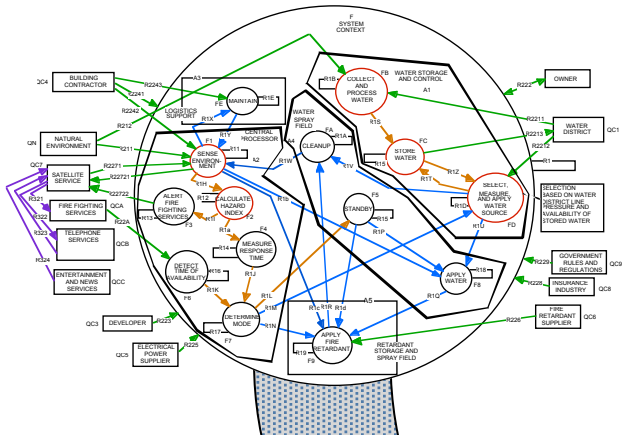
Document the Modeling Results in a Form that can be Configuration Managed

System Architecture Report Using TSA Shown



The Flow of Development Knowledge

Model the Problem Space Annotating Artifacts With MID



List Artifacts in RAS in MID Alphanumeric Order

Allocate Requirements

MID	REQUIREMENTS	ENTITY	SPECIFICATION
	RAS		

Derive Requirements

Employ Universal Format For Entity Specification

Published Specifications

And on to Verification

A Suggested Course of Action

- Before we leap to new solutions let us try actually applying the one we have – system engineering manuals in companies seldom have coffee stains and dog-eared pages
- Then assess the effectiveness
- If warranted then we should make changes that will lead to a more cost-effective process
- Managers at all levels who look to continuous improvement of process over time avoiding a saw tooth result with only momentary periods of some success

Who Is Jeff Grady?

CURRENT POSITION

1993-Preset Owner, JOG System Engineering
System Engineering Assessment, Consulting, and Education Firm

PRIOR EXPERIENCE

U.S. Marines
General Precision Librascope Division
- Customer Training Instructor, SUBROC and ASROC ASW Systems

Teledyne Ryan Aeronautical
- Field Engineer, AQM-34 Series Special Purpose Aircraft System
- Project Engineer, System Engineer, Unmanned Aircraft Systems

General Dynamics Convair Division
- System Engineer, Cruise Missile, Advanced Cruise Missile

General Dynamics Space Systems Division
- Manager, Systems Development Department

FORMAL EDUCATION

SDSU - BA Math; UCSD - Systems Engineering Certificate
USC - MS Systems Management with Information Systems Certificate

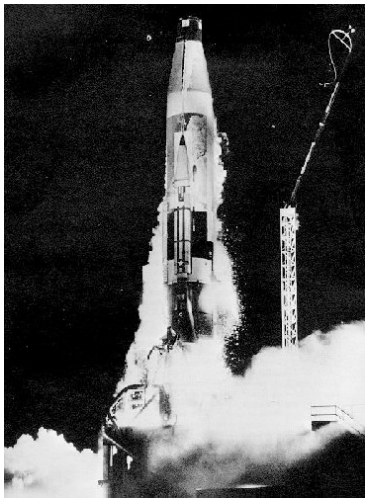
INCOSE First Elected Secretary, Fellow, Founder, Expert System Engineering Professional

AUTHOR System Requirements Analysis (2), System Verification, System Integration, System Validation and Verification, System Engineering Planning and Enterprise Identity, System Engineering Deployment, System Synthesis, System Management

Systems Worked On As a Captive Employee

US Navy ASROC

USAF/GD Convair
AQM 129 Advanced Cruise Missile



GD Space Systems
Atlas Space Transport

USAF/Ryan AQM-34L Tom Cat
58 Combat Missions

US Navy/IAF/
Ryan Model 147SK

USAF/Ryan BGM-34C