



WEBINARS 2020

The Financial Cost of Bad Quality Requirements –
A Surprising Discovery Using the COSYSMO
Model

February, 2020

Presenters' profile

- ▶ Christer Fröling
 - ▶ CEO, Reuse Scandinavia AB



Christer Fröling
christer.froling@reusecompany.com

- ▶ Cecilia Karlsson
 - ▶ Marketing & Communication



Cecilia Karlsson
cecilia.karlsson@reusecompany.com

Introduction: Webinar rules

- Webinar rules:
 - You'll be muted all along the Webinar
 - There's a chatting box to ask your questions or send your comments when you want
 - Please address these comments and questions to the user "The REUSE Company" and not to the presenter directly
 - If you have any technical issue please use this chatting box, or mail us at: support@reusecompany.com
 - The Webinar will be recorded. A link to the recording will be sent to you in few days

Table of Contents

- Description of The Reuse Company
- Presenter's profile
- COSYSMO Presentation
- Q&A



About The REUSE Company (TRC)



01 The company was created in **1999**

As a spin-off of a local university in Madrid (Spain)

02 **System + Software Engineers**

Smart combination between Company staff and R&D from Academia

03 **Head Quarters:** Madrid (Spain)

International offices:
London (UK)
Stockholm (Sweden)

04 Offering a **knowledge centric** approach to leverage system engineering activities in our customers

Research and innovation in our DNA. Public projects

Research and Innovation in our DNA

Spin-off of Carlos III University of Madrid

TRC's headquarter is in the Legatec Technology Park of the University

≈10% of revenues are devoted to R&D

TRC is actively involved in several large EU research projects



REVaMP²

Past

ARTEMIS CRYSTAL
Requirements
Engineering



AMASS
Assurance and Certification of CPS



ARROWHEAD

Current

Celtic+: IoD



ITEA3

Future

ITEA3: EMBRACE

New Control



ECSEL JU

T (he) **R** (euse) **Q** (ompany)y

Leveraging Systems Engineering activities



Knowledge
Centric Approach

TRACEABILITY







QUALITY



REUSABILITY

Who is using our technology?

	Aerospace and defense
	Energy
	Automotive
	Healthcare
	Other industries



Christer Fröling



- Christer worked in the Medical and Defence sectors at either industrial organisations or as business entrepreneur for over 20 years at various operational and management levels.
- Currently he is the CEO of REUSE Scandinavia in Sweden which specializes in requirements quality services and tools within the Scandinavian region.
- Christer is a driven change facilitator and has successfully adopted and implemented international process frameworks and standards within industry.
- He has in recent years specialised in organisational learning, change management, process improvements, LEAN and Systems Engineering (SE) and Requirements Engineering (RE).

The value in Requirements quality

Calculate potential project cost savings using the
COSYSMO model

Christer Fröling

The REUSE Company

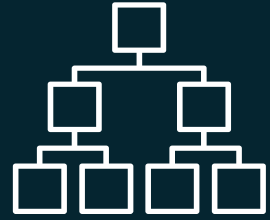
christer.froling@reusecompany.com



THE
REUSE
COMPANY

Contents

- The reason for project failure or success
- The need of mutual understanding
- The COSYSMO model
- The simulation – Improving requirements quality
- The simulation – Improving the SE process
- The cost of change
- The RoI - Summary



The reason for project failure or success

The purpose of requirements

- Form the basis of system **architecture** and **design** activities.
- Form the basis of system **integration** and **verification** activities.
- Act as reference for **validation** and stakeholder acceptance.
- Provide a means of **communication** between the various technical staff that interact throughout the project

Source: www.sebokwiki.org/wiki/System_Requirements

A grand, multi-story library with high ceilings and wooden bookshelves. The central focus is a staircase with a dark wooden railing. At the top of the stairs, there is a large, ornate window with a decorative arch. The text is overlaid on the image in a black, sans-serif font.

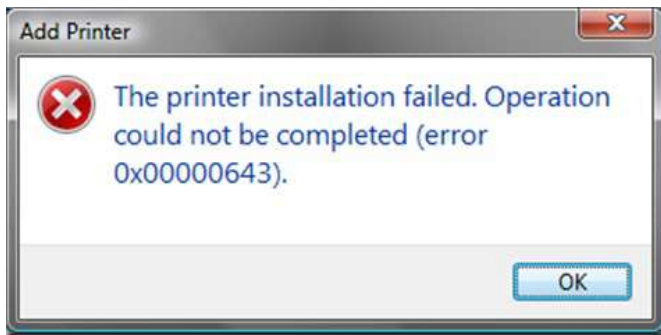
You will not get what you asked for...

You will get what the receiver of the
information **THINKS** you asked for!

AMERICA - AFRICA
ASIA - AUSTRALASIA

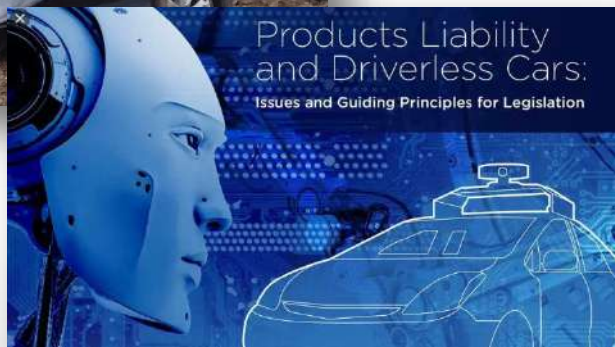
We have all seen them...

The small annoying things that makes us mad:



We have also seen...

The large things that makes us scared:



French railway operator SNCF orders hundreds of new trains that are too big

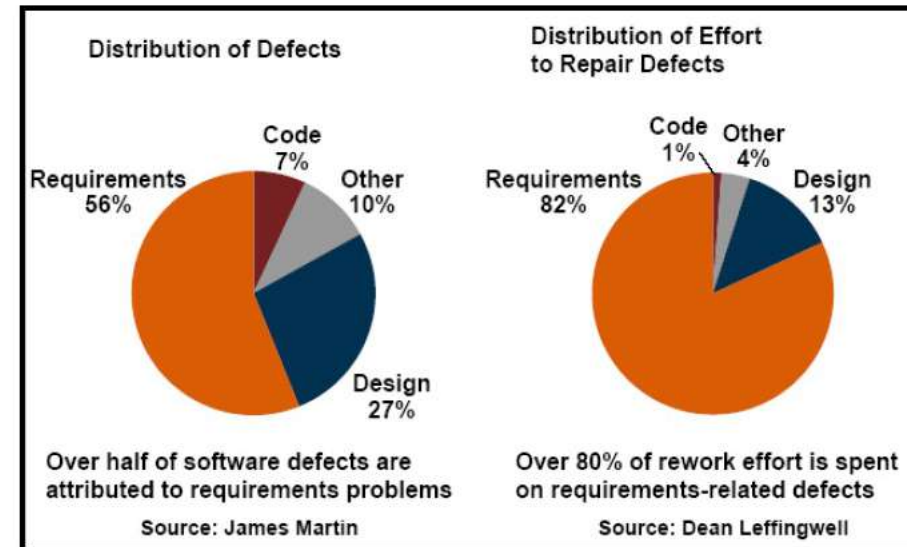
SNCF's failure to verify measurements results in cost of €50m to modify 1,300 platforms in one in six regional stations



Why projects FAIL?

- Many studies show the impact of Requirements on the Quality, Costs & Delivery Time of projects
 - The Chaos report, James Martin’s “56%”, Dean Leffingwell’s “82%” ...

CHAOS REPORT	Finished projects (overspent € or time)	Abandoned projects
<u>Lack of user implication</u>	12,80%	12,40%
<u>Incomplete requirements and specifications</u>	12,30%	13,10%
<u>Requirements volatility</u>	11,80%	8,70%
Lack of support from leaders	7,50%	9,30%
Technological Incompetency	7,00%	4,30%
Lack of resources	6,40%	10,60%
<u>Unrealistic expectations</u>	5,90%	9,90%
<u>Poorly defined objectives</u>	5,30%	7,50% *
<u>Unrealistic time-schedule</u>	4,30%	8,10% *
New technology	3,70%	6,20% *
Others	23%	9,90%



Source: The Standish group Chaos Report, <https://www.projectsmart.co.uk/white-papers/chaos-report.pdf>

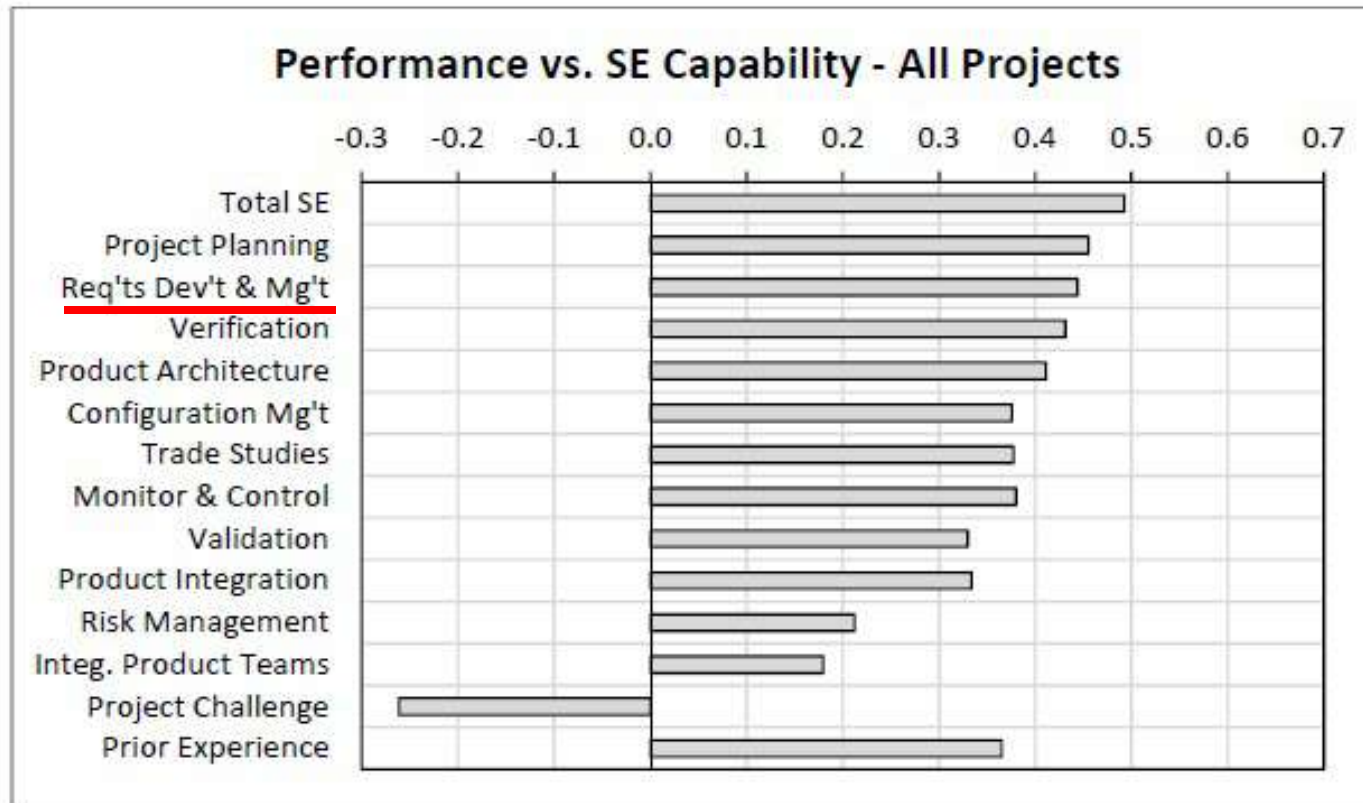
Why projects FAIL?

- The second largest reason for project failure is **BAD REQUIREMENTS**
- Also high correlation between bad requirements and failed test (3rd reason for project failure)
- If you add that “unrealistic goals” are part of low-quality requirements work and think about WHY the projects have massive schedule overrun....

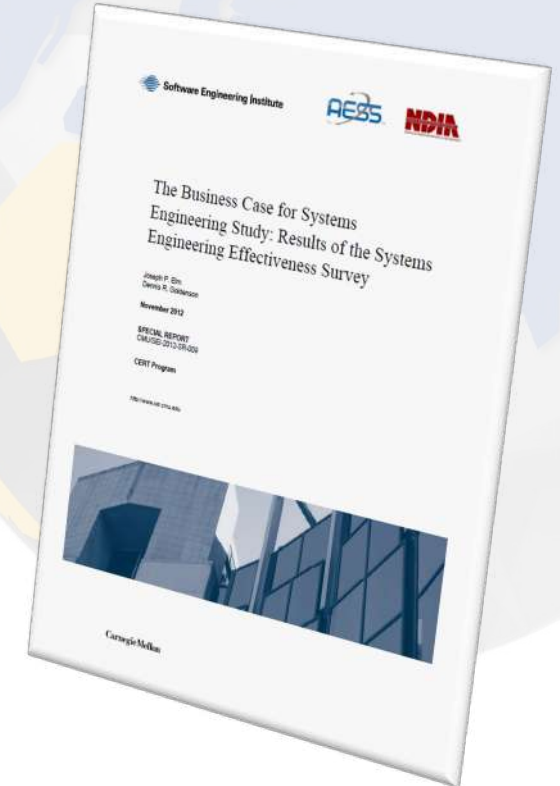
Failure Factors	Failure Factors ID	Odds to Project Failure
Unrealistic Project Goals and Expectations	FFA	10.765095510
Changing or Unclear Requirements	FFB	29.888343170
Insufficient Technical knowledge	FFC	2.458660736
Problematic Technology	FFD	4.867921328
Lack of Executive Leadership Support	FFE	10.459640733
Insufficient User Commitment	FFF	0.033420039
Project Cost Overruns	FFG	1.679315636
Project Schedule Delays	FFH	78.615538492
Insufficient Project Management and Control	FFI	0.751118550
Project Failure in Test Phase	TestF	11.369641083

Source: *Improving Software Project Outcomes Through Predictive Analytics*, Gina Guillaume-Joseph, 2016

Why projects **SUCCEED**?

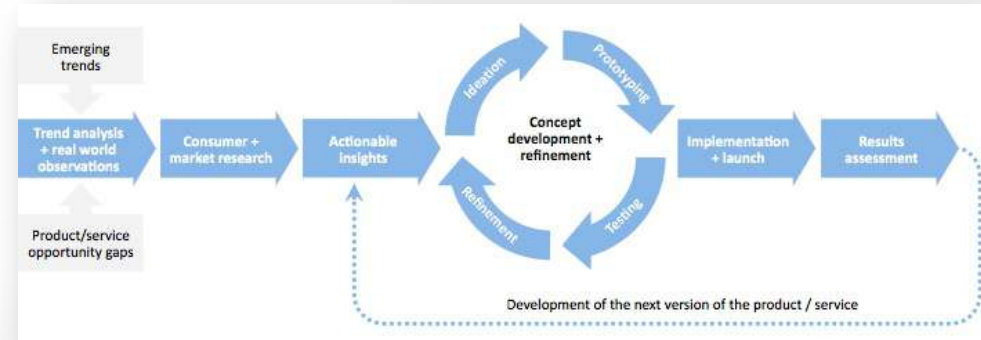
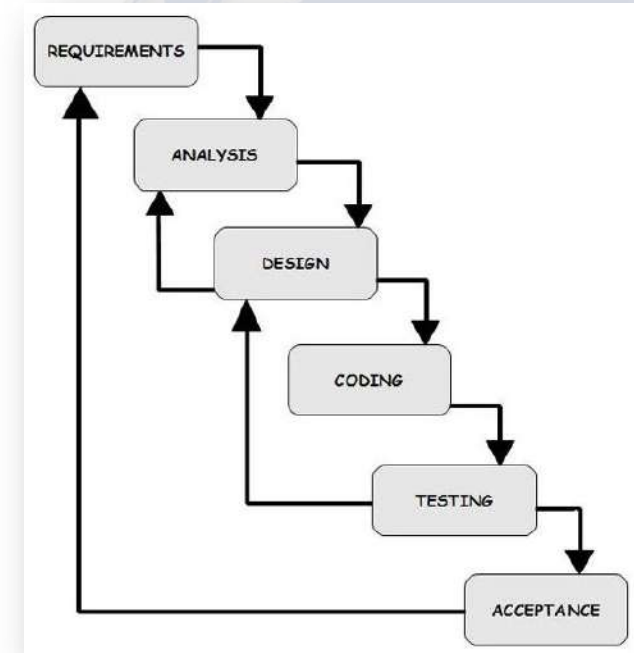
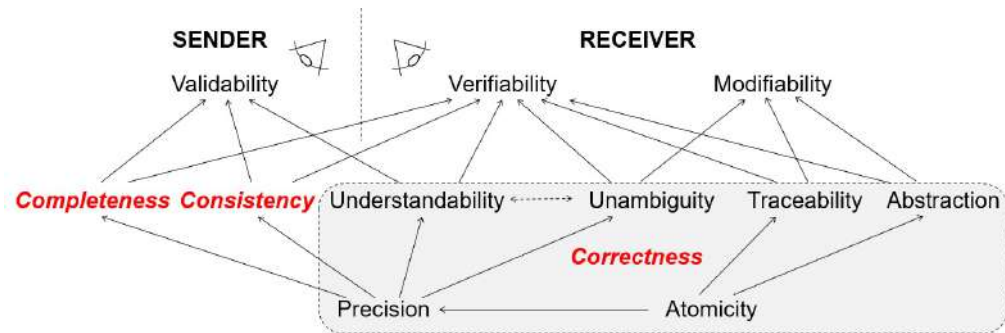


Source: *The Business Case for Systems Engineering Study: Results of the Systems Engineering Effectiveness Survey, 2012*

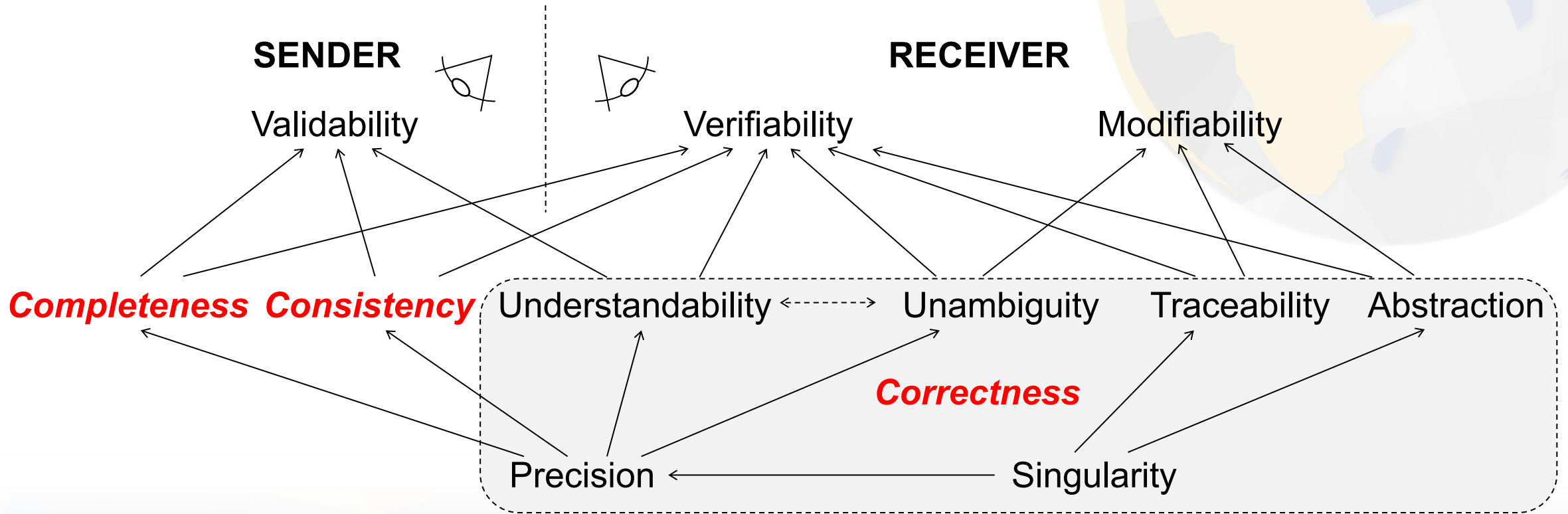


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The whispering game – we are only humans



The meaning of communication between stakeholders



INCOSE GfWR

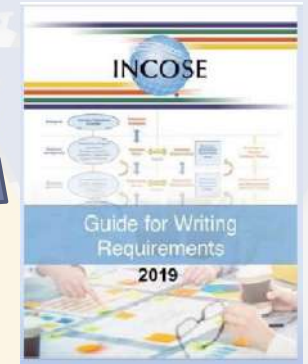
➤ **Characteristics** of individual and sets of needs and requirements, provides rationale and guidance for helping understand the characteristics.

➤ **Rules** for individual and sets of needs and requirements that help to formulate them. Included an explanation of the rule and examples of the application of the rule.

➤ **Attributes** that can be attached to a need or requirement statements to form need or requirement expressions. Also included is guidance on the use of attributes.

41 Rules / 14 Characteristics

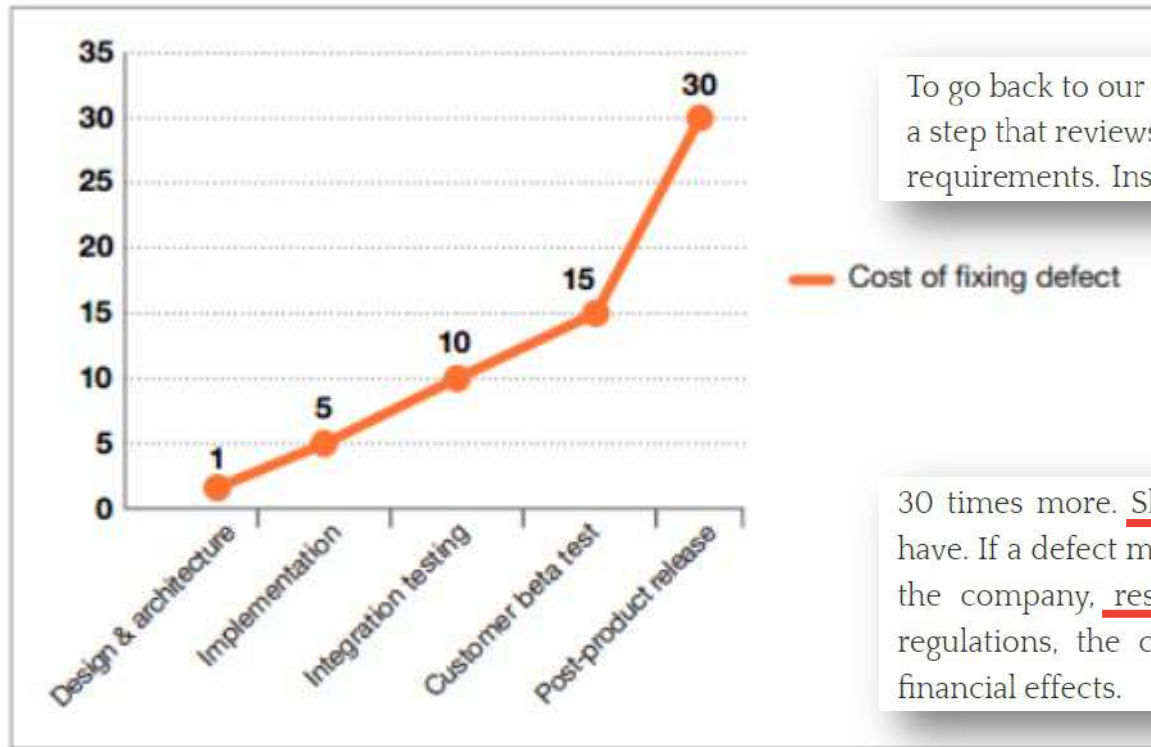
Type	Rule Number	Rule name	CHARACTERISTICS OF NEED AND REQUIREMENT STATEMENTS							SETS OF NEEDS AND REQUIREMENTS					
			C1 - NECESSARY	C2 - APPROPRIATE	C3 - UNAMBIGUOUS	C4 - COMPLETE	C5 - SINGULAR	C6 - FEASIBLE	C7 - VERIFIABLE	C8 - CORRECT	C9 - CONFORMING	C10 - COMPLETE	C11 - CONSISTENT	C12 - FEASIBLE	C13 - COMPREHENSIBLE
Accuracy	R01	Sentence Structure			1				1						
	R02	Use Active Voice			1				1						
	R03	Subject Verb		1	1				1						1
	R04	Use Defined Terms			1				1		1		1	1	
	R05	Use Definite Articles			1				1						
	R06	Units			1	1			1	1					
	R07	Avoid Vague Terms			1	1			1						
	R08	No Escape Clauses			1	1			1						
	R09	No Open Ended			1	1	1		1						
Conciseness	R10	Superfluous Infinitives			1				1						
	R11	Separate Clauses			1										
Non Ambiguity	R12	Correct Grammar			1					1					
	R13	Correct Spelling			1										
	R14	Correct Punctuation			1										
	R15	Logical Condition			1										
	R16	Avoid Not			1				1						
	R17	Oblique			1				1						
Singularity	R18	Single Sentence			1	1	1		1				1		
	R19	Avoid Combinators			1		1								
	R20	Avoid Purpose					1								
	R21	Avoid Parentheses					1								
	R22	Enumeration			1		1								
	R23	Context			1		1								
	R24	Avoid Pronouns			1	1			1						
Completeness	R25	Use Of Headings				1									
	R26	Avoid Absolutes						1	1				1		
Realism	R27	Explicit				1			1						
Conditions	R28	Explicit Lists				1			1						
	R29	Classify				1					1	1	1		
Uniqueness	R30	Express Once	1							1		1	1		
Abstraction	R31	Solutionfree		1											
Quantifiers	R32	Universals			1				1	1					
Tolerance	R33	Value Range			1	1			1	1	1			1	
Quantification	R34	Measurable			1	1			1				1		
	R35	Temporal Indefinite			1	1			1						
Uniform Language	R36	Use Consistent Terms			1					1	1		1	1	1
	R37	Define Acronyms			1					1		1	1	1	1
	R38	Avoid Abbreviations			1					1		1	1	1	1
	R39	Style Guide					1	1			1		1	1	1
Modularity	R40	Related Requirements								1		1	1	1	1
	R41	Structured								1	1		1	1	1



46 Attributes

Attribute	Attributes to Help Define the Requirement and its Intent	Associated with the System of Interest (SOI) Verification	Attributes to Help Maintain and Allow Reuse	Attributes to Show Applicability and Allow Reuse
A01	Rationale*	1		
A02	SOI Primary Verification or Validation Method*	1		
A03	SOI Verification or Validation Approach	1		
A04	Trace to Parent*	1		
A05	Trace to Source*	1		
A06	Condition of Use	1		
A07	States and Modes	1		
A08	Allocation*	1		
A09	SOI Verification or Validation Level		1	
A10	SOI Verification or Validation Phase		1	
A11	SOI Verification or Validation Results		1	
A12	SOI Verification or Validation Status		1	
A13	Unique Identifier*			1
A14	Unique Name			1
A15	Originator/Author*			1
A16	Date Requirement Entered			1
A17	Owner*			1
A18	Stakeholders			1
A19	Change Board			1
A20	Change Status			1
A21	Version Number			1
A22	Approval Date			1
A23	Date of Last Change			1
A24	Stability			1
A25	Responsible Person			1
A26	Need or Requirement Verification Status*			1
A27	Need or Requirement Validation Status*			1
A28	Status (of the Need or Requirement)			1
A29	Status (of Implementation)			1
A30	Trace to Interface Definition			1
A31	Trace to Peer Requirements			1
A32	Priority*			1
A33	Criticality or Essentiality*			1
A34	Risk (of Implementation)*			1
A35	Risk (Mitigation)			1
A36	Key Driving Need or Requirement (KDN/KDR)			1
A37	Additional Comments			1
A38	Type/Category			1
A39	Applicability			1
A40	Region			1
A41	Country			1
A42	State/Province			1
A43	Application			1
A44	Market Segment			1
A45	Business Unit			1
A46	Business (Product)Line			1

The cost of defects..

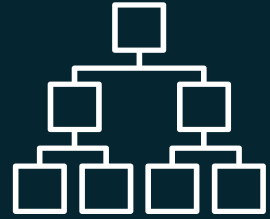


To go back to our earlier example, if the root cause of a defect is poorly written requirements, adding a step that reviews requirements for vague language will save development time and provide testable requirements. Instead of a requirement that states, “the application must load in a timely manner,”

30 times more. SkYROCKETING development costs aren't the only financial impact that defects can have. If a defect makes it into the release, customers may lose faith in the product and perhaps even the company, resulting in lost revenue. And if a defect results in harm or violates industry regulations, the company could face substantial fines, lawsuit damages, and other deleterious financial effects.

Figure 1: The cost of fixing defects rises the later they are discovered in the development cycle (NIST study)

https://www.medtechintelligence.com/feature_article/using-root-cause-analysis-for-powerful-defect-prevention/

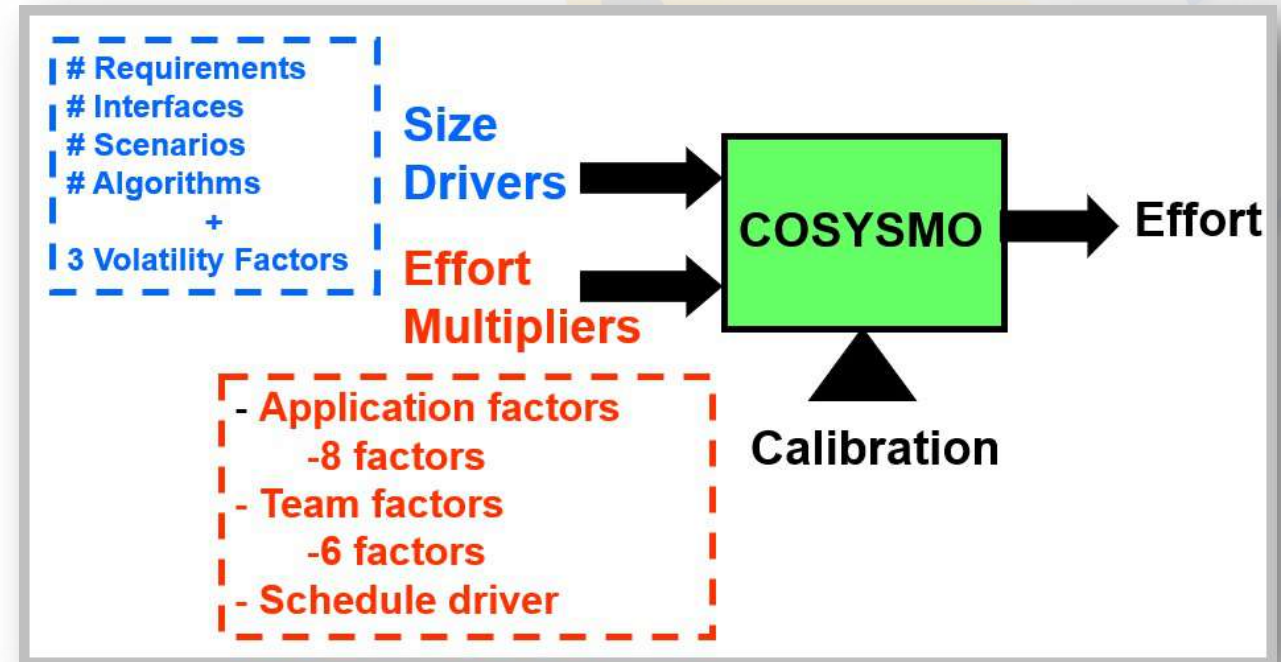


The COSYMO model

The COSYSMO model

➤ COSYSMO Developed by MIT and calibrated with more than 60 projects since 2005 from companies like:

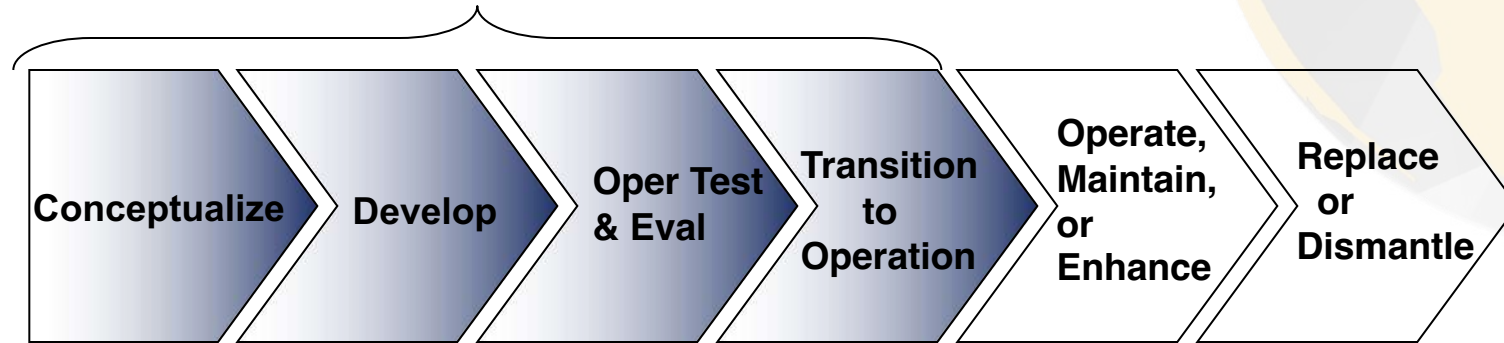
- Raytheon
- Lockheed Martin
- BAE Systems
- Boeing
- Northrop Grumman
- General Dynamics
- BAE Systems
- L-3 Communications



Source: <http://cosysmo.mit.edu/>

COSYSMO Scope

- **Addresses first four phases of the system engineering lifecycle (per ISO/IEC 15288)**



- **Considers standard Systems Engineering Work Breakdown Structure tasks (per EIA/ANSI 632)**

How is Systems Engineering Defined?

What is included from EIA/ANSI 632 “Processes for Engineering a System”?

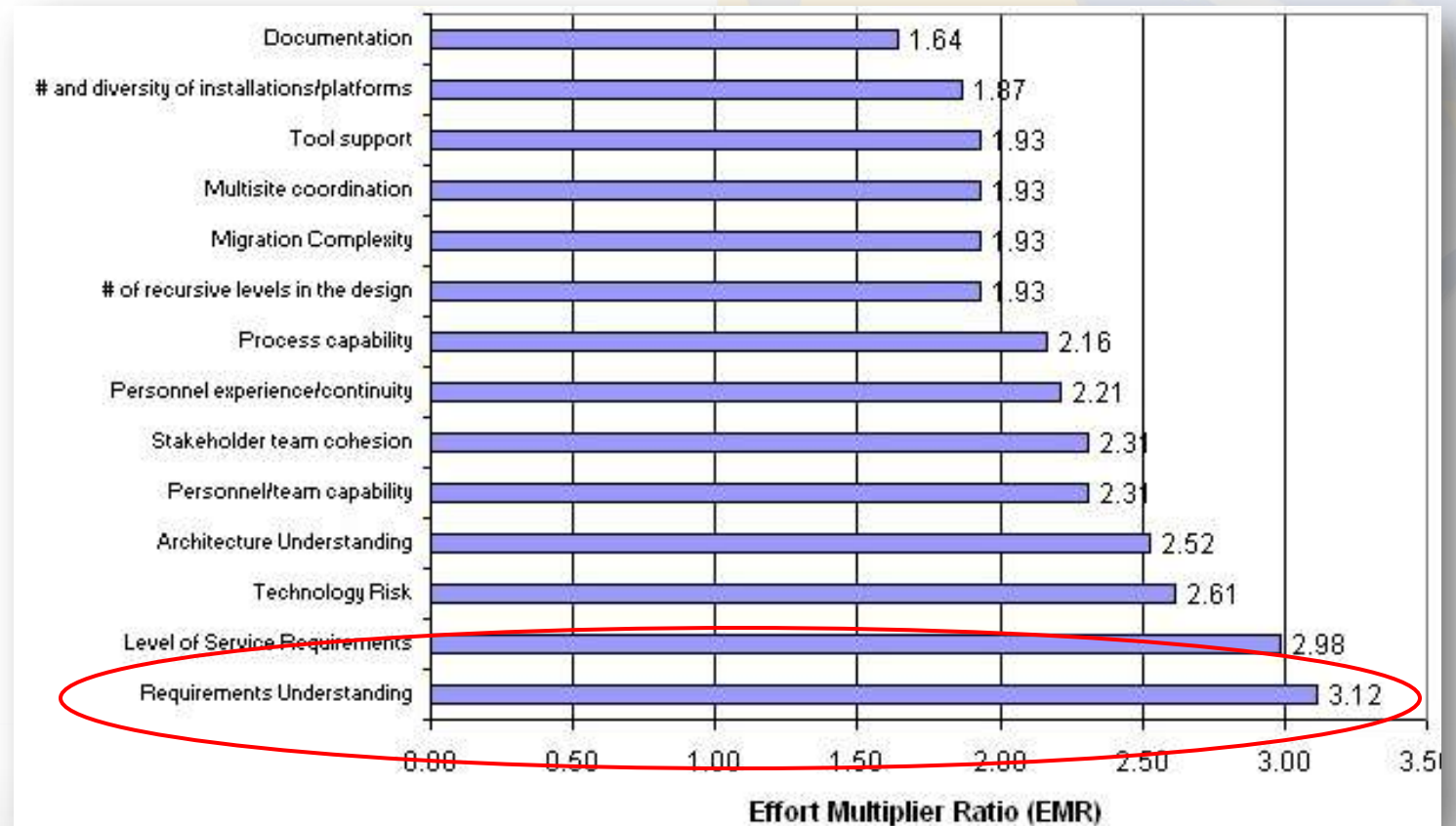
- ▶ **Acquisition and Supply**
 - ▶ Supply Process
 - ▶ Acquisition Process
- ▶ **Technical Management**
 - ▶ Planning Process
 - ▶ Assessment Process
 - ▶ Control Process
- ▶ **System Design**
 - ▶ Requirements Definition Process
 - ▶ Solution Definition Process
- ▶ **Product Realization**
 - ▶ Implementation Process
 - ▶ Transition to Use Process
- ▶ **Technical Evaluation**
 - ▶ Systems Analysis Process
 - ▶ Requirements Validation Process
 - ▶ System Verification Process
 - ▶ End Products Validation Process

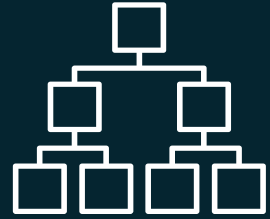


The COSYSMO model – Effort multipliers



- COSYSMO research gives validated data that **REQUIREMENTS UNDERSTANDING** is the single most important aspects and cost driver in a project.





The Simulation Requirements improvement

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Example from a large railroad project

Original Specification

- 329 Requirements

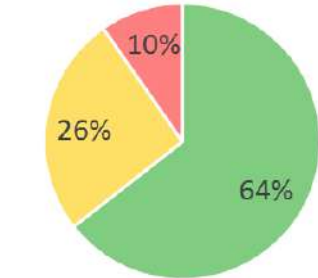


Modified Specification

- 438 Requirements
- 66.26% Modified Requirements

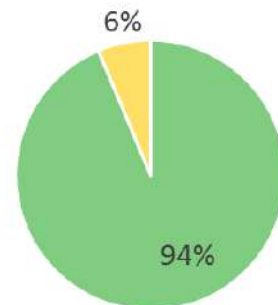


% of Requirements



■ High ■ Medium ■ Low ■ N/A

% of Requirements



■ High ■ Medium ■ Low ■ N/A

Source: *Your Wish, My Command – Speeding up Projects in the Transportation Industry Using Ontologies*, Hugo Guillermo Chalé Góngora, et.al., 27th Annual INCOSE International Symposium, 2017




Number of System Requirements


This driver represents the number of requirements for the system-of-interest at a specific level of design. The quantity of requirements includes those related to the effort involved in system engineering the system interfaces, system specific algorithms, and operational scenarios. Requirements may be functional, performance, feature, or service-oriented in nature depending on the methodology used for specification. They may also be defined by the customer or contractor. Each requirement may have effort associated with it such as verification and validation, functional decomposition, functional allocation, etc. System requirements can typically be quantified by counting the number of applicable shalls/wills/shoulds/mays in the system or marketing specification. Note: some work is involved in decomposing requirements so that they may be counted at the appropriate system-of-interest.

Easy	Nominal	Difficult
- Simple to implement	- Familiar	- Complex to implement or engineer
- Traceable to source	- Can be traced to source with some effort	- Hard to trace to source
- Little requirements overlap	- Some overlap	- High degree of requirements overlap

Number of System Interfaces

This driver represents the number of shared physical and logical boundaries between system components or functions (internal interfaces) and those external to the system (external interfaces). These interfaces typically can be quantified by counting the number of external and internal system interfaces among ISO/IEC 15288-defined system elements.

Easy 	Nominal 	Difficult 
- Simple message	- Moderate complexity	- Complex protocol(s)
- Uncoupled	- Loosely coupled	- Highly coupled
- Strong consensus	- Moderate consensus	- Low consensus
- Well behaved	- Predictable behavior	- Poorly behaved

 Static value in the simulation

Number of System-Specific Algorithms

This driver represents the number of newly defined or significantly altered functions that require unique mathematical algorithms to be derived in order to achieve the system performance requirements. As an example, this could include a complex aircraft tracking algorithm like a Kalman Filter being derived using existing experience as the basis for the all aspect search function. Another example could be a brand new discrimination algorithm being derived to identify friend or foe function in space-based applications. The number can be quantified by counting the number of unique algorithms needed to realize the requirements specified in the system specification or mode description document.

Easy	Nominal	Difficult
- Algebraic	- Straight forward calculus	Complex constrained optimization; pattern recognition
- Straightforward structure	- Nested structure with decision logic	- Recursive in structure with distributed control
- Simple data	- Relational data	- Noisy, ill-conditioned data
- Timing not an issue	- Timing a constraint	- Dynamic, with timing and uncertainty issues
- Adaptation of library-based solution	- Some modeling involved	- Simulation and modeling involved

★ 25




★ 20


★ 5

★ Static value in the simulation

Number of Operational Scenarios

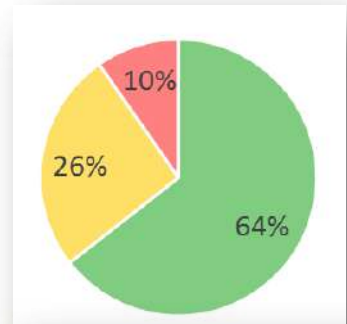
This driver represents the number of operational scenarios that a system must satisfy. Such scenarios include both the nominal stimulus-response thread plus all of the off-nominal threads resulting from bad or missing data, unavailable processes, network connections, or other exception-handling cases. The number of scenarios can typically be quantified by counting the number of system test thread packages or unique end-to-end tests used to validate the system functionality and performance or by counting the number of use cases, including off-nominal extensions, developed as part of the operational architecture.

Easy 	Nominal 	Difficult 
- Well defined	- Loosely defined	- Ill defined
- Loosely coupled	- Moderately coupled	- Tightly coupled or many dependencies/conflicting requirements
- Timelines not an issue	- Timelines a constraint	- Tight timelines through scenario network
- Few, simple off-nominal threads	- Moderate number or complexity of off-nominal threads	- Many or very complex off-nominal threads

 Static value in the simulation



1,1



■ High ■ Medium ■ Low ■ N/A

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ENTER SIZE PARAMETERS FOR SYSTEM OF INTEREST

	Easy	Nominal	Difficult
# of System Requirements	211	86	32
# of System Interfaces	10	30	10
# of Algorithms	25	20	5
# of Operational Scenarios	4	4	2

352
158
195
142
846
equivalent size

SELECT COST PARAMETERS FOR SYSTEM OF INTEREST

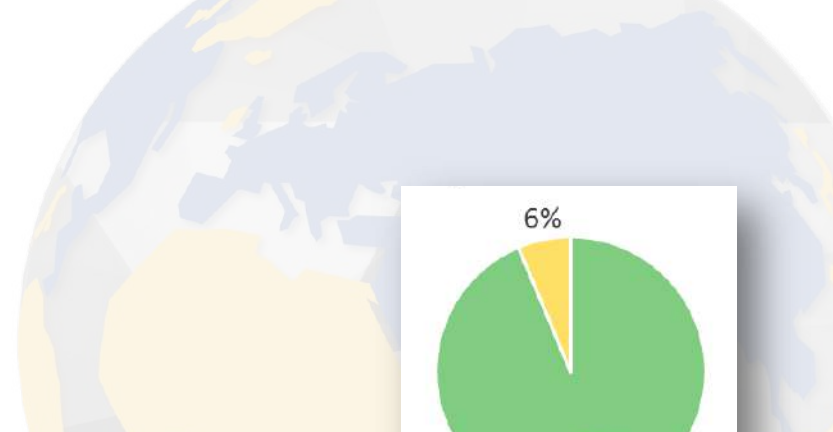
Requirements Understanding	N	1,00
Architecture Understanding	N	1,00
Level of Service Requirements	N	1,00
Migration Complexity	N	1,00
Technology Risk	H	1,32
Documentation	N	1,00
# and diversity of installations/platforms	N	1,00
# of recursive levels in the design	N	1,00
Stakeholder team cohesion	L	1,22
Personnel/team capability	N	1,00
Personnel experience/continuity	N	1,00
Process capability	L	1,21
Multisite coordination	L	1,15
Tool support	L	1,16
Composite Effort Multiplier		2,61

composite effort multiplier

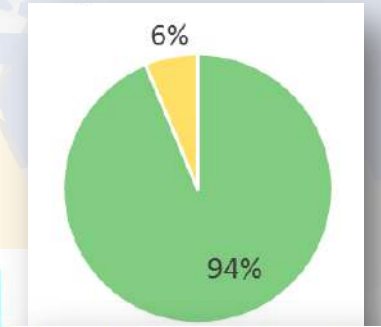
SYSTEMS ENGINEERING PERSON.MONTHS	838,3
SYSTEMS ENGINEERING SCHEDULE MONTHS	11,3



Reduced effort: -17,5%
+/- 30% uncertainty



1,1



■ High ■ Medium ■ Low ■ N/A

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ENTER SIZE PARAMETERS FOR SYSTEM OF INTEREST

	Easy	Nominal	Difficult
# of System Requirements	412	26	0
# of System Interfaces	10	30	10
# of Algorithms	25	20	5
# of Operational Scenarios	4	4	2

232
158
195
142
727
equivalent size

SELECT COST PARAMETERS FOR SYSTEM OF INTEREST

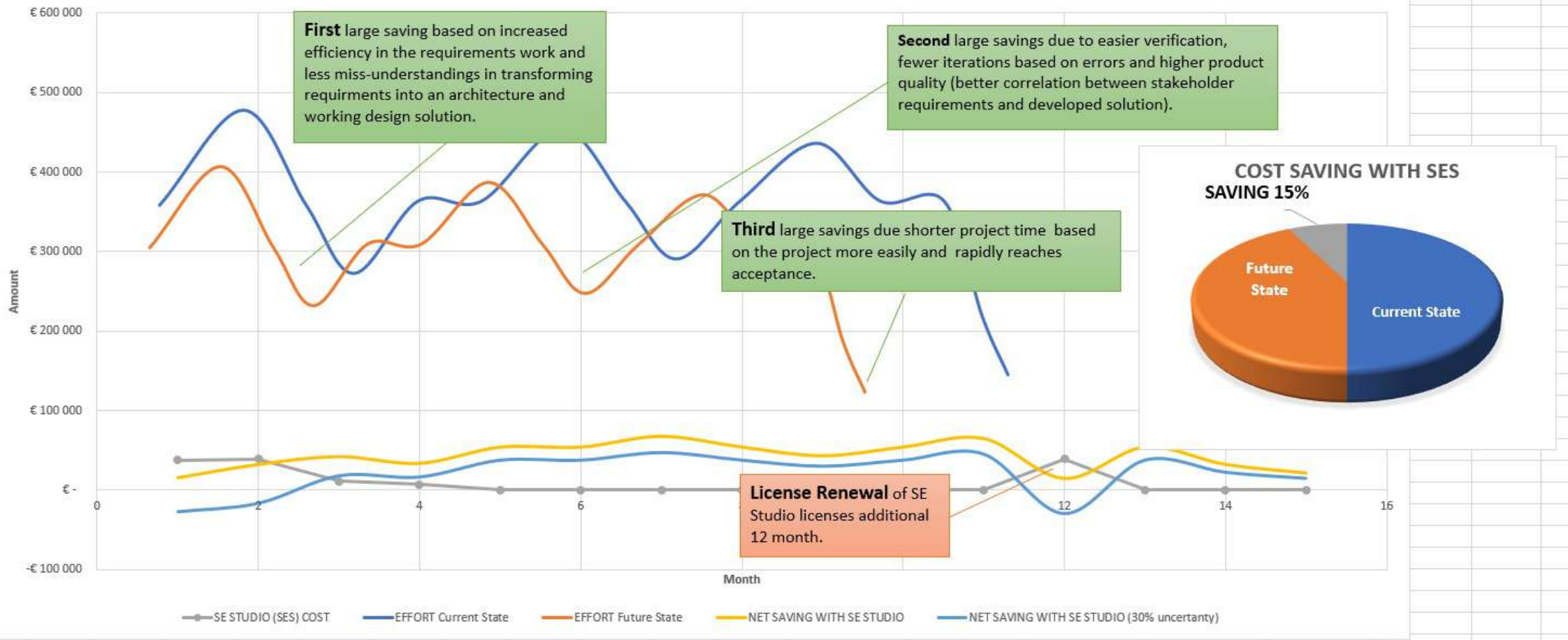
Requirements Understanding	N	1,00
Architecture Understanding	N	1,00
Level of Service Requirements	N	1,00
Migration Complexity	N	1,00
Technology Risk	H	1,32
Documentation	N	1,00
# and diversity of installations/platforms	N	1,00
# of recursive levels in the design	N	1,00
Stakeholder team cohesion	L	1,22
Personnel/team capability	N	1,00
Personnel experience/continuity	N	1,00
Process capability	L	1,21
Multisite coordination	L	1,15
Tool support	L	1,16
Composite Effort Multiplier		2,61

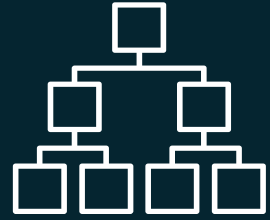
composite effort multiplier

SYSTEMS ENGINEERING PERSON.MONTHS	713,4
SYSTEMS ENGINEERING SCHEDULE MONTHS	9,5

The VALUE of high quality requirements – 15% potential cost saving!

RETURN OF INVESTMENT WITH SE STUDIO (SES) ON ONE PILOT PROJECT





The Simulation

- Improved SE
process

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Example of application – Nominal Values for efficient SE process

COSYSMO - Constructive Systems Engineering Model

Model(s): COSYSMO
Monte Carlo Risk: Off
Auto Calculate: Off

System Size

	Easy	Nominal	Difficult
# of System Requirements	75	100	25
# of System Interfaces	10	30	10
# of Algorithms	250	200	50
# of Operational Scenarios	40	40	20

System Cost Drivers

Requirements Understanding	Nominal	Documentation	Nominal	Personnel Experience/Continuity	Nominal
Architecture Understanding	Nominal	# and Diversity of Installations/Platforms	Nominal	Process Capability	Nominal
Level of Service Requirements	Nominal	# of Recursive Levels in the Design	Nominal	Multisite Coordination	Nominal
Migration Complexity	Nominal	Stakeholder Team Cohesion	Nominal	Tool Support	Nominal
Technology Risk	Nominal	Personnel/Team Capability	Nominal		

Maintenance: Off

System Labor Rates
Cost per Person-Month (Dollars): 6000

Calculate

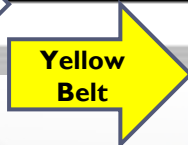
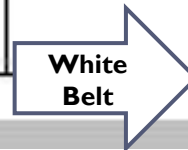
Results
Systems Engineering
Effort = 1575.7 Person-months
Schedule = 17.0 Months
Cost = \$9454288

SE Cost for Nominal Values = \$9,454,288.00

1. Requirements Understanding

This cost driver rates the level of understanding of the system requirements by all stakeholders including the systems, software, hardware, customers, team members, users, etc. Primary sources of added system engineering effort are unprecedented systems, unfamiliar domains, or systems whose requirements are emergent with use.

<i>Very Low</i>	<i>Low</i>	<i>Nominal</i>	<i>High</i>	<i>Very High</i>
Poor: emergent requirements or unprecedented systems	Minimal: many undefined areas	Reasonable: some undefined areas	Strong: few undefined areas	Full: understanding of requirements, familiar systems



Requirements **CORRECTNESS**



RQA



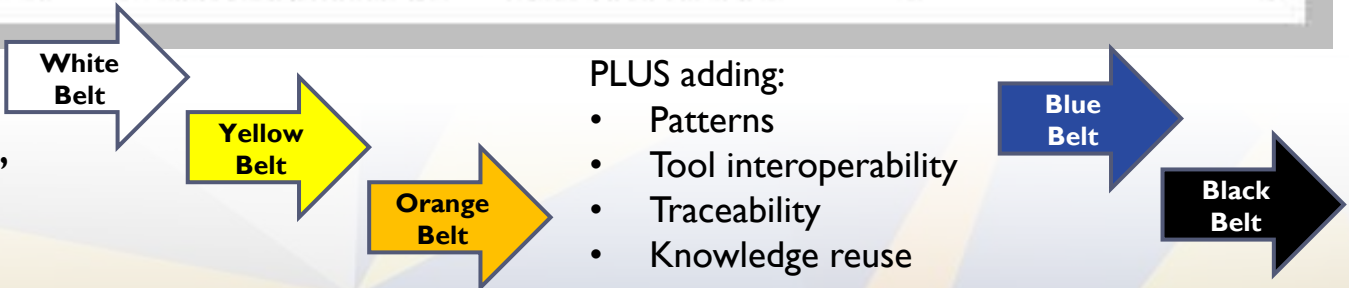
RAT

2. Architecture Understanding

This cost driver rates the relative difficulty of determining and managing the system architecture in terms of platforms, standards, components (COTS, GOTS, NDI, new), connectors (protocols), and constraints. This includes tasks like systems analysis, tradeoff analysis, modeling, simulation, case studies, etc.

Very low	Low	Nominal	High	Very High
Poor understanding of architecture and COTS, unprecedented system	Minimal understanding of architecture and COTS, many <u>unfamiliar</u> areas	Reasonable understanding of architecture and COTS, some unfamiliar areas	Strong understanding of architecture and COTS, few unfamiliar areas	Full understanding of architecture, familiar system and COTS
>6 level WBS	5-6 level WBS	3-4 level WBS	2 level WBS	

Requirements and Architecture **CORRECTNESS, CONSISTENCY & COMPLETENESS**



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Example of application – High Values for efficient SE process

COSYSMO - Constructive Systems Engineering Model

Model(s)
COSYSMO
Monte Carlo Risk Off
Auto Calculate Off

System Size

	Easy	Nominal	Difficult
# of System Requirements	75	100	25
# of System Interfaces	10	30	10
# of Algorithms	250	200	50
# of Operational Scenarios	40	40	20

System Cost Drivers

Requirements Understanding	High	Documentation	Nominal	Personnel Experience/Continuity	Nominal
Architecture Understanding	High	# and Diversity of Installations/Platforms	Nominal	Process Capability	Nominal
Level of Service Requirements	Nominal	# of Recursive Levels in the Design	Nominal	Multisite Coordination	Nominal
Migration Complexity	Nominal	Stakeholder Team Cohesion	Nominal	Tool Support	Nominal
Technology Risk	Nominal	Personnel/Team Capability	Nominal		

Maintenance Off

System Labor Rates
Cost per Person-Month (Dollars) 6000

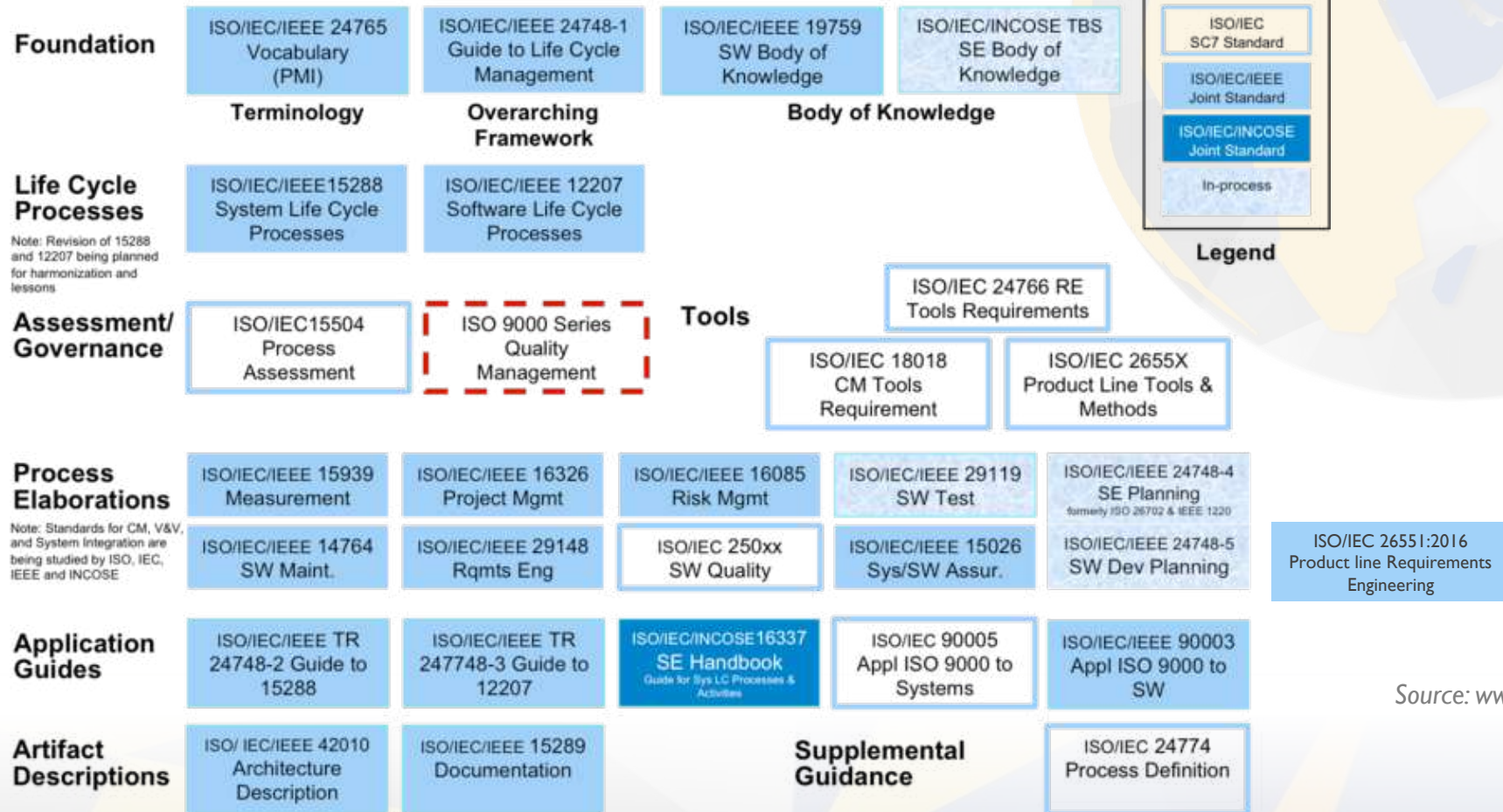
Calculate

Results
Systems Engineering
Effort = 982.8 Person-months
Schedule = 14.6 Months
Cost = \$5896640

*Percent Change
Nominal to High = 37.63%*

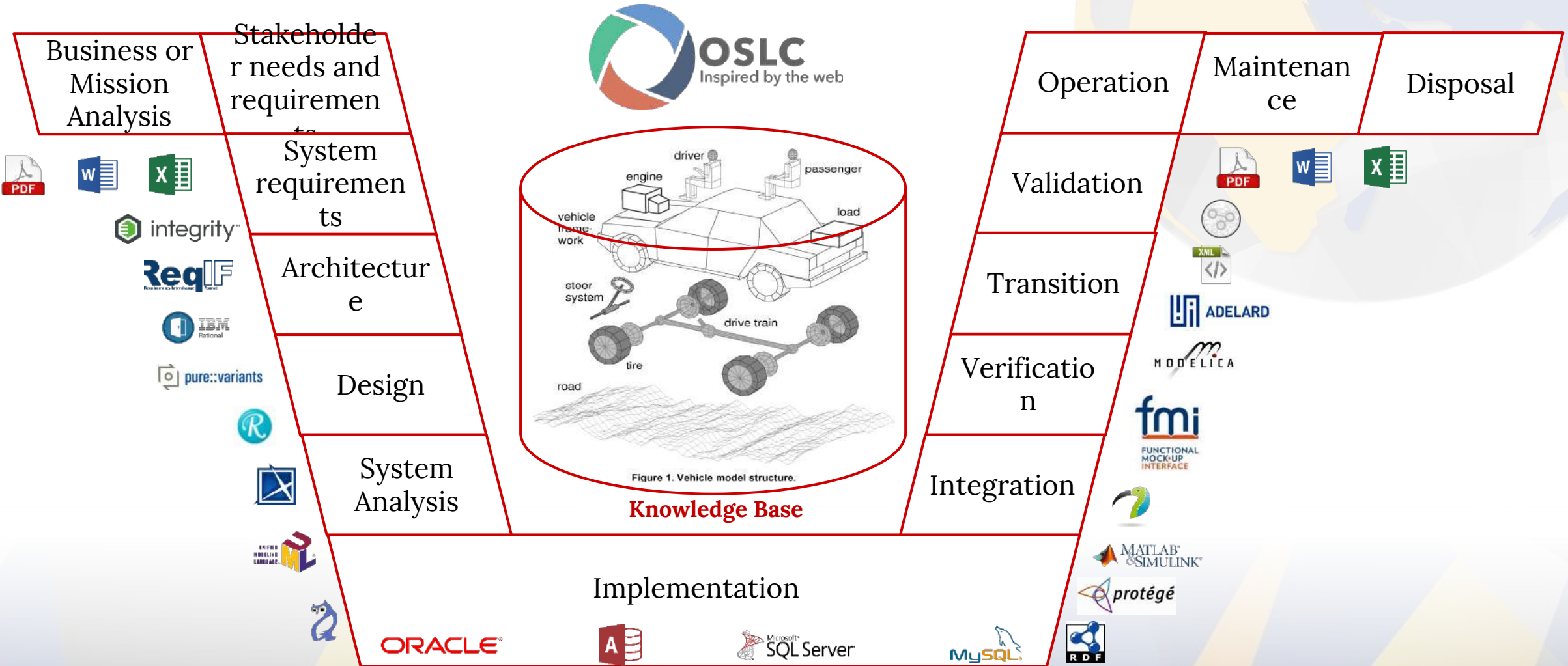
*SE Cost for
High Values = \$5,896,640.00*

The supporting standards – An overview




Source: www.sebokwiki.org/wiki

The Product Line Knowledge Base is formed by all types of Knowledge



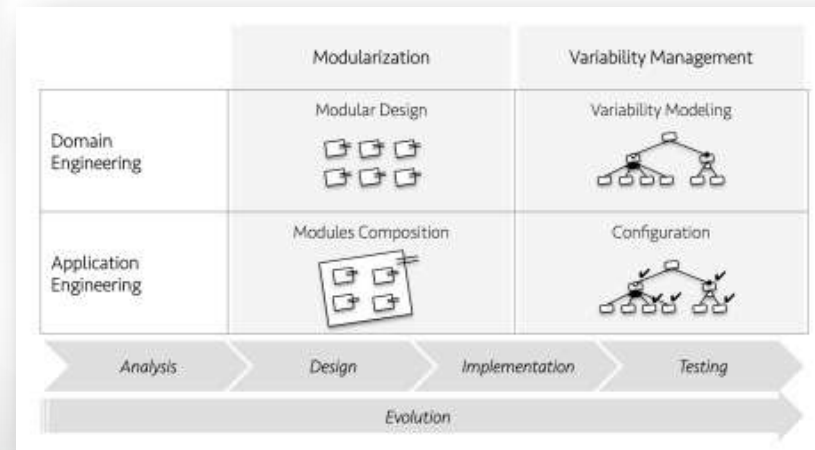
The supporting standards – Product line engineering


The European automotive sector differed greatly in the level of variety they offered to customers, although variety had little relation to unitary sales.

	Bodies	Power trains	Total number of variations	European units sales in 2002
Mercedes E-Class	30	15	3,347,807,348,000,000,000,000,000	157,584
BMW 3-Series	10	20	64,081,043,660,000,000	350,723
Peugeot 206	5	24	1,739	596,531

Source: <http://ctiseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.469.2061&rep=rep1&type=pdf>

- **Extraction** of requirements from the product-line assets
 - Automatic allocation of assets from the solution space to requirements document
- **Identification of the variant features** in the requirements
 - Patterns and Thesaurus to cover commonality and variability
- **Coverage** of the specific system features
 - Knowledge interfaces with Product Lifecycle Management software tools



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Example of application – Very High Values for efficient SE process

COSYSMO - Constructive Systems Engineering Model

Model(s): COSYSMO
Monte Carlo Risk: Off
Auto Calculate: Off

System Size

	Easy	Nominal	Difficult
# of System Requirements	75	100	25
# of System Interfaces	10	30	10
# of Algorithms	250	200	50
# of Operational Scenarios	40	40	20

System Cost Drivers

Requirements Understanding	Very High	Documentation	Nominal	Personnel Experience/Continuity	Nominal
Architecture Understanding	Very High	# and Diversity of Installations/Platforms	Nominal	Process Capability	Nominal
Level of Service Requirements	Nominal	# of Recursive Levels in the Design	Nominal	Multisite Coordination	Nominal
Migration Complexity	Nominal	Stakeholder Team Cohesion	Nominal	Tool Support	Nominal
Technology Risk	Nominal	Personnel/Team Capability	Nominal		

Maintenance: Off

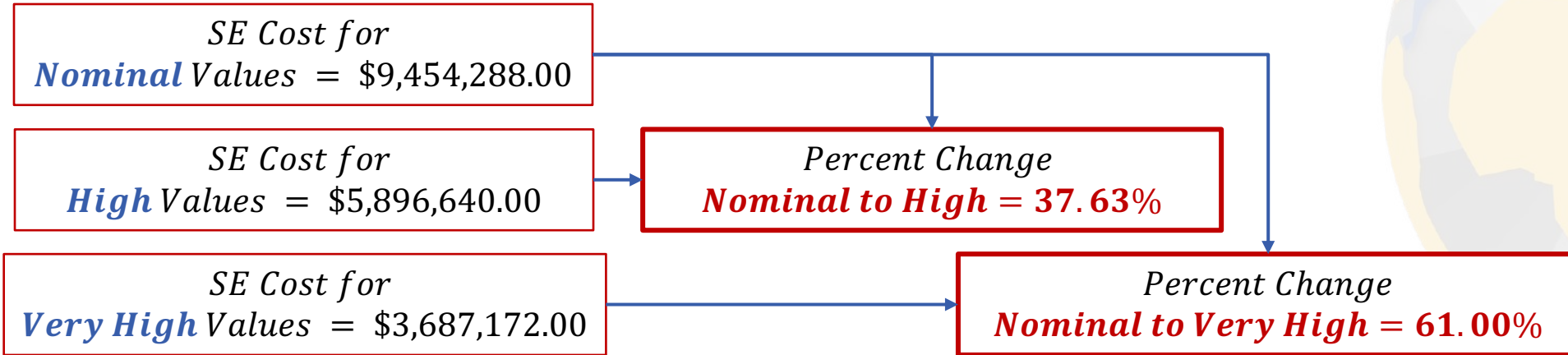
System Labor Rates
Cost per Person-Month (Dollars): 6000

Calculate

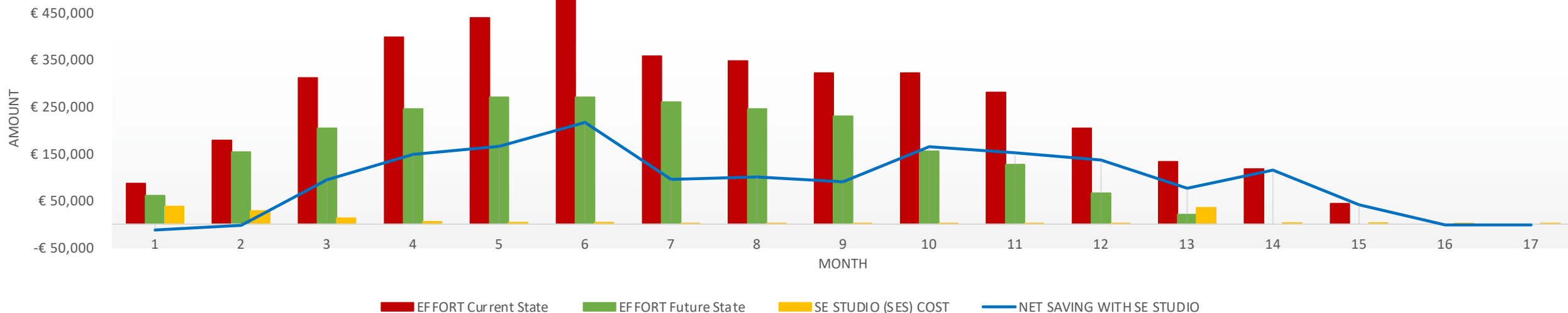
Results
Systems Engineering
Effort = 614.5 Person-months
Schedule = 12.5 Months
Cost = \$3687172

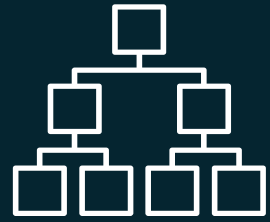
*Percent Change
Nominal to Very High = 61.00%*

*SE Cost for
Very High Values = \$3,687,172.00*



Return on Investment with SES v18 - Pilot Project





The Cost of change

Key elements of the CCC approach

P

Pros

Reach high level of quality, for requirements and other assets
Reduce time of inspection and re-work



Cons

Reaching the full CCC approach requires help from ontologies

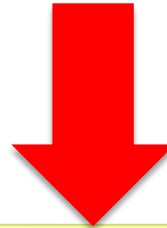
C



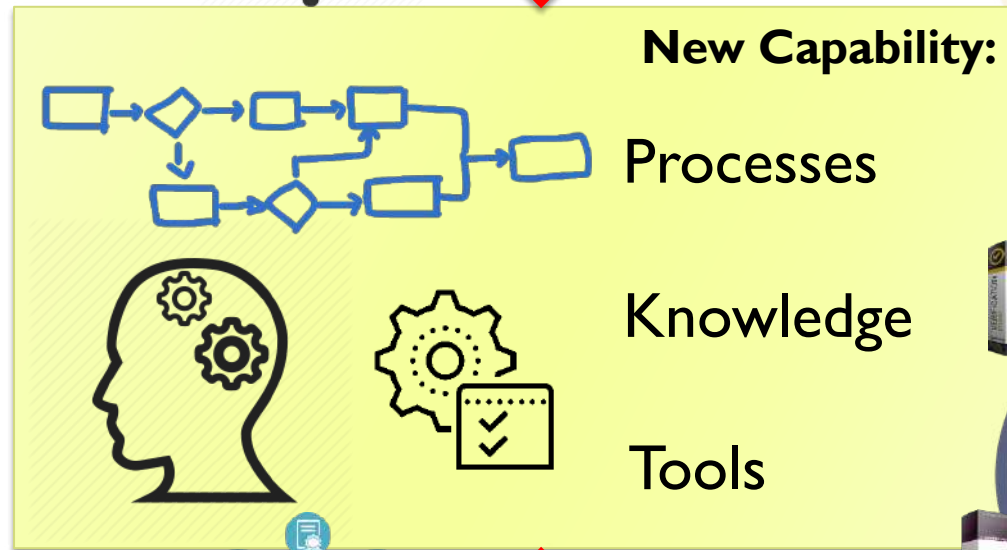
Building a new capability requires resources

Change Process:

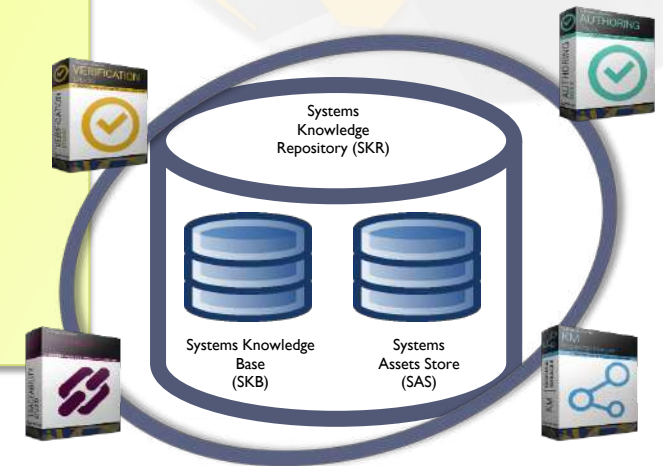
- ▶ Pace?
- ▶ Focus?
- ▶ Goals?
- ▶ Resources?
- ▶ Implementation?



Management Support
& Attention



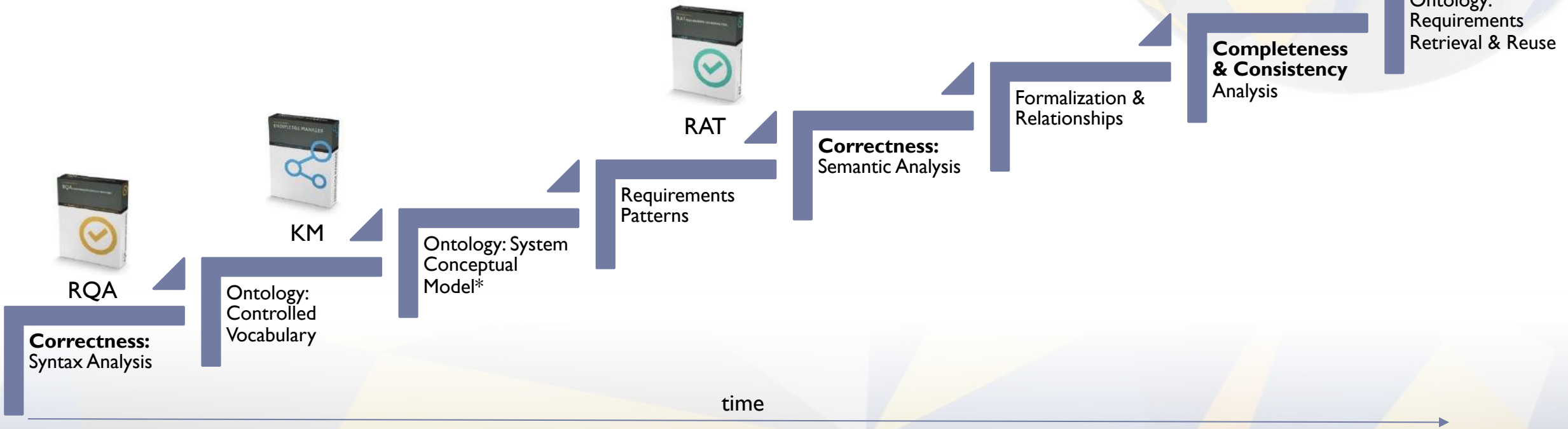
Resources



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The Knowledge buildup

* Functional models, States/Modes, Product Breakdowns, Specification structures, etc.....

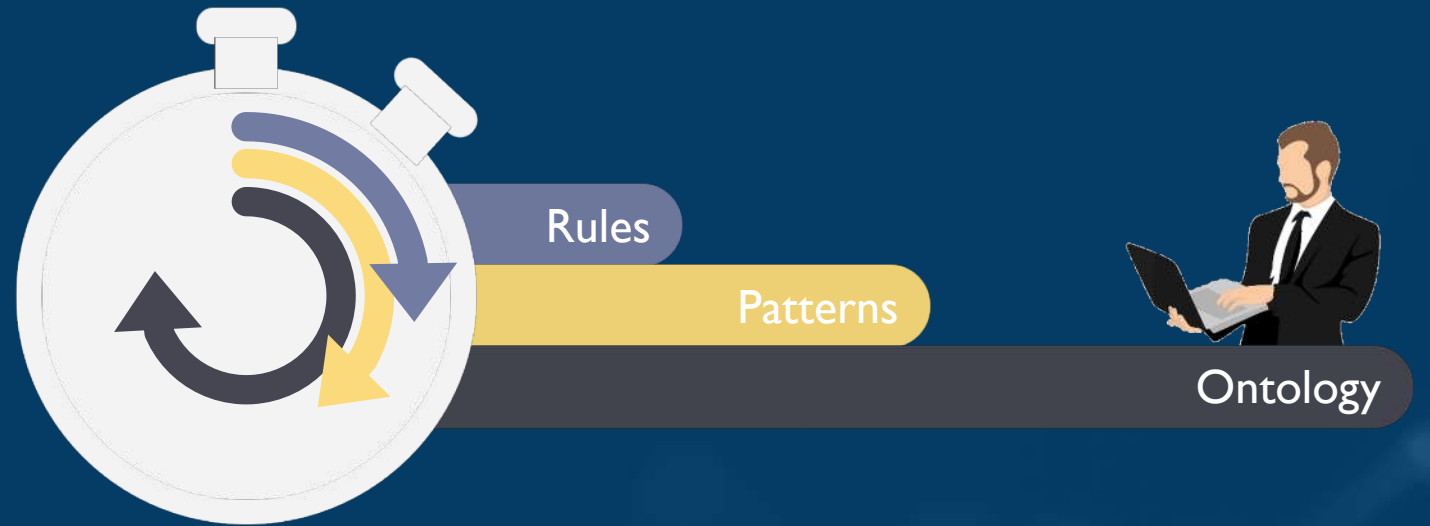


Key elements of the CCC approach

Manual definition

Requires time

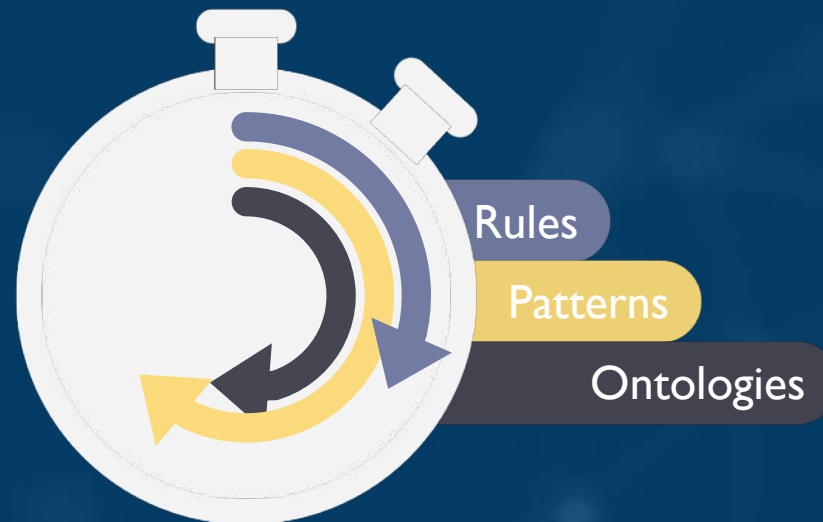
Requires an intensive help from SME



AI + NLP

Reduction of time

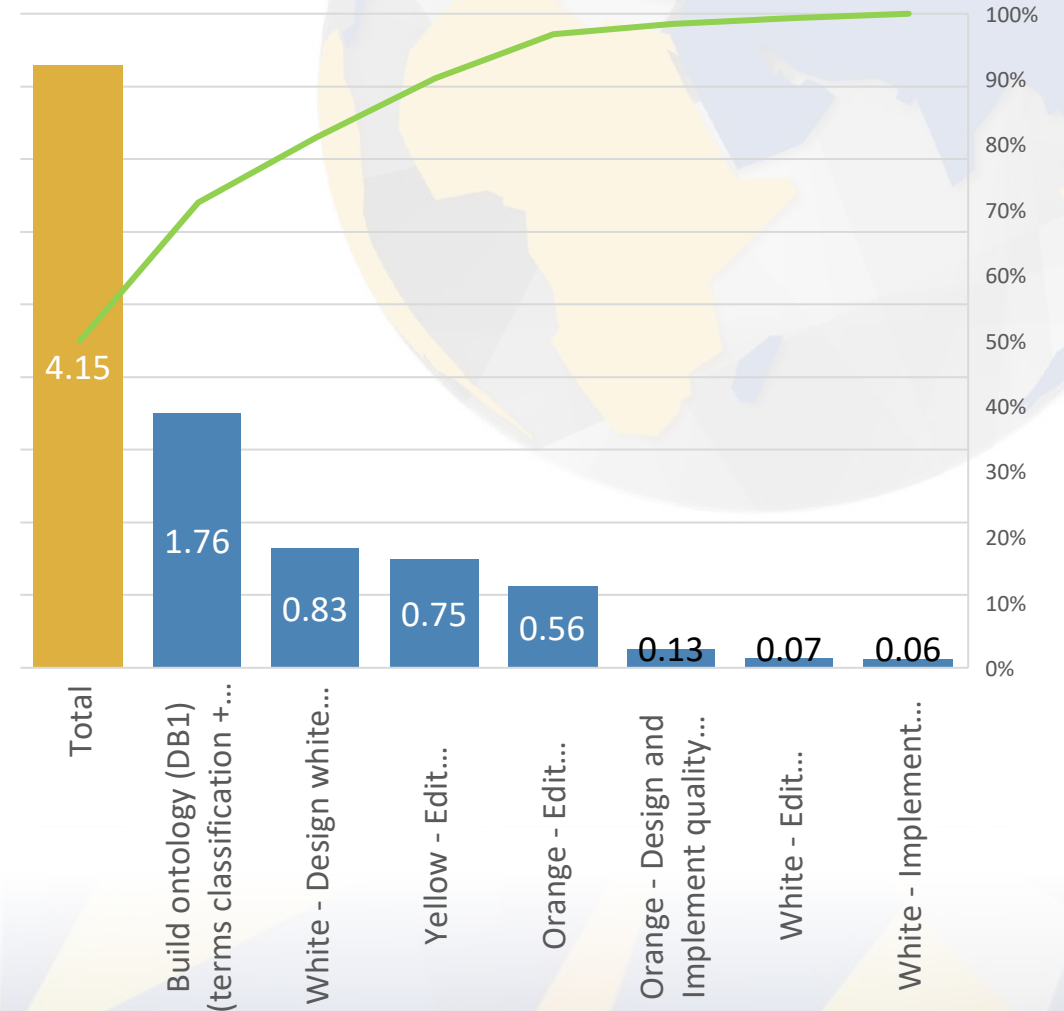
Less help from SME

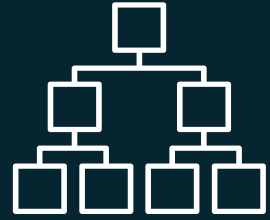


Task	Hours	Person Month
Build Ontology (DBI) (terms classification + PBS + patterns)	281.20	1.76
White Belt - Edit Requirements (approx. 350 req.)	10.60	0.07
White Belt - Design Quality configuration	132.00	0.83
White Belt – Implement Quality configuration (metrics elaboration + quality assessment)	9.64	0.06
Yellow Belt - Edit Requirements	120.00	0.75
Orange Belt – Design and Implement quality configuration	20.98	0.13
Orange Belt - Edit Requirements	90.00	0.56
Total	664.43	4.15

SES Suite – real example

Effort

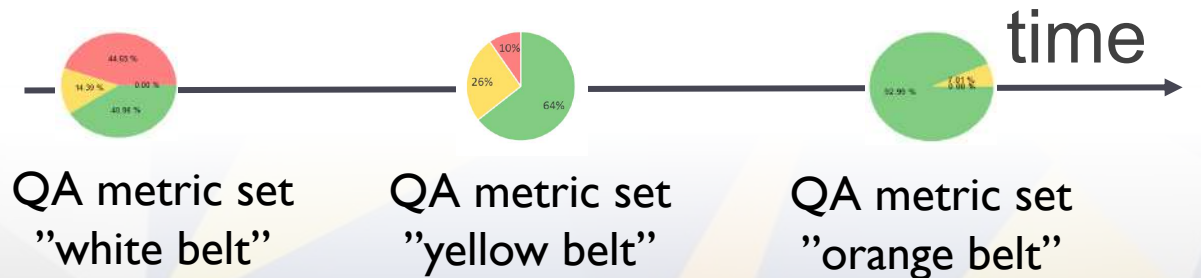




The Rol - Summary

Project and department control over progress, risks and maturity

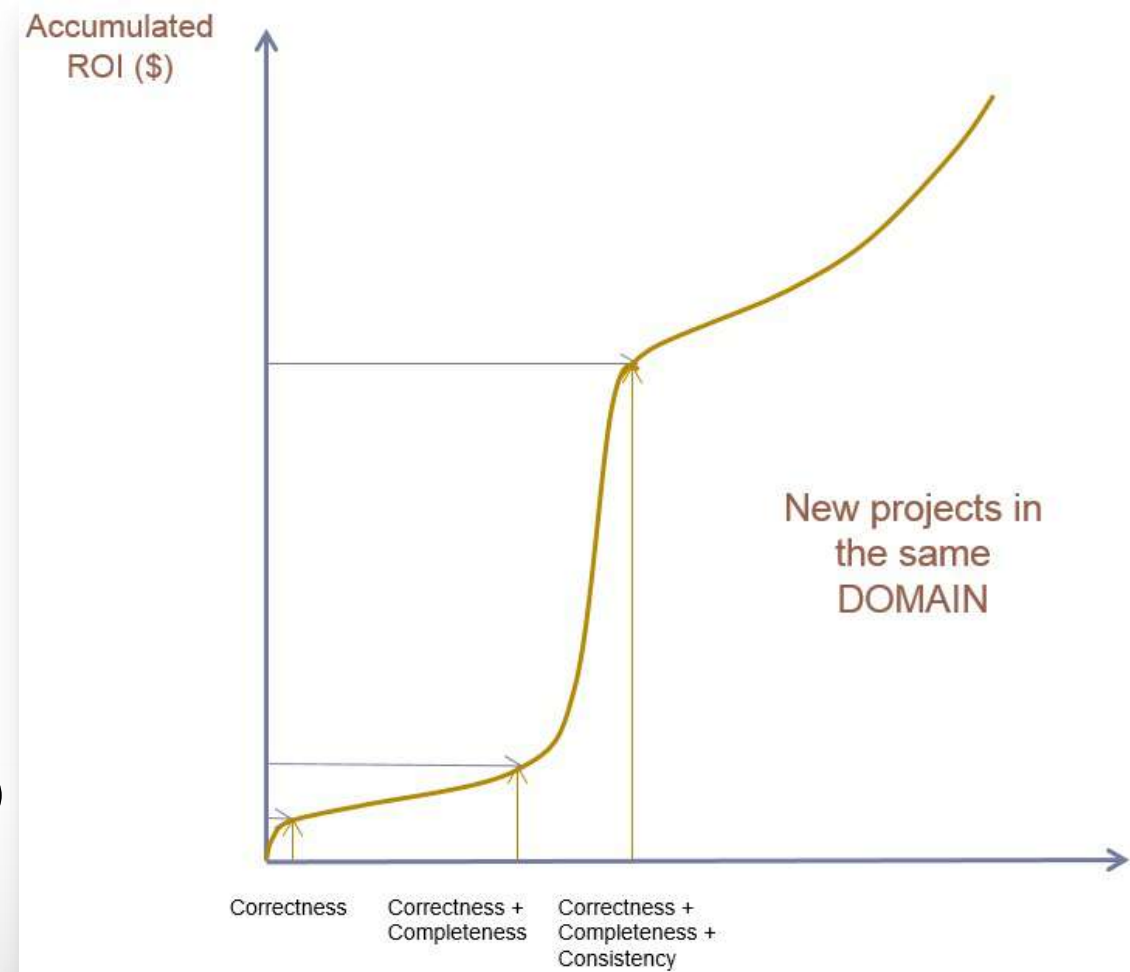
- Key benefits observed by using the tools for a Project manager (PM):
 1. Makes the team realize the need for a **standardized workflow**
 2. Increased the team **communication**
 3. Gave the PM a tool to **manage risk** and communicate progress
 4. Increased the **quality** of the specifications (or everything analyzed..)



The Return on Investment - Summary

Adding the SES suite to your way of working with System or Procurement adds tremendous returns:

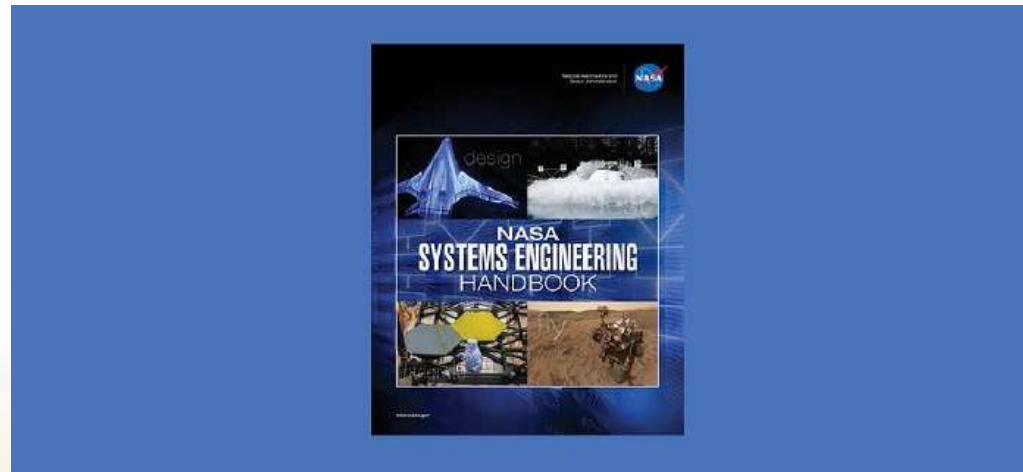
- Reduced time/effort for each Project/RFI/RFQ
- Decreased levels of misunderstanding
- Reusable information & knowledge
- Reduced project risk
- Increased overall system quality
- Increased customer satisfaction
- Lower project cost (as demonstrated with COSYSMO)





Next webinar

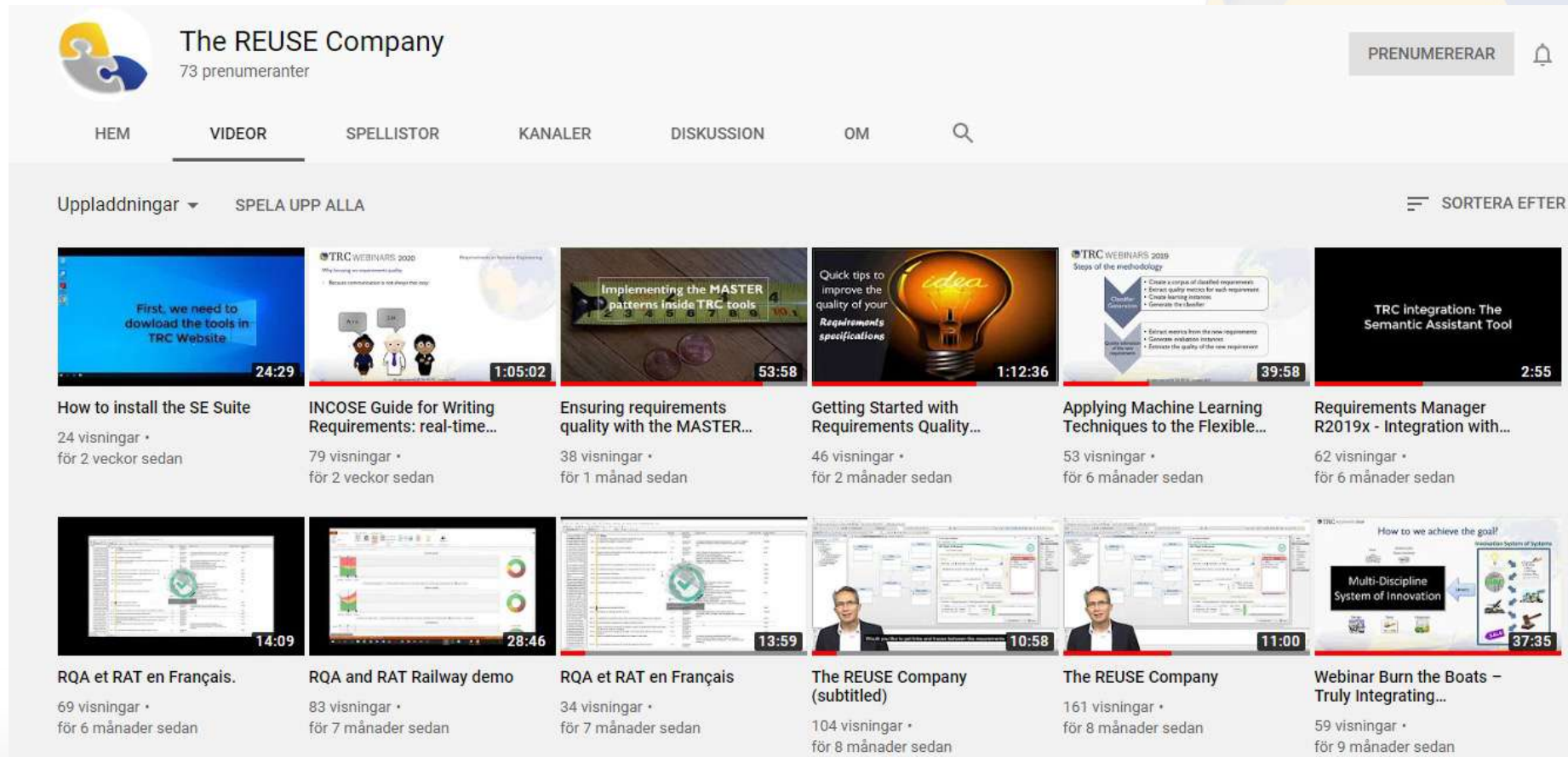
- **Writing Requirements with a Knowledge Library Based on the NASA Systems Engineering Handbook**
- The NASA Systems Engineering Handbook is considered as top-level guidance for systems engineering practices in the space industry. The REUSE Company has developed a knowledge library to be used in our SE Suite in order to follow the NASA guidelines in an easy way. The knowledge library includes glossary, acronyms, abbreviations, specific taxonomies, hierarchies, and terms relationships. It also includes guidance for well-formed requirements through rules and patterns.
- In this webinar you will see how you can improve the quality of your requirements as well as your requirements authoring and checking process. Using this approach you will discover requirements errors in an early stage of the process and prevent extra costs and time for your projects.
 - **Dates:**
 - May 12 and 14





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Reuse on Youtube



The REUSE Company
73 prenumeranter

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Thumbnail	Title	Views	Time
	How to install the SE Suite	24 visningar	24:29
	INCOSE Guide for Writing Requirements: real-time...	79 visningar	1:05:02
	Ensuring requirements quality with the MASTER...	38 visningar	53:58
	Getting Started with Requirements Quality...	46 visningar	1:12:36
	Applying Machine Learning Techniques to the Flexible...	53 visningar	39:58
	Requirements Manager R2019x - Integration with...	62 visningar	2:55
	RQA et RAT en Français.	69 visningar	14:09
	RQA and RAT Railway demo	83 visningar	28:46
	RQA et RAT en Français	34 visningar	13:59
	The REUSE Company (subtitled)	104 visningar	10:58
	The REUSE Company	161 visningar	11:00
	Webinar Burn the Boats - Truly Integrating...	59 visningar	37:35

<https://www.youtube.com/user/TheREUSECompany/videos>

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Contact information



Christer Fröling – Reuse Company Scandinavia



christer.froling@reusecompany.com



+46 (0)72 232 24 63



[@ReuseCompany](https://twitter.com/ReuseCompany)



www.linkedin.com/in/christerfroling





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