



Tailoring the INCOSE GfWR

a comprehensive guide



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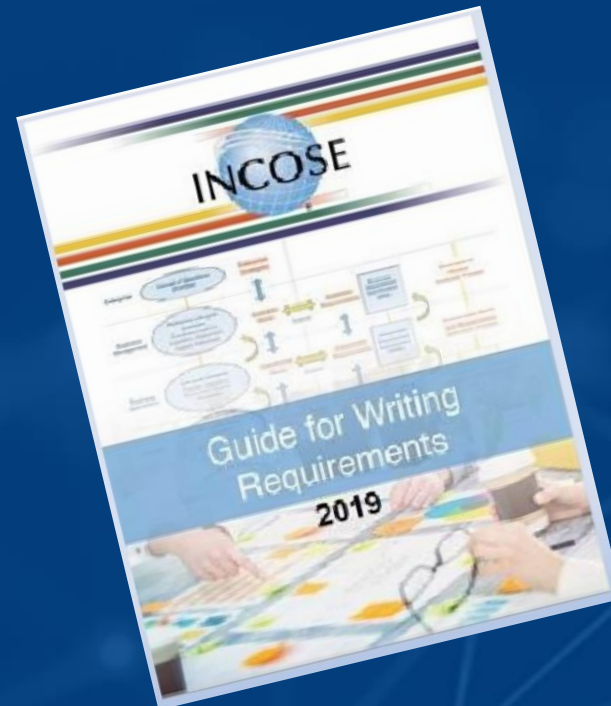
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THE
REUSE
COMPANY



Contents

- Introduction to The REUSE Company and the speakers
- Brief introduction to the INCOSE GfWR
- Challenges: the need for tailoring
- Proposed solution
- Quick quiz
- Download our tailoring book



○ Providing a **knowledge centric** approach to leverage system engineering activities in our customers



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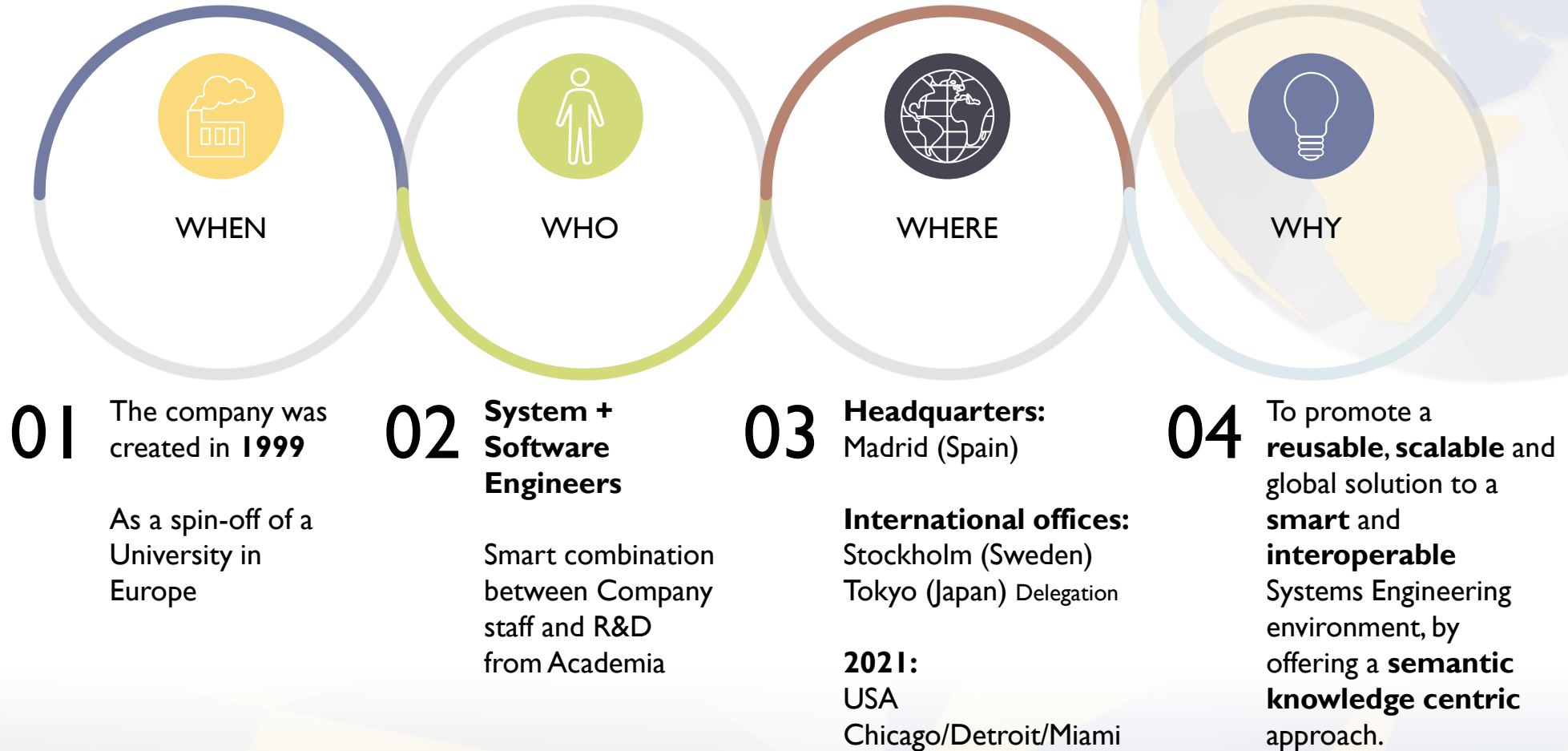


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28919 – Leganés (Madrid)
SPAIN



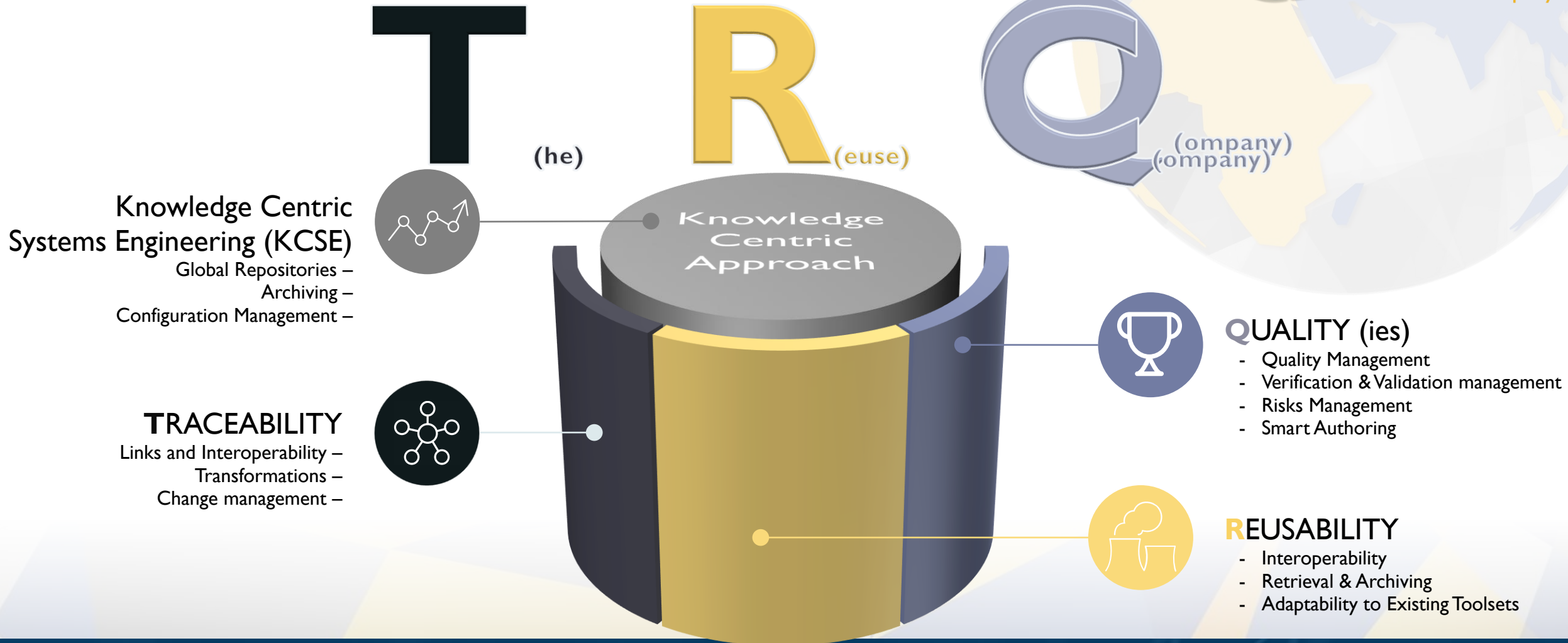
+34 912 172 596

Introduction to The REUSE Company



Introduction to The REUSE Company

Introduction to The REUSE Company



The presenters



José M. Fuentes

- **Current position:** Chief Operating Officer at The REUSE Company

José Fuentes obtained his degree in Information Science at the Carlos III University of Madrid (Spain). After getting his degree, he founded, together with other 5 colleagues, an SME with the vision of streamlining the software development processes. After some years as product manager of tools aimed at software engineers, he and his company turned into the systems engineering discipline. engineering. For more than 10 years, he's been leading the team of developers in charge of creating the suite of tools Requirements Quality Suite in The REUSE Company.

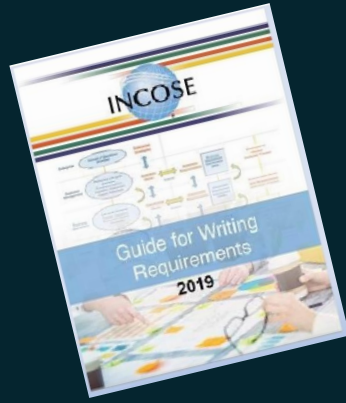


Ilyes Yousfi

- **Current position:** Sales & Consulting Engineer at The REUSE Company

Ilyes Yousfi got his Master's degree from the University of Montreal (Canada) and the IMT Atlantique School of Engineering (France). Ilyes has 5 years of experience in sales, technical background in energy and mechanical engineering and was involved in a research project around the environmental impacts of end-of-life management of aircrafts.

Passionate about international projects and learning languages, Ilyes speaks 4 languages fluently: English, French, German and Spanish.



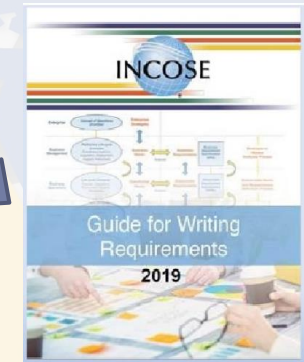
**Brief
introduction
to the
INCOSE GfWR**

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

I4 Characteristics			CHARACTERISTICS OF NEED AND REQUIREMENT STATEMENTS							SETS OF NEEDS AND REQUIREMENTS						
Type	Rule Number	Rule name	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	C14 - ABLE TO BE VALIDATED
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	
	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							
Concision	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				1	
	R19	Avoid Combinators			1		1									
	R20	Avoid Purpose					1									
	R21	Avoid Parentheses					1									
	R22	Enumeration			1		1									
	R23	Context			1		1									
Completeness	R24	Avoid Pronouns			1	1			1							
	R25	Use Of Headings				1										
Realism	R26	Avoid Absolutes						1	1					1		
Conditions	R27	Explicit				1			1							
	R28	Explicit Lists			1				1							
Uniqueness	R29	Classify										1	1	1		
	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
	R38	Avoid Abbreviations									1		1		1	1
	R39	Style Guide				1	1				1		1		1	1
Modularity	R40	Related Requirements									1		1		1	
	R41	Structured										1	1		1	1



46 Attributes

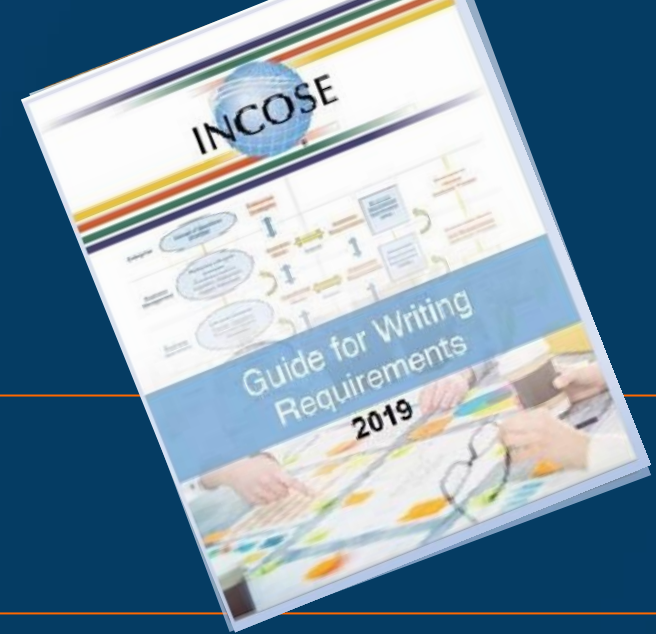
Attribute	Attributes to Help Define the Requirement and its Intent	Associated with the System of Interest (SOI) Verification	Attributes to Help Maintain the Requirements	Attributes to Show Applicability and Allow Reuse
A01: Rationale*	1			
A02: SOI Primary Verification or Validation Method*	1			
A03: 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 challenges of the

INCOSE GfWR

INCOSE GfWR: Pros and Cons



P

Pros

Represents the state-of-the-art
Nice starting point



Cons

Considered by many as written in stone
Considered as one single check-list

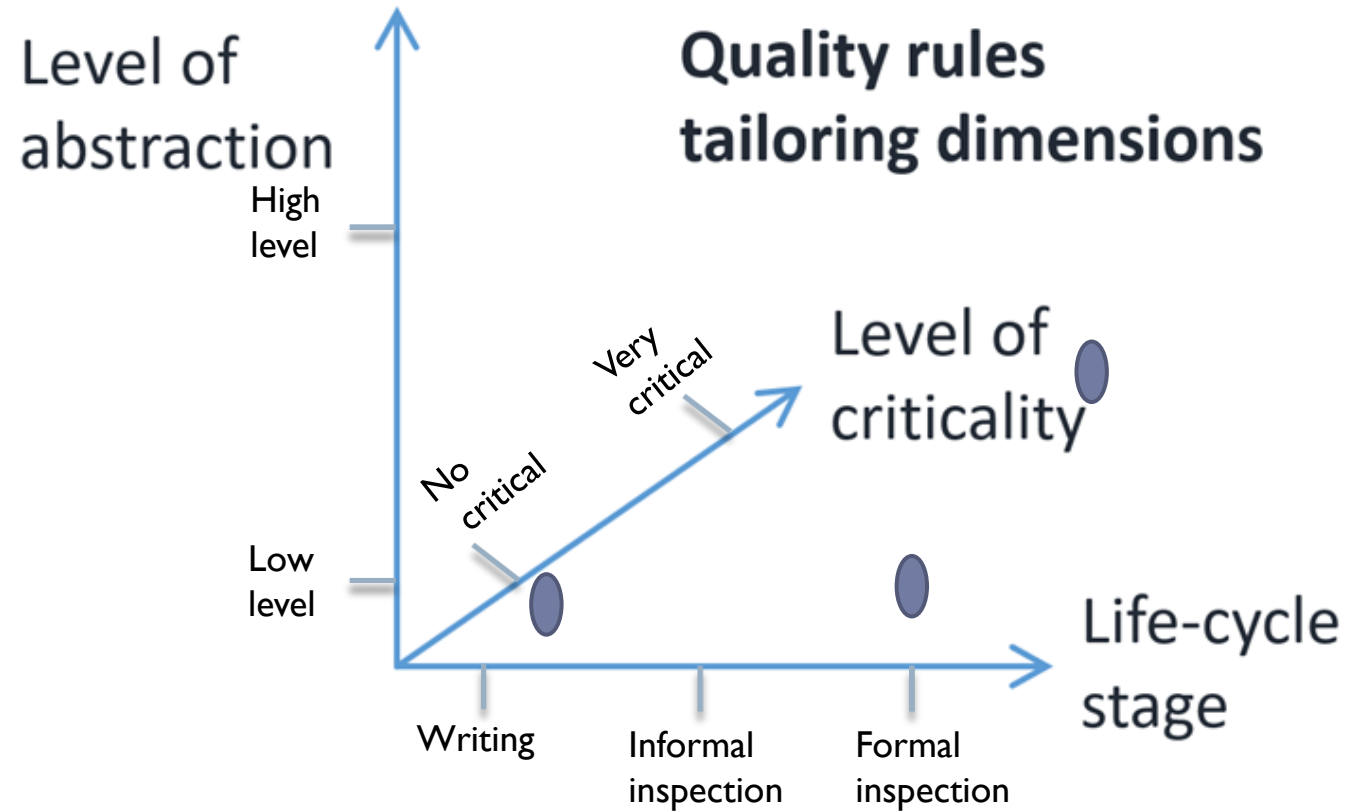
C



Why tailoring the INCOSE Guide for Writing Requirements poses many challenges?

- The guide cannot be considered as a “frozen” set of rules, as it depends on several parameters to be considered :
 - The 3-dimensional tailoring space, which includes :
 - Stage in the lifecycle when the rules are used
 - Level of criticality of the SOI
 - Level of abstraction
 - The need of other references to go beyond correctness checking
 - Adaptability to the skills of the team members
 - The role of patterns in the tailoring
 - Adaptability to different types of requirements

The 3-dimensional tailoring space

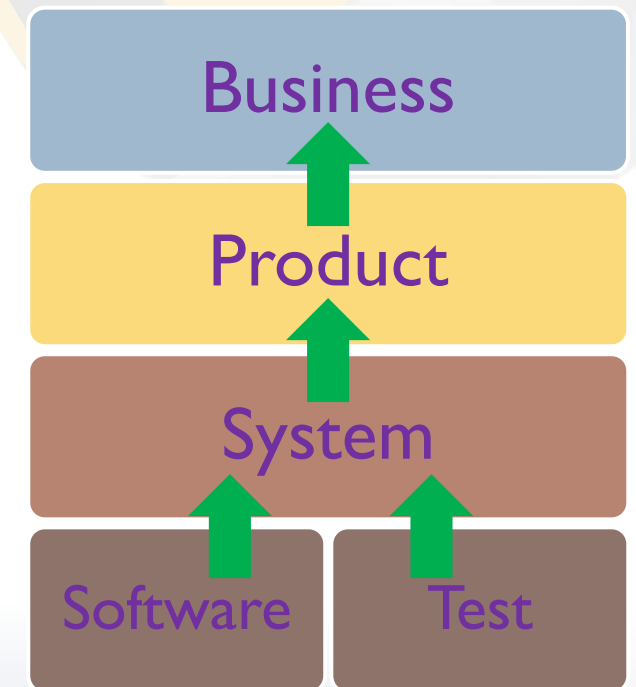


The 3-dimensional tailoring space: level of abstraction

The INCOSE GfWR (in Section 1.5 Concepts) states that : ***“How requirements are expressed differs through these levels [of abstraction] and, therefore, so do the rules for expressing them”.***

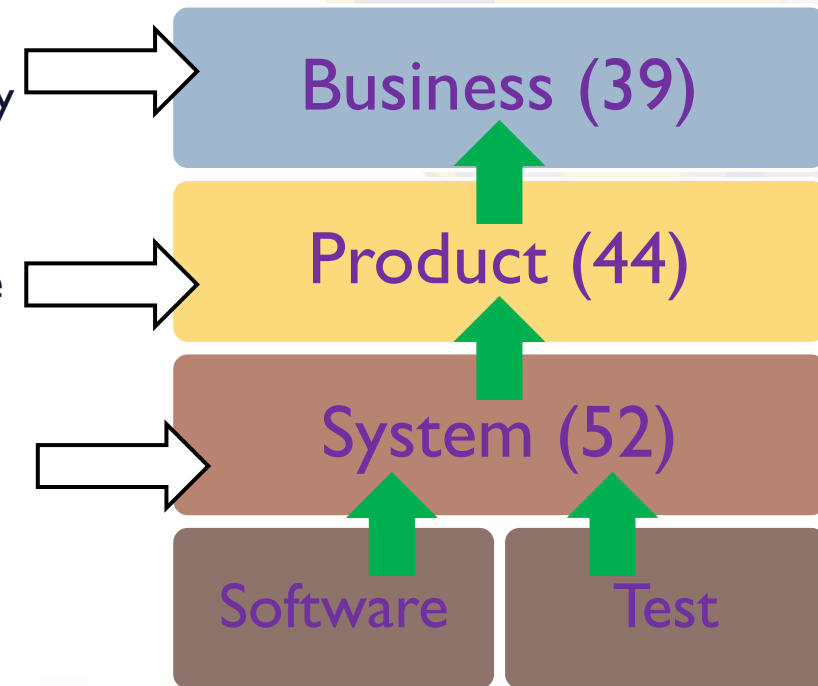
For example :

	High-level requirements	Low-level requirements
Ambiguity	Might be ambiguous	No ambiguity
Accuracy in measures	No need for the measures to be precise	As accurate as possible providing a specific tolerance

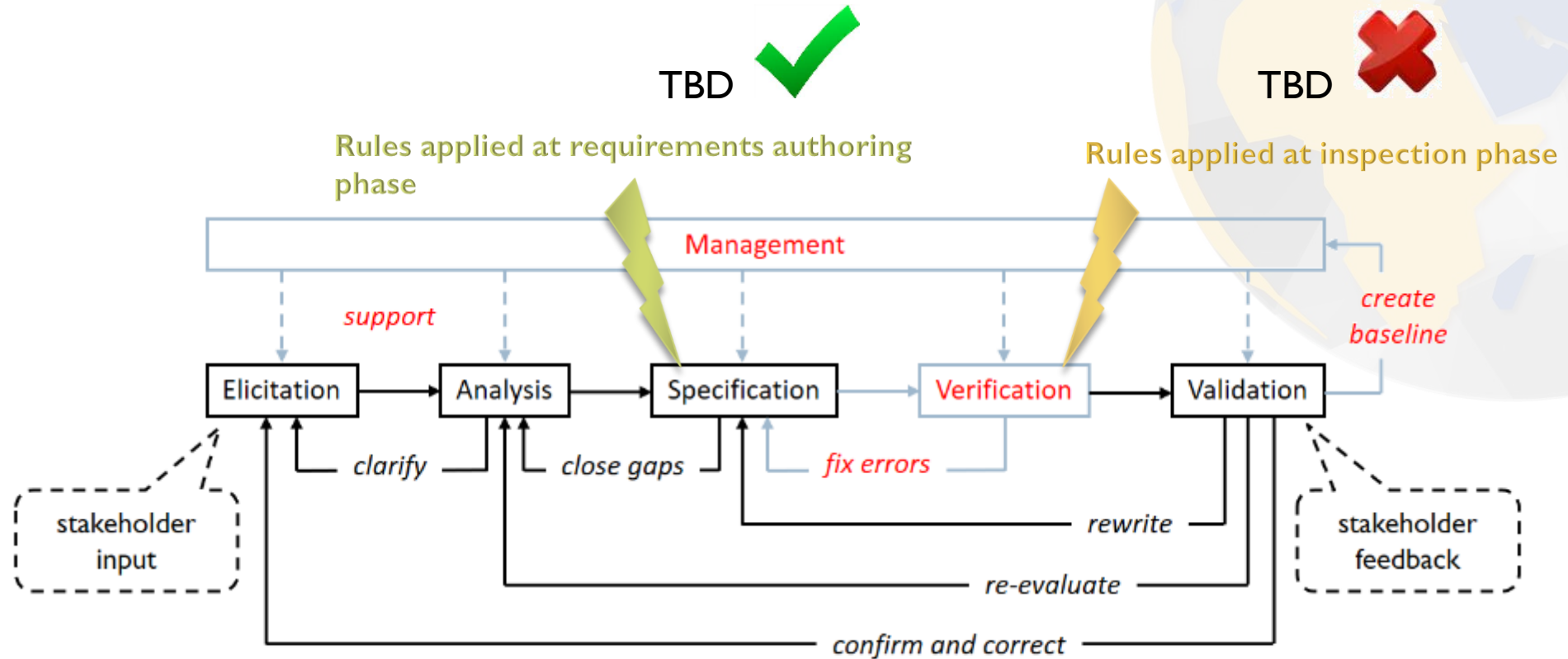


The 3-dimensional tailoring space: level of abstraction

- The eco-truck must have a revolutionary look and feel to make it really stand out in a crowd, it must be a vehicle for the 21st Century
- The Eco-Truck shall have a futuristic appearance based on a design similar to the "Silver Bullet" trains already deployed in Japan, France and other countries.
- The chassis of the Eco-Truck shall use aluminium



The 3-dimensional tailoring space: life-cycle stage

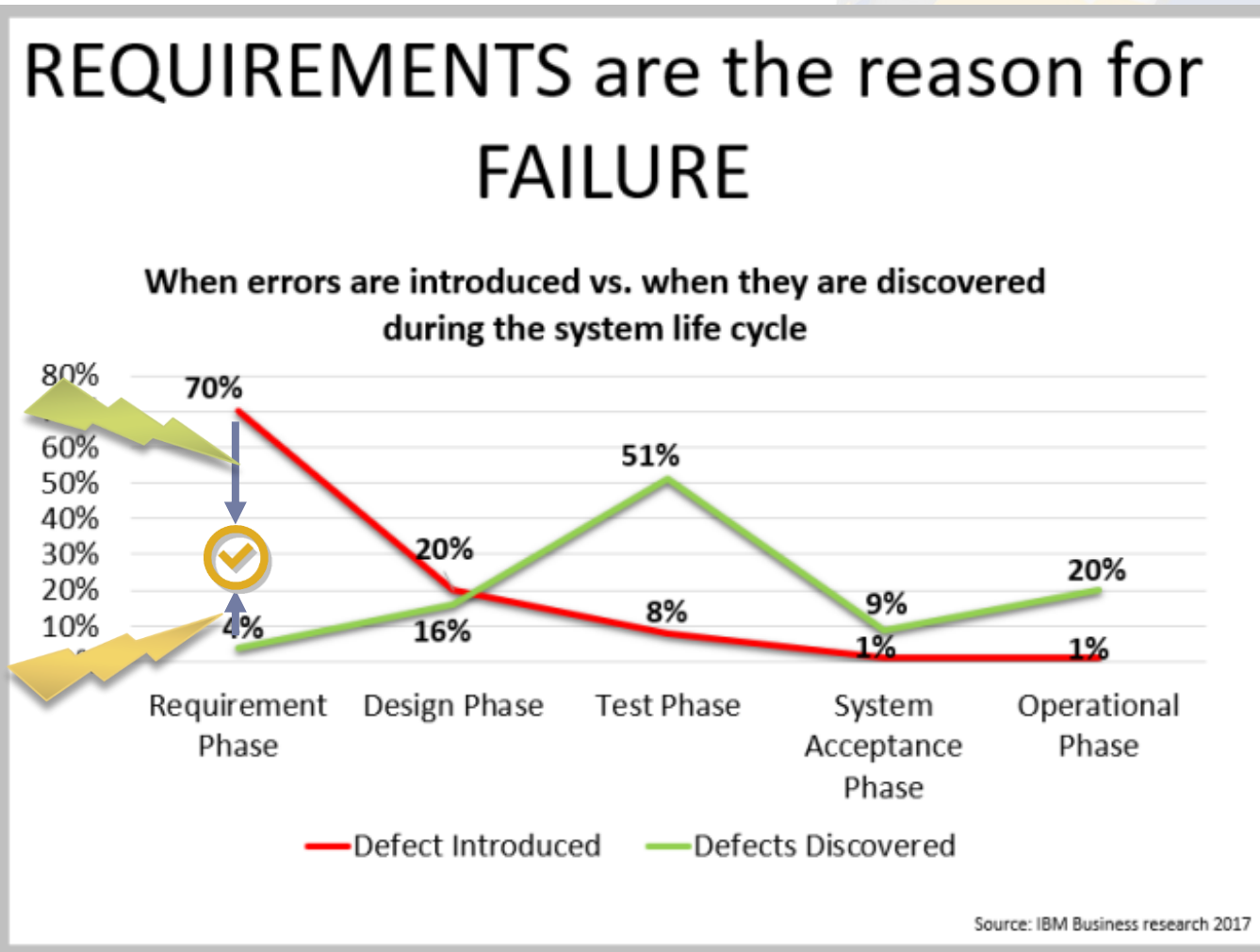


Adapted from: Karl Wiegiers

The 3-dimensional tailoring space: life-cycle stage

Authoring with a tailored set of rules

Inspection with a tailored set of rules



The 3-dimensional tailoring space: level of criticality

The more critical the SOI, the more thorough the set of rules to be applied, for example :

➤ Non-critical SOI : **Entertainment System**

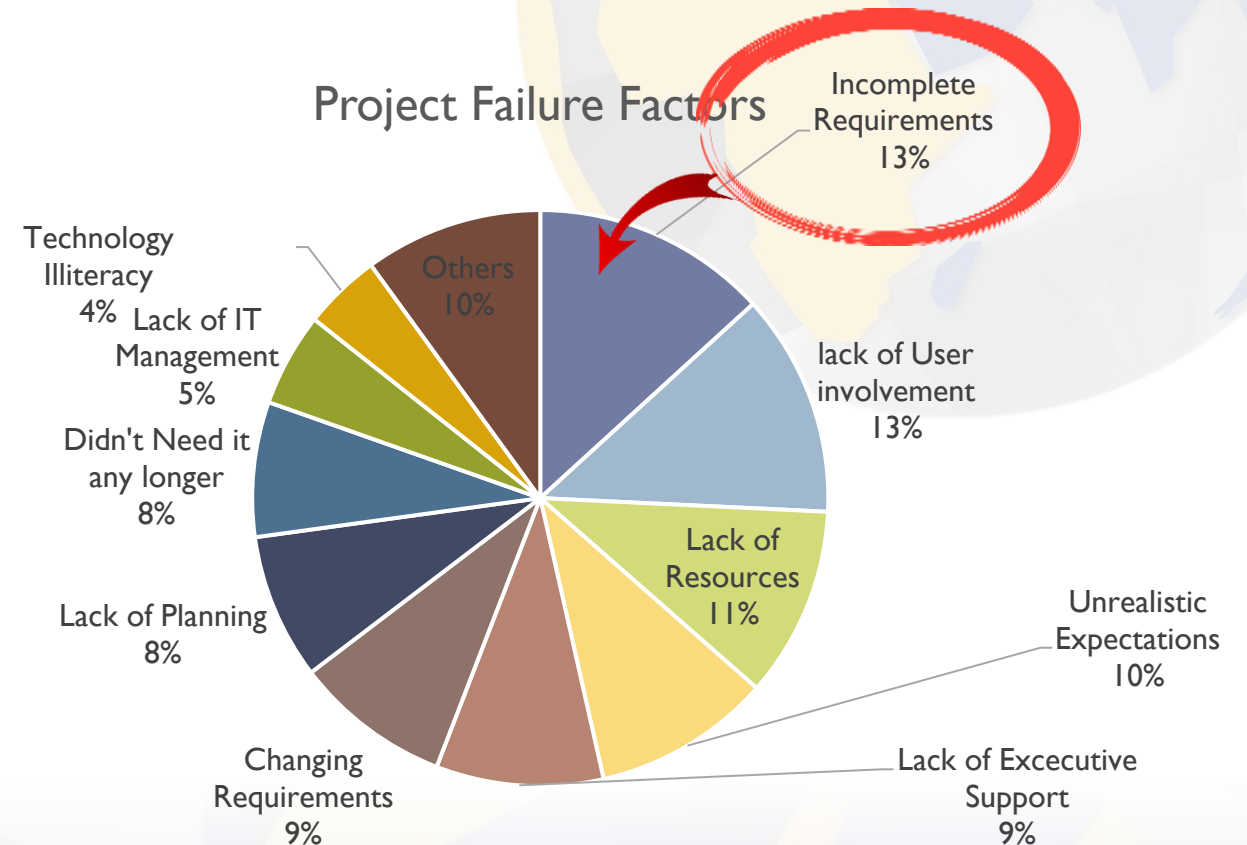


➤ Critical SOI : **Engine or Electronic Control Unit**



The need for other references to go beyond correctness checking: completeness

Project Success Factors	% of Responses
1. User Involvement	15.9%
2. Executive Management Support	13.9%
3. Clear Statement of Requirements	13.0%
4. Proper Planning	9.6%
5. Realistic Expectations	8.2%
6. Smaller Project Milestones	7.7%
7. Competent Staff	7.2%
8. Ownership	5.3%
9. Clear Vision & Objectives	2.9%
10. Hard-Working, Focused Staff	2.4%
Other	13.9%



The need for other references to go beyond correctness checking: completeness

Completeness in the GfWR:

Characteristics C4 :for individual requirements

Characteristics C10 :for sets of requirements

Completeness:

R24 – Avoid the use of pronouns and indefinite pronouns

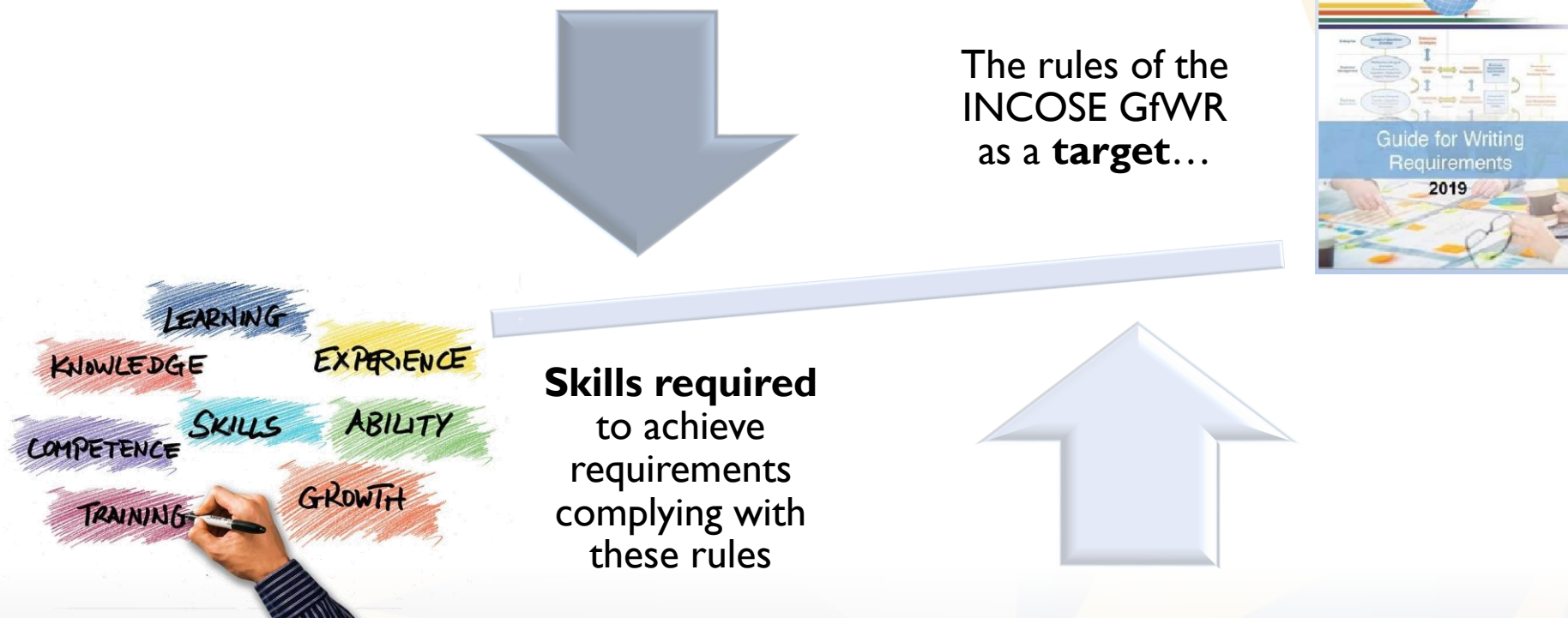
R25 – Avoid relying on headings to support explanations or understanding of the requirements

CHARACTERISTICS OF NEED AND REQUIREMENT STATEMENTS									CHARACTERISTICS OF 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	C14 - ABLE TO BE VALIDATED
1	2	29	12	8	2	21	4	8	3	9	5	8	7



Challenges: Adaptability to the skills of the team members

- Need for a roadmap to improve the tailored set of rules from the INCOSE GfWR

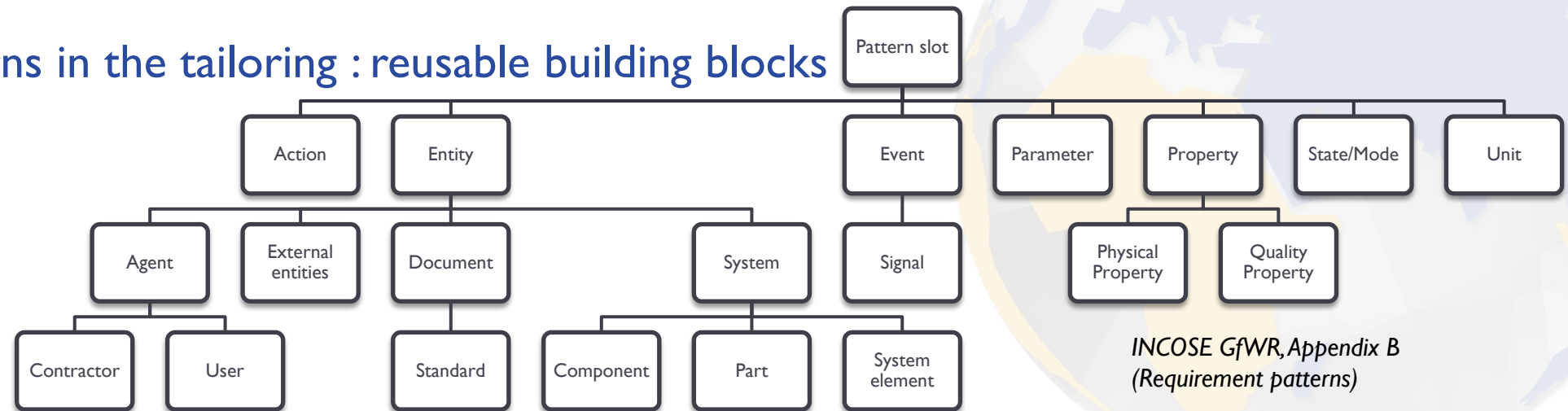


Challenges: The role of patterns in the tailoring



- Some rules of the INCOSE GfWR (for example R1 or R39) rely on requirement patterns (or boilerplates)
- Some of the benefits offered by requirement patterns are :
 - Write concise, easy to read and atomic requirement statements;
 - Find and classify requirements in large documents and identify missing requirements;
 - Find duplicated requirements (and finding and reusing requirements in general;
 - Follow with other activities such as analysis and implementation.

The role of patterns in the tailoring : reusable building blocks



INCOSE GfWR, Appendix B
(Requirement patterns)

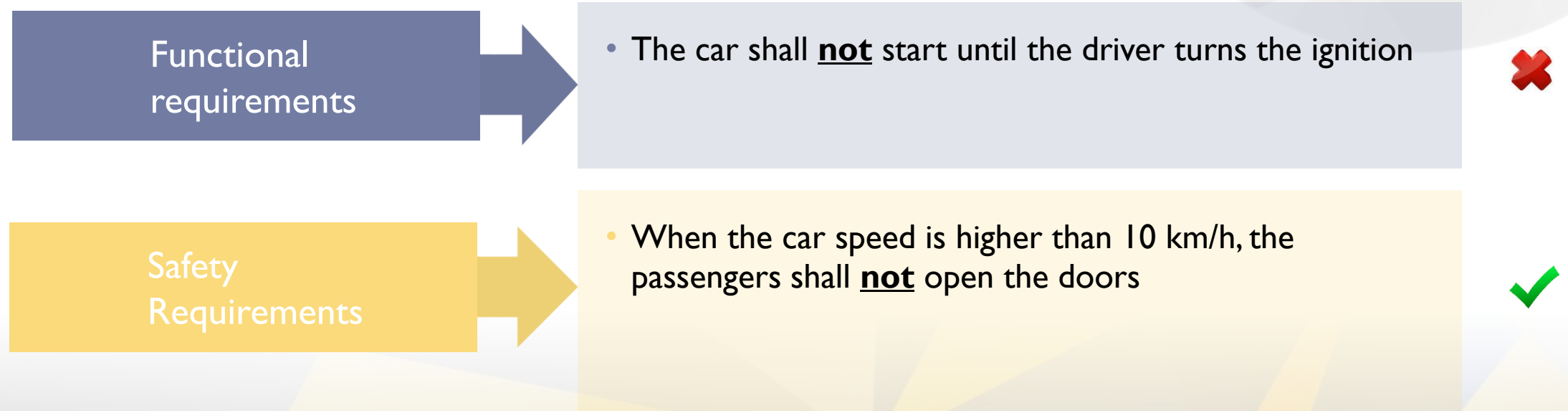
The INCOSE GfWR does not introduce any list of patterns, but the writer can refer to some well-known catalogs such as :

- Jeremy Dick, Juan Llorens, "Using Statement-level Templates to Improve the Quality of Requirements", *International Conference on Software and Systems Engineering and Applications. ICSSEA 2012*, Paris, France.
- Hull et al: *Requirements Engineering*, Springer, 2012.
- EARS Patterns: by Alistair "Mav" Mavin (<http://www.alistairmavin.com/ears>)
- MASTER Patterns: by SOPHIST GmbH (<https://www.sophist.de>)
- The PABRE Catalog (<http://www.upc.edu/gessi/PABRE/index.html>)
- ARTEMIS CRYSTAL EU Research Project (<http://www.crystal-artemis.eu>)

Adaptability to different types of requirements

- Most of the rules in the INCOSE GfWR can apply to all types of requirements, ...
- ... but some of them should only apply to specific types of requirements

Example : Rule 16 – Avoid Not





**Proposed
solution**

The solution : Overview

- Help the requirements authors, not only the quality analysts, to **apply the rules at the earliest stages**
- Our **CCC** (Correctness, Consistency & Completeness) approach to analyze requirements
- Follow an **incremental methodology** that adapts to the overall context
- Automated support to tackle this **time-consuming phase**
 - Support of patterns for authoring
 - Support of tools to distinguish authoring and quality inspection
 - Advanced semantics
 - Use of domain-specific libraries to adapt the rules to the domain of the requirements.



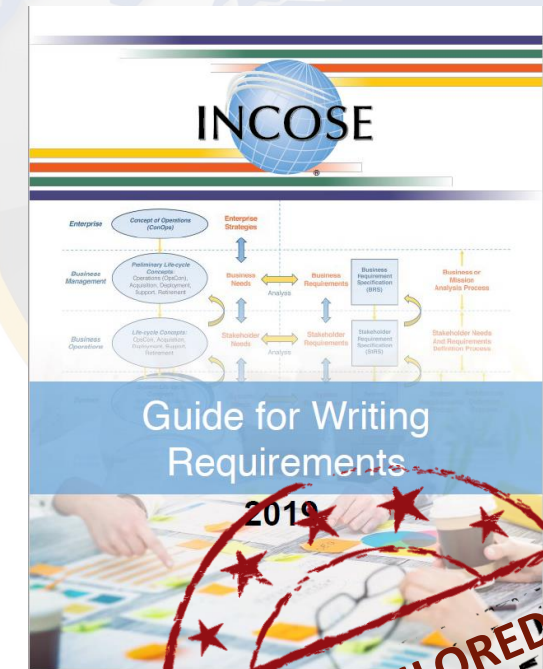
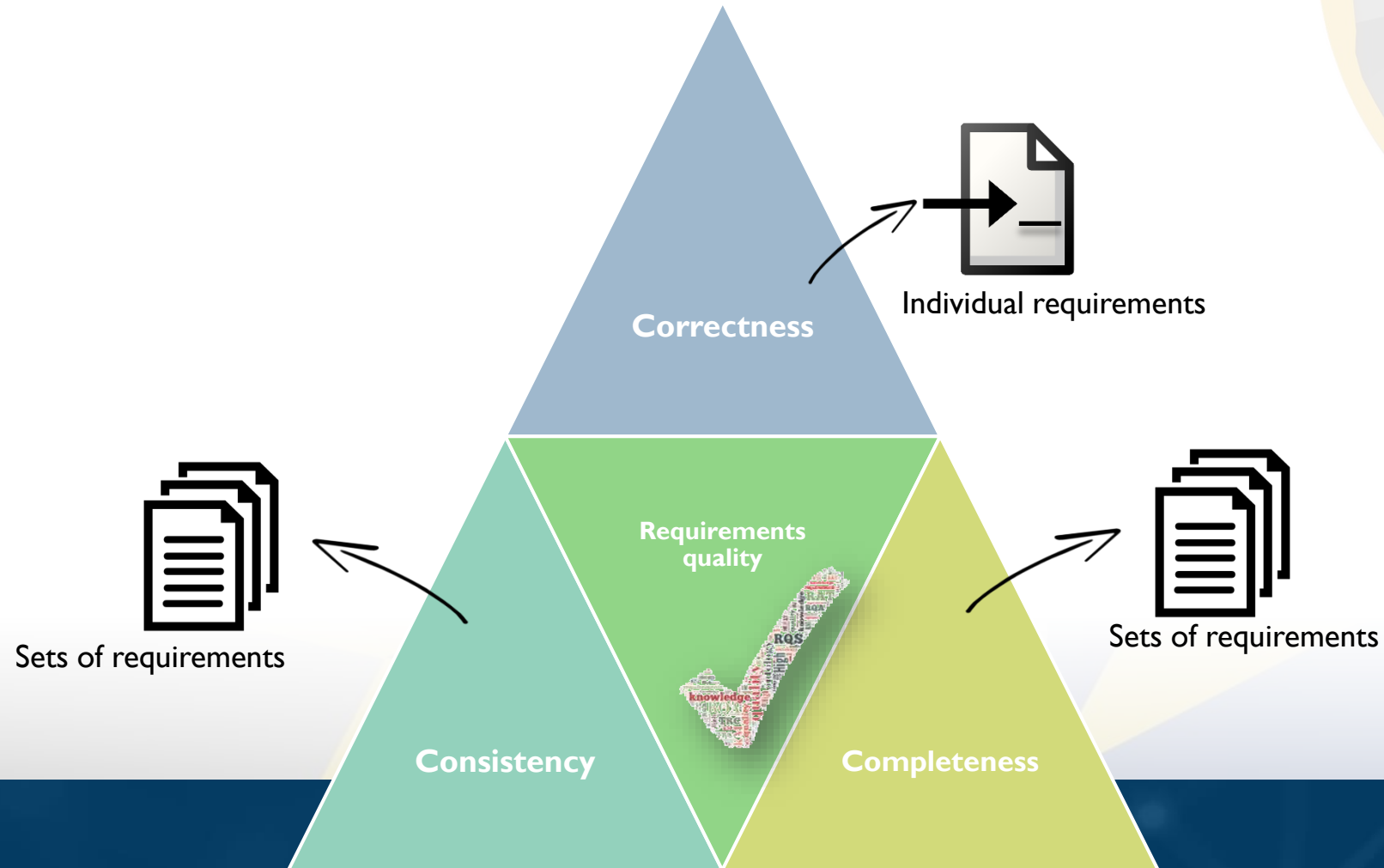
The solution: The sandwich model

- Use models as an additional source of truth : **“The systems engineering sandwich”** (J. Dick)

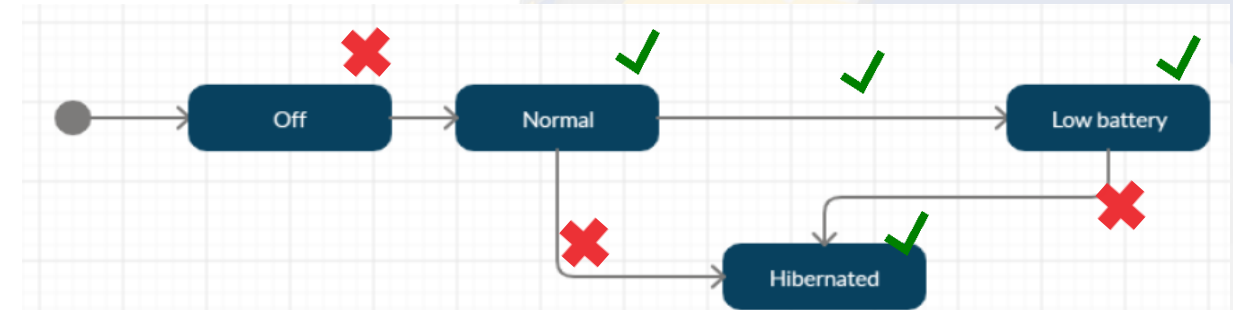
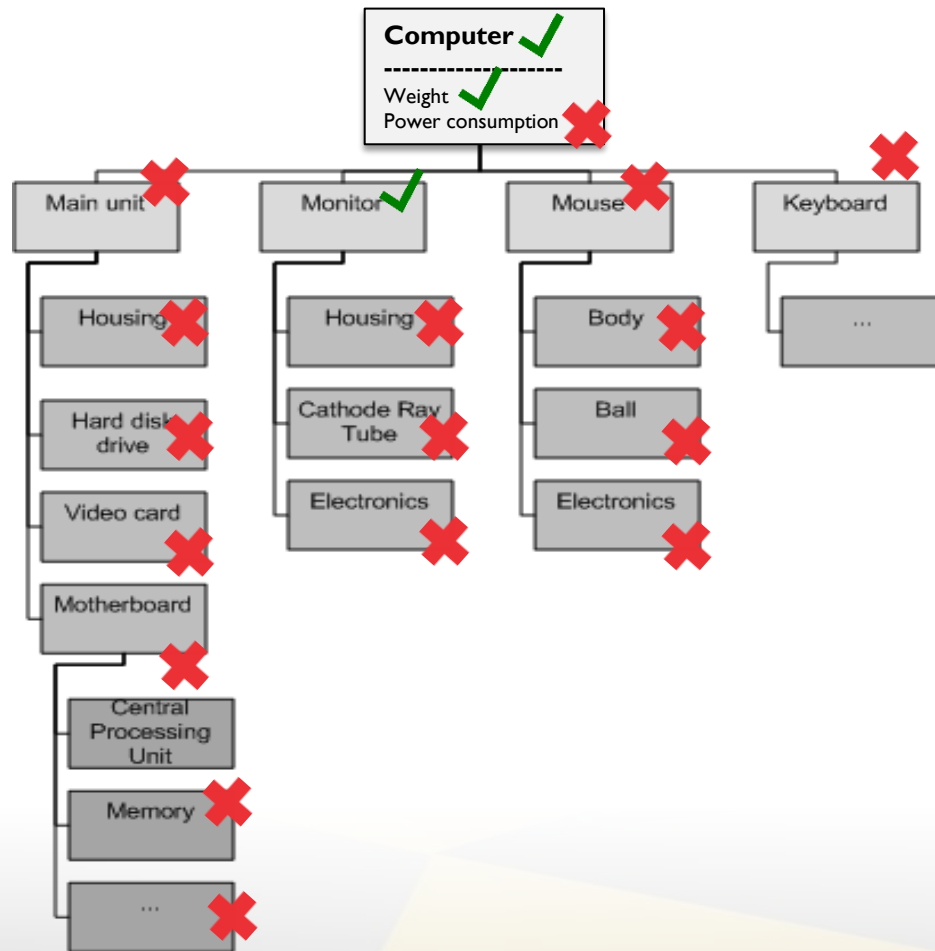


The solution: The CCC Approach

- CCC – Correctness, Consistency and Completeness



The solution: completeness



The computer shall have 2 monitors

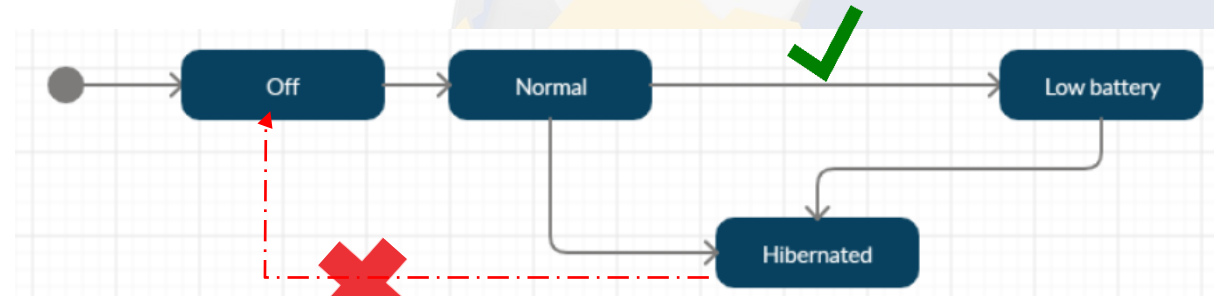
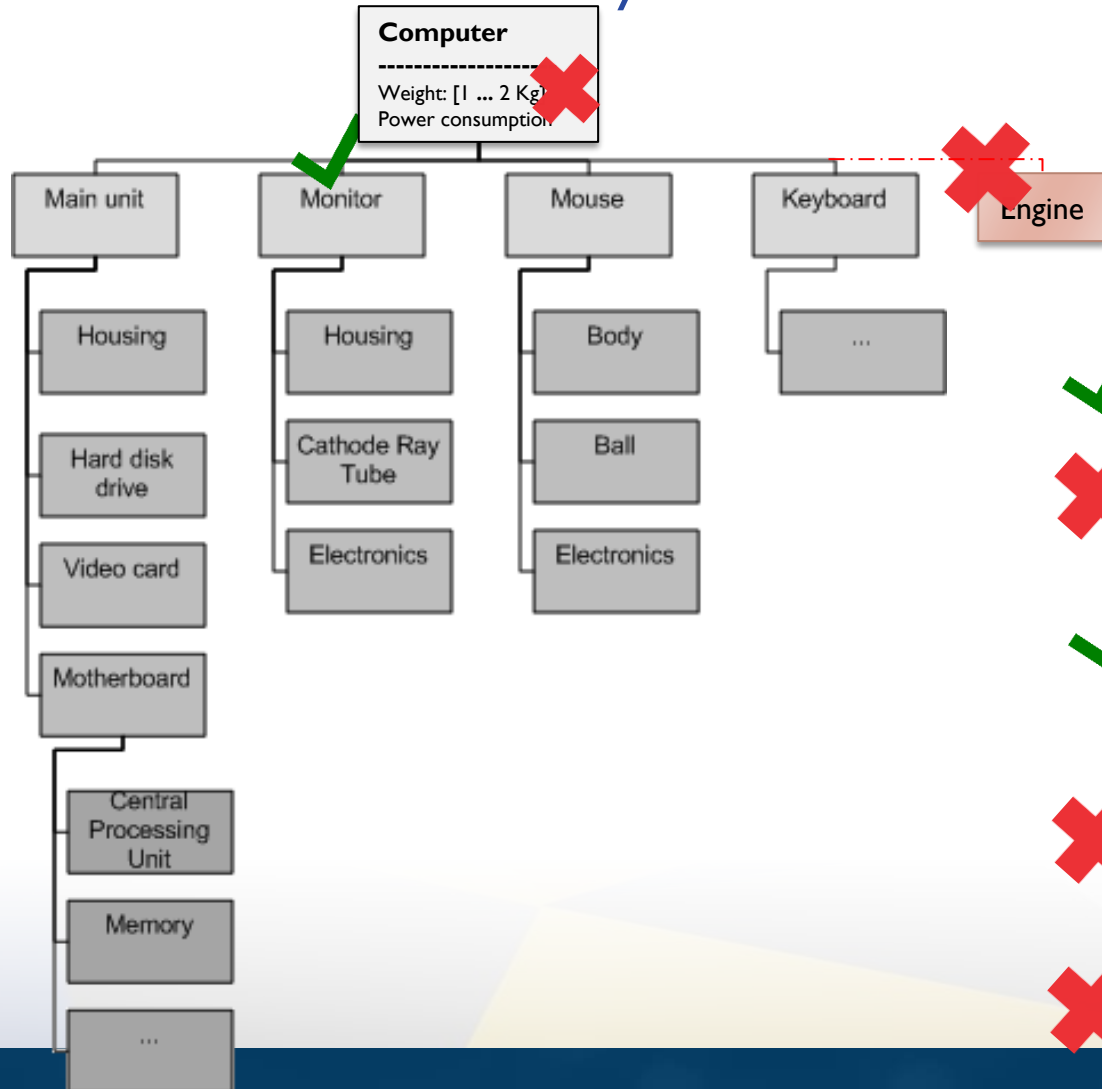
The computer shall have 2 engines

When the Computer is not plugged in, and the computer is in Normal mode and the level of battery drops below 10%, the computer shall transit to Low battery mode

When the Computer is in Hibernated mode, the monitor shall turn black

The weight of the computer shall be 1.2 kg +/- 10%

The solution : consistency



The computer shall have 2 monitors

The computer shall have 2 engines

When the Computer is not plugged in, and the computer is in Normal mode and the level of battery drops below 10%, the computer shall transit to Low battery mode

When the Computer is in Hibernated mode and EventX is received, the computer shall transit to Off mode

The weight of the computer shall be 3.5 kg +- 10%

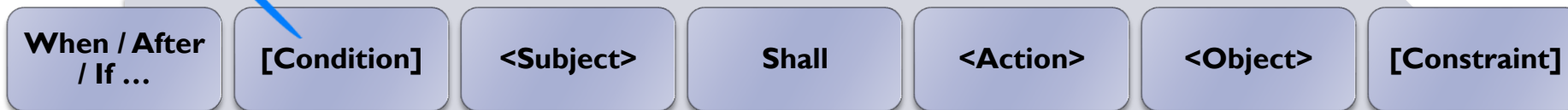
The solution : quality checking for authors, not only quality inspections

Example : application of R02 (Use Active Voice) to detect passive voice **only outside condition sentences** :

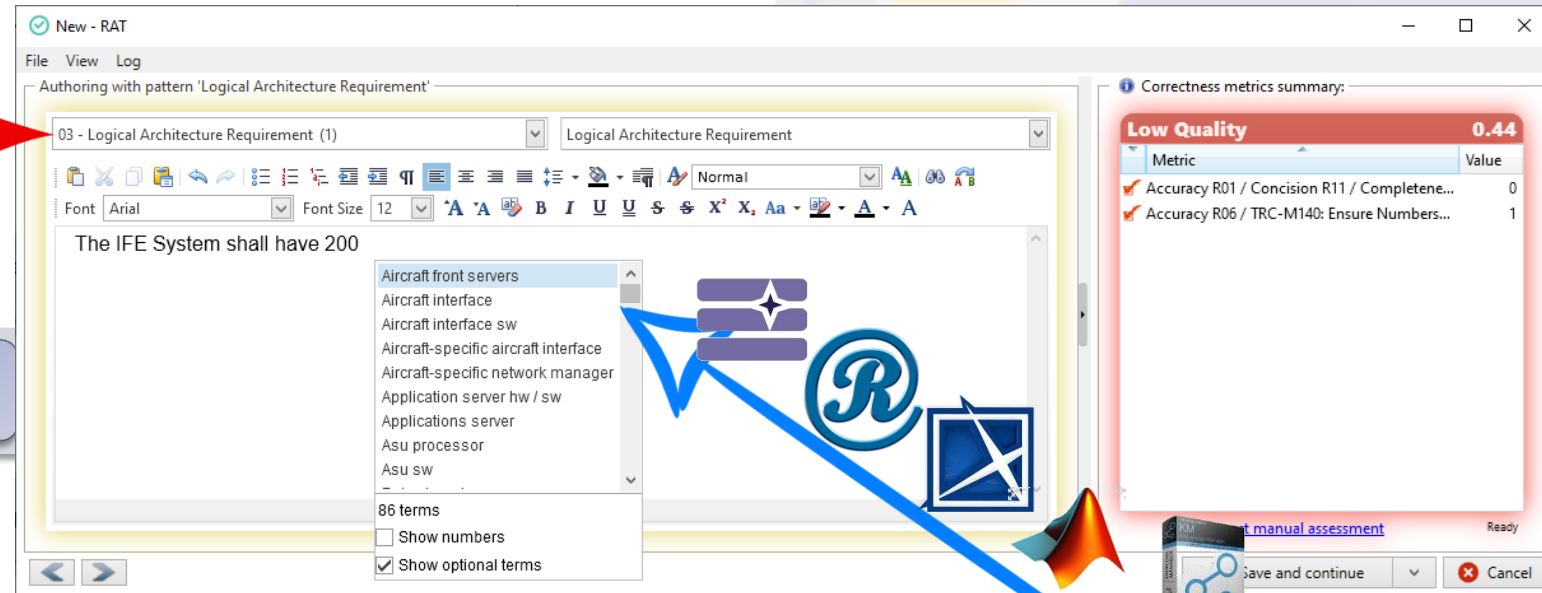
The screenshot shows the INCOSE GfWR interface. The main text area contains the sentence: "when the alarm is activated, the train shall be redirected to the closest station". The phrase "be redirected" is circled in red. A tooltip points to this phrase, displaying the metric: "Metric: R02 Precision - Passive voice (avoid)" and the value "N/A". A blue arrow points from the "[Condition]" button in the template below to the start of the sentence. On the right, the "Correctness metrics summary" panel shows a "Low Quality" status with a score of 20.00. A table lists the metrics:

Metric	Value
✓ R02 Precision - Passive voice (avoid)	1

The value "1" is circled in red. Below the table is a link "Edit manual assessment" and the status "Ready".



The solution : pattern based writing



When / After /
If ...

[Condition]

<Component>

<Component>

Shall

Have

a/NUMBER

<Component>

The

<Property>

Of

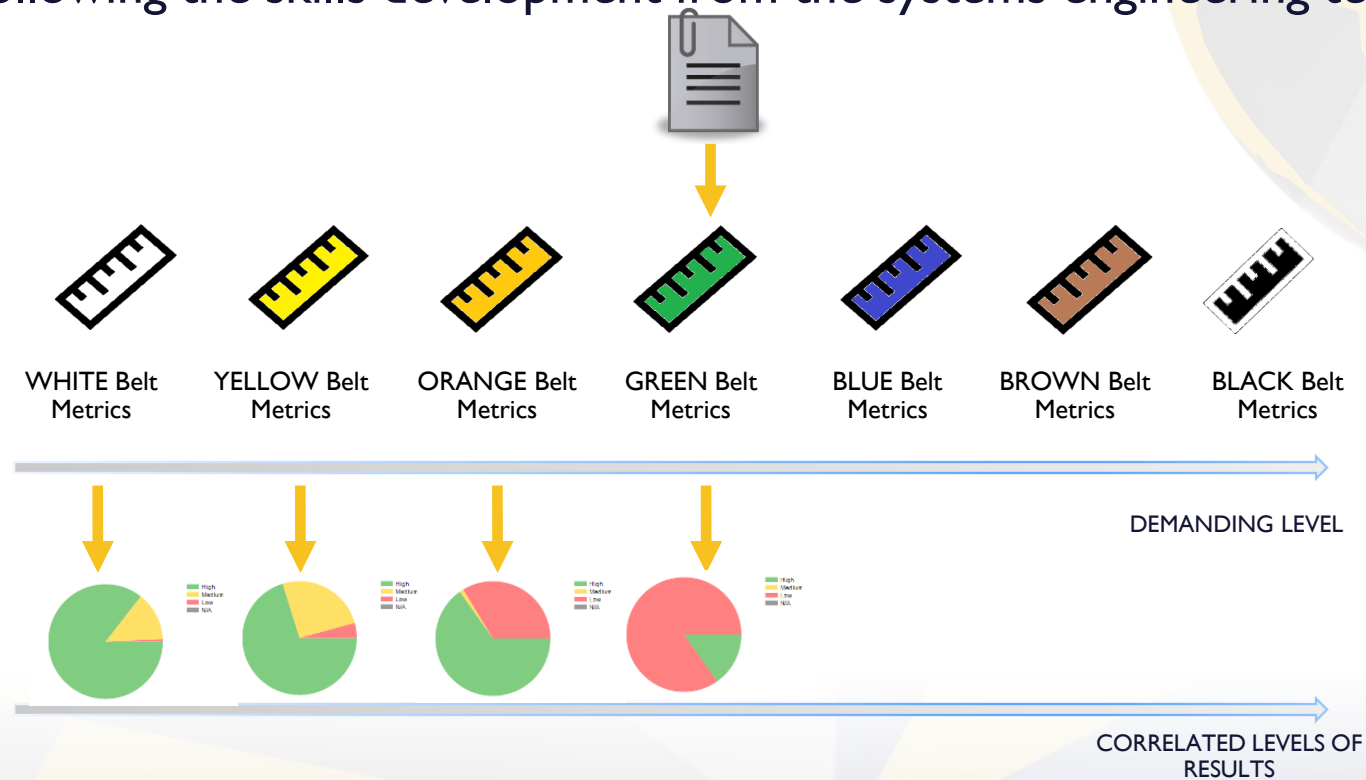
<Component>

Shall be

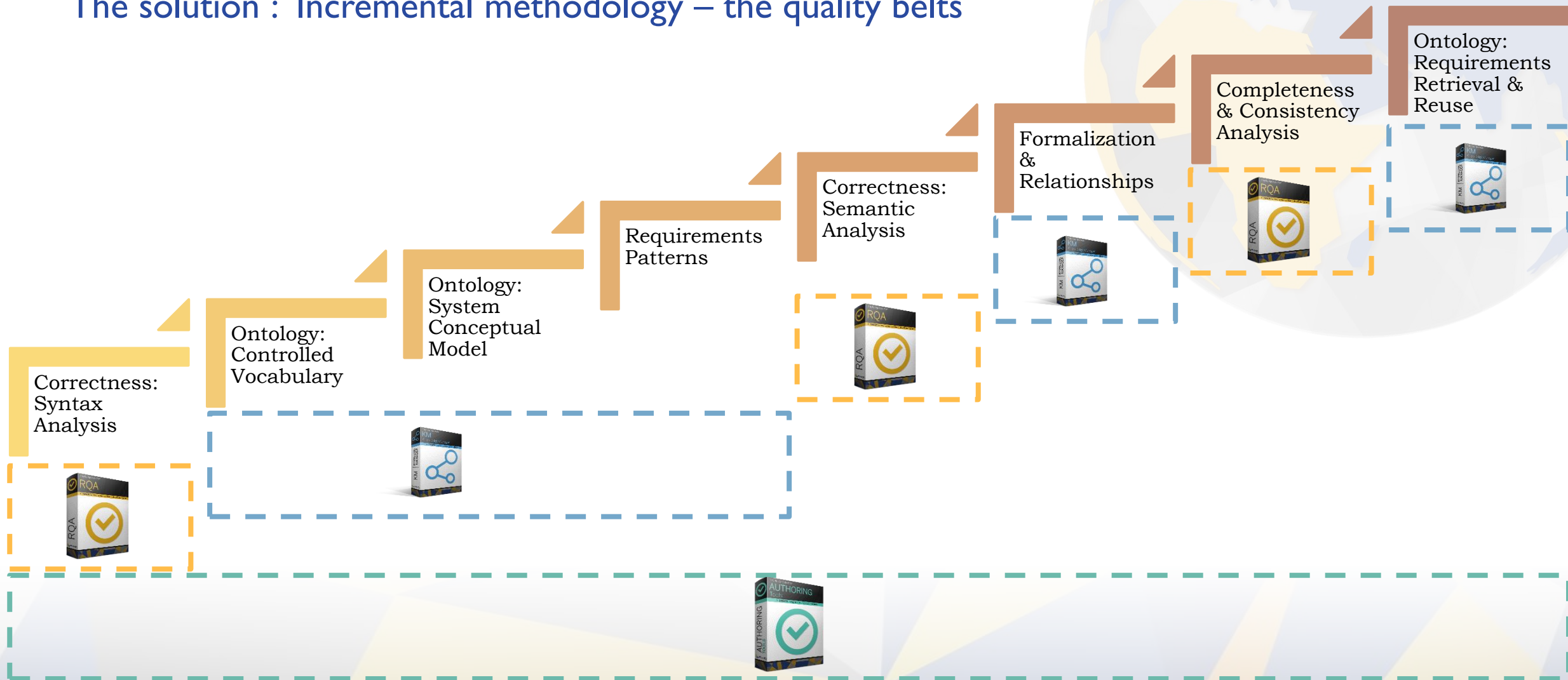
[Value]

The solution : Incremental methodology – the quality belts

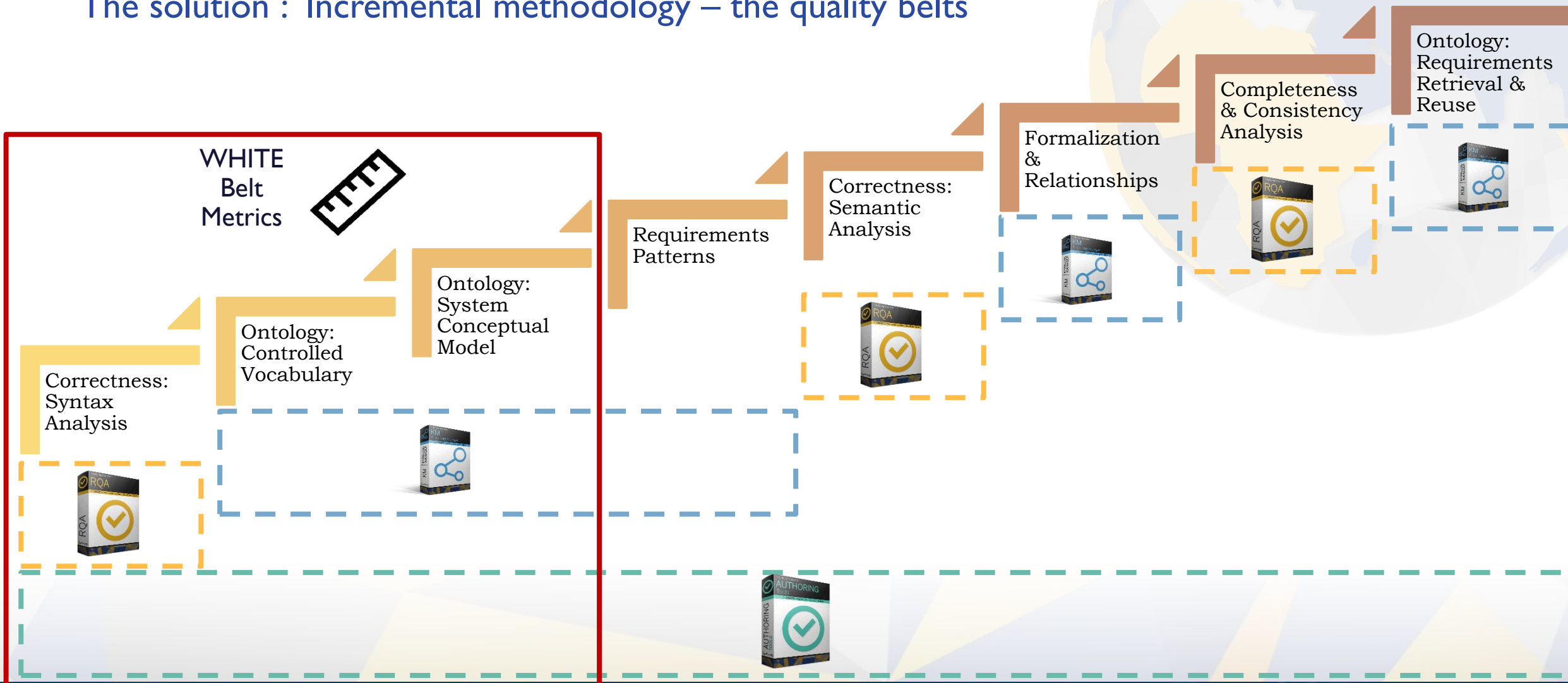
- Design a roadmap based on the concept of belts, like in martial arts, to gradually increase the complexity and following the skills development from the systems engineering team.



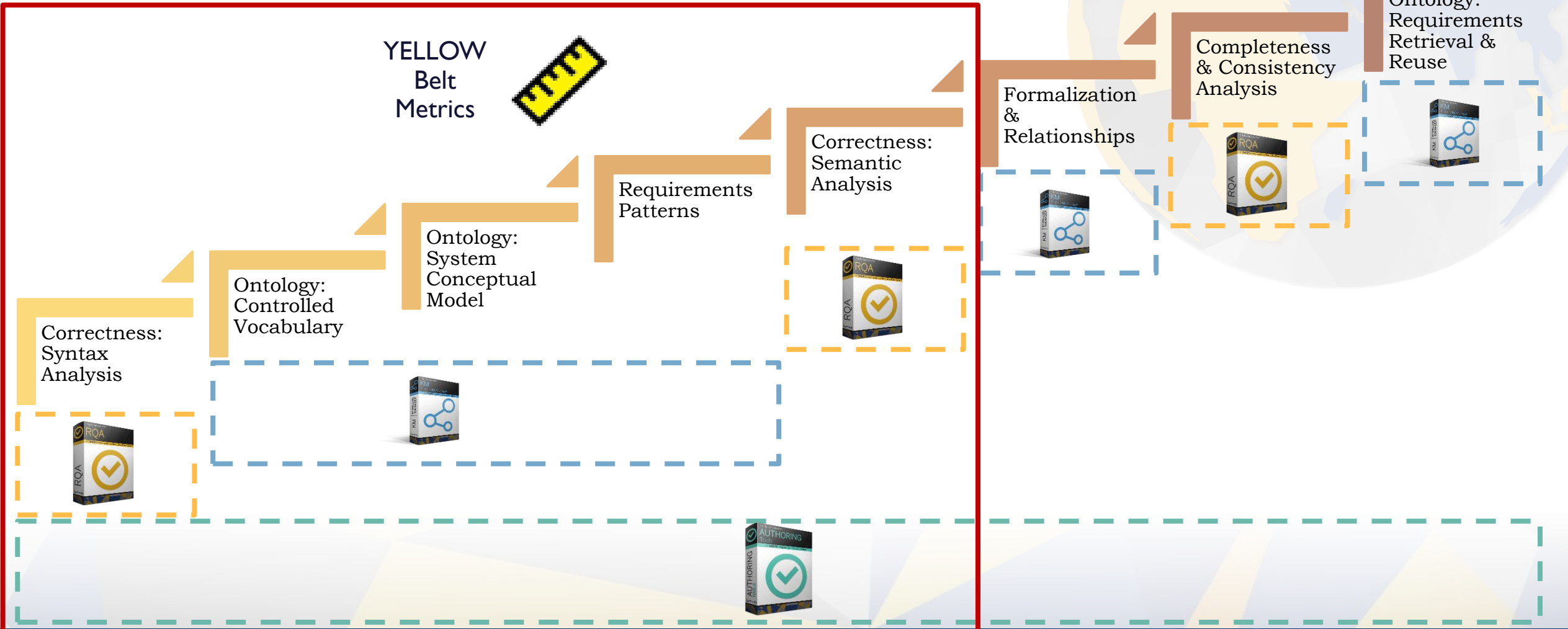
The solution : Incremental methodology – the quality belts



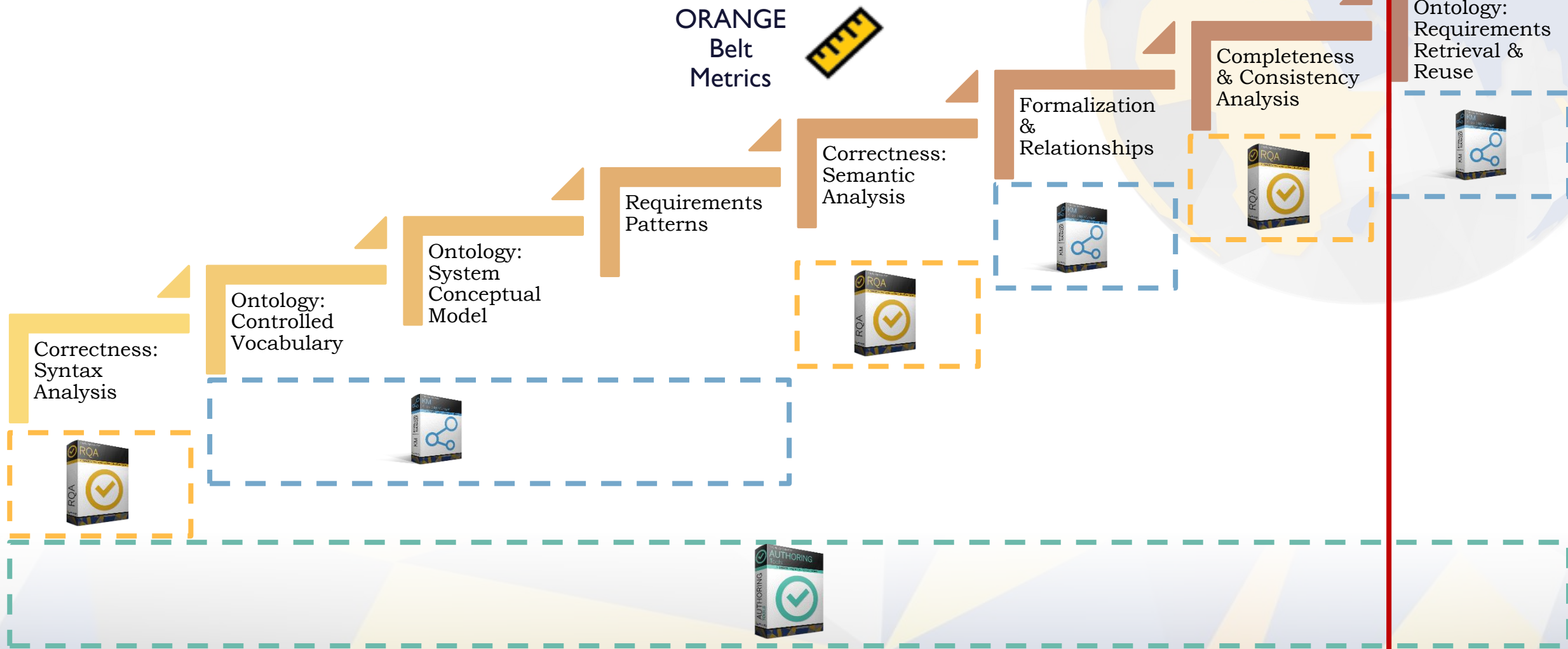
The solution : Incremental methodology – the quality belts



The solution : Incremental methodology – the quality belts



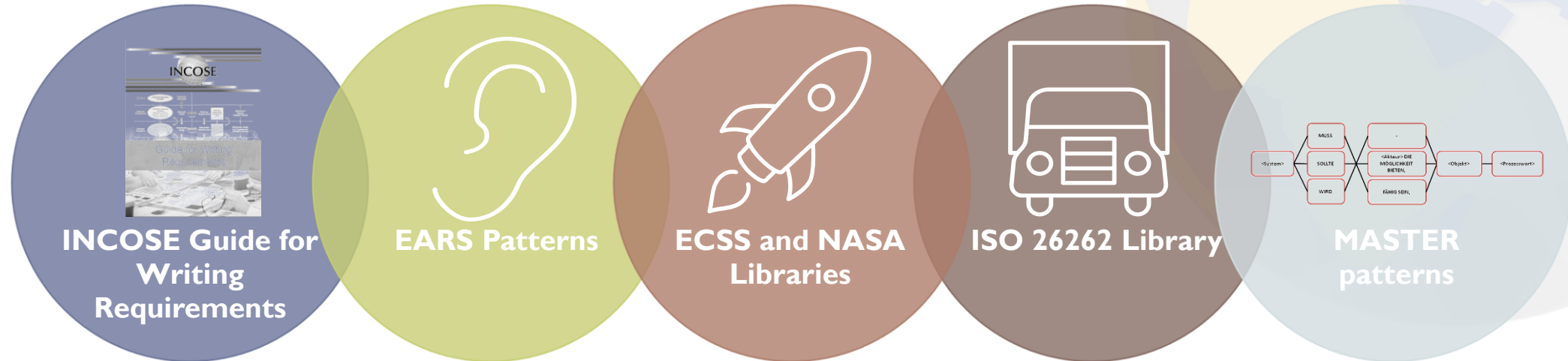
The solution : Incremental methodology – the quality belts



The solution : Incremental methodology – the quality belts



The solution : Domain-specific Libraries



INCOSE
Quality rules for the
analysis of textual
requirements

EARS
Requirements
patterns


Knowledge Base

Users

ISO 26262
Glossary, patterns and
rules

MASTER
Quality rules for
requirements and
requirements
patterns

 TRC WEBINARS

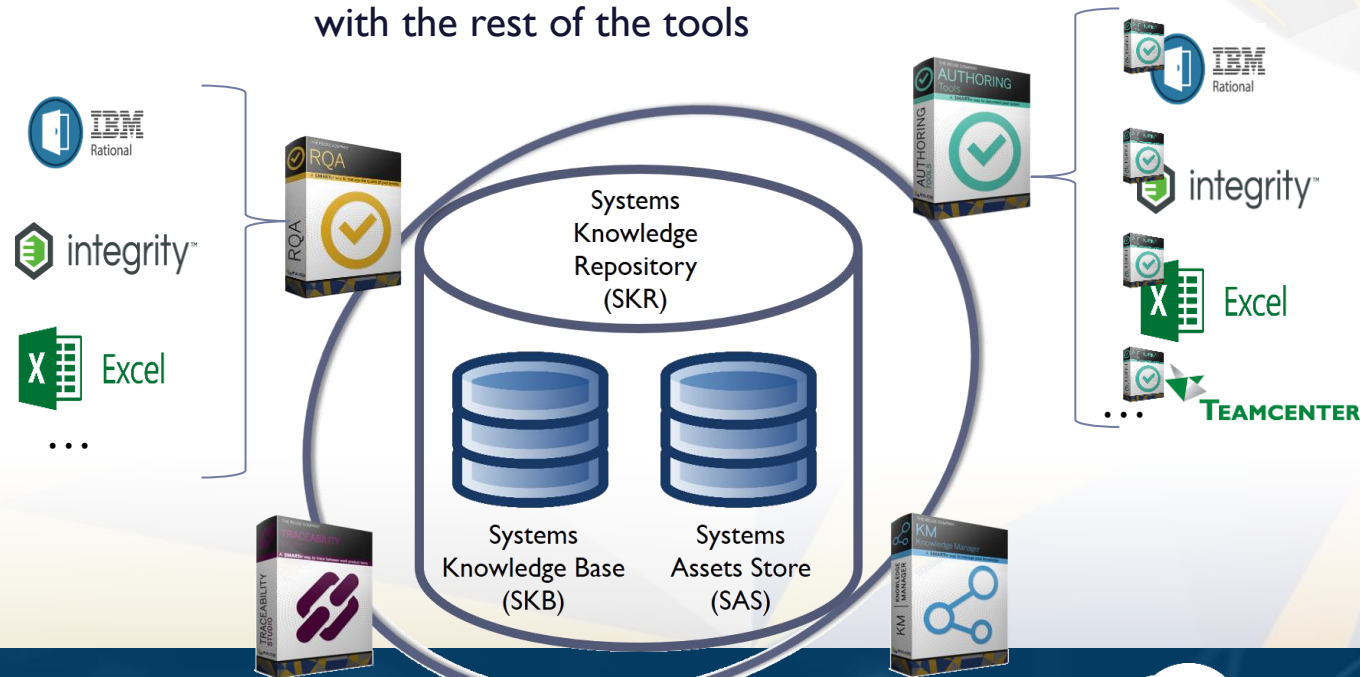
Link to TRC webinar section :
<https://www.reusecompany.com/webinars>

The solution : The Systems Engineering Suite

➤ <http://www.reusecompany.com>



- **RQA / V&V Studio:** to setup, check and manage the quality of a requirements specification
- **Rich Authoring Tool (RAT):** to assist authors while they are creating or editing requirements
- **Knowledge Manager (KM):** to manage knowledge around a requirements specification: dictionaries, glossaries, concept maps, knowledge models, ontologies, patterns...
- **TRACEABILITY Studio:** to link together all the different types of artifacts managed with the rest of the tools

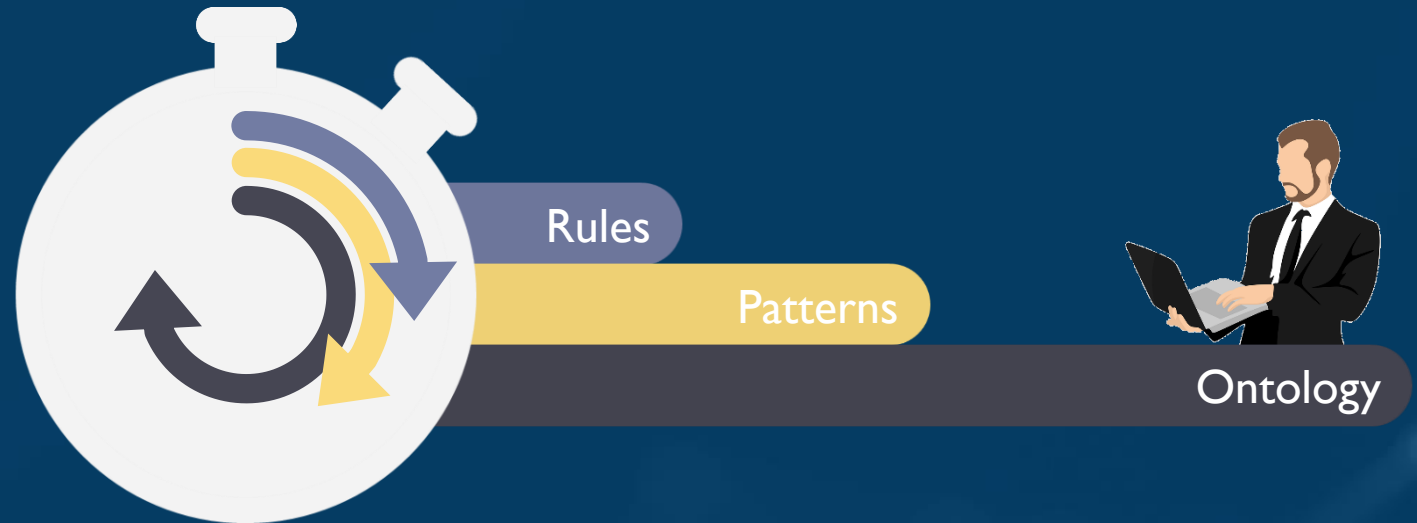


The solution : The Systems Engineering Suite + AI

Manual definition

Requires time

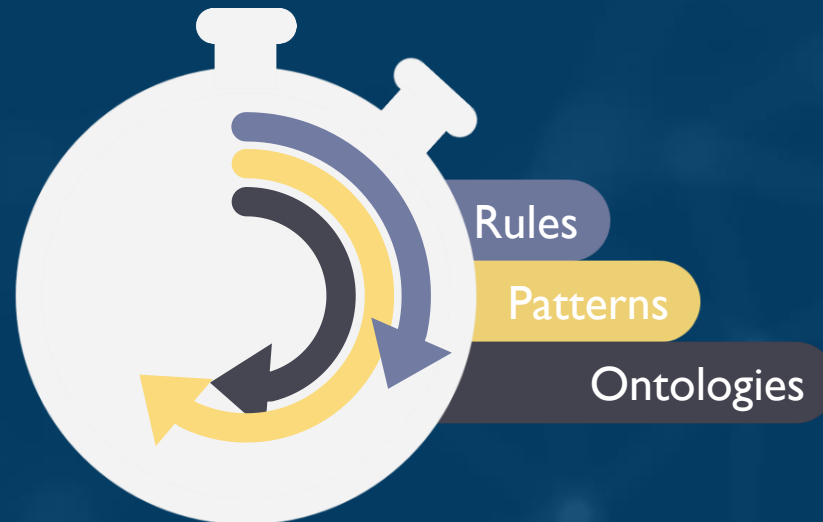
Requires an intensive help from SME

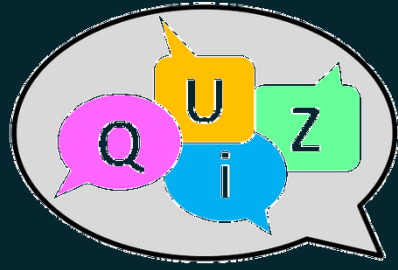


AI + NLP

Reduction of time

Less help from SME





The tailoring

Quick quiz

The tailoring quick quiz

- Follow this link or scan the image: **www.kahoot.it**



- And enter this PIN: 303640
- Then your nickname (it can be any Anonymous Nick)



The tailoring book

**Ask for your
copy, now!**

Real-time quality assessment of the INCOSE GfWR: a tailoring guide



Real-time quality assessment of the INCOSE GfWR: a tailoring guide

- Fill out this form: <https://share.hsforms.com/1NhIzIZaRRwG53dvfUHgb6Q2lpn5>



- And request your personal copy
- Plus a free License of the SES Suite to evaluate the library that implements this tailoring guide



the
REUSE
company

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