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SMART Traceability:

The core of a successful Systems Engineering discipline



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THE
REUSE
COMPANY

Introduction to
TRC and the
presenters

01



03



Traceability in
complex systems

Q&A

05



02



What is
traceability

04



The tool
TRACEABILITY
Studio



Introduction to TRC and the presenters



01 The company was established in **1999**

As a spin-off of a University in Madrid



02 **System + Software Engineers**

Smart combination between Company staff and R&D from Academia



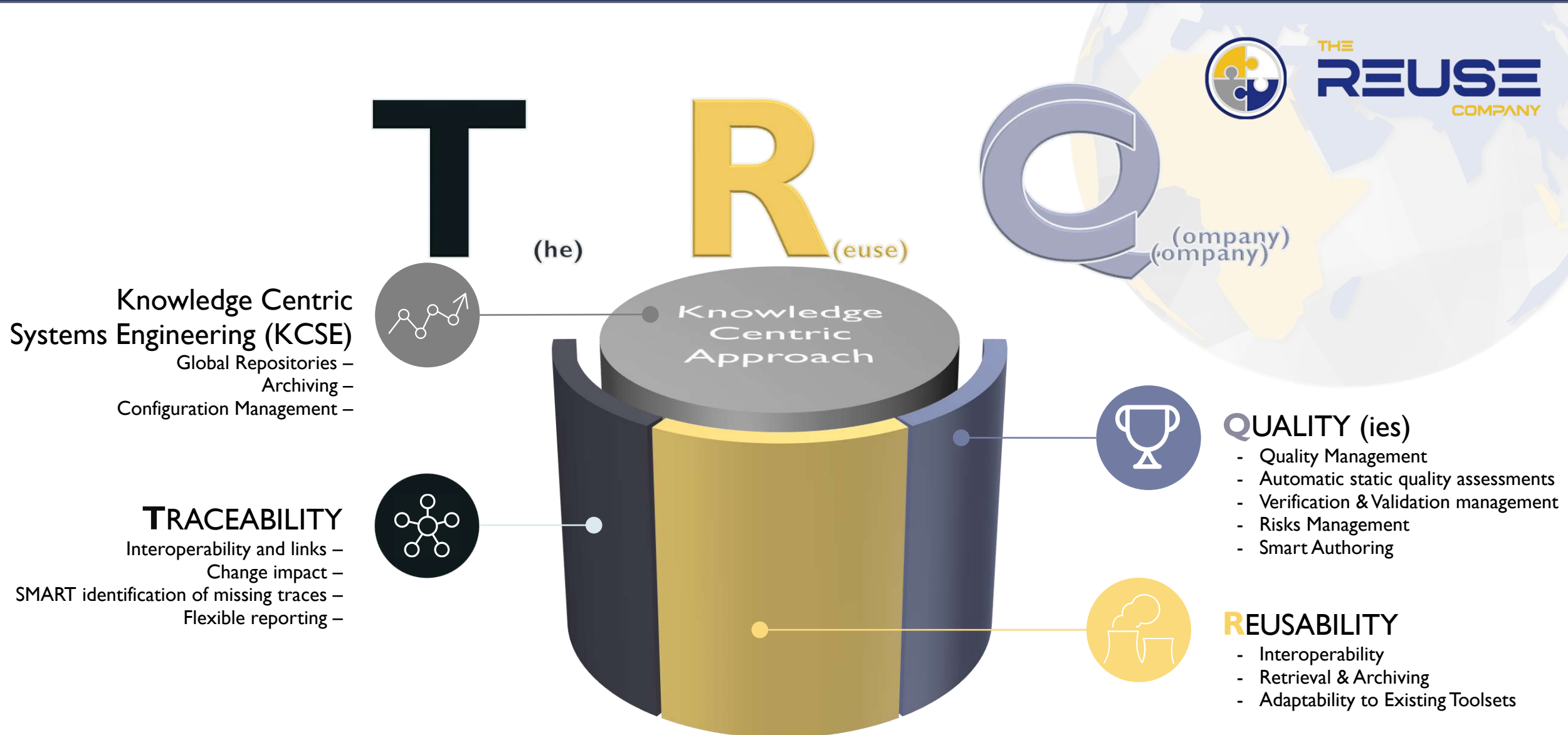
03 **Headquarters:** Madrid (Spain)

International offices: Stockholm (Sweden)
Tokyo (Japan) Delegation

2021: USA
Chicago/Detroit/Miami



04 To promote a **reusable, scalable** and global solution to a **smart** and **interoperable** Systems Engineering environment, by offering a **semantic knowledge centric** approach.

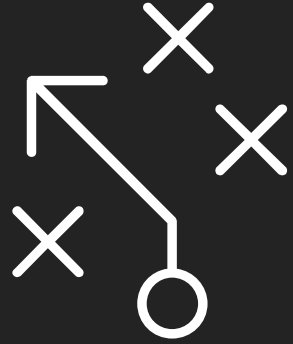




José Fuentes



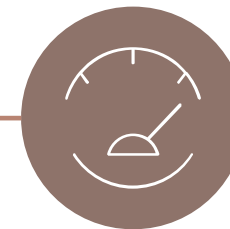
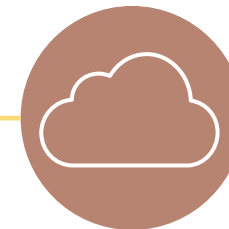
- **Current position:** Chief Operating Officer at The REUSE Company
- Product manager of the Systems Engineering Suite tools during the last 5 years
- INCOSE CSEP Certified
- Graduated in the INCOSE Institute for Technical Leadership
- Member of the board of AEIS – the Spanish chapter of INCOSE
- Active contributor to the INCOSE Guide for Writing Requirements



What is Traceability



- The capacity to find where a product was made
- What raw material and added components were used
- How it was produced
- Where it was stored
- How it has been released
- All along the logistic chain
- ...
- From beginning to end





”
“

➤ *“A software requirements specification is traceable if
(i) the origin of each of its requirements is clear and if
(ii) it facilitates the referencing of each requirement in
future development or enhancement documentation”*

Source: ANSI/IEEE Standard 830-1984

➤ *“ A requirement is verifiable if, and only if, there exists
some finite cost-effective process with which a person or
machine can check that the software product meets the
requirement”*

Source: ANSI/IEEE Standard 830-1984



Sample traceability matrix

Requirement Identifiers	Reqs Tested	REQ1 UC 1.1	REQ1 UC 1.2	REQ1 UC 1.3	REQ1 UC 2.1	REQ1 UC 2.2	REQ1 UC 2.3.1	REQ1 UC 2.3.2	REQ1 UC 2.3.3	REQ1 UC 2.4	REQ1 UC 3.1	REQ1 UC 3.2	REQ1 TECH 1.1	REQ1 TECH 1.2	REQ1 TECH 1.3
Test Cases	321	3	2	3	1	1	1	1	1	1	2	3	1	1	1
Tested Implicitly	77														
1.1.1	1	x													
1.1.2	2		x	x											
1.1.3	2	x											x		
1.1.4	1			x											
1.1.5	2	x												x	
1.1.6	1		x												
1.1.7	1			x											
1.2.1	2				x		x								
1.2.2	2					x		x							
1.2.3	2								x	x					
1.3.1	1										x				
1.3.2	1										x				
1.3.3	1											x			
1.3.4	1											x			
1.3.5	1											x			
etc....															
5.6.2	1														x



Might be good as a first step



Allows to check where every requirement comes from



Allows you to check completeness of tests



Ensures that implementation meets specification



Enough for some projects (e.g. SW)



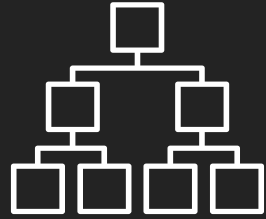
Not enough in complex projects



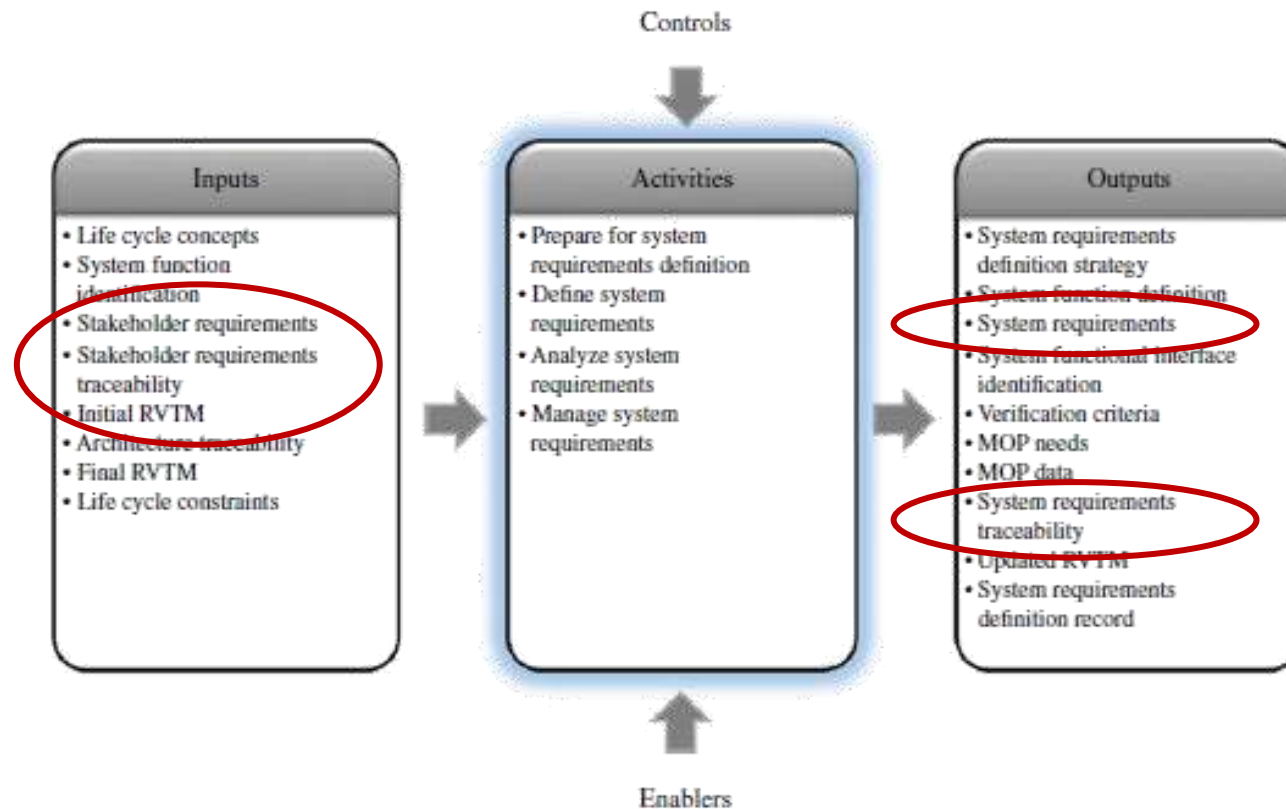
No support to req. decomposition or design



Doesn't satisfy standards like: ARP4754, DO-174, DO-254, ISO26262...



Traceability in complex S.E. projects



Source: INCOSE Systems Engineering Handbook, Ed. 4

FIGURE 4.5 IPO diagram for the system requirements definition process. INCOSE SEH original figure created by Shortell and Walden. Usage per the INCOSE Notices page. All other rights reserved.



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“

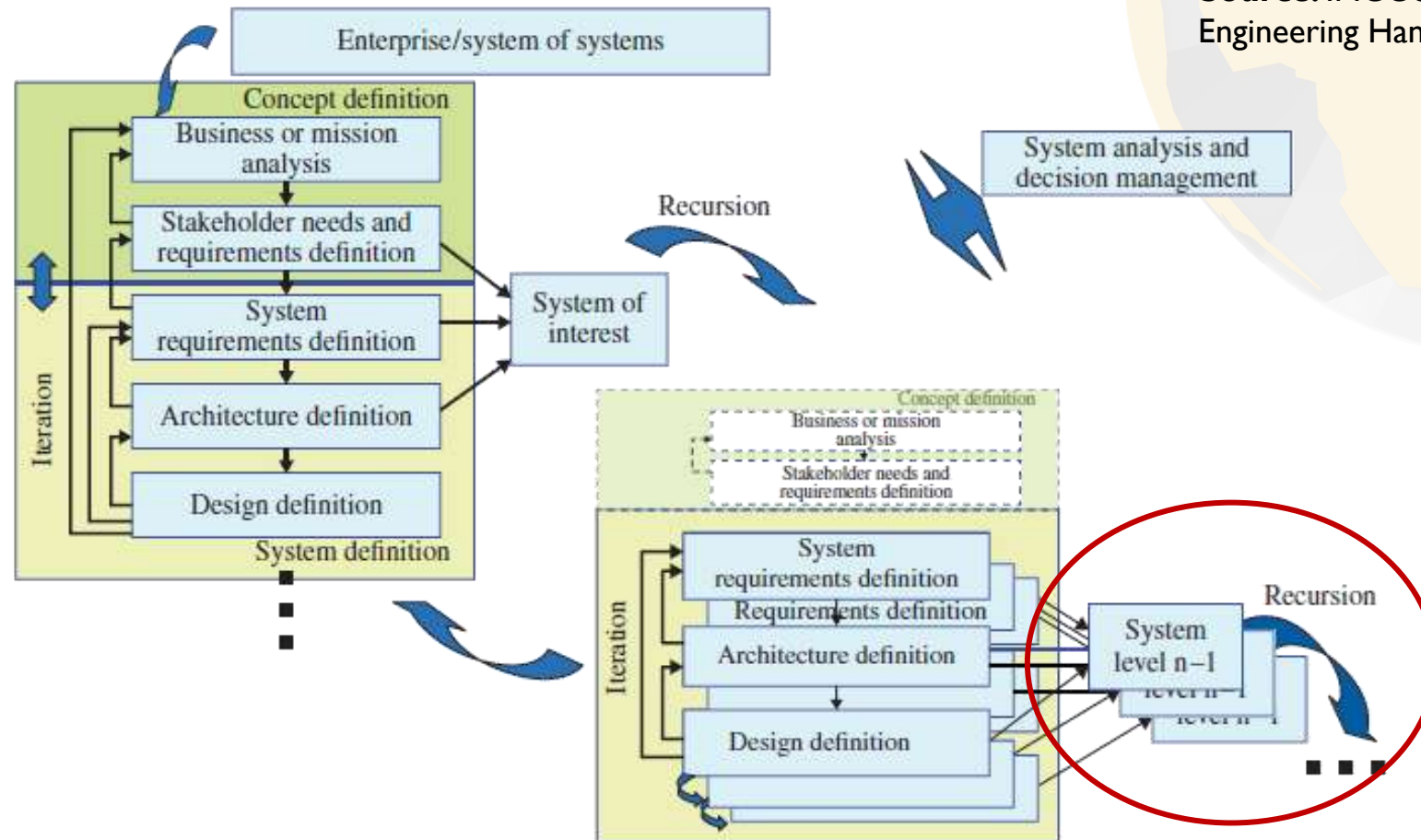
“Manage System Requirements: Establish and maintain traceability between the system requirements and the relevant elements of the system definition (e.g., stakeholder requirements, architecture elements, interface definitions, analysis results, verification methods or techniques, and allocated, decomposed and derived requirements.”

Source: INCOSE Systems
Engineering Handbook, Ed. 4

“Requirement’s traceability is the ability to describe and follow the life of a requirement, in both a forwards and backwards direction (i.e., from its origins, through its development and specification, to its subsequent deployment and use, and through periods of on-going refinement and iteration in any of these phases).”

”
“

Source: Gotel and Finkelstein



Source: INCOSE Systems
 Engineering Handbook, Ed. 4

FIGURE 3.5 Iteration and recursion. Reprinted with permission from Garry Roedler. All other rights reserved.

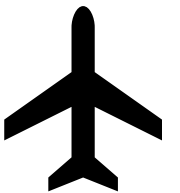
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Listed below are the processes the supplier should provide to show they are meeting the ARP4754A objectives:

- › Requirements management process, including traceability and allocation processes
- › Requirements validation process
- › Requirements verification process
- › Safety analysis process
- › Configuration control processes (for DA data)
- › Change management process (covering change impact and regression analysis)
- › Problem reporting process
- › PA (audit/assessment process to verify adherence to the processes)

Source: DOT/FAA/TC-16/39

Safety Issues and Shortcomings With Requirements Definition, Validation, and Verification Processes Final Report

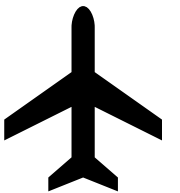




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“

The following objective statement is from ARP4754A, Section 5.3.1.1, Safety Requirements:

“Requirements that are defined to prevent failure conditions or to provide safety related functions should be uniquely identified and traceable through the levels of development. This will ensure visibility of the safety requirements at the software and electronic hardware design level.”



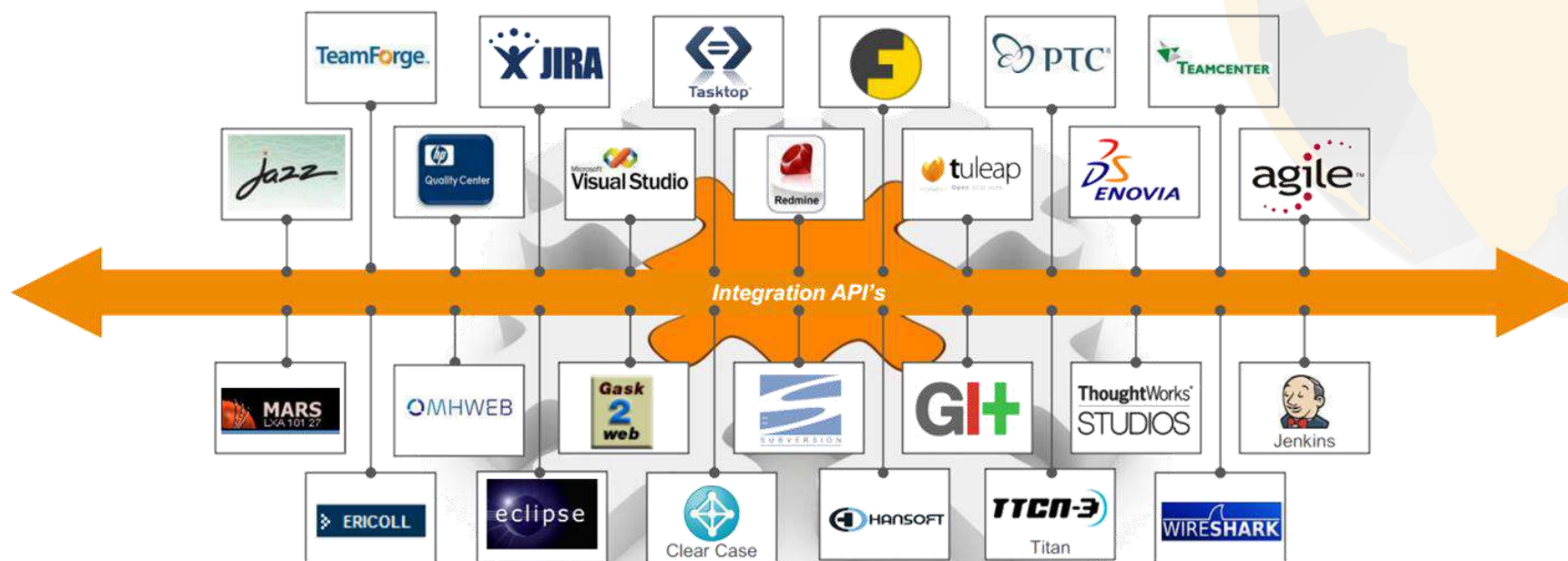
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- “Safety Requirements shall be traceable with a reference being made to:
 - a) each source of a safety requirement at the next upper hierarchical level;
 - b) each derived safety requirement at the next lower hierarchical level, or to its realization in the design; and
 - c) the verification specification.”

Source: ISO 26262



Mats Berglund (Ericsson) <http://www.ices.kth.se/upload/events/I3/84404189f85d41a6a7d1cafd0db4ee80.pdf>



- Multiple **domains**
 - Different **types of artifacts**
- Need of **intra-operability**
 - Intra-domain
- Need of **interoperability**
 - Inter-domain

- Prepare for changes (impact analysis):

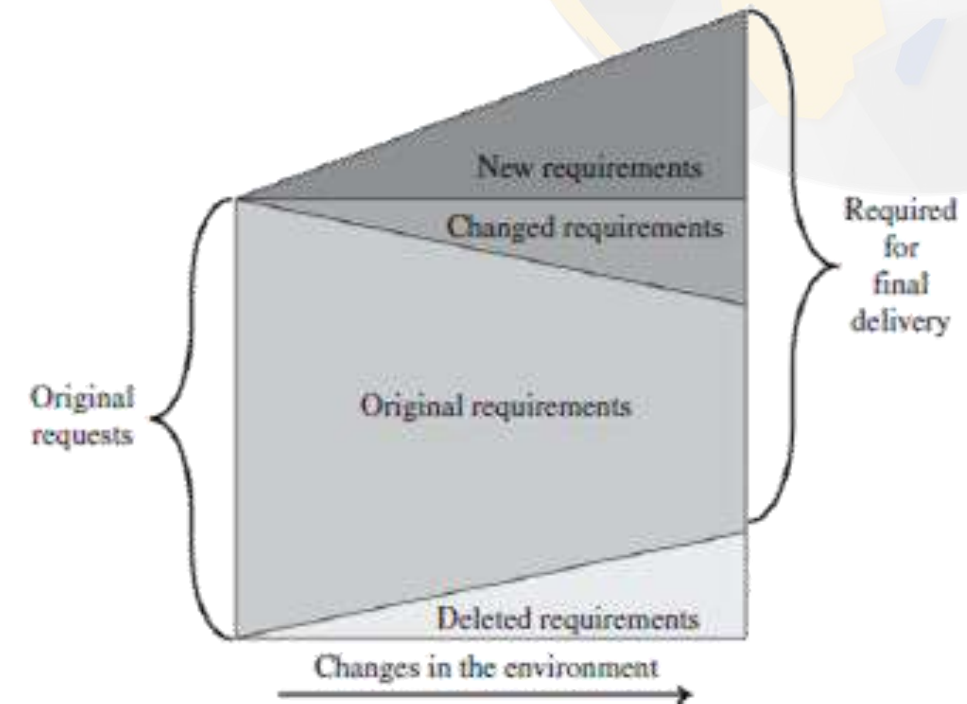


FIGURE 5.9 Requirements changes are inevitable. Derived from (Forsberg et al., 2005) Figure 9.3. Reprinted with permission from Kevin Forsberg. All other rights reserved.



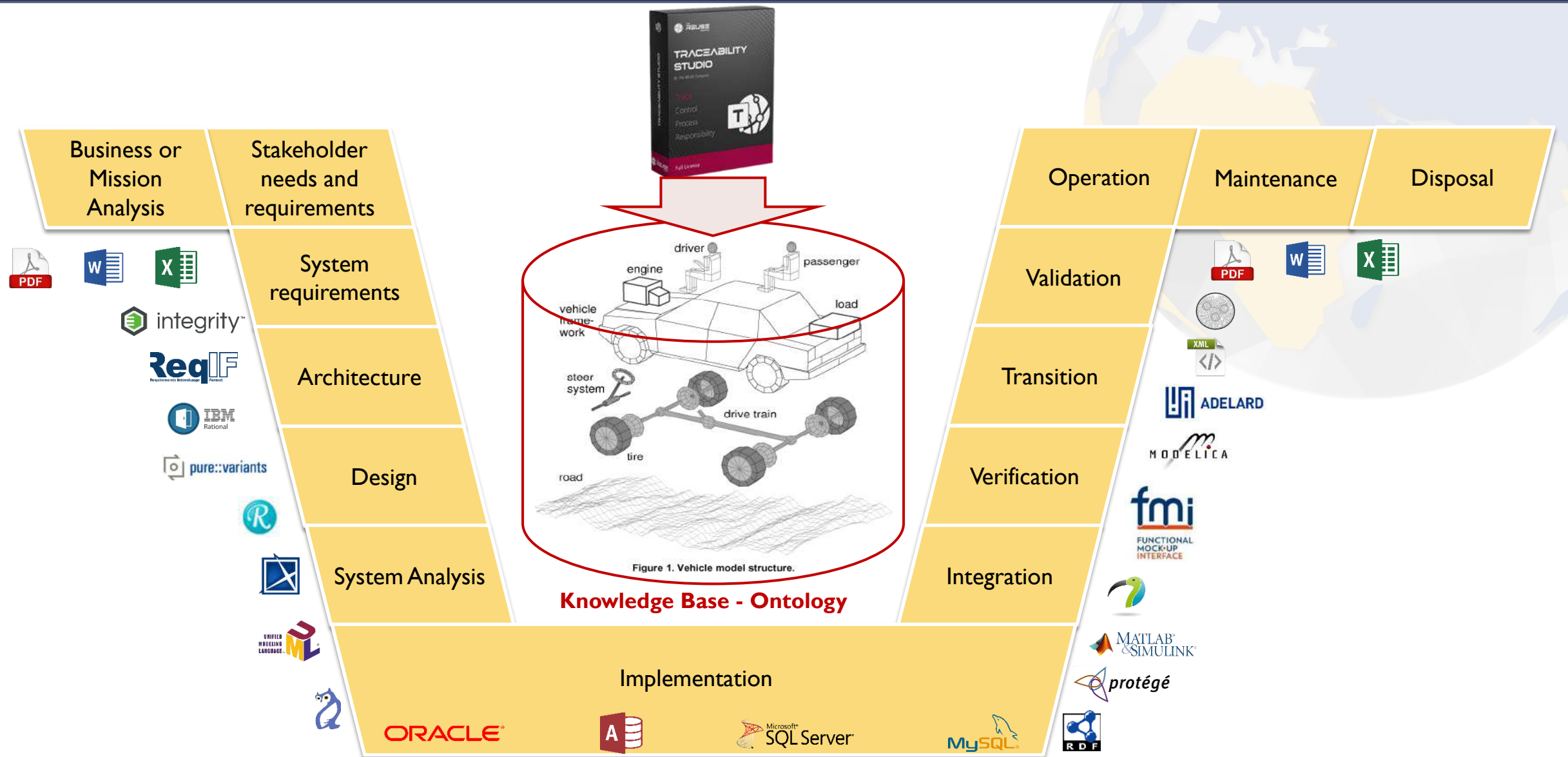
- **Project quality:**
 - Are all the requirements properly tested?
 - Completeness:
 - Have we considered every high level requirement?
 - Have we created all the expected work products following requirements
- **Scope management (project control):**
 - Clear reference to source...
 - ... to avoid Gold plating / scope creep
- **Visibility:**
 - Impact analysis
- **Collaboration:**
 - Among different roles: requirements manager, architects, designers, testers and... above all, Project manager

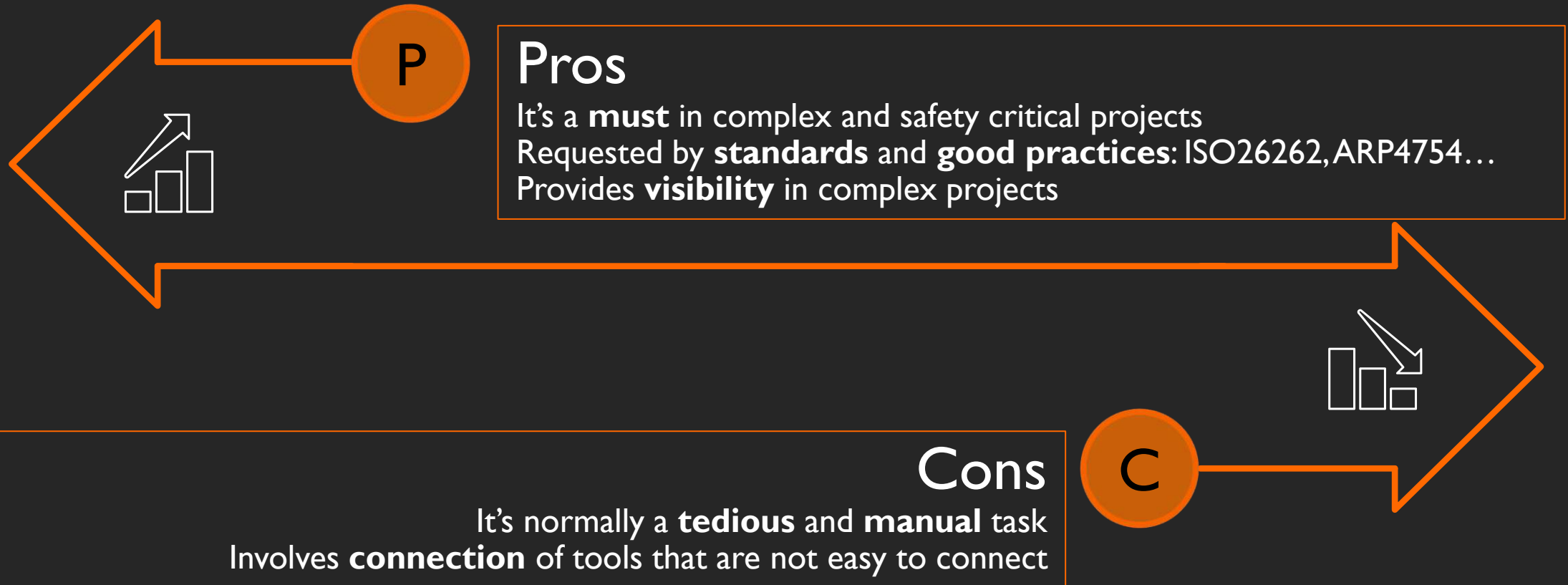




- Traceability provides visibility in large projects:



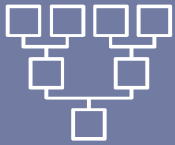






Main capabilities of **TRACEABILITY Studio**

Connections



Connection to data sources

- Connection to multiple types of sources
- Graphical definition of a project map

[→ Click Here](#)

Traceability



Traceability management

- Management of types of traces
- Management of traces
- Impact analysis

[→ Click Here](#)

Semantics



Semantic approach

- Automatic suggested links
- SMART suspect links management

[→ Click Here](#)

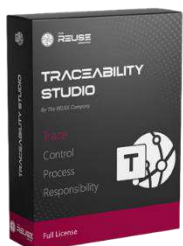
Reporting



Our qualifications

- OOTB reports
- Custom reports in MS Word
- Custom code reports

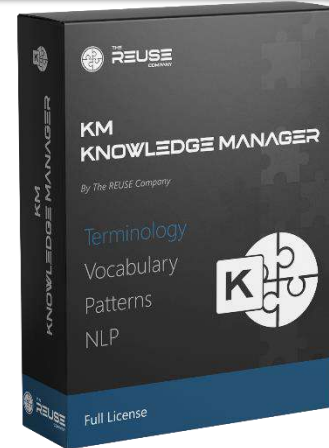
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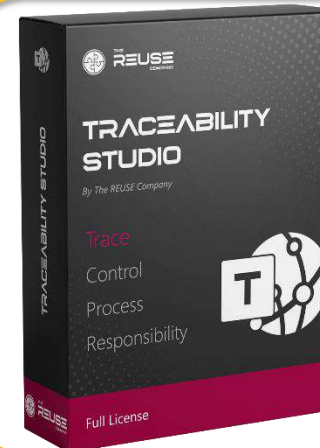
Knowledge Management

Capture, creation, **representation**, and **exchange of knowledge** across targeted groups of **stakeholders**



Traceability

Support the **integration** among assets through semantic **interoperability** to discover and keep the **traces** among related elements



Authoring

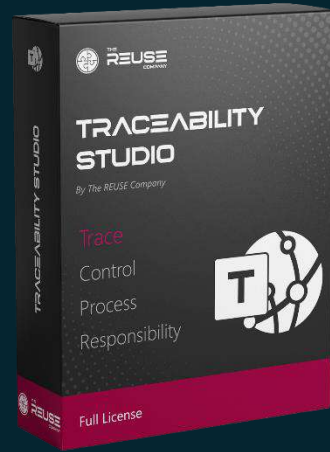
Definition of requirements and other textual engineering assets based on **real-time analysis** (NLP), **writing assistance**, **identification of similar items**...



Quality Management

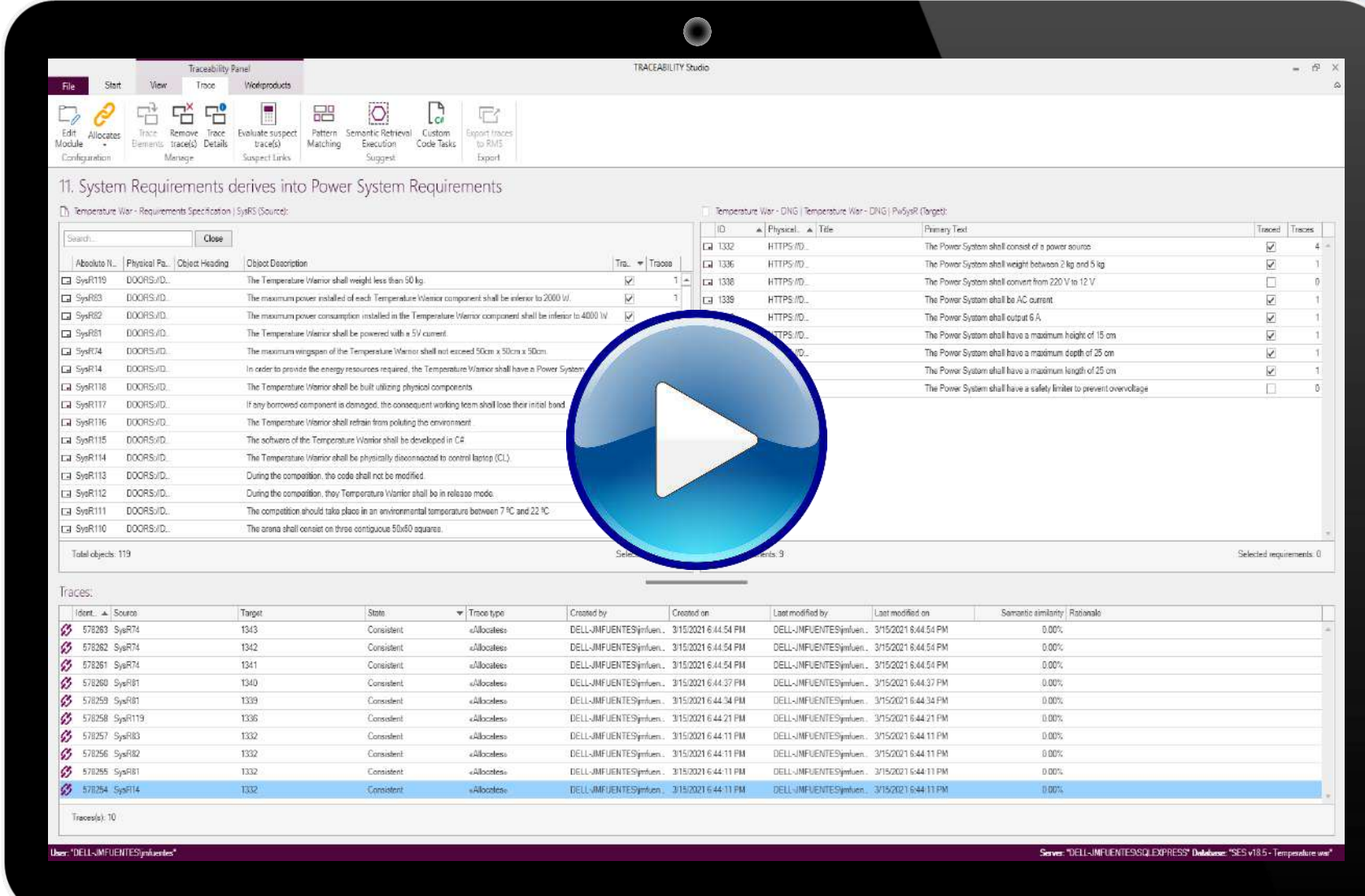
Define, implement and perform **measures** to meet the **quality priorities** that satisfy the **verification** of any engineering element





TRACEABILITY Studio

Demo



TRACEABILITY Studio

File Start View Trace Workproducts

Edit Module Allocates Trace Elements Remove trace(s) Trace Details Evaluate suspect trace(s) Suspect Links Pattern Matching Semantic Retrieval Execution Suggest Custom Code Tasks Export traces to RMS Export

11. System Requirements derives into Power System Requirements

Temperature Warmer - Requirements Specification | SysRS (Source):

Search...	Close	Trace	Traces
Abstract N...	Physical Pa...	Object Heading	Object Description
SysR119	DOORS/JD...	The Temperature Warmer shall weight less than 50 kg.	1
SysR83	DOORS/JD...	The maximum power installed of each Temperature Warmer component shall be inferior to 2000 W.	1
SysR82	DOORS/JD...	The maximum power consumption installed in the Temperature Warmer component shall be inferior to 4000 W.	1
SysR81	DOORS/JD...	The Temperature Warmer shall be powered with a 5V current.	1
SysR74	DOORS/JD...	The maximum wingspan of the Temperature Warmer shall not exceed 50cm x 50cm x 50cm.	1
SysR14	DOORS/JD...	In order to provide the energy resources required, the Temperature Warmer shall have a Power System.	1
SysR118	DOORS/JD...	The Temperature Warmer shall be built utilizing physical components.	1
SysR117	DOORS/JD...	If any borrowed component is damaged, the consequent working team shall lose their initial band.	1
SysR116	DOORS/JD...	The Temperature Warmer shall refrain from polluting the environment.	1
SysR115	DOORS/JD...	The software of the Temperature Warmer shall be developed in C#.	1
SysR114	DOORS/JD...	The Temperature Warmer shall be physically disconnected to control laptop (CL).	1
SysR113	DOORS/JD...	During the composition, the code shall not be modified.	1
SysR112	DOORS/JD...	During the composition, the Temperature Warmer shall be in release mode.	1
SysR111	DOORS/JD...	The composition should take place in an environmental temperature between 7 °C and 22 °C.	1
SysR110	DOORS/JD...	The arena shall consist on three contiguous 50x60 squares.	1

Total objects: 119

Temperature Warmer - DNG | Temperature Warmer - DNG | PuSysR (Target):

ID	Physical...	Title	Primary Text	Traced	Traces
1332	HTTPS/JD...	The Power System shall consist of a power source.		<input checked="" type="checkbox"/>	4
1336	HTTPS/JD...	The Power System shall weight between 2 kg and 5 kg.		<input checked="" type="checkbox"/>	1
1338	HTTPS/JD...	The Power System shall convert from 220 V to 12 V.		<input type="checkbox"/>	0
1339	HTTPS/JD...	The Power System shall be AC current.		<input checked="" type="checkbox"/>	1
	HTTPS/JD...	The Power System shall output 6 A.		<input checked="" type="checkbox"/>	1
	HTTPS/JD...	The Power System shall have a maximum height of 15 cm.		<input checked="" type="checkbox"/>	1
	HTTPS/JD...	The Power System shall have a maximum depth of 25 cm.		<input checked="" type="checkbox"/>	1
	HTTPS/JD...	The Power System shall have a maximum length of 25 cm.		<input checked="" type="checkbox"/>	1
	HTTPS/JD...	The Power System shall have a safety limiter to prevent overvoltage.		<input type="checkbox"/>	0

Traces:

Ident.	Source	Target	State	Trace type	Created by	Created on	Last modified by	Last modified on	Semantic similarity	Rationale
578283	SysR74	1343	Consistent	Allocated	DELL-IMPUESTES@nluen...	3/15/2021 6:44:54 PM	DELL-IMPUESTES@nluen...	3/15/2021 6:44:54 PM	0.00%	
578282	SysR74	1342	Consistent	Allocated	DELL-IMPUESTES@nluen...	3/15/2021 6:44:54 PM	DELL-IMPUESTES@nluen...	3/15/2021 6:44:54 PM	0.00%	
578281	SysR74	1341	Consistent	Allocated	DELL-IMPUESTES@nluen...	3/15/2021 6:44:54 PM	DELL-IMPUESTES@nluen...	3/15/2021 6:44:54 PM	0.00%	
578280	SysR81	1340	Consistent	Allocated	DELL-IMPUESTES@nluen...	3/15/2021 6:44:37 PM	DELL-IMPUESTES@nluen...	3/15/2021 6:44:37 PM	0.00%	
578259	SysR81	1339	Consistent	Allocated	DELL-IMPUESTES@nluen...	3/15/2021 6:44:34 PM	DELL-IMPUESTES@nluen...	3/15/2021 6:44:34 PM	0.00%	
578258	SysR119	1336	Consistent	Allocated	DELL-IMPUESTES@nluen...	3/15/2021 6:44:21 PM	DELL-IMPUESTES@nluen...	3/15/2021 6:44:21 PM	0.00%	
578257	SysR83	1332	Consistent	Allocated	DELL-IMPUESTES@nluen...	3/15/2021 6:44:11 PM	DELL-IMPUESTES@nluen...	3/15/2021 6:44:11 PM	0.00%	
578256	SysR82	1332	Consistent	Allocated	DELL-IMPUESTES@nluen...	3/15/2021 6:44:11 PM	DELL-IMPUESTES@nluen...	3/15/2021 6:44:11 PM	0.00%	
578255	SysR81	1332	Consistent	Allocated	DELL-IMPUESTES@nluen...	3/15/2021 6:44:11 PM	DELL-IMPUESTES@nluen...	3/15/2021 6:44:11 PM	0.00%	
578254	SysR114	1332	Consistent	Allocated	DELL-IMPUESTES@nluen...	3/15/2021 6:44:11 PM	DELL-IMPUESTES@nluen...	3/15/2021 6:44:11 PM	0.00%	

Traces(s): 10

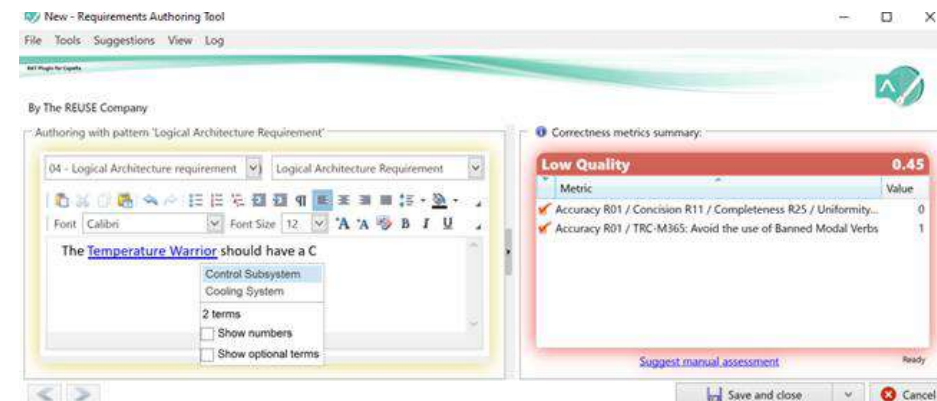
User: "DELL-IMPUESTES@nluen..." Server: "DELL-IMPUESTES@EXPRESS" Database: "SES v18.5 - Temperature war"



- **Requirements Authoring Tool for Capella - The Perfect Way for Blending Models and Textual Requirements**
- While Model Based Systems Engineering and Requirements Engineering are usually opposed as a means to support complex systems development, there is a growing trend in considering the combination of both approaches.
- This webinar will introduce the new version of the RAT – Authoring Tool add-on for Eclipse Capella, which goals are :
 - to ensure the correctness of the requirements created inside the Capella project,
 - to help requirement writers follow pre-defined patterns to standardize well-formed requirements,
 - to ensure naming consistency between the model elements and the textual requirements,
 - to provide a complete round-trip between textual requirements in Requirement Management Systems and models in Capella.

➤ **Dates:**

- April 21 and 22, 2021







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