



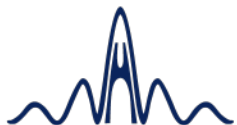
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A world in which ...

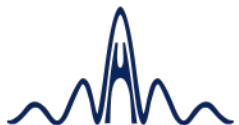
- *There is **systems engineering content in every engineering degree** worldwide and engineering academics, without exception, see systems engineering as **an integral part of the discipline of engineering**.*
- *CEOs expect and require systems engineering to be practiced at **every level of the enterprise**.*
- *The need for our services has disappeared because **every engineer graduates**, not only as a competent technologist, but with an understanding of how to go about successfully **applying** that technology expertise via **systems engineering**.*
- *There is systems engineering content in **every MBA**.*



To improve the performance of our clients and the lives of their people by improving the practice of engineering, based on systems thinking, and using the principles and methods of systems engineering.



To grow agents of change in enterprises worldwide, at every level of the enterprise, by delivering demonstrably outstanding, evidence-based consulting and training services that win hearts and minds. To do so using a team of outstanding professionals who gain satisfaction from empowering others.



ROBERT J. HALLIGAN

FIE Aust CPEng IntPE(Aus)



rhalligan@ppi-int.com

CAREER HIGHLIGHTS

- **Founder & Managing Director** | Project Performance International
- **Content Contributor** | EIA/IS-632, EIA 632, IEEE 1220, ISO/IEC 15288 SE standards
- **Past INCOSE Head of Delegation** | ISO/IEC SC7 on Software and Systems Engineering
- **Past Member** | INCOSE Board of Directors
- **Past President** | Systems Engineering Society of Australia
- **Consultant/Trainer** | BAE Systems, Mitsubishi, Airbus, Thales, Raytheon, General Electric, Boeing, Lockheed, General Dynamics, OHB, Nokia, AREVA, BHP Billiton, Rio Tinto, Embraer, Halliburton, Dyson and many other leading enterprises on six continents



KEY MEMBERS OF PPI's CONSULTING AND TRAINING TEAM



Paul Davies



Randall Iliff



George Sousa



Bijan Elahi



René King



Clive Tudge



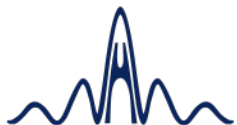
Michael Gainford



Alwyn Smit



John Fitch



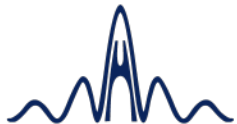


More generally, PPI has trained over 15,400 professionals worldwide in systems engineering, in 41 countries on six continents. CTI has trained another 3,100+ professionals to take the SEP examination.



- **Architectural Design – AD5D (5-day)**
- **Engineering Successful Infrastructure Systems – ESIS5D (5-day)**
- **INCOSE SEP Exam Preparation - ISEP5D (5-day, delivered by CTI)**
- **Interface Engineering and Management – IEM2D (2-day)**
- **Medical Device Risk Management – MDRM2D (2-day)**
- **Project Risk and Opportunity Management – PROM3D (3-day)**
- **Requirements Engineering – RASW5D (5-day)**
- **Requirements, OCD & CONOPS in Capability Development – ROC5D (5-day)**
- **SE-ZERT® program – SEZERT12D (12 day, delivered by CTI)**
- **Systems Engineering Overview –SEO3D (3-day)**
- **Systems Engineering – SE5D (5-day) – our flagship course**
- **Systems Engineering Management – SEM5D (5-day)**

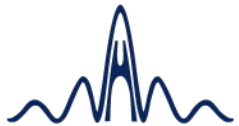
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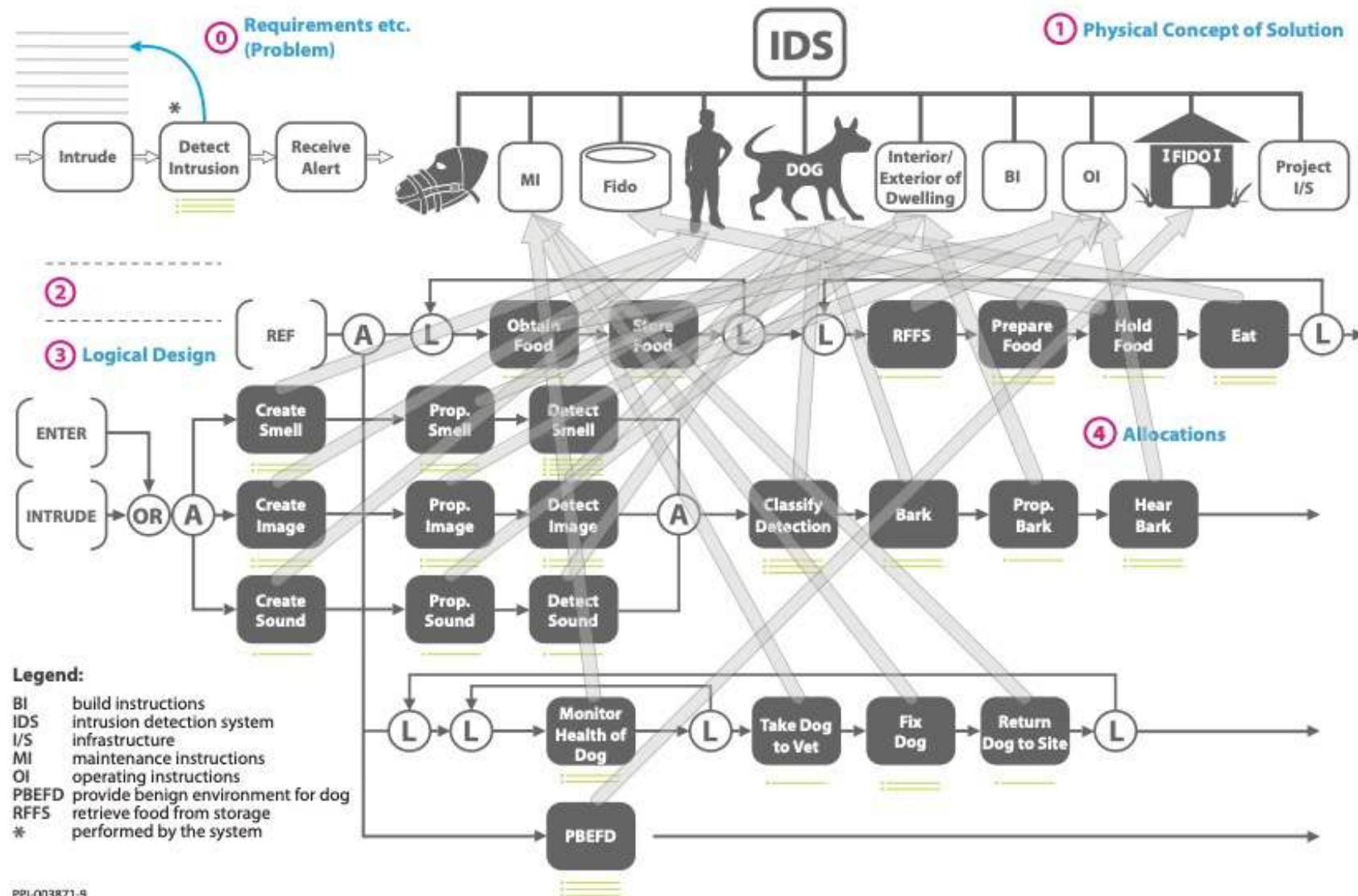


- **BAE Systems (Australia)**
- **Carl Zeiss (Germany)**
- **Genentech (USA)**
- **Harvard-Smithsonian Center for Astrophysics (USA)**
- **Hologic (USA)**
- **TÜBİTAK SAGE (Turkey)**
- **MISO (USA)**
- **NEC (Australia)**
- **New Zealand Defence Force (New Zealand)**
- **Singapore Institute of Technology (Singapore)**
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- **TDW (USA)**
- **Department of Defence (Australia)**



SOME TALKING POINT DIAGRAMS

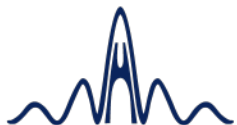




Legend:

BI build instructions
 IDS intrusion detection system
 I/S infrastructure
 MI maintenance instructions
 OI operating instructions
 PBEFD provide benign environment for dog
 RFFS retrieve food from storage
 * performed by the system

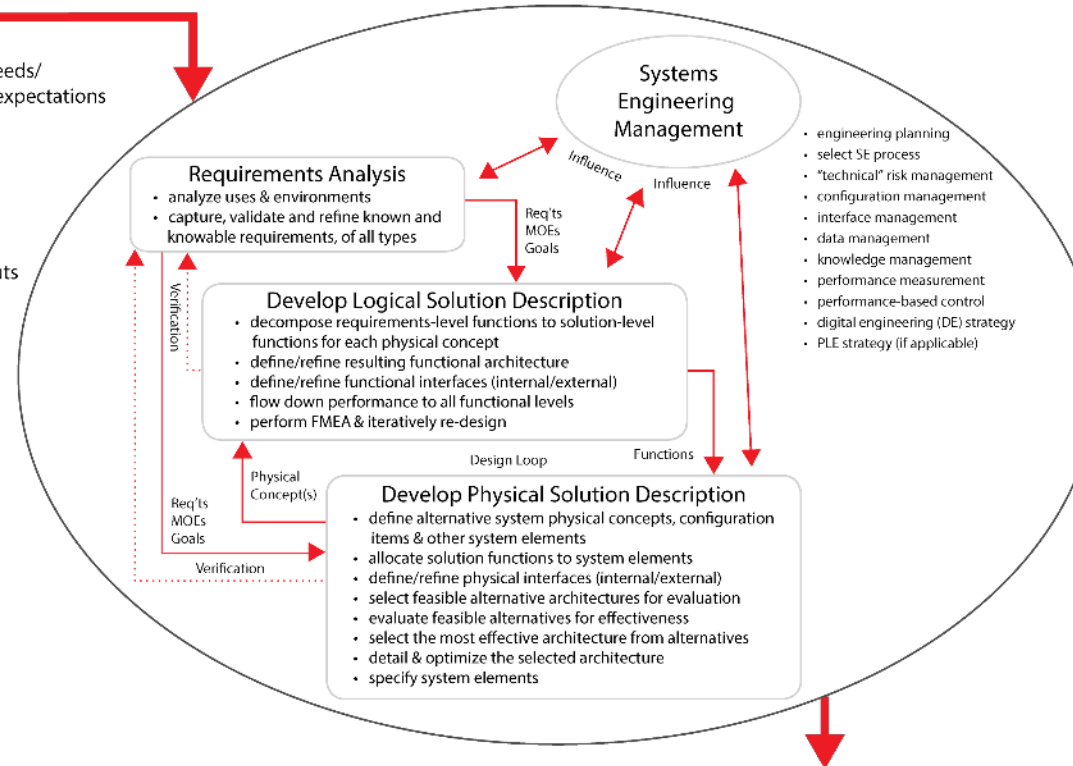
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RELATIONSHIPS IN A SYSTEMS ENGINEERING APPROACH

PROCESS INPUT

- problem domain info
 - user/customer/other stakeholder needs/ desires/wants/goals/requirements/expectations
 - uses/missions
 - measures of effectiveness
 - value information
 - environments
 - other constraints
- technology base
- concurrent engineering – related inputs



Acronyms:

DE	Digital Engineering
FMEA	Failure Modes & Effects Analysis
MOE	Measure of Effectiveness
PLE	Product Line Engineering
SE	Systems Engineering

Note 1: The Systems Engineering Process is applied repeatedly to each design object, starting at, for example, the Capability, Mission or Use System, then to, for example, the Prime Mission or Use Product, Maintenance System, Production System, Operational Infrastructure, etc., then to subsystems of these systems.

Note 2: Also, where applicable, validate data products (not shown diagrammatically).

Note 3: The process also performs the integration of the system elements to build the system for the first time (system integration).

Note 4: The process also includes the conduct of verification of the produced system against the requirements for that system, thereby verifying both the system, and the design of the system.

Note 5: The process also includes the conduct of validation of the produced system against the need.

PROCESS OUTPUT

- **identification & specification of each system element, including build instructions**
- requirements traceability information
- system & system element verification requirements
- design traceability information
 - system functional & physical architecture and detail descriptions
 - design decision support data
 - design decision rationale data
- concurrent engineering-related outputs
- prototypes, where applicable

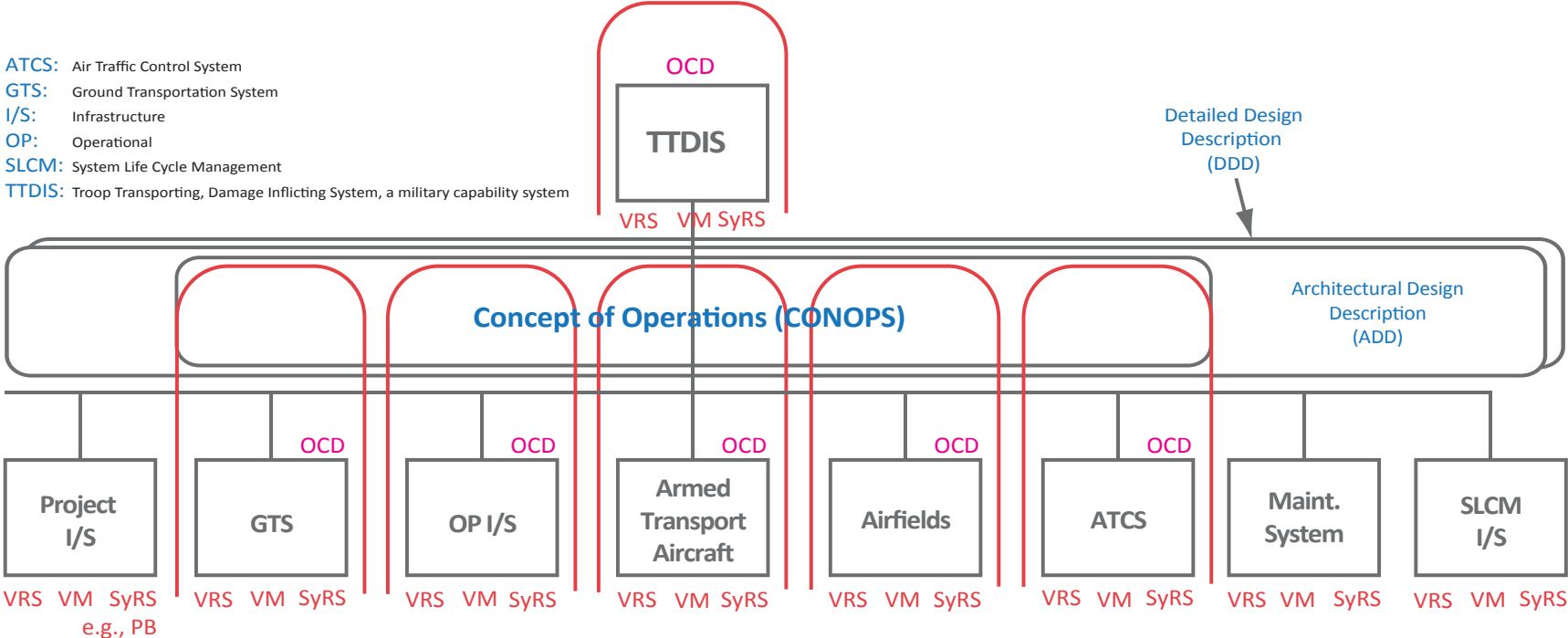
A systems engineering approach ...

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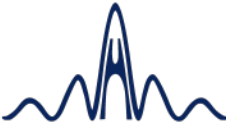


REQUIREMENTS/OCD/CONOPS RELATIONSHIPS

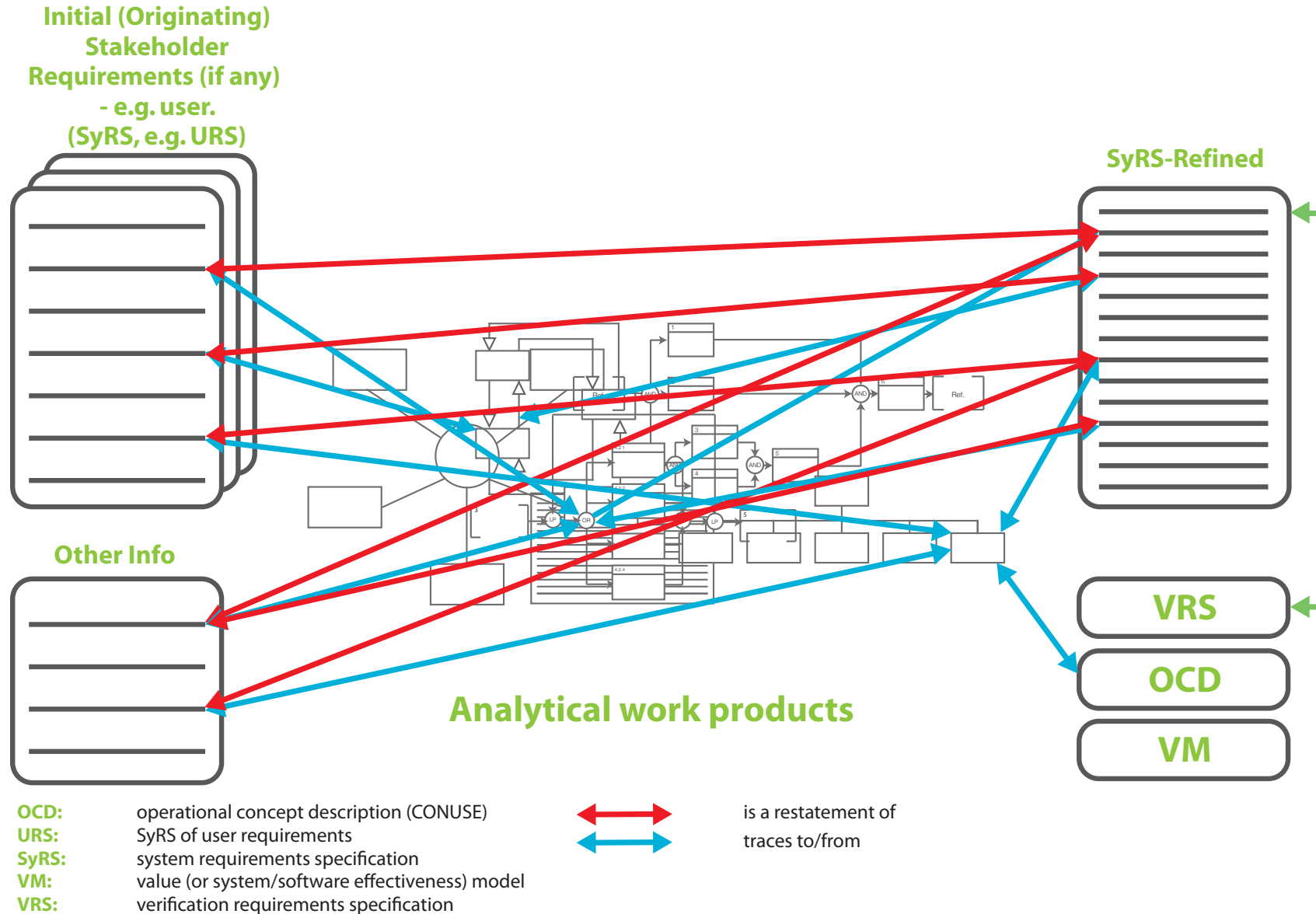


- ADD:** Architectural Design Description. An ADD describes the concept of the solution to meet ALL of the requirements of the TTDIS.
- CONOPS:** Concept of Operations. A CONOPS describes the concept of the solution to meet the subset of the requirements of the TTDIS that are directly use-related. Also called an Operational Solution Description (OSD).
- DDD:** Detailed Design Description. A DDD describes the design to meet ALL of the requirements of the TTDIS. The description is at a level of detail that is implementable, e.g. sufficient to contract for, and/or design and develop, or otherwise acquire, each element of solution at the physical level shown. The DDD incorporates the set of SyRSs for the set of system elements, together with instructions for configuration of the set of elements into a whole solution.
- OCD:** Operational Concept Description. An OCD is a system (subsystem, etc.)-centric description of the users of the system, the intended uses of that system, how it is intended the system be used, and the external conditions during which the system will be used. The OCD describes the context within which the problem definition (requirements, MOEs, goals and value relationships) exists, i.e. the purpose of the system. Also called a Concept of Use (CONUSE).
- PB:** Project Brief.
- SyRS:** System Requirements Specification. A SyRS specifies the required characteristics of the item, together with goals (if any) for that item.
- VM:** Value Model: A model containing Measures of Effectiveness, Goals, Weights and Value Functions.
- VRS:** Verification Requirements Specification. Specification of the qualities of evidence required that each requirement has been satisfied.

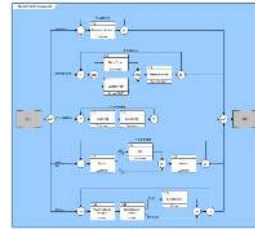
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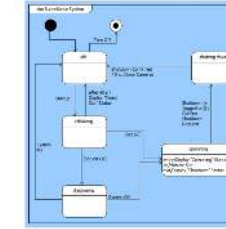
ENSURE ADEQUATE PROBLEM DEFINITION



Functional Logic (General):



State-Based Logic:



Mathematical Logic:

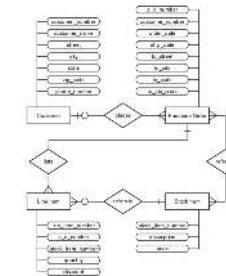
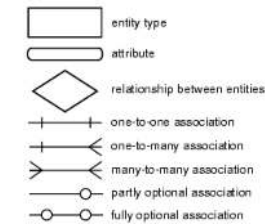
$$\sum_{i=1}^n i = \frac{n(n+1)}{2}$$

$$\sum_{i=1}^n i^2 = \frac{n(n+1)(2n+1)}{6}$$

$$\sum_{i=1}^n i^3 = \frac{n^2(n+1)^2}{4}$$

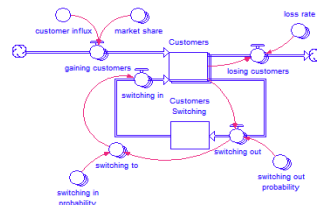
Relationship Logic:

Symbols:

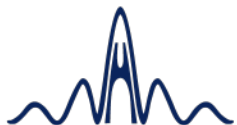
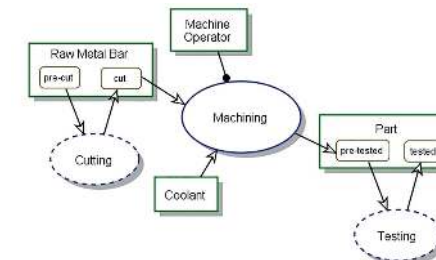


System Dynamics:

(incorporation functional logic)



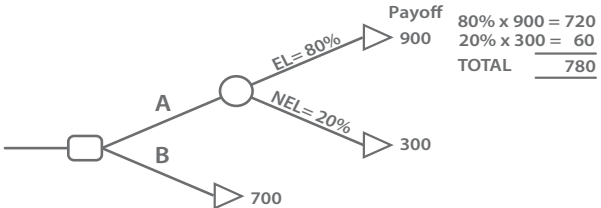
Object Process Methodology:



Value (System Effectiveness) Model

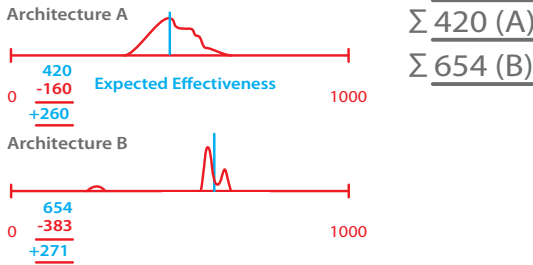
Architecture A Evaluation

MOEs	Worst	Best	Pri	Pts	Weight %	UF	Value of MOE	RVC	AVC (RVC x wt)	
Cost, \$ks per unit	200	50	1	100	25		55k 57	10 10	250 250	
Reliability, %	95	100	1	100	25		95.5% 97.5	1 5	25 125	+100
Interoperability	0	17	7	14	4		0	0	0	0
Size(A/B/C)	C	A	8	3	1		C B	0 5	0 5	+5
Schedule (Months)	12	6	3	40	10		7 8	10 9	100 90	-10
Visible Optical Range, m	1000	5000	5	30	7		1200 2500	2 5	14 35	+21
Duration of Transmission, hr	48	96	6	27	6		50	0.5	3	
Readiness, %	90	100	4	39	10		91 95	1 5	40 50	+40
OS & D Cost, \$k pu/10 years	300	10	2	50	12		200k 106	1.5 8	18 96	+78



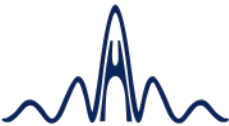
Payoff is the optimized outcome for A & B respectively, without consideration for A of the risk added by needing to obtain an Export License (EL).

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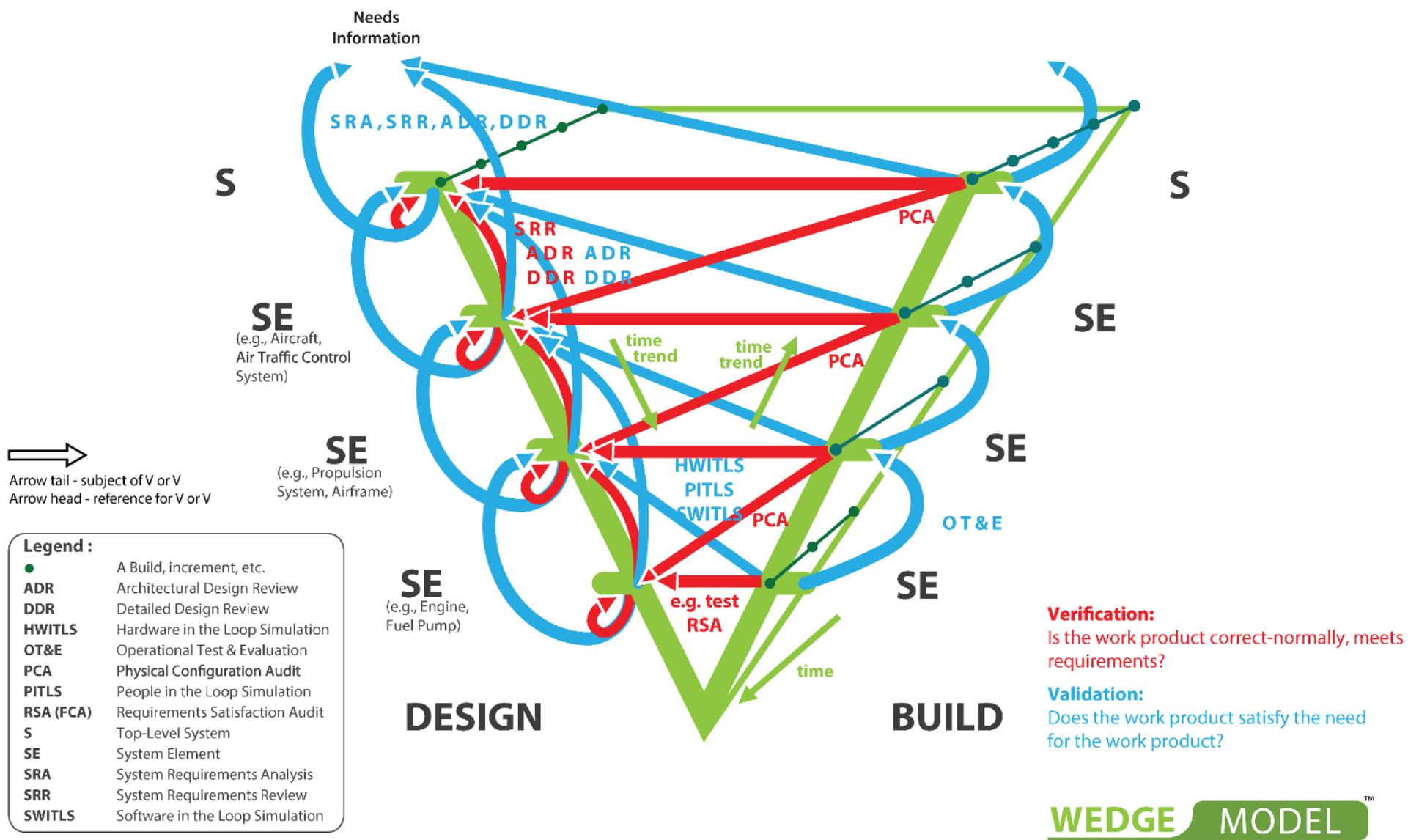


Σ 420 (A)

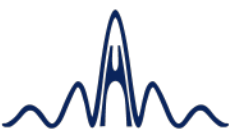
Σ 654 (B)

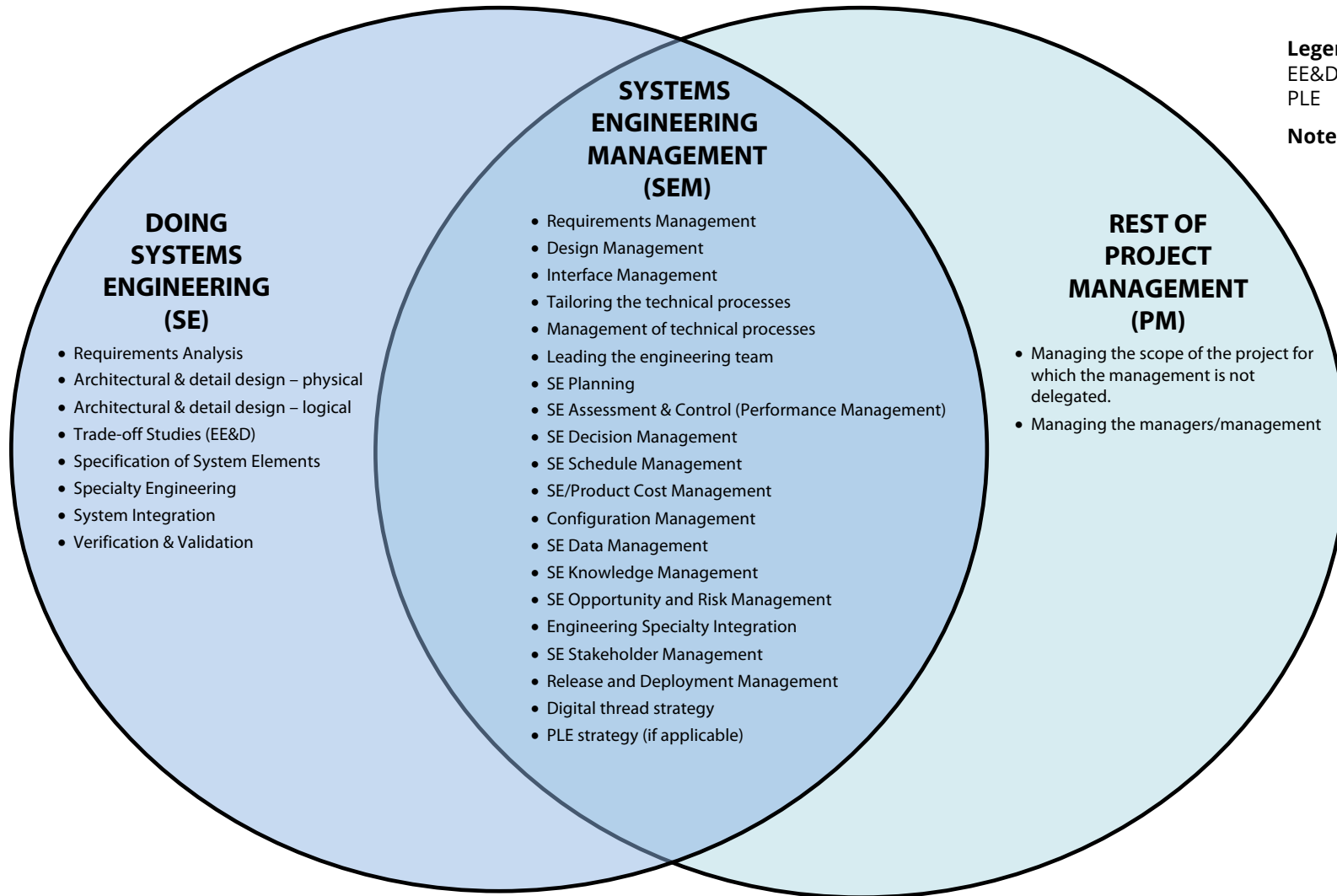


THE WEDGE MODEL™ AS A FRAMEWORK FOR VERIFICATION AND VALIDATION



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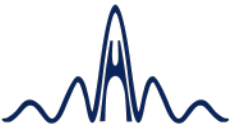


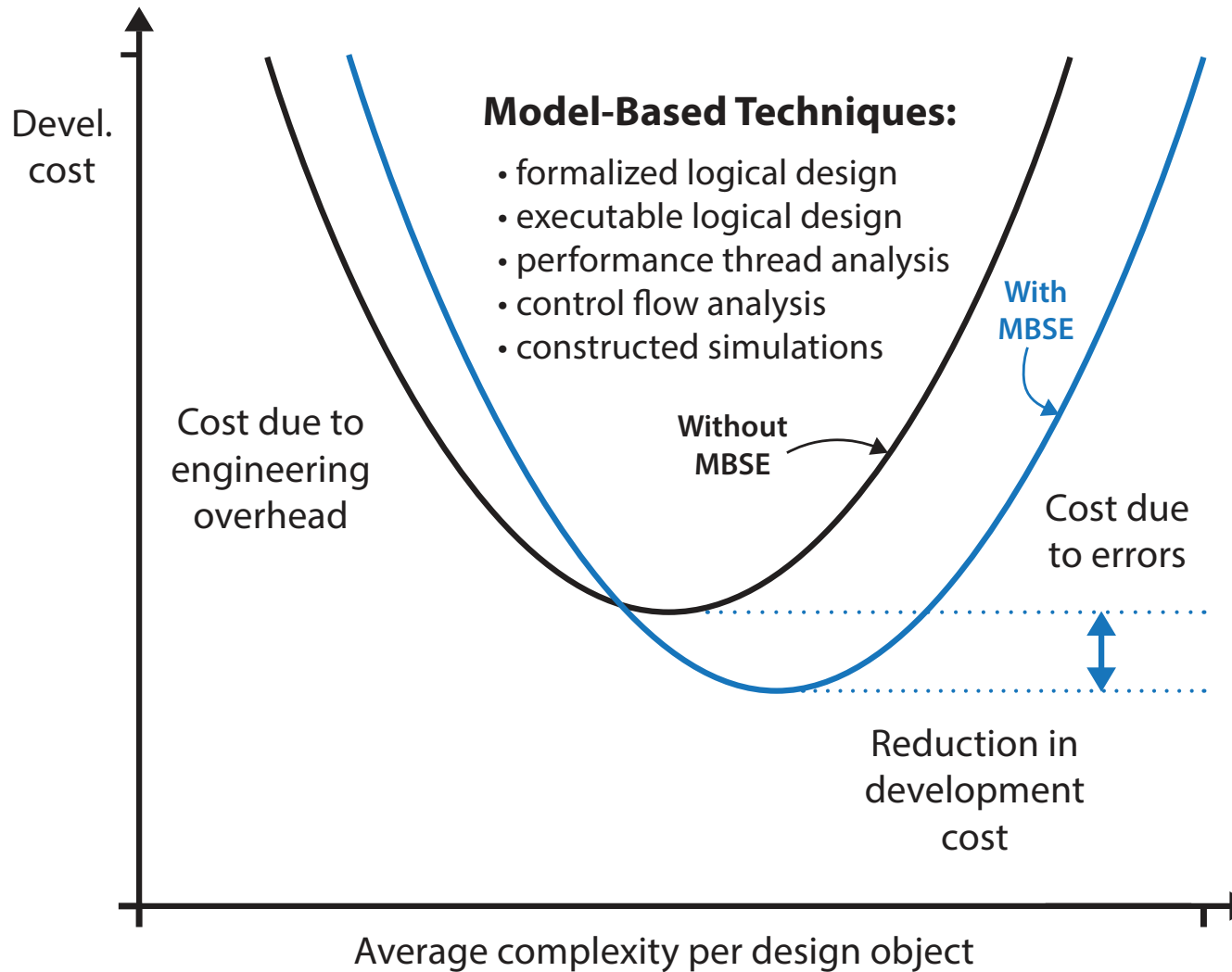
Legend:

EE&D Effectiveness Evaluation & Decision
 PLE Product Line Engineering

Note:

The manager of the project may delegate the management of the systems engineering, and potentially other elements of project scope, e.g., production, commissioning, contract.





MAPPING TO THE INCOSE SE COMPETENCY FRAMEWORK

ISECF Competency Areas	AD5D	ISEP	ROC5D	SE-ZERT	RASW5D	SE5D	SEM5D	IEM2D
ISECF Core Systems Engineering Principles								
Systems Thinking	L	L	H	L	L	H	L	
Lifecycles		H	H	H	L	H	H	
Capability Engineering	H	L	H	L	L	H	L	
Critical Thinking	L	L	L	H	L	H	H	
Systems Modelling and Anal.	H		H	L	H	H		
ISECF Technical								
Requirements Definition			H	L	H	H	L	
System Architecting	H		H	L		H	L	L
Design for...	H	L	L	H		H	L	
Integration		L	L	L		H	H	L
Interfaces	H	L	L	L	H	H	L	H
Verification		L		L		H	L	
Validation		L		L	H	H	L	
Transition*		L	L	L			L	
Operations and Support*		L	H	L	L	H	L	
ISECF Professional								
Communications				H			H	

Legend for PPI/CTI training courses:

AD5D: Architectural Design 5-Day

ISEP: INCOSE SEP Exam Prep Training 5-Day (by CTI)

ROC5D: Requirements, OCD and CONOPS in Military Capability Development 5-Day

SE-ZERT: German SE Certification counterpart of INCOSE SEP 10-Day (by CTI)

RASW5D: Requirements Analysis and Specification Writing 5-Day

SE5D: Systems Engineering 5-Day

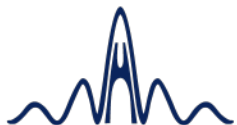
SEM5D: Systems Engineering Management 5-Day

IEM2D: Interface Engineering and Management 2-Day

L – low but useful fulfillment of competency area


H – high fulfillment of competency area

Only some of the mapping is shown. The full mapping is available upon request.

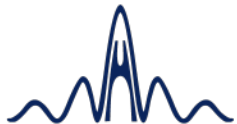


PPI Data Item Descriptions:

- **Project Plan (PP)**
- **Task Specification (TS)**
- **Statement of Work (SOW)**
- **Systems Engineering Plan (SEP)**
- **Operational Concept Description (OCD)**
- **System Requirements Specification (SyRS)**
- **Software Requirements Specification (SRS)**
- **Verification Requirements Specification (VRS)**
- **Interface Requirements Specifications (IRS)**
- **Interface Design Description (IDD)**
- **System/Subsystem Design Description (SSDD)**
- **Concept of Operations (CONOPS) – Operational Solution Description (OSD)**



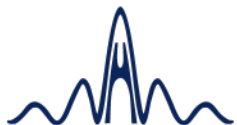
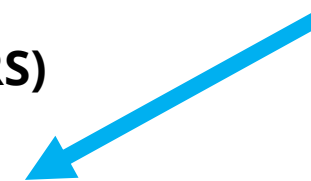
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PPI Example Documents:


- **Concept of Employment (CONEMP)**
- **Concept of Use (CONUSE - OCD)**
- **Capability System Requirements Specification (CapSyRS)**
- **Capability System Value Model**
- **Operational Solution Description (OSD)**
- **Concept of Use (CONUSE - OCD) for a technology item**
- **Systems Requirements Specification (SyRS) for a technology item**
- **Interface Requirements Specification (IRS)**
- **System Effectiveness Model for a technology item**
- **Statement of Work (SOW)**
- **Verification Requirements Specification (VRS) for a technology item**

You can access for free a coordinated, high quality set of example engineering documents



PPI Application Guides to Systems Engineering Standards:

- **EIA-632: 2003**
- **IEEE 1220**
- **ECSS-E-ST-10C**
- **ISO/IEC 15288:2008**
- **ISO/IEC/IEEE 15288:2015**
- **ISO/IEC/IEEE 29148:2018**
- **ISO/IEC/IEEE 15288:202X (when released)**



Be aware of the many pitfalls in the use of systems engineering standards. These guides to the standards, authored by PPI, can help enormously. We have content in many of the standards.



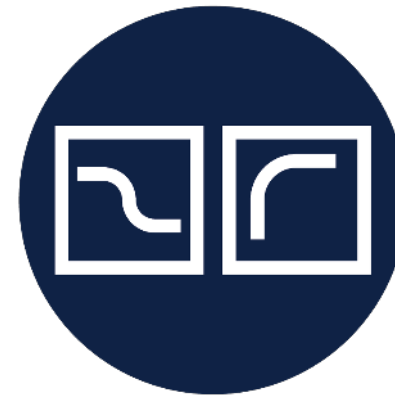
PPI Practice Guides:



**Requirements
Capture and
Validation Guide**



**Requirements
Specification
Development
Guide**



**Military
Capability
Development Guide**



The Systems Engineering Goldmine (SEG) is a dedicated website developed and maintained by PPI that provides clients with free access to:

Documents:

- An archive of over 4GB of downloadable project performance documents, mainly on systems engineering
- The archive includes handbooks, guides, standards, papers and other resources, all curated, with flexible search facilities (but not of internal content)
- There are links to documents that cannot be included for reason of copyright.

Definitions:

- A searchable database of project performance-related definitions, mainly systems engineering, presently 7,900+ terms.

Systems Engineering Tools Database:

- Jointly developed and operated with INCOSE under a MOU and available via the SEG.





Systems Engineering Goldmine

Welcome to PPI's free Systems Engineering Goldmine (SEG) page. The Goldmine, a separate site growing almost daily, contains over 4GB of downloadable information relevant to the engineering of systems and a searchable database of 8,000+ defined terms.

[VISIT SEG SITE](#)[REQUEST SEG ACCESS](#)

The **Systems Engineering Goldmine** is a free searchable resource containing a wealth of **downloadable documents, definitions and other information** relevant to the successful engineering of systems.

This resource is intended for use by alumni, clients and friends of Project Performance International (PPI) together with alumni, clients and friends of subsidiary company Certification Training International (CTI).



- A searchable database of standards
- A searchable database of over 8,000 defined terms
- Forms
- Example Systems Engineering documents
- Guides, handbooks, reports & papers
- Software tools
- Checklist
- Diagrams and educational graphics

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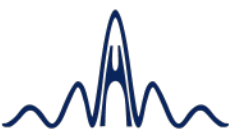
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Document Identifier	Type	Title	Date	Author(s)	Size	
	technical white paper	Evaluating ARCADIA/Capella vs. OOSEM/SysML for System Architecture Development	2019-08		44.64 MB	
		Architecture Evaluation and Quality Attribute Specification for Software, Systems and SoS Architectures	2011-03	Mike Gagliardi, Bill Wood	1.81 MB	
		La ville de demain pensée avec l'Architecture des Systèmes	2011		3.63 MB	
	conference presentation	The Integrated Defence Architecture- The Models and The Value	2010-11-12		1.5 MB	
		Architecture Frameworks	2010-10		471.69 KB	
		Architecture Frameworks	2010-10		459.26 KB	
	presentation	Applying Enterprise Architecture to Model Based Systems Engineering	2010-05-11		3.97 MB	





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Defined Term	Is equal to	architecture
Acronym	Is equal to	Acronym
Engineering glossaries	- Any -	

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- 1 Architecture

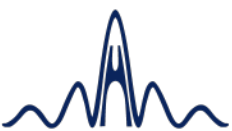
Acronym:

The structure of components, their interrelationships, and the principle guidelines governing their design and evolution over time.

Source: [DSMC Definitions](#)
- A high level design that provides decisions made about: the problem(s) that the product will solve, component descriptions, relationships between components, and dynamic operation description.

Source: [EIA/IS-731.1 Document2 - Systems Engineering Capability Model](#)
- The structure of components in a program/system, their interrelationships, and the principles and guidelines governing their design and evolution over time.

Source: [Modelling_SimGlossary-1](#)
- The fundamental organization of a system embodied in its components, their relationships to each other, and to the environment.



Systems Engineering Tools Database

Welcome from the International Council on Systems Engineering (INCOSE) and Project Performance International (PPI) to the Systems Engineering Tools Database (SETDB). We hope that the SETDB helps you to find appropriate software tools and cloud services that support your engineering activities. In order to access the SETDB, you need to be an INCOSE member logged in to the INCOSE website, or a PPI alumnus, alumna or guest logged in to PPI's Systems Engineering Goldmine website, from which you can navigate to a SETDB landing page without further login. This home page is mainly for the benefit of members of the engineering community who are not already members of INCOSE or account holders with PPI, to gain exposure to the SETDB. You can explore example content of the SETDB from this page (see Explore below). This page also provides access for Tool Vendors to register and list their tools, and login access for SETDB administration.

Login



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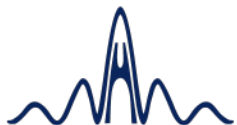


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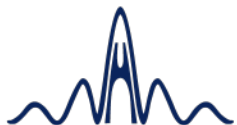
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Business Architecture Solution	Capstera		Modeling & Simulation - MBSE (excluding CAD, Math & Value Modeling) Requirements Engineering	2021-03-23	2021-11-09	
3D Models	MVRsimulation Inc.	7.0	Visualization - Other	2022-03-12	2022-03-12	
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@RISK	Palisade	8	Mathematical Analysis & Modeling Risk Management Decision Support - Other and more	2022-03-11	2022-03-11	
ABACUS	avolution	6.0	Modeling & Simulation - MBSE (excluding CAD, Math & Value Modeling) Engineering Management - Other Engineering Planning and more	2021-03-03	2021-07-12	
Acclaro DFSS	Functional Specs Inc.		Requirements Engineering Design for Six Sigma (DFSS) Quality Function Deployment (QFD) and more	2021-03-03	2021-11-09	
Accompa	Accompa Inc.		Requirements Engineering	2021-05-11	2021-07-18	
Accunote	Pluron, Inc. (DBA Acunote)		Domain Specific - Software Engineering Management - Other Engineering Planning and more	2021-03-03	2021-11-09	
Acoustic Testing	Siemens Digital Industries Software	2021	Modeling & Simulation - MBSE (excluding CAD, Math & Value Modeling) Verification & Validation - Other	2022-03-08	2022-03-08	
Active Risk Manager	Sword GRC	2020	Risk Management	2022-03-11	2022-03-11	

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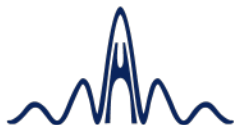
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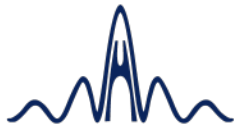
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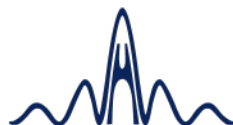
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