PROJECT PERFORMANCE INTERNATIONAL

PROJECT PERFORMANCE INTERNATIONAL

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.***

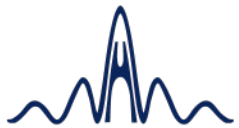
- *CEOs expect and require systems engineering to be practiced at **every level of the enterprise.***

- *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.



rhalligan@ppi-int.com

ROBERT J. HALLIGAN

FIE Aust CPEng IntPE(Aus)

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

WHERE WE'VE MADE A DIFFERENCE

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.

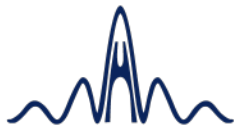
SOME OF OUR SE TRAINING COURSES

- 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)

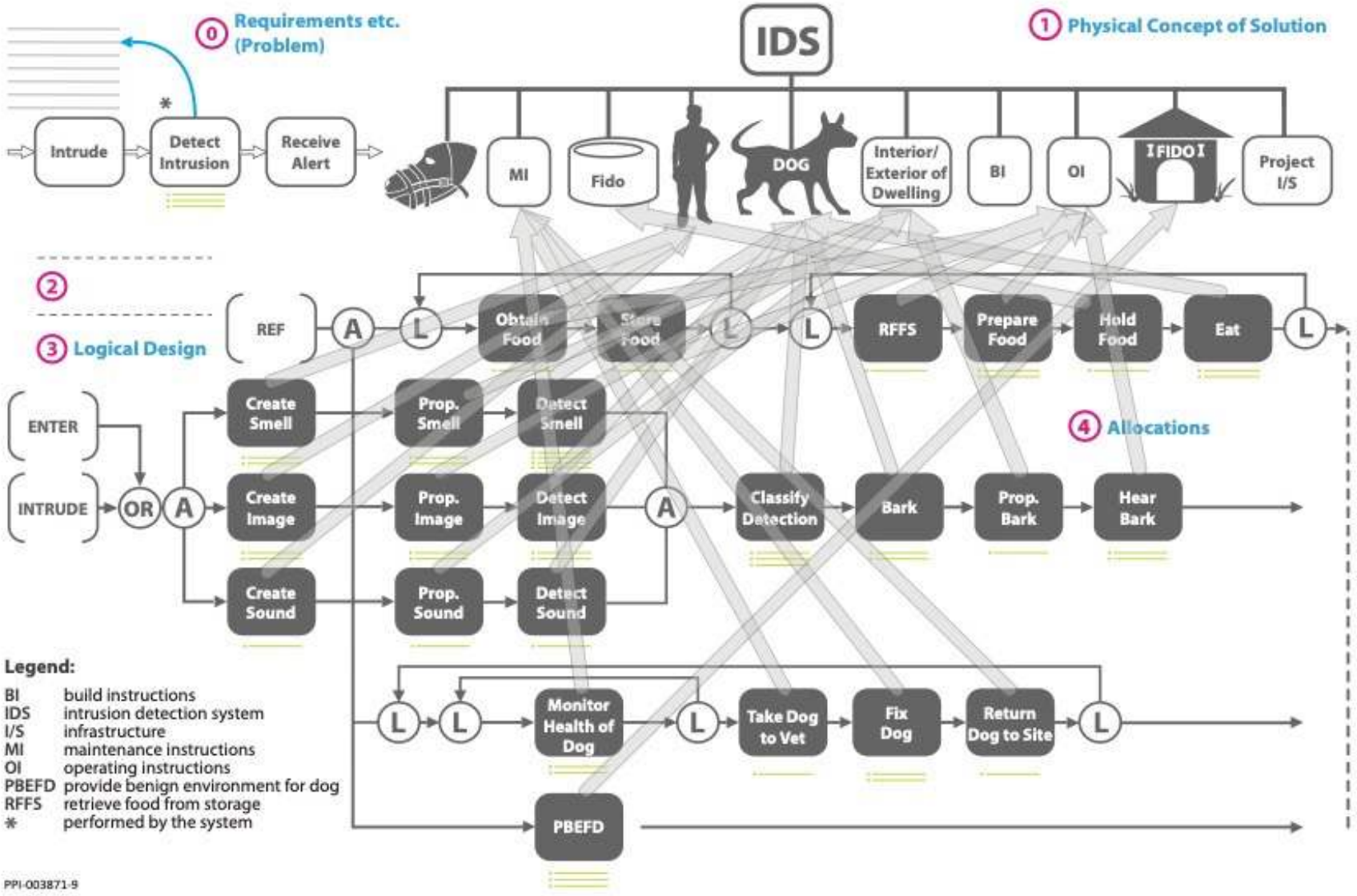
CTI is a wholly-owned subsidary of PPI

WE CONSULT WORLDWIDE IN WHAT WE TEACH – EXAMPLE OF SE CONSULTING CLIENTS

- 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)
- Airservices Australia
- TDW (USA)
- Department of Defence (Australia)



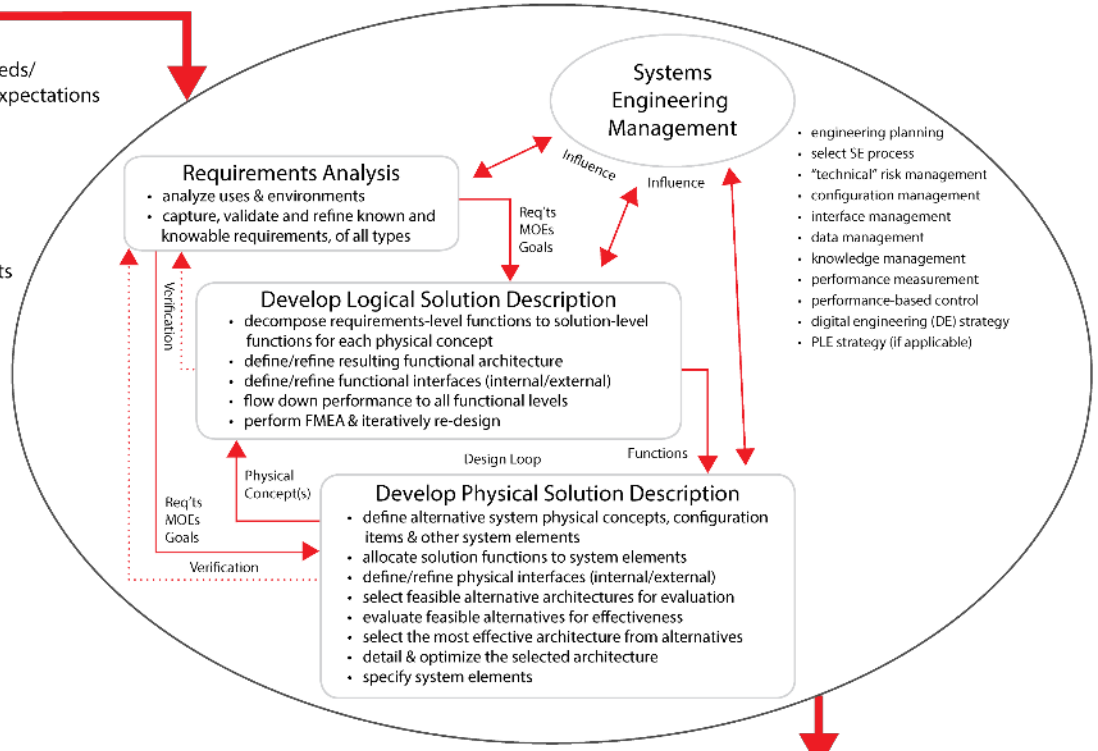
SOME TALKING POINT DIAGRAMS



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 diagramatically).

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

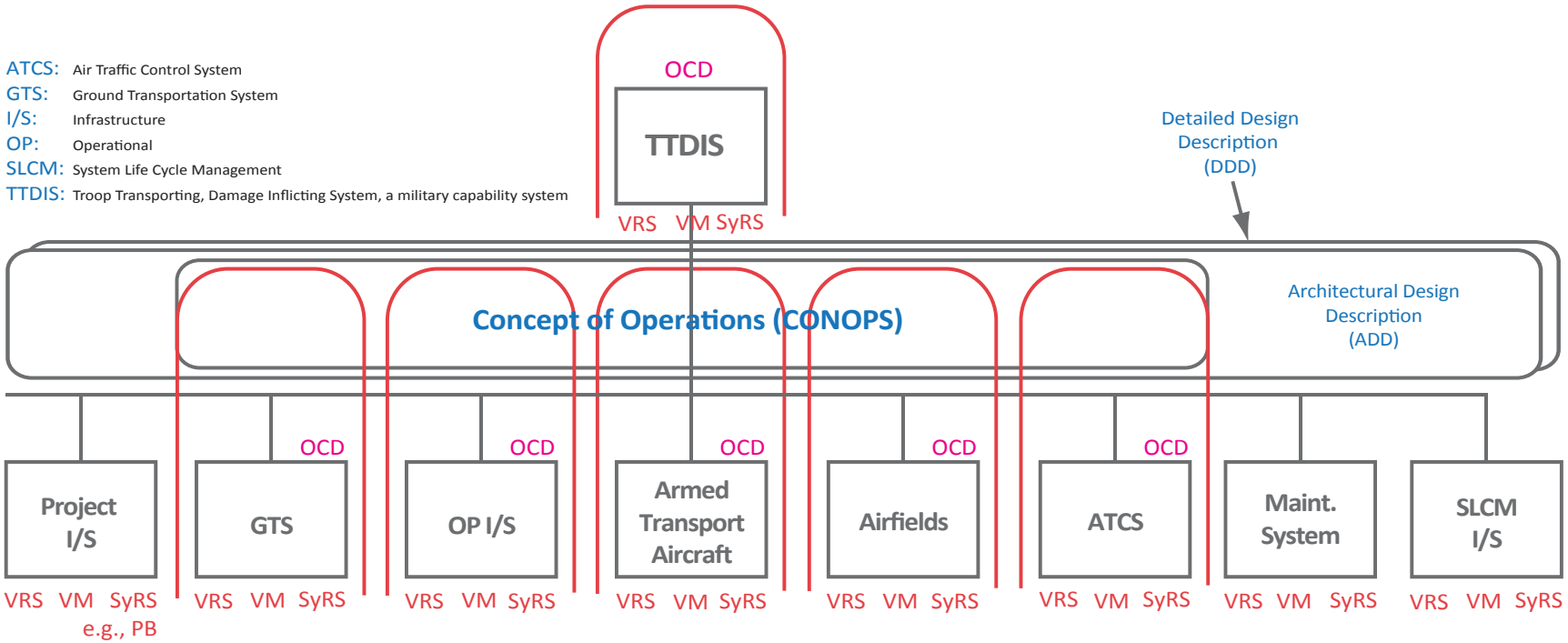
- **identification & specification of each system element, including build instructions**
- requirements traceability information
- system & system element verification requirements
- design traceability information
  - system functional & physical architecture and detail descriptions
  - design decision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

A systems engineering approach ...

PPI-005348-39

REQUIREMENTS/OCD/CONOPS RELATIONSHIPS

ATCS: Air Traffic Control System
GTS: Ground Transportation System
I/S: Infrastructure
OP: Operational
SLCM: System Life Cycle Management
TTDIS: Troop Transporting, Damage Inflicting System, a military capability system



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.

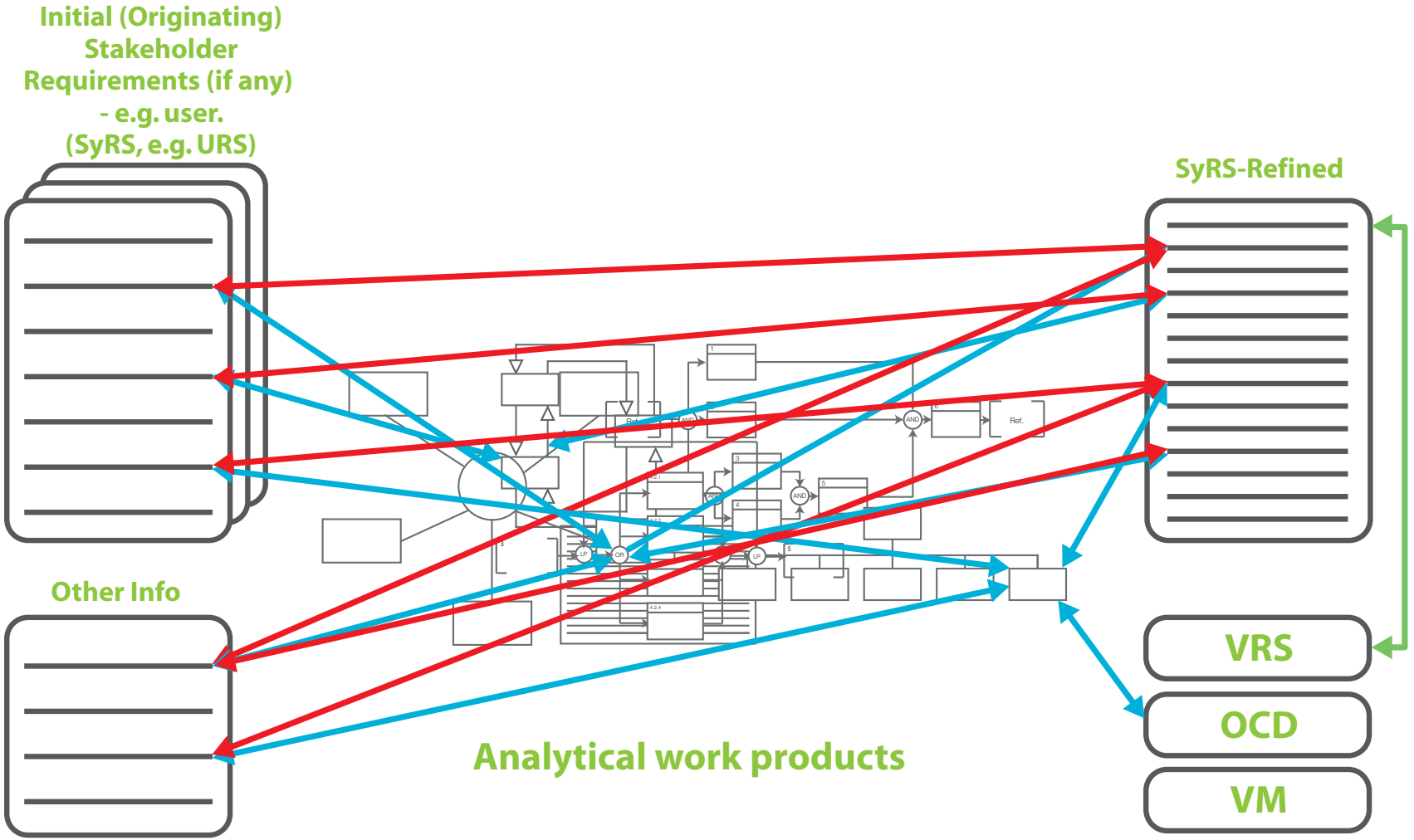
SyRS: System Requirements Specification. A SyRS specifies the required characteristics of the item, together with goals (if any) for that item.

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.

PPI-003927-12

ENSURE ADEQUATE PROBLEM DEFINITION

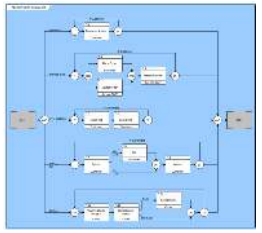


OCD:	operational concept description (CONUSE)		is a restatement of
URS:	SyRS of user requirements		traces to/from
SyRS:	system requirements specification		
VM:	value (or system/software effectiveness) model		
VRS:	verification requirements specification		

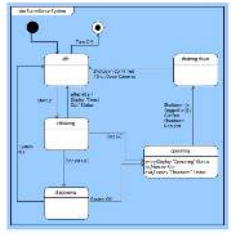
PPI-005499-4

COMPLEMENT "HOW WE WILL BUILD" WITH "HOW IT WILL WORK"

Functional Logic (General):



State-Based Logic:



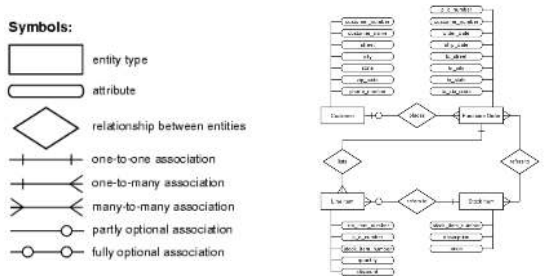
Mathematical Logic:

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

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

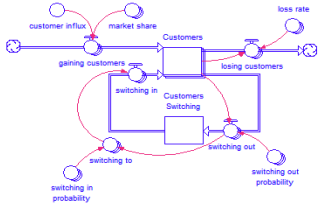
$$\sum_{i=1}^{n} i^3 = \frac{n^2(n+1)^2}{4}$$

Relationship Logic:

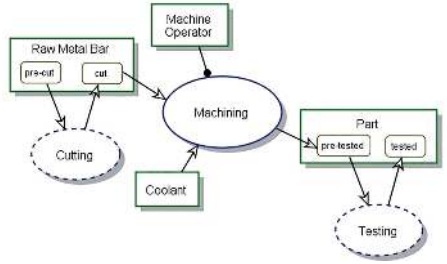


System Dynamics:

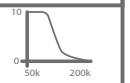
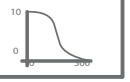
(incorporation functional logic)

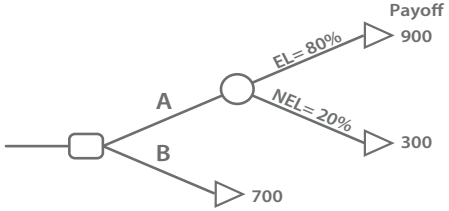


Object Process Methodology:



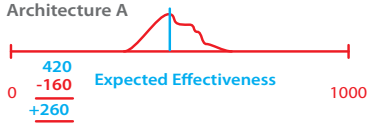
Value (System Effectiveness) Model

MOEs	Worst	Best	Pri	Pts	Weight %	UF	Value of MOE	RVC	AVC (RVC x wt)	
							Architecture A Evaluation			
Cost, $ks per unit	200	50	1	100	25		~~55k~~ 57	~~10~~	~~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	~~10~~ 50	+40
OS & D Cost, $k pu/10 years	300	10	2	50	12		~~200k~~ 106	~~15~~ 8	~~18~~ 96	+78
				403	100				Σ 420 (A)	
									Σ 654 (B)	

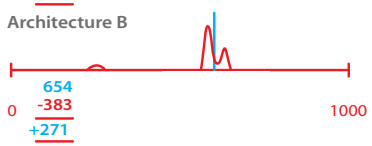


80% x 900 = 720
20% x 300 = 60
TOTAL 780

Architecture A



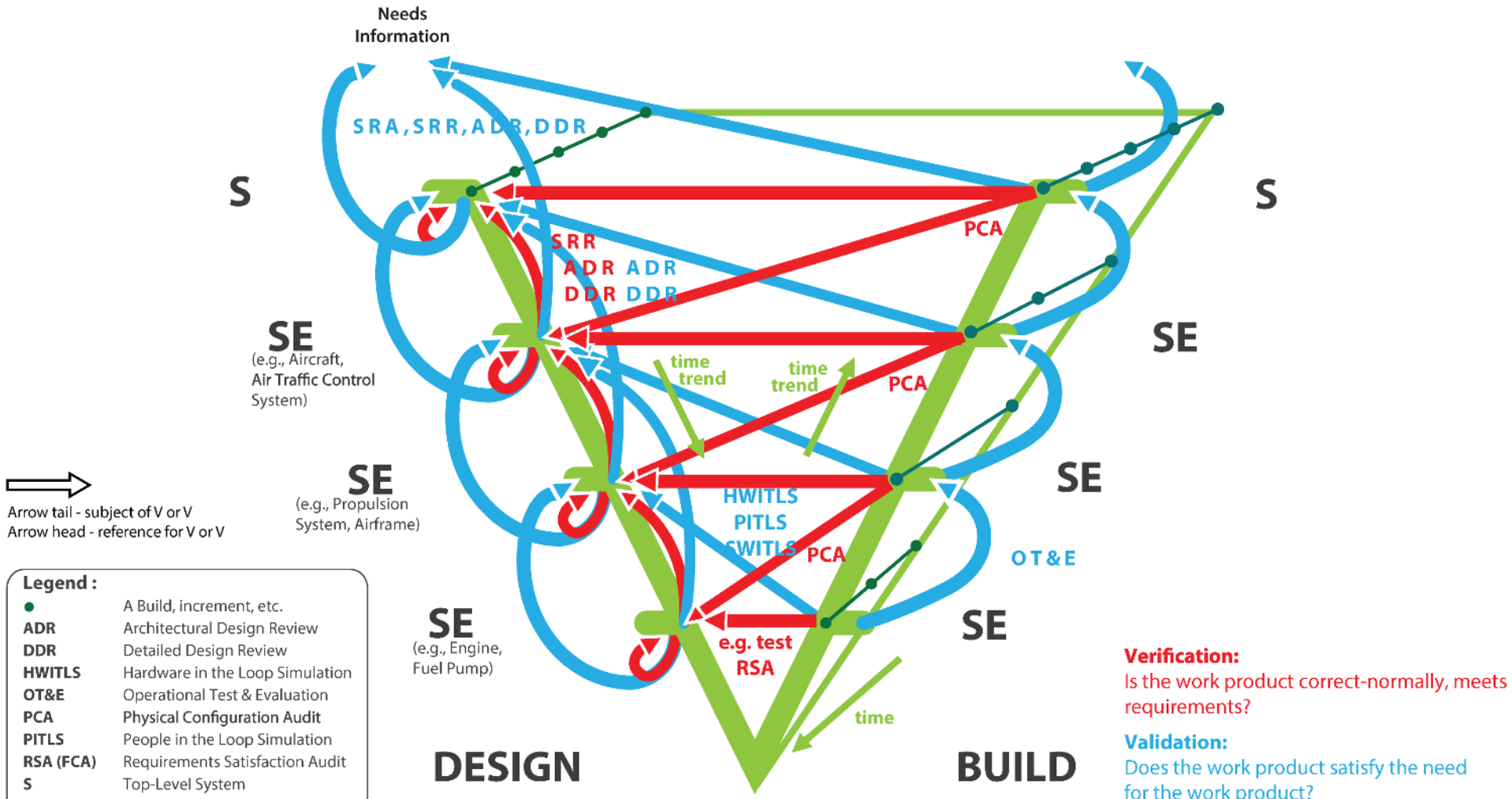
Architecture B



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

PPI-006001-8

THE WEDGE MODEL™ AS A FRAMEWORK FOR VERIFICATION AND VALIDATION



Arrow tail - subject of V or V
Arrow head - reference for V or V

Legend :

●	A Build, increment, etc.
ADR	Architectural Design Review
DDR	Detailed Design Review
HWITLS	Hardware in the Loop Simulation
OT&E	Operational Test & Evaluation
PCA	Physical Configuration Audit
PITLS	People in the Loop Simulation
RSA (FCA)	Requirements Satisfaction Audit
S	Top-Level System
SE	System Element
SRA	System Requirements Analysis
SRR	System Requirements Review
SWITLS	Software in the Loop Simulation

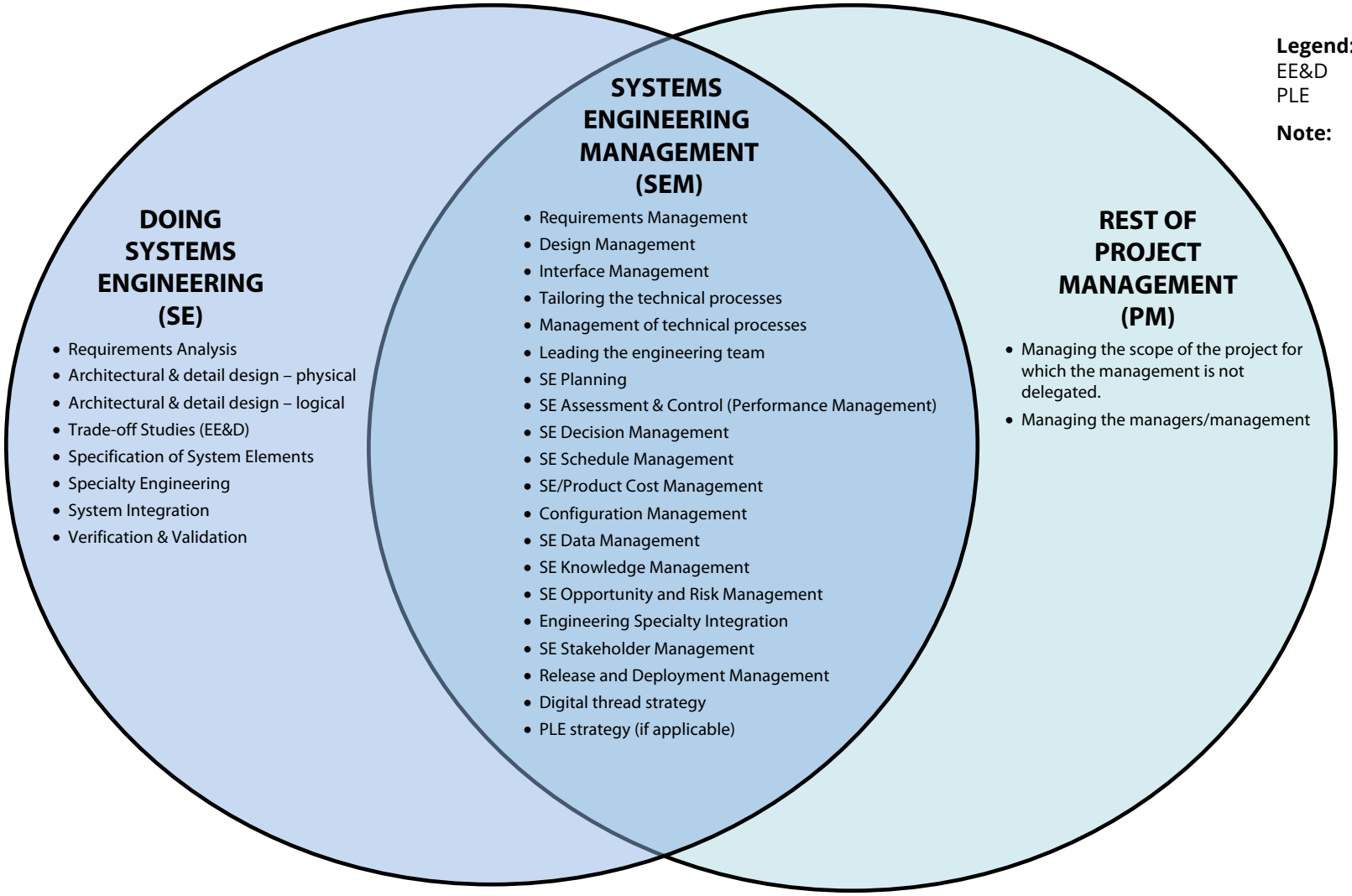
Verification:
Is the work product correct-normally, meets requirements?

Validation:
Does the work product satisfy the need for the work product?

WEDGE MODEL™

PPI-006003-12

SE-SEM-PM RELATIONSHIPS



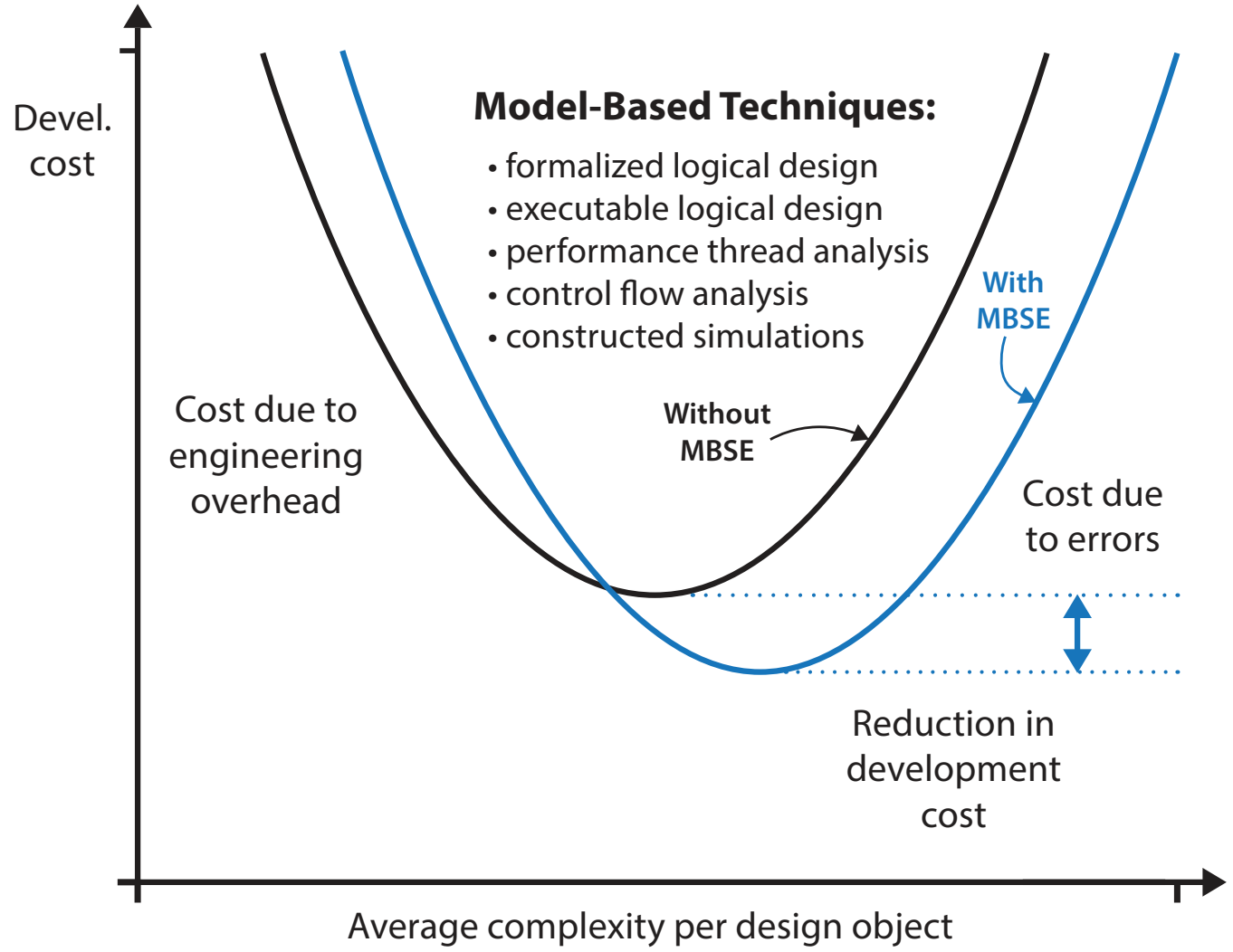
Legend:

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.

PPI-006000-6

OVERHEAD-DESIGN COMPLEXITY TRADE-OFF



PPI-005382-4

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

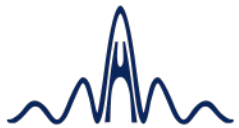
L – low but useful fulfillment of competency area
H – high fulfillment of competency area

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)

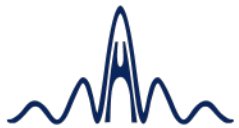
All of our clients gain immediate access to a host of high quality templates and data item descriptions to streamline their work.



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.

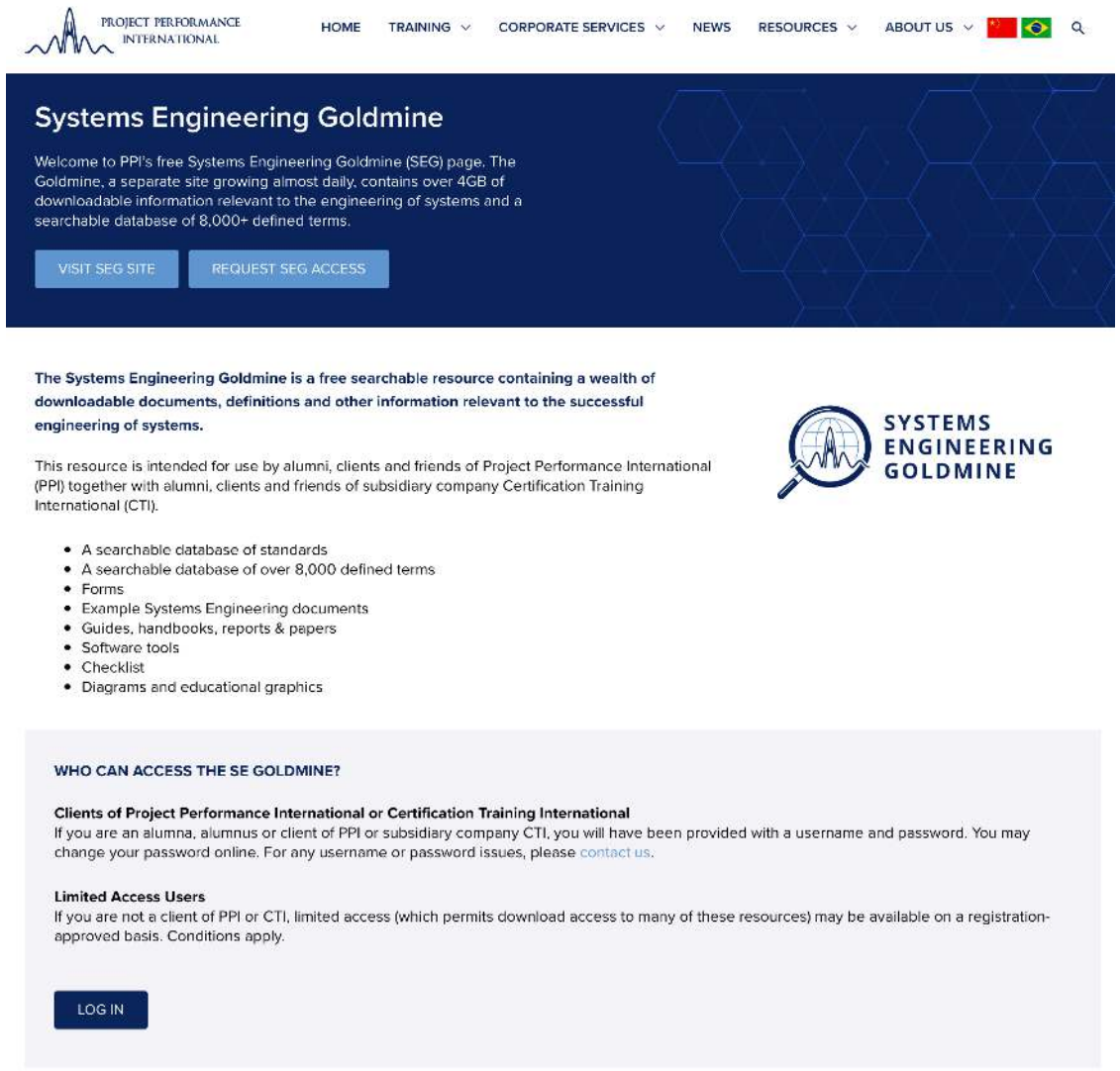
Definitions:

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

Systems Engineering Tools Database:

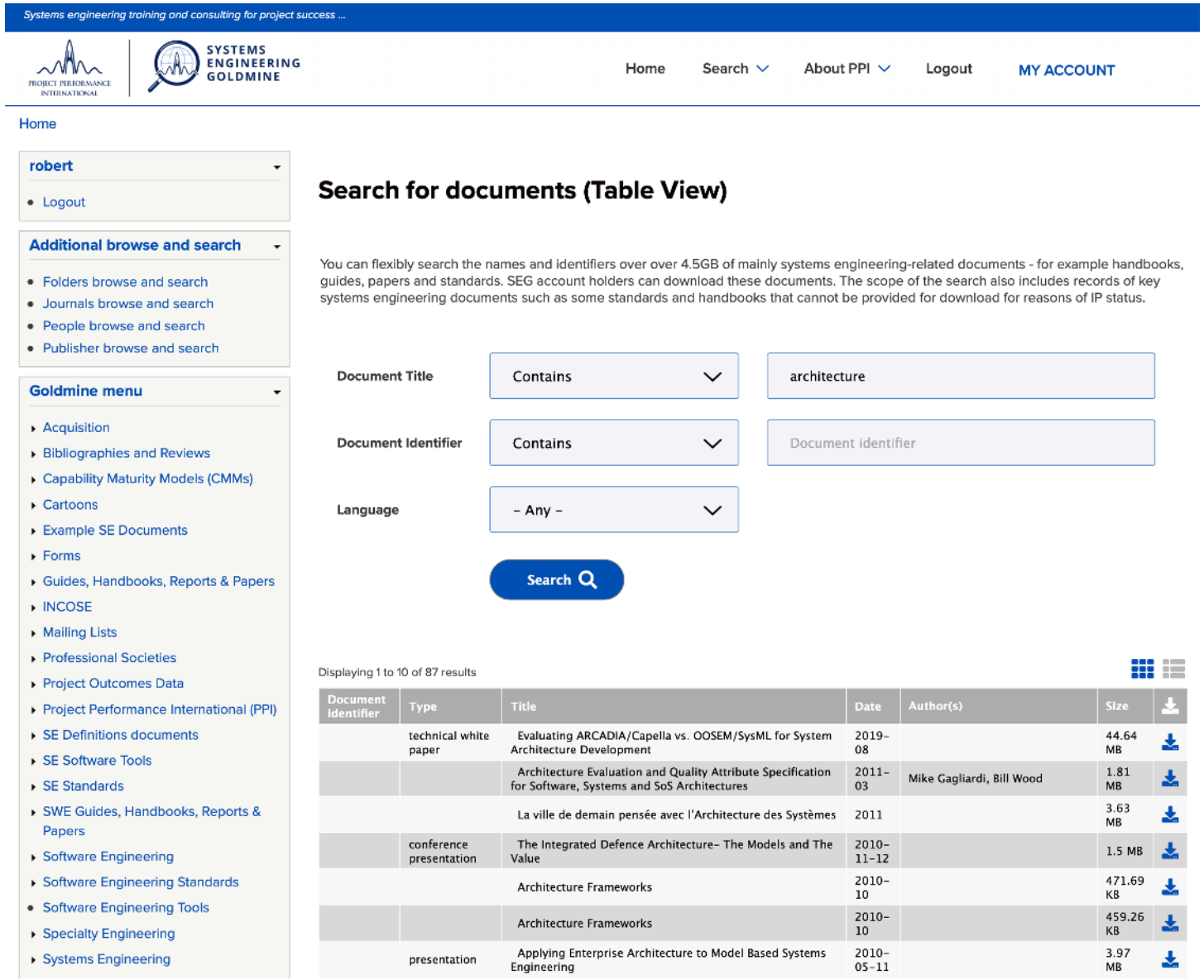
- Jointly developed and operated with INCOSE under a MOU and available via the SEG.

THE SEG HOME PAGE

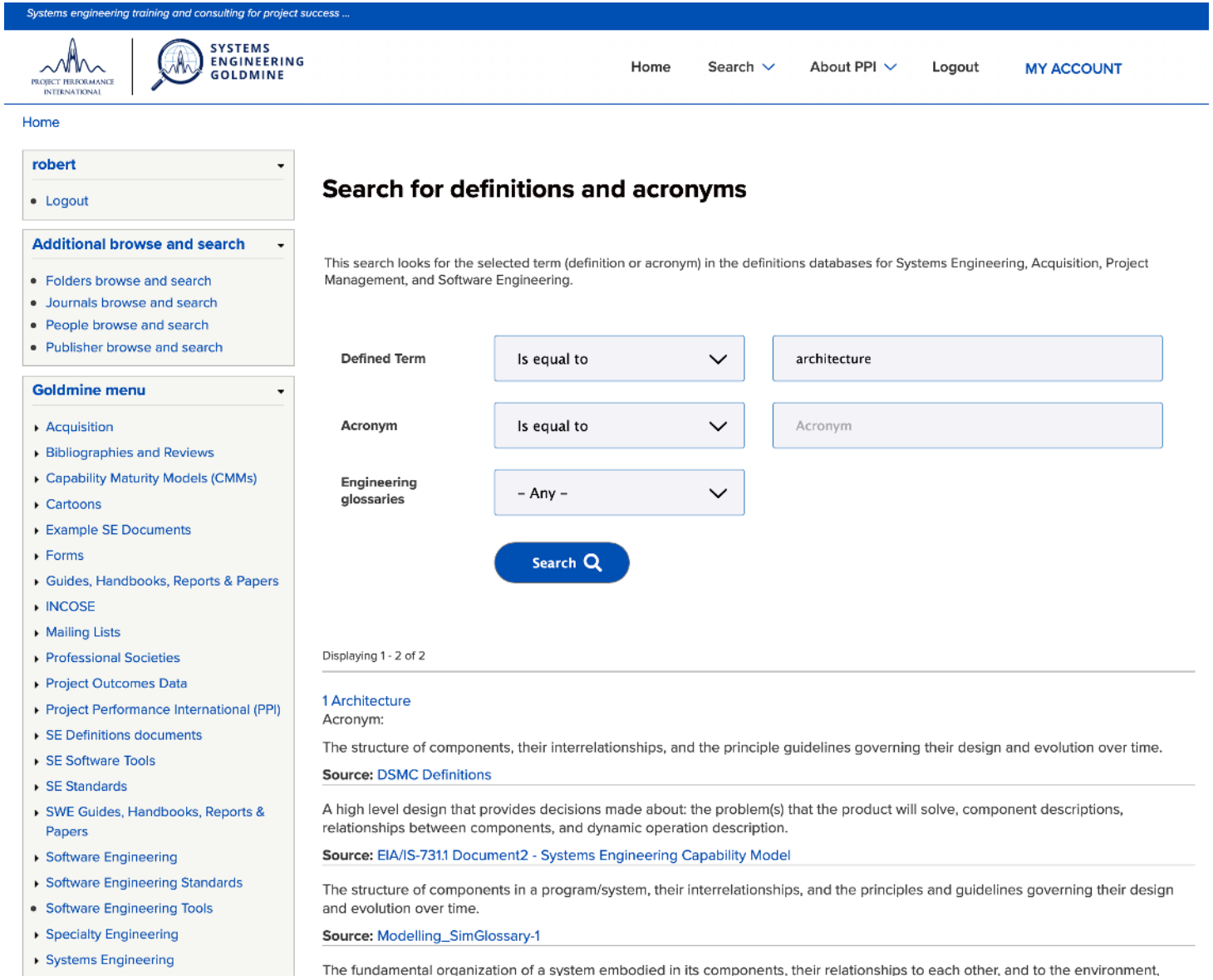


www.ppi-int.com/resources/systems-engineering-goldmine/

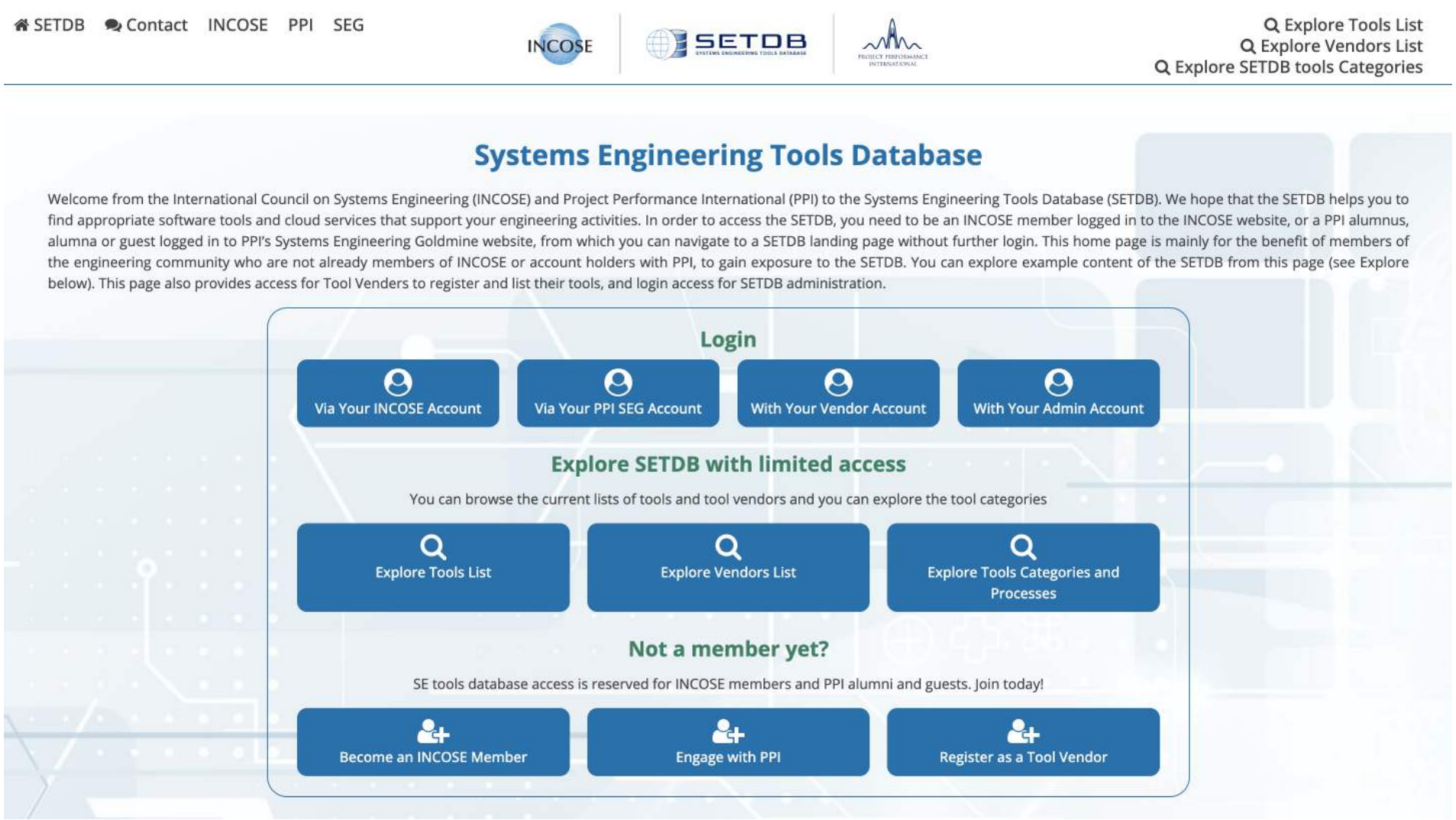
EXAMPLE SEG DOCUMENT SEARCH



EXAMPLE SEG DEFINITIONS SEARCH

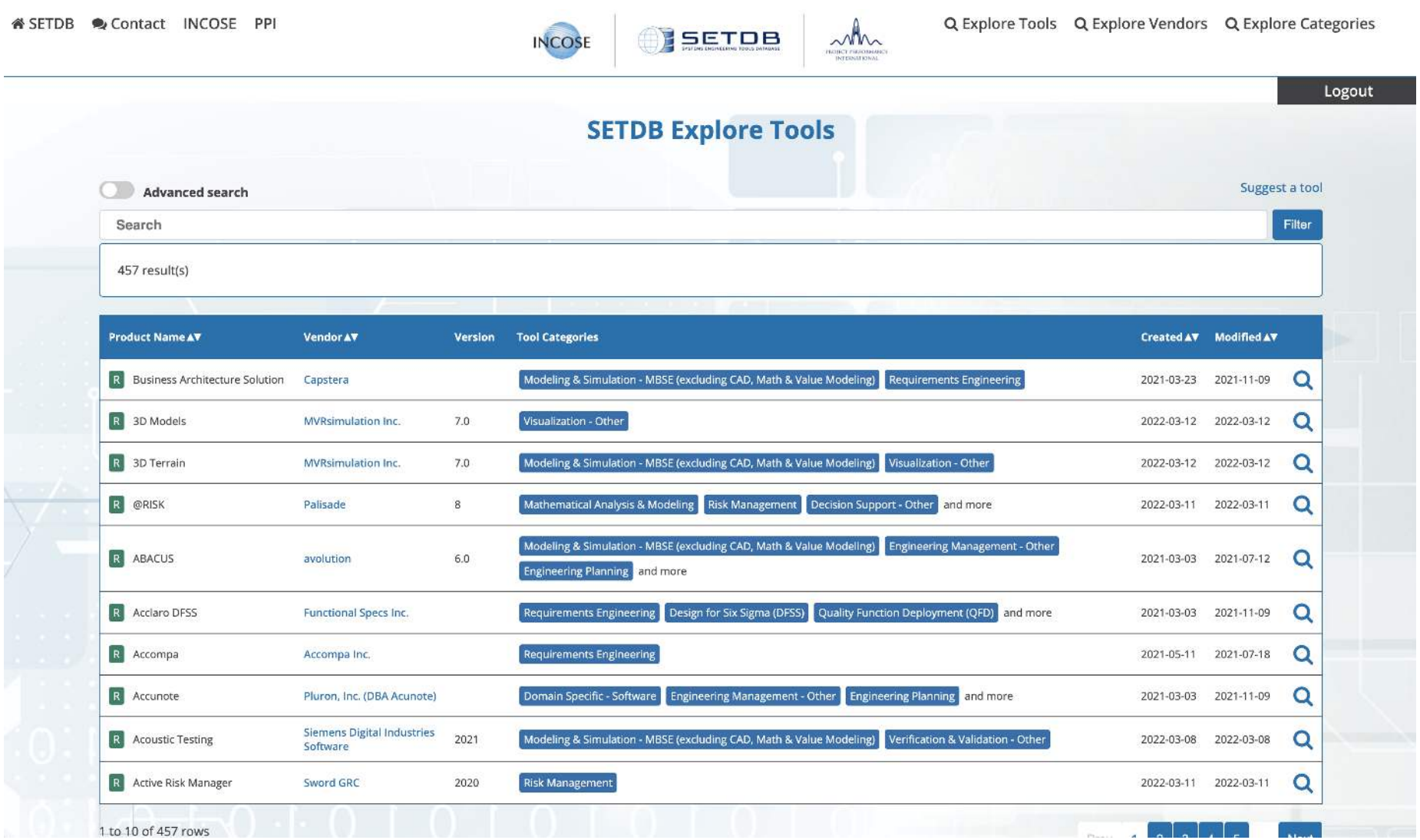


THE FREE TO CLIENTS PPI-INCOSE SYSTEMS ENGINEERING TOOLS DATABSE (SETDB)



www.systemsengineeringtools.com

EXPLORE THE SETDB BY TOOLS, VENDORS AND PROCESS CATEGORIES



www.systemsengineeringtools.com

PROJECT PERFORMANCE INTERNATIONAL

HOME TRAINING CORPORATE SERVICES NEWS RESOURCES ABOUT US

PPI SyEN Newsjournal

Read monthly Project Performance International's Systems Engineering Newsjournal, named "PPI SyEN". PPI SyEN presents for the engineering professional 30-60 pages of valuable technical articles on topical subjects, shorter technical pieces, in-depth coverage of the month's news in systems engineering and directly related fields, pointers to useful resources and relevant industry events, plus limited information on PPI's activities.

SUBSCRIBE FOR ONGOING LEARNING

www.ppi-int.com/systems-engineering-newsjournal

We make it easy for you to develop systems more effectively.

We understand what it's like learning any new skill, and how valuable sharing a relevant example from our diverse experience can be. We also understand how difficult it can be to bring new ideas into established organizations and power structures.

Whatever your development challenge, simply contact us and we'll put our experience and resources to work for you!

CLIENT SURVEY QUESTION	"YES" RESPONSE*
Did the PPI training you took improve your personal work performance?	100%
Did the PPI training you took improve the performance of the company's engineering projects?	98.3%
Did the PPI training you took improve the performance of your company / organization?	93.5%

*PPI-conducted client survey. Independent audit possible.

Australia (Administration Center)
PO Box 2385
Ringwood North, Victoria, 3134
Australia
Phone: +61 (0) 3 9876 7345

Project Performance (Australia) Pty Ltd
Trading as Project Performance International
email: enquiries@ppi-int.com
web: www.ppi-int.com
ACN 055 311 941

Robert Halligan: rhalligan@ppi-int.com
René King: rking@ppi-int.com

Brazil
Phone: +55 12 9 9780 3490

China
Phone: +86 188 5117 2867

South Africa
Phone: +27 21 854 4023

United Kingdom
Phone: +44 20 3608 6754

United States of America
Phone: +1 888 772 5174

PPI does not operate in nor accept training or consulting assignments from Russia.