

# The INCOSE GfWR

## Raising the Ante



**René Oosthuizen**

The REUSE Company

*rene.oosthuizen@reusecompany.com*



**José M. Fuentes**

The REUSE Company

*jose.fuentes@reusecompany.com*



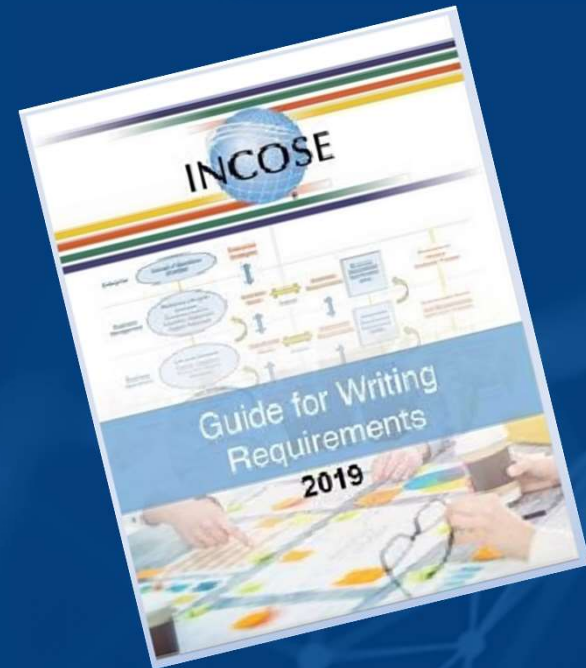
**Ilyes Yousfi**

The REUSE Company

*ilyes.yousfi@reusecompany.com*



THE  
**REUSE**  
COMPANY



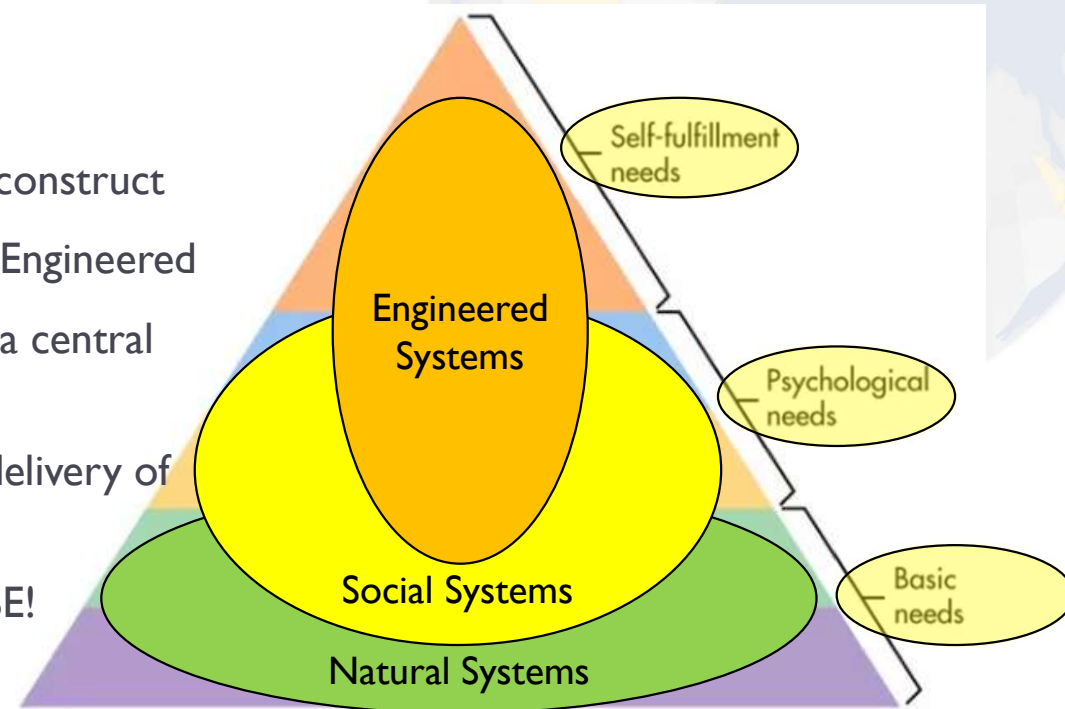
## Presentation Overview

- Introduction
  - Requirements – Why the hype?
  - Brief introduction to The REUSE Company
- Brief overview of the INCOSE GfWR
- Challenges & Solutions – Raising the ante
- Raising the Ante – Live demo
- INCOSE GfWR – A Tailoring Guide
- Q&A



## Requirements – Why the hype?

- ▶ Human needs are ubiquitous
- ▶ SE is a “Self-Actualization Need” driven human construct
- ▶ System application domains: Natural, Social and Engineered
- ▶ Requirements are derived from needs and fulfil a central role in the SE process
- ▶ Quality requirements are critical to successful delivery of products and systems
- ▶ Conclusion: Requirements are the **lifeblood** of SE!





## The INCOSE GfWR: Raising the Ante

Leveraging systems engineering activities through a **semantics-based knowledge centric** approach



[contact@reusecompany.com](mailto:contact@reusecompany.com)



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



Calle Margarita Salas, 16 2-D  
28919 – Leganés (Madrid)  
SPAIN



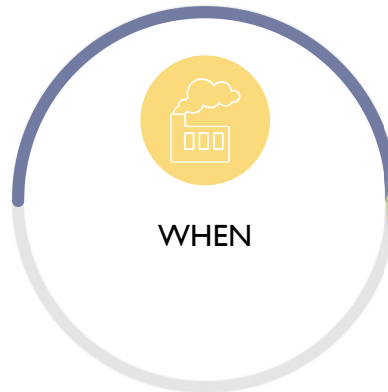
+34 912 172 596





THE  
**REUSE**  
COMPANY

The INCOSE GfWR: Raising the Ante



WHEN

**01** The company was established in **1999**

A spin-off from the Carlos III University in Madrid



WHO

**02** **Systems and Software Engineers**

Smart collaboration between Company and R&D staff from Academia



WHERE

**03** **Headquarters:** Madrid (Spain)

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

**2021:**  
USA  
Chicago/Detroit/Miami



WHY

**04** To promote **reusable**, **scalable** and global solutions in a **smart** and **interoperable** Systems Engineering environment through a **semantics-based knowledge centric** approach

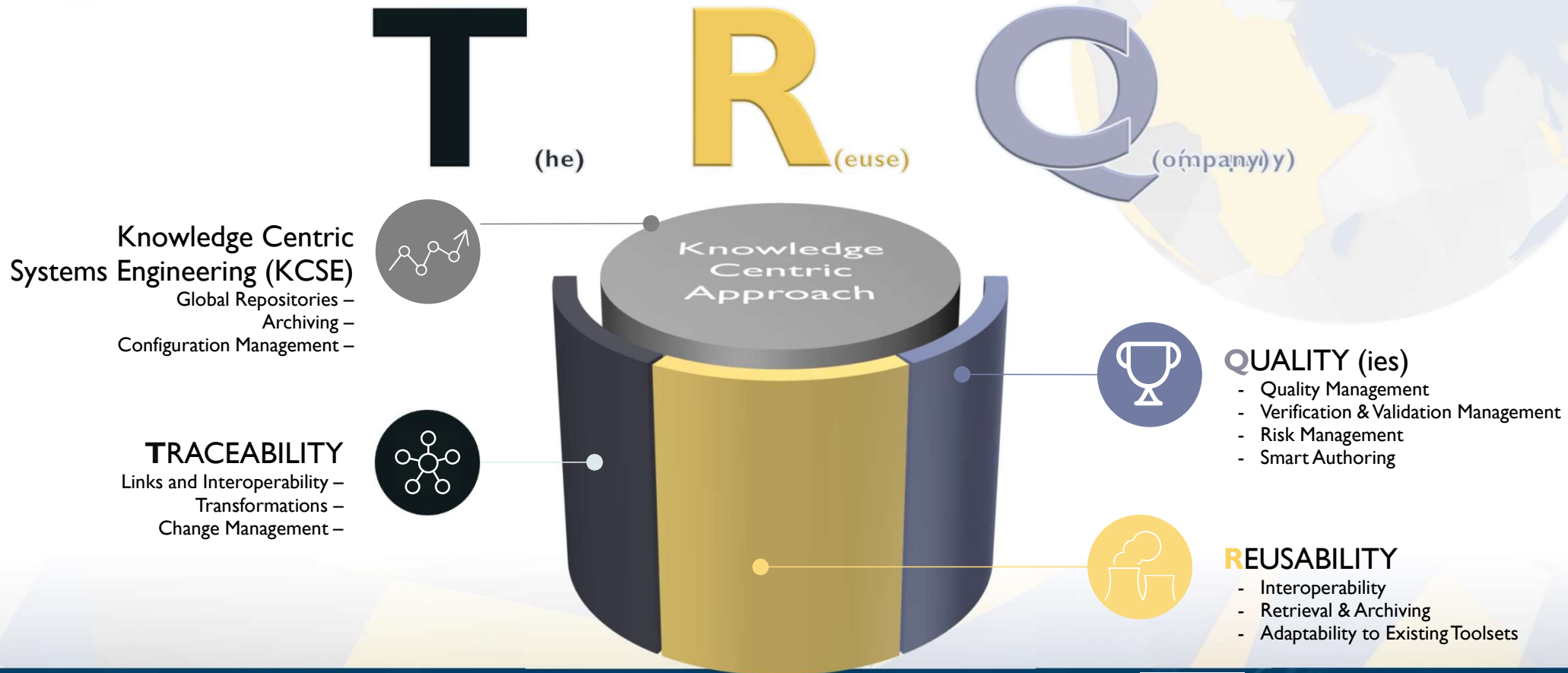


THE  
**REUSE**  
COMPANY

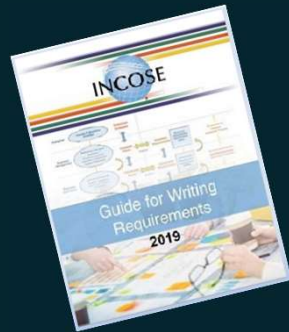


THE  
**REUSE**  
COMPANY

The INCOSE GfWR: Raising the Ante



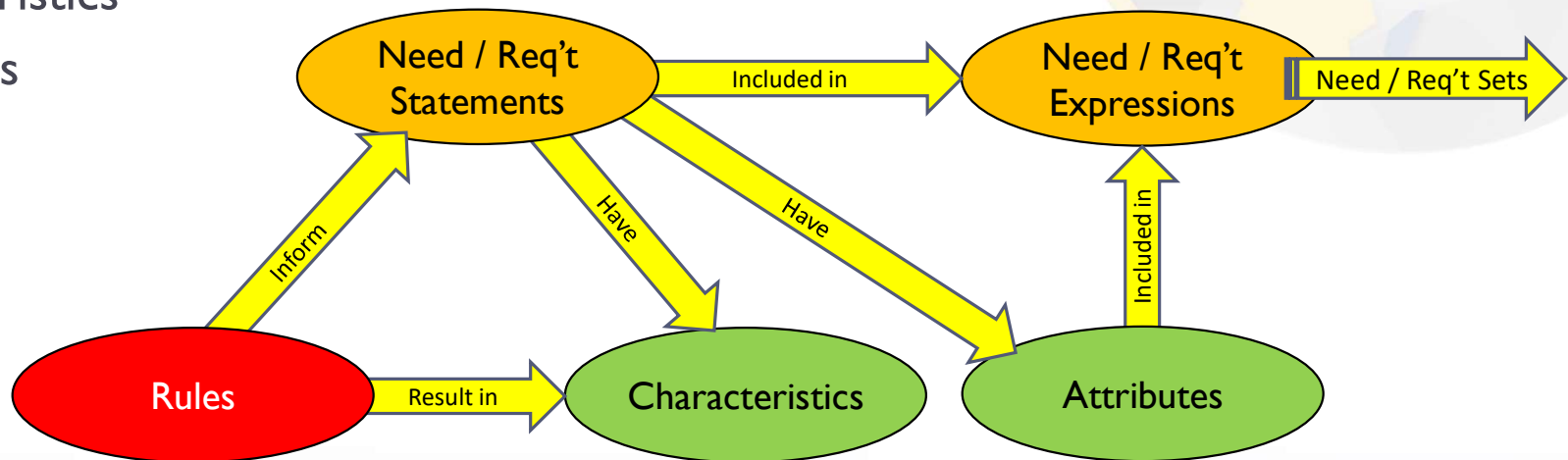
THE  
**REUSE**  
COMPANY



# **Brief overview of the INCOSE GfWR**

## INCOSE GfWR Ontology

- ▶ Needs, Requirements & Sets of Needs & Requirements
- ▶ Need / Requirement Statements & Expressions
- ▶ Characteristics
- ▶ Attributes
- ▶ Rules





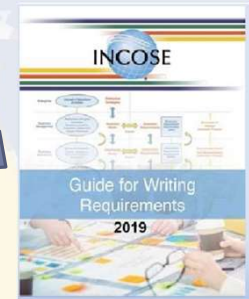
## Brief introduction to the INCOSE GfWR

### INCOSE GfWR

- **14 Characteristics** of individual and sets of needs and requirements. The GfWR provides rationale and guidance for helping understand characteristics.
- **46 Attributes** are attached to need or requirement statements to form need or requirement expressions. The GfWR provides guidance on the use of attributes.
- **41 Rules** to help formulate individual and sets of needs and requirements. The GfWR provides an explanation of the rules and examples of their application.

### 41 Rules / 14 Characteristics

14 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						
	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							
	R18	Single Sentence			1	1	1		1		1				1	
Singularity	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		
Uniqueness	R30	Express Once	1								1			1	1	
	R31	Solutionfree		1												
Abstraction	R32	Universals			1				1	1						
Quantifiers	R33	Value Range			1	1		1	1	1				1		
Tolerance	R34	Measurable			1	1			1					1		
	R35	Temporal Indefinite			1	1			1							
Quantification	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	1	
	R39	Style Guide					1	1				1	1	1	1	
	R40	Related Requirements									1		1	1	1	
Uniform Language	R41	Structured										1	1	1	1	



### 46 Attributes

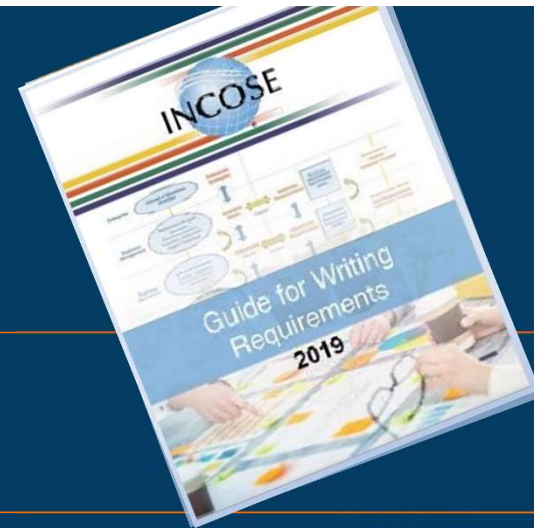
Attribute	Attributes to Help Define the Requirement and its Intent	Associated with the System of Interest (SOI) Verification	Attributes to Help Maintain the Requirements	Attributes to Show Applicability
A01: Rationale*	1			
A02: SOI Primary Verification or Validation Method*	1			
A03: SOI Verification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



# **Challenges & Solutions**

**Raising the Ante**

# INCOSE GfWR: Pros and Cons



P

## Pros

Represents the state-of-the-art  
Very good starting point



## Cons

Time consuming  
Considered by many as cast in stone  
Considered as one single check-list



C



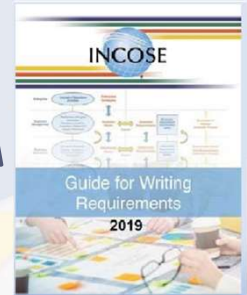
## INCOSE GfWR with TRC Tailoring

- **Characteristics**
- **Attributes**
- **Rules**
- **Metrics:** A quality metric is a property which aims to quantify a qualitative indicator. It enables answering the question *'How should we measure?'*
- **Quality Function:** After defining the metric, the quality function is the conversion of the obtained result (quantitative value) to a quality level. Different profiles can be set (binary, concave, convex...)

## Challenges & Proposed Solutions – Raising the Ante

Mapping INCOSE 2019 rules with TRC quality metrics

Tid	Type	INCOSE Rule	Rule short name	Metric Number	Metric Name	Metric Type
R01	Accuracy	R01	Sentence structure	TRC-A010	Enforce the use of a complete sentence structure	Non-parameterized
			Avoid the use of Bareword Nouns Verbs	TRC-A015	Avoid the use of Bareword Nouns Verbs	Parameterized - Cluster
			Use Active Voice	TRC-A030	Avoid the use of Passive Voice	Parameterized - Pattern matching
		R03	Avoid the use of Passive Voice after the modal verb	TRC-A035	Avoid the use of Passive Voice after the modal verb	Parameterized - Pattern matching
			Avoid the use of Passive Voice out of the condition block	TRC-A040	Avoid the use of Passive Voice out of the condition block	Parameterized - Pattern matching
			Determine if the subject is a recognized Agent term	TRC-A050	Determine if the subject is a recognized Agent term	Parameterized - Cluster
			Detect inappropriate subject at the document level	TRC-A055	Detect inappropriate subject at the document level	Parameterized - Sub terms in SCM
			Avoid the use of Vague Verbs after Modal Verbs	TRC-A065	Avoid the use of Vague Verbs after Modal Verbs	Parameterized - Pattern matching
		R04	Determine if the main verb is a Controlled Action Verb	TRC-A120	Determine if the main verb is a Controlled Action Verb	Parameterized - Pattern matching
			Avoid Unclassified Terms	TRC-A125	Avoid Unclassified Terms	Parameterized - Term tag
R05	Use Defined Terms	R05	Enforce the use of Defined Terms by avoiding Synonyms	TRC-A030	Enforce the use of Defined Terms by avoiding Synonyms	Non-parameterized
			Avoid the use of Indefinite Articles	TRC-A020	Avoid the use of Indefinite Articles	Parameterized - Term tag
		R06	Avoid the use of Indefinite Articles in front of an Agent	TRC-A130	Avoid the use of Indefinite Articles in front of an Agent	Parameterized - Pattern matching
			Enforce Numbers are followed by Units or noun qualifications	TRC-A140	Enforce Numbers are followed by Units or noun qualifications	Parameterized - Term tag
		R07	Detect inadequate use for a Characteristic	TRC-A150	Detect inadequate use for a Characteristic	Parameterized - Term tag
			Avoid mixing up different measurement systems	TRC-A160	Avoid mixing up different measurement systems	Measurement units consistency metric
		R08	Avoid the use of Vague Verbs	TRC-A040	Avoid the use of Vague Verbs	Parameterized - Cluster
			Avoid the use of Vague Adjectives	TRC-A170	Avoid the use of Vague Adjectives	Parameterized - Cluster
		R09	Avoid the use of Vague Terms	TRC-A050	Avoid the use of Vague Terms	Parameterized - Cluster
			Avoid the use of Escape clauses	TRC-A180	Avoid the use of Escape clauses	Parameterized - Special Sentences
R10	Concision	R10	Avoid the use of Open-Ended clauses	TRC-A030	Avoid the use of Open-Ended clauses	Parameterized - Special Sentences
			Avoid the use of Superfluous Infinitives	TRC-A020	Avoid the use of Superfluous Infinitives	Parameterized - Pattern group matching
		R11	Enforce the use of a complete sentence structure	TRC-A010	Enforce the use of a complete sentence structure	Non-parameterized
			Check the number of condition clauses	TRC-A125	Check the number of condition clauses	Parameterized - Cluster
		R12	Avoid inadequate grammar structures	TRC-A030	Avoid inadequate grammar structures	Parameterized - Pattern group matching
			Avoid incorrect spelling	TRC-A040	Avoid incorrect spelling	Non-parameterized
		R13	Facilitate readability	TRC-A050	Facilitate readability	Non-parameterized
			Review incorrect punctuation	TRC-A060	Review incorrect punctuation	Non-parameterized
		R14	Set a convention for subject expression forms	TRC-A070	Set a convention for subject expression forms	Parameterized - Cluster
			Avoid the use of Combinators out of the condition block	TRC-A080	Avoid the use of Combinators out of the condition block	Parameterized - Cluster
R15	Non-ambiguity	R15	Avoid the use of Negatives out of the condition block	TRC-A090	Avoid the use of Negatives out of the condition block	Parameterized - Cluster
			Avoid the use of Absolute Number "1"	TRC-A100	Avoid the use of Absolute Number "1"	Parameterized - Term tag
		R16	Check the text length by counting paragraphs	TRC-A110	Check the text length by counting paragraphs	Non-parameterized
			Check the text length by counting words	TRC-A130	Check the text length by counting words	Non-parameterized
		R17	Control the number of Action Verbs out of the condition block	TRC-A140	Control the number of Action Verbs out of the condition block	Parameterized - Pattern matching
			Check the number of Modal Verbs	TRC-A160	Check the number of Modal Verbs	Parameterized - Term tag
		R18	Avoid the use of Combinators out of the condition block	TRC-A080	Avoid the use of Combinators out of the condition block	Parameterized - Cluster
			Multiple subject detection	TRC-A170	Multiple subject detection	Parameterized - Pattern matching
		R19	Multiple verbs detection	TRC-A175	Multiple verbs detection	Parameterized - Pattern matching
			Avoid phrases that indicate the purpose	TRC-A180	Avoid phrases that indicate the purpose	Parameterized - Special Sentences
R20	Avoid Purpose	R20	Avoid the use of Parentheses out of the condition block	TRC-A090	Avoid the use of Parentheses out of the condition block	Parameterized - Cluster
			Avoid the use of Pronouns to refer to nouns	TRC-A070	Avoid the use of Pronouns to refer to nouns	Parameterized - Term tag
		R21	Enforce the use of a complete sentence structure	TRC-A010	Enforce the use of a complete sentence structure	Non-parameterized
			Avoid the use of Pronouns to refer to nouns	TRC-A070	Avoid the use of Pronouns to refer to nouns	Parameterized - Term tag
		R22	Avoid unachievable Absolute expressions impossible to verify	TRC-A100	Avoid unachievable Absolute expressions impossible to verify	Parameterized - Cluster
			Ensure tolerance value are within an adequate value range	TRC-A125	Ensure tolerance value are within an adequate value range	Parameterized - Custom code
		R23	Check the number of Modal Verbs	TRC-A160	Check the number of Modal Verbs	Parameterized - Term tag
			Avoid lots of actions after a condition activation	TRC-A040	Avoid lots of actions after a condition activation	Parameterized - Pattern matching
		R24	Avoid lots of conditions after an action	TRC-A055	Avoid lots of conditions after an action	Parameterized - Pattern matching
			Enforce attribute type is not empty	TRC-A060	Enforce attribute type is not empty	Parameterized - Attribute
R25	Uniqueness	R25	Avoid overlapping among the requirements	TRC-A080	Avoid overlapping among the requirements	Overlapping consistency metric
			Avoid stating a condition	TRC-A090	Avoid stating a condition	Parameterized - Cluster
		R26	Avoid the use of True sentences	TRC-A100	Avoid the use of True sentences	Parameterized - Cluster
			Avoid the use of Ambiguous Universal Quantifiers	TRC-A110	Avoid the use of Ambiguous Universal Quantifiers	Parameterized - Cluster
		R27	Force to include tolerance value for the units that required tolerance	TRC-A120	Force to include tolerance value for the units that required tolerance	Parameterized - Pattern group matching
			Ensure tolerance value are within an adequate value range	TRC-A125	Ensure tolerance value are within an adequate value range	Parameterized - Custom code
		R28	Confirms the value for a property is within a restricted value	TRC-A130	Confirms the value for a property is within a restricted value	Parameterized - Cluster
			Avoid the use of Imprecise Quantifiers	TRC-A140	Avoid the use of Imprecise Quantifiers	Parameterized - Cluster
		R29	Avoid the range of Inverse Quantifiers applied to a property	TRC-A150	Avoid the range of Inverse Quantifiers applied to a property	Parameterized - Pattern matching
			Avoid the use of Temporal Indefinite keywords out of the condition block	TRC-A060	Avoid the use of Temporal Indefinite keywords out of the condition block	Parameterized - Cluster
R30	Uniformity of Language	R30	Enforce the use of Defined Terms by avoiding Synonyms	TRC-A030	Enforce the use of Defined Terms by avoiding Synonyms	Non-parameterized
			Avoid the use of Unknown acronyms	TRC-A050	Avoid the use of Unknown acronyms	Non-parameterized
		R31	Avoid the use of unknown abbreviations	TRC-A060	Avoid the use of unknown abbreviations	Non-parameterized
			Enforce the use of a complete sentence structure	TRC-A010	Enforce the use of a complete sentence structure	Non-parameterized



46 Attributes

Attribute	Value	Unit	Measurement	Profile
TRC-A010	1		Non-parameterized	
TRC-A015	1		Parameterized - Cluster	
TRC-A030	1		Parameterized - Pattern matching	
TRC-A035	1		Parameterized - Pattern matching	
TRC-A040	1		Parameterized - Pattern matching	
TRC-A050	1		Parameterized - Cluster	
TRC-A055	1		Parameterized - Sub terms in SCM	
TRC-A065	1		Parameterized - Pattern matching	
TRC-A120	1		Parameterized - Pattern matching	
TRC-A125	1		Parameterized - Term tag	
TRC-A030	1		Non-parameterized	
TRC-A020	1		Parameterized - Term tag	
TRC-A130	1		Parameterized - Pattern matching	
TRC-A140	1		Parameterized - Term tag	
TRC-A150	1		Parameterized - Term tag	
TRC-A160	1		Measurement units consistency metric	
TRC-A040	1		Parameterized - Cluster	
TRC-A170	1		Parameterized - Cluster	
TRC-A050	1		Parameterized - Cluster	
TRC-A180	1		Parameterized - Special Sentences	
TRC-A030	1		Parameterized - Special Sentences	
TRC-A020	1		Parameterized - Pattern group matching	
TRC-A010	1		Non-parameterized	
TRC-A125	1		Parameterized - Cluster	
TRC-A030	1		Parameterized - Pattern group matching	
TRC-A040	1		Non-parameterized	
TRC-A050	1		Non-parameterized	
TRC-A060	1		Non-parameterized	
TRC-A070	1		Parameterized - Cluster	
TRC-A080	1		Parameterized - Cluster	
TRC-A090	1		Parameterized - Cluster	
TRC-A100	1		Parameterized - Term tag	
TRC-A110	1		Non-parameterized	
TRC-A130	1		Non-parameterized	
TRC-A140	1		Parameterized - Pattern matching	
TRC-A160	1		Parameterized - Term tag	
TRC-A080	1		Parameterized - Cluster	
TRC-A170	1		Parameterized - Pattern matching	
TRC-A175	1		Parameterized - Pattern matching	
TRC-A180	1		Parameterized - Special Sentences	
TRC-A090	1		Parameterized - Cluster	
TRC-A070	1		Parameterized - Term tag	
TRC-A010	1		Non-parameterized	
TRC-A070	1		Parameterized - Term tag	
TRC-A100	1		Parameterized - Cluster	
TRC-A125	1		Parameterized - Custom code	
TRC-A160	1		Parameterized - Term tag	
TRC-A040	1		Parameterized - Pattern matching	
TRC-A055	1		Parameterized - Pattern matching	
TRC-A060	1		Parameterized - Attribute	
TRC-A080	1		Overlapping consistency metric	
TRC-A090	1		Parameterized - Cluster	
TRC-A100	1		Parameterized - Cluster	
TRC-A110	1		Parameterized - Cluster	
TRC-A120	1		Parameterized - Pattern group matching	
TRC-A125	1		Parameterized - Custom code	
TRC-A130	1		Parameterized - Cluster	
TRC-A140	1		Parameterized - Cluster	
TRC-A150	1		Parameterized - Pattern matching	
TRC-A060	1		Parameterized - Cluster	
TRC-A030	1		Non-parameterized	
TRC-A050	1		Non-parameterized	
TRC-A060	1		Non-parameterized	
TRC-A010	1		Non-parameterized	



### Need for an automated process: Real-time quality assessment

INCOSE Rule	Rule short name	Metric Number	Metric Name	Metric Type
R06	Units	TRC-M140	Ensure Numbers are followed by Units or noun qualifications	Parameterized - Term tag
		TRC-M150	Detect inadequate Unit for a Characteristic	Parameterized - Relationships not SCM compliant
		TRC-M160	Avoid mixing up different measurement systems	Measurement units consistency metric

#### 4.1.6 R6 - /ACCURACY/UNITS

Use appropriate units when stating quantities.

##### Elaboration:

All numbers should have units of measure explicitly stated in terms of the measurement system used or the thing the number refers.

Within a project, a **common measurement system** must be used consistently. For example, don't mix both US and metric units of measure within any of the project's artifacts.

There are three primary measurement systems: British imperial, US, Metric

For temperatures the following are used: celsius, fahrenheit, or kelvin, etc.

Use appropriate units when stating quantities





### Need for an automated process: Real-time quality assessment

#### 4.1.2 R2 - /ACCURACY/USEACTIVEVOICE

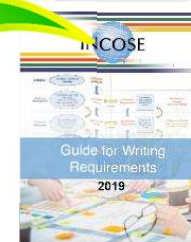
Use the active voice **in the main sentence** structure of the need or requirement statement with the responsible entity clearly identified as the subject of the sentence.

##### *Elaboration:*

The active voice requires that the entity performing the action is the subject of the sentence. This is important in writing needs and requirements since the onus for satisfying the requirement is on the subject, not the object of the statement. If the entity responsible for the action is not identified explicitly, it is unclear who or what should perform the action making verification of that requirement very difficult. Including the entity in the subject also helps ensure the requirement refers to the appropriate level consistent with the entity name (see R1).

Often when the phrase “shall be” is used, the statement is in the passive voice.

GUIDE



#### 4.4.2 R19 - /SINGULARITY/AVOIDCOMBINATORS

Avoid combinators.

##### *Elaboration:*

Combinators are words that join clauses, such as “and”, “or”, “then”, “unless”, “but”, “as well as”, “but also”, “however”, “whether”, “meanwhile”, “whereas”, “on the other hand”, and “otherwise.” Their presence in a requirement usually indicates that multiple requirements should be written.

**Exception:** AND, OR, NOT can be used in need and requirement statements as logical conditions and qualifiers as stated in R15.

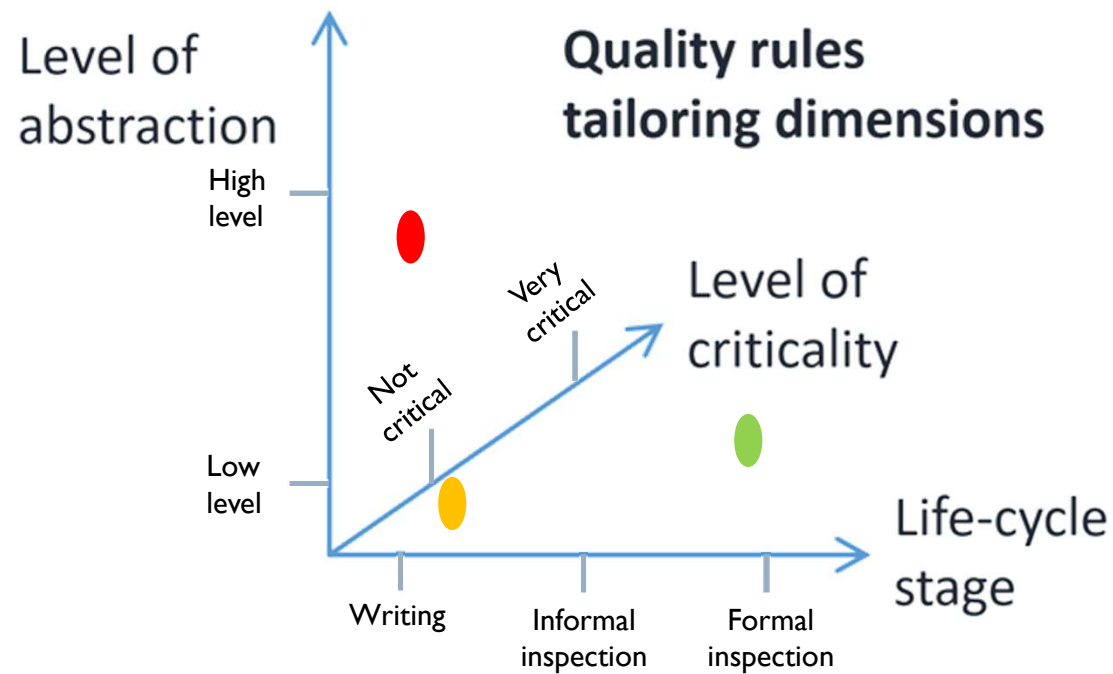
See also R16 and R17.



-



## The 3-dimensional tailoring space





## The 3-D 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-D tailoring space: Level of Criticality

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

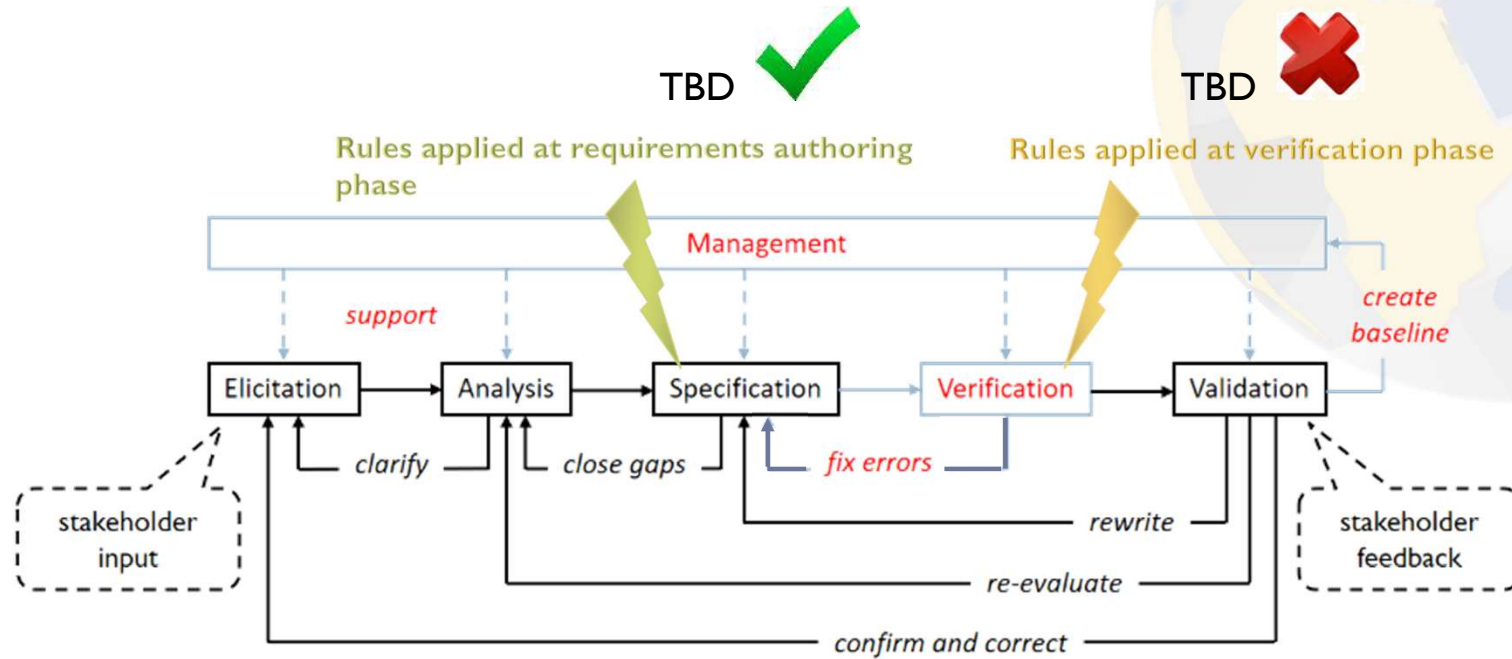
- Non-critical SOI: **Entertainment System**
- Critical SOI: **Engine** or **Electronic Control Unit**







## The 3-D tailoring space: Life-cycle Stage

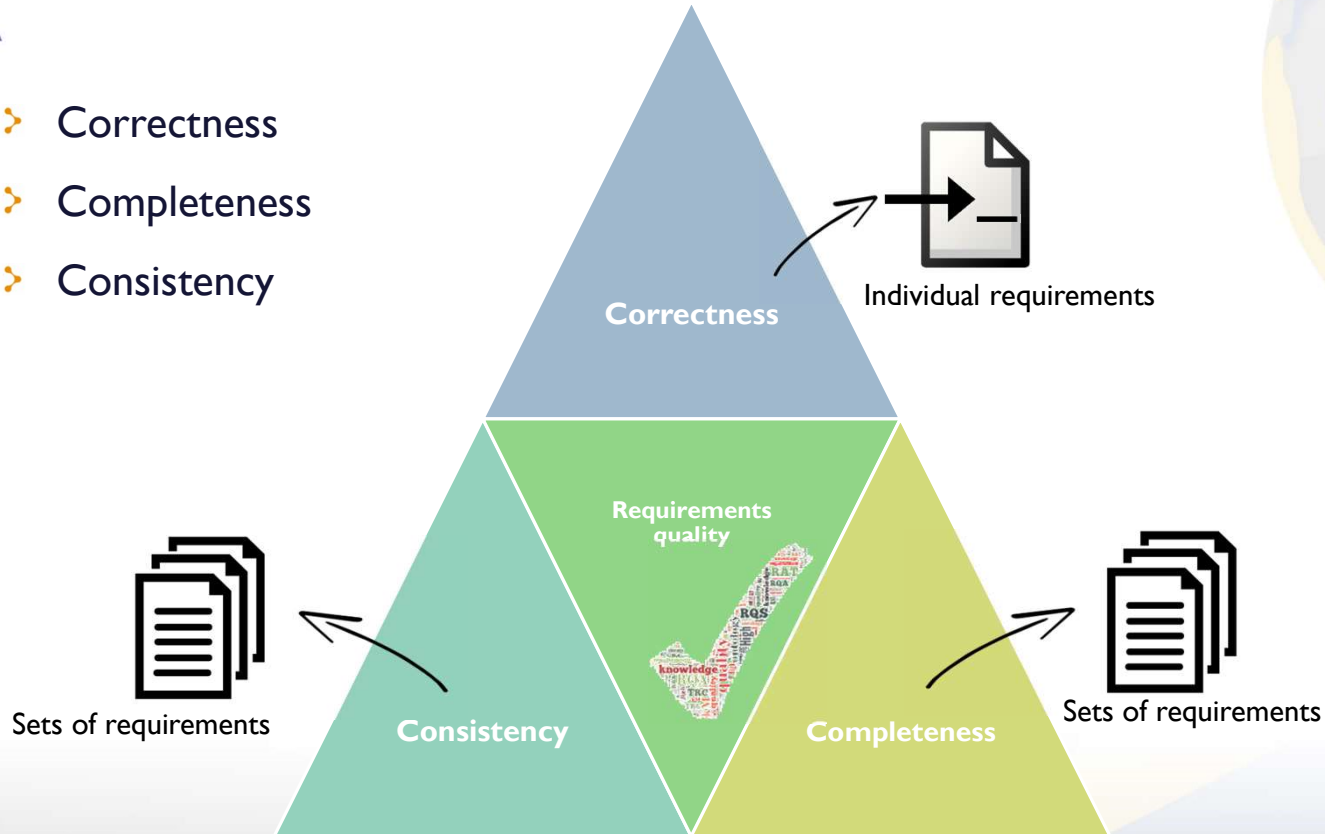


Adapted from: Karl Wiegers

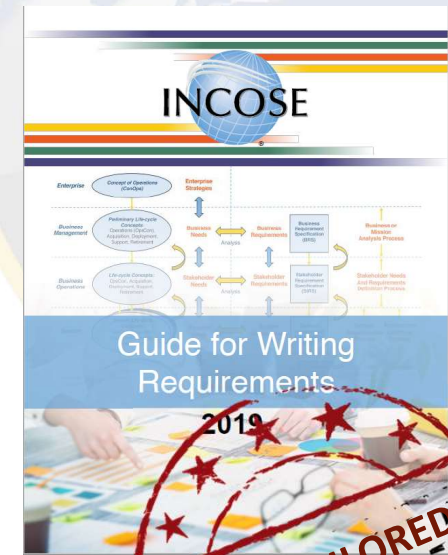


## Solution: The CCC approach

- Correctness
- Completeness
- Consistency



## Challenges & Proposed Solutions – Raising the Ante

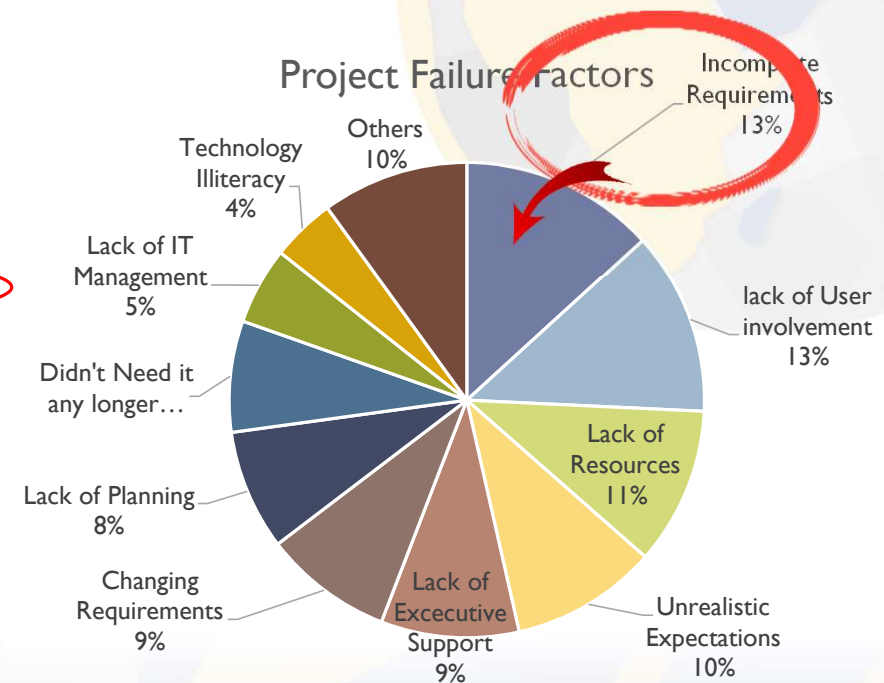




## Need to go beyond correctness checking: Completeness

### Challenges & Proposed Solutions – Raising the Ante

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%





### Need to go beyond correctness checking: Completeness

Completeness in the GfVR:

Characteristics C4: for individual requirements

Characteristics C10: for sets of requirements

#### Two Completeness Rules:

R24 – Avoid the use of pronouns and indefinite pronouns

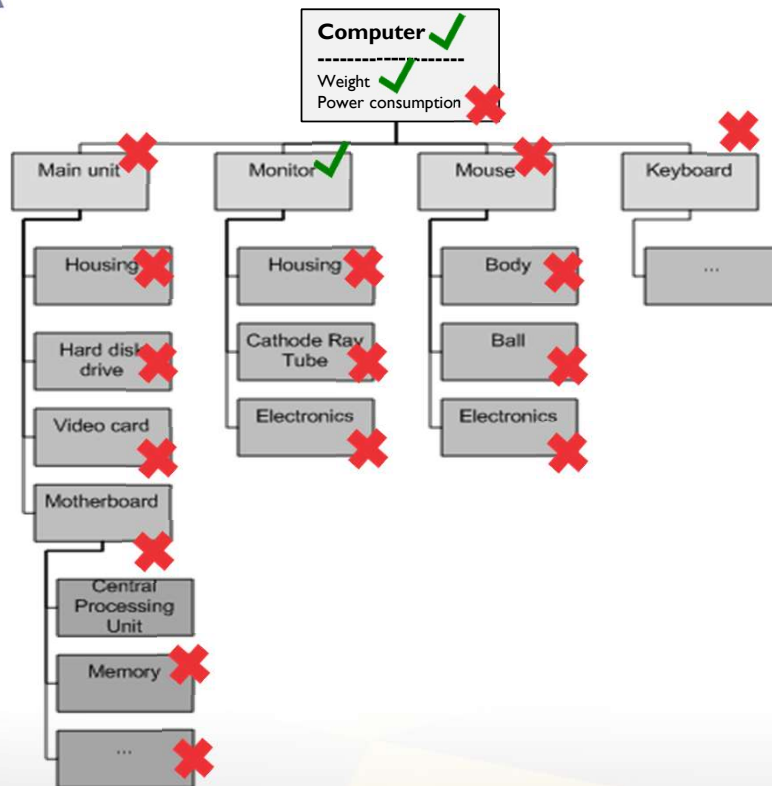
R25 – Avoid relying on headings to support explanations or understanding of the requirements

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

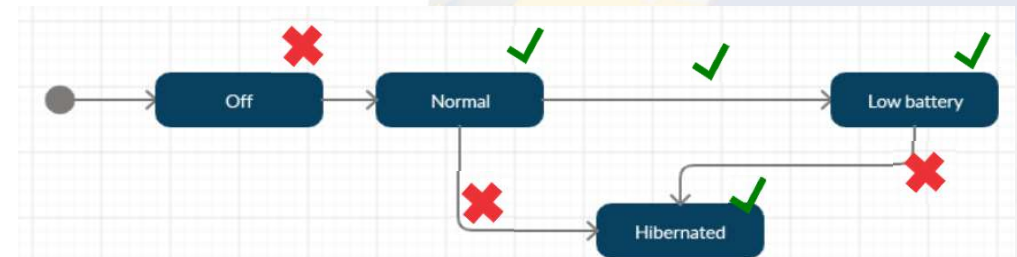




## Solution: Real-time quality checking for Completeness



## Challenges & Proposed Solutions – Raising the Ante



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

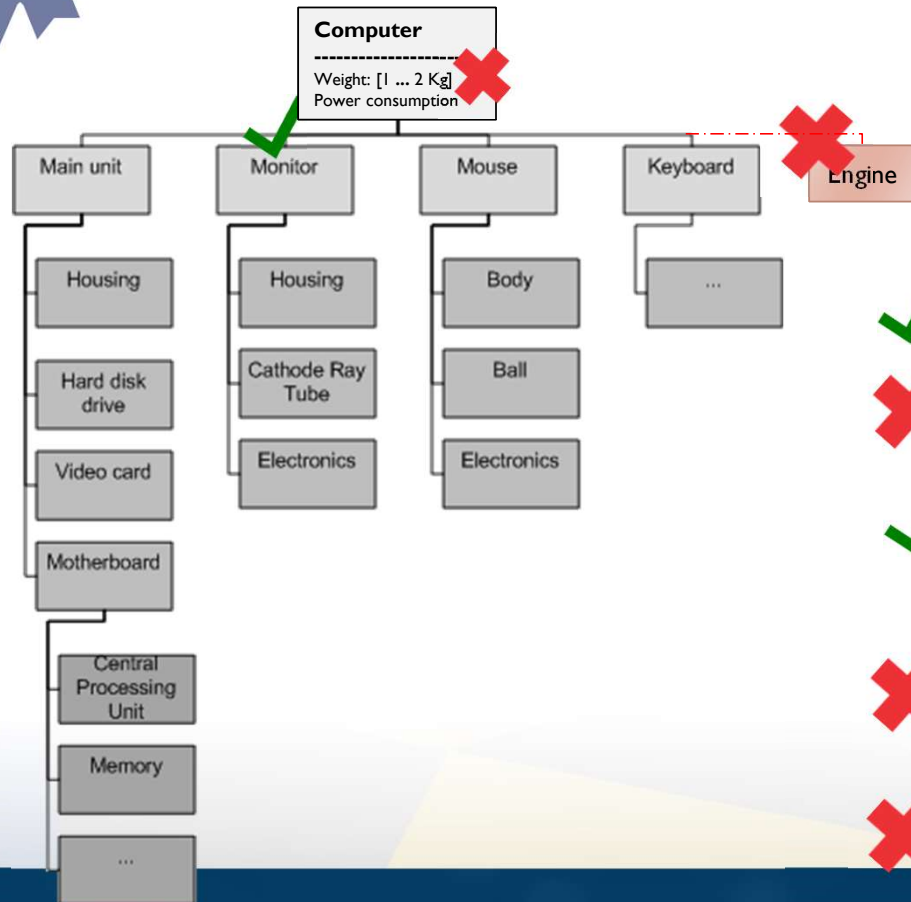
When the Computer is in Hibernated mode, the monitor shall turn black

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

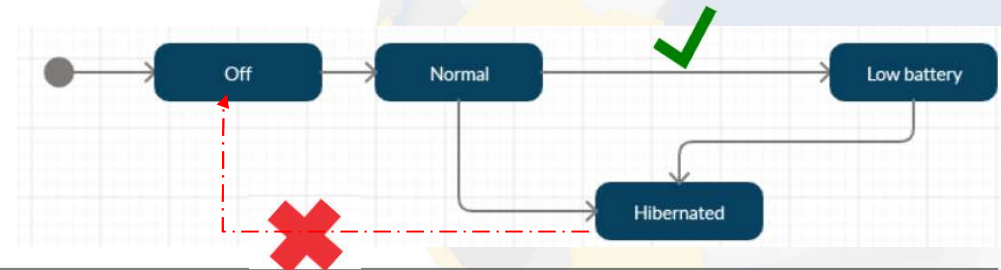




## Solution: Real-time quality checking for Consistency



## Challenges & Proposed Solutions – Raising the Ante



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

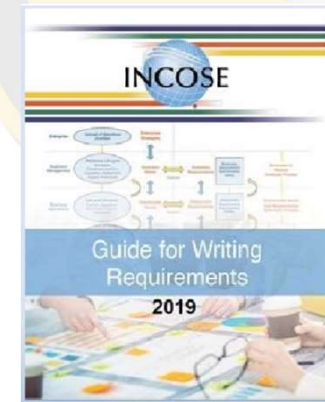
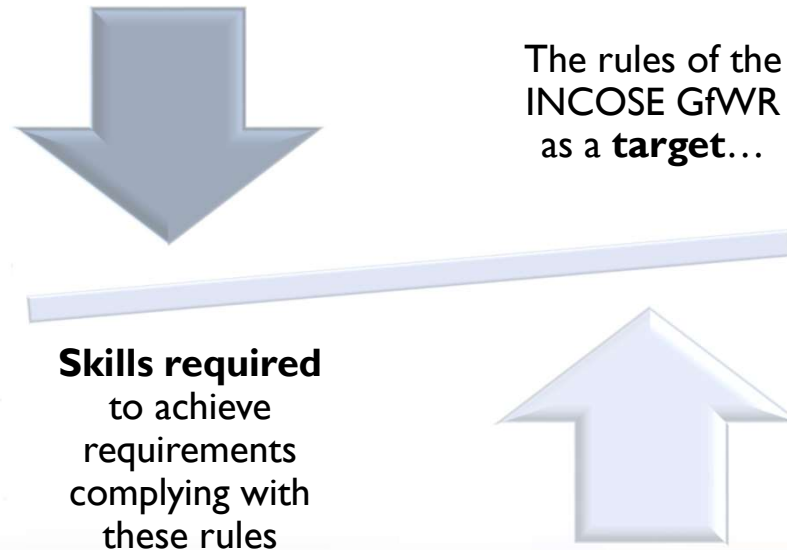
When the Computer is in Hibernated mode and EventX is received, the computer shall transit to Off mode

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



## Challenges: Adaptability to the skills of team members

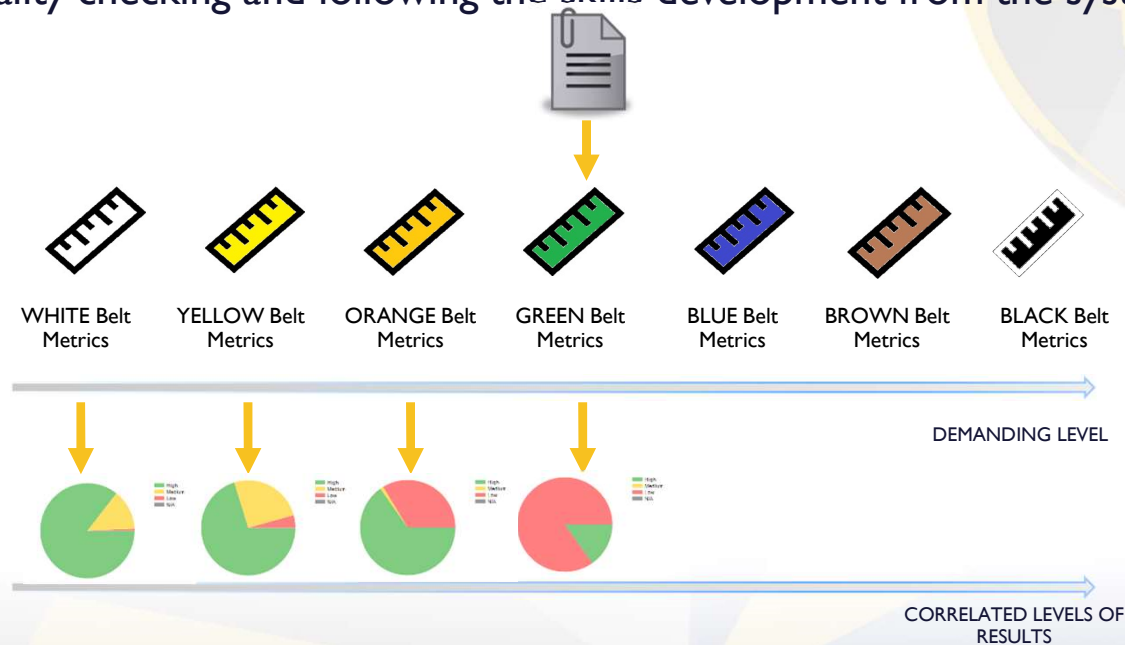
- Need for a roadmap to improve the tailored set of rules from the INCOSE GfWR





## Solution: Incremental methodology – Quality belts

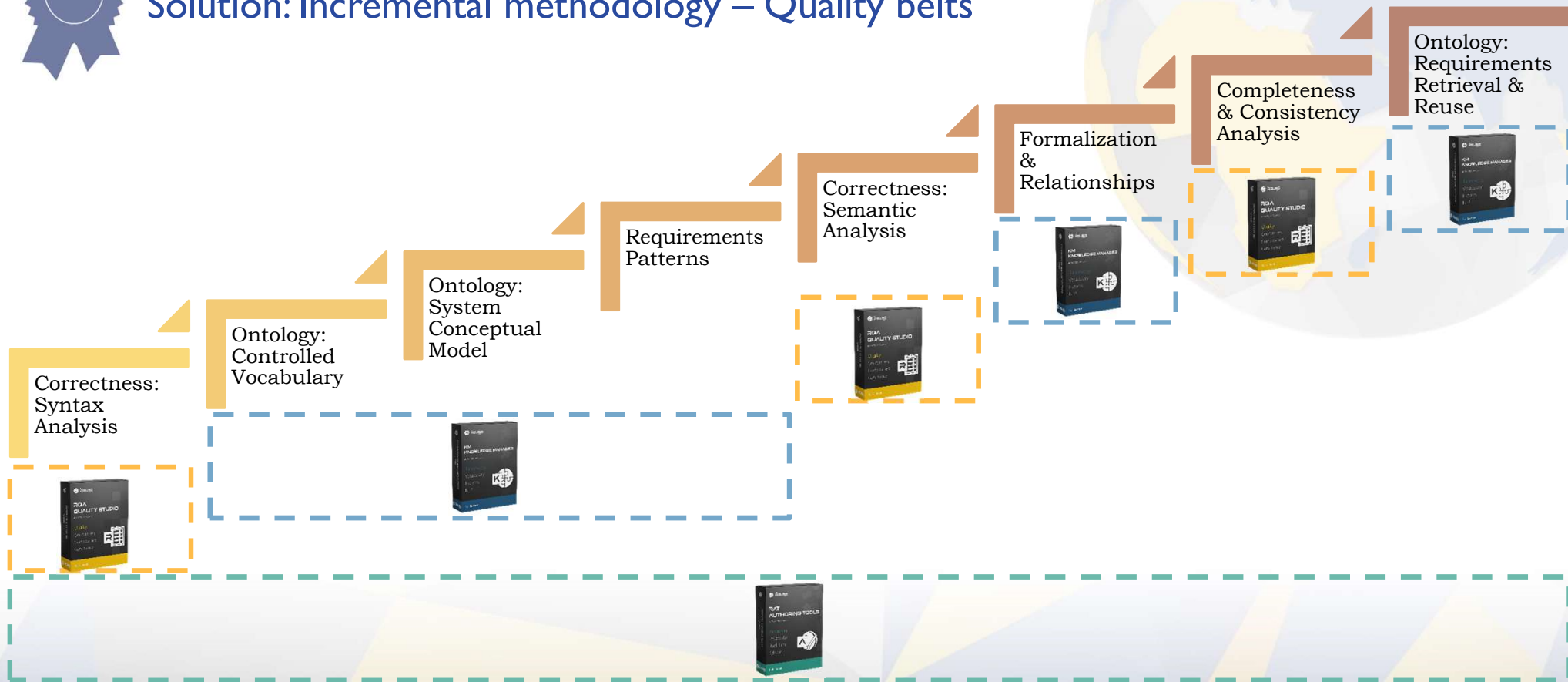
- Design a roadmap based on the concept of belts, like in martial arts, to gradually increase the complexity of quality checking and following the skills development from the systems engineering team.





## Solution: Incremental methodology – Quality belts

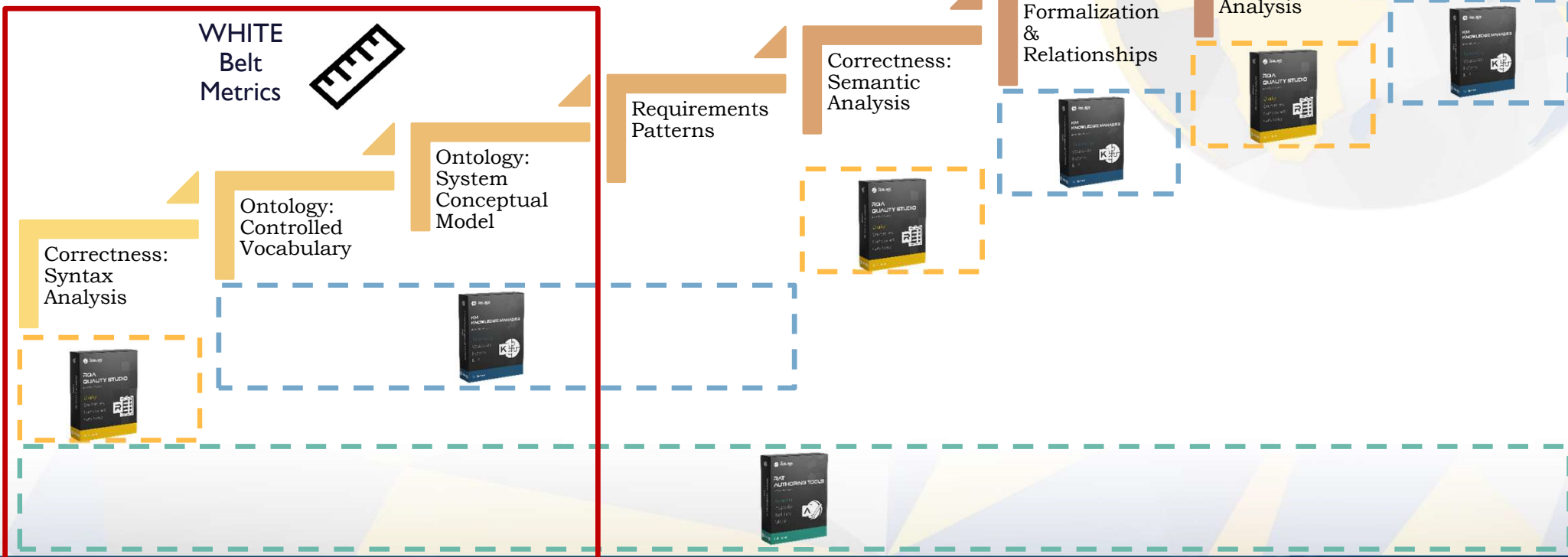
### Challenges & Proposed Solutions – Raising the Ante





## Challenges & Proposed Solutions – Raising the Ante

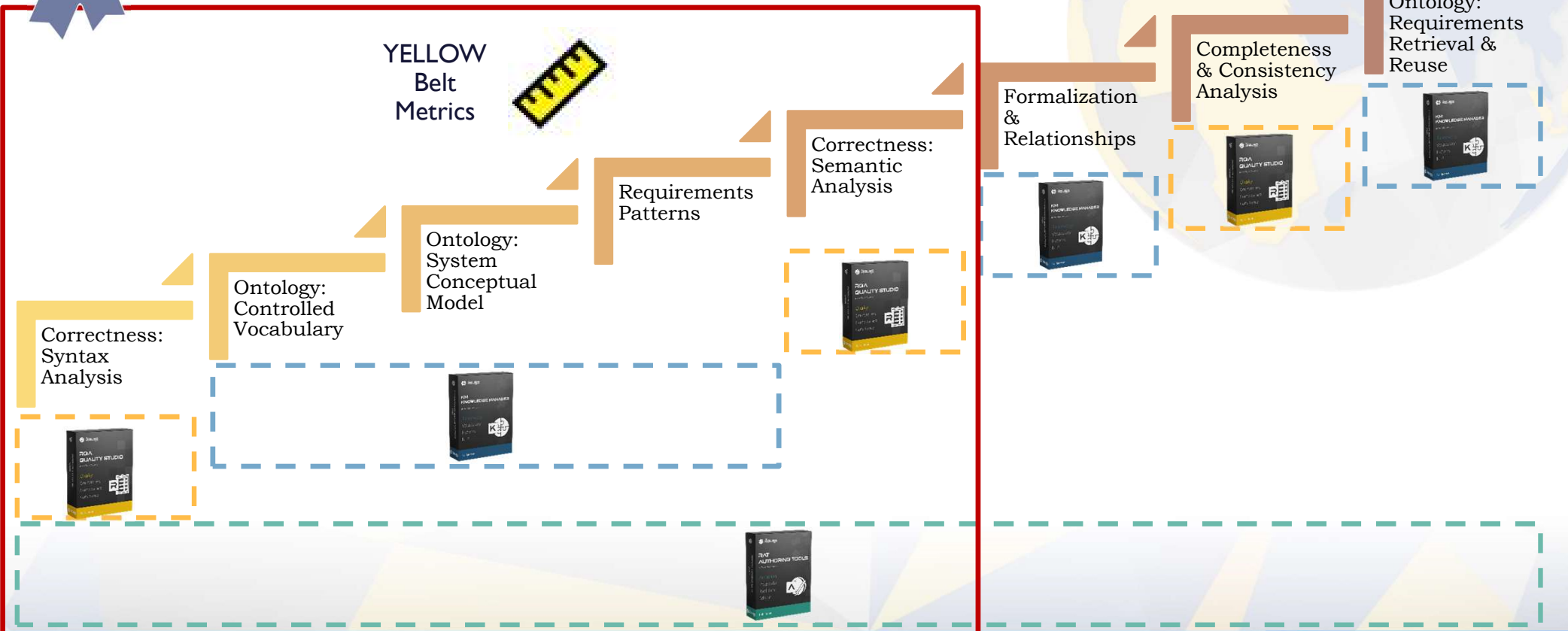
### Solution: Incremental methodology – Quality belts





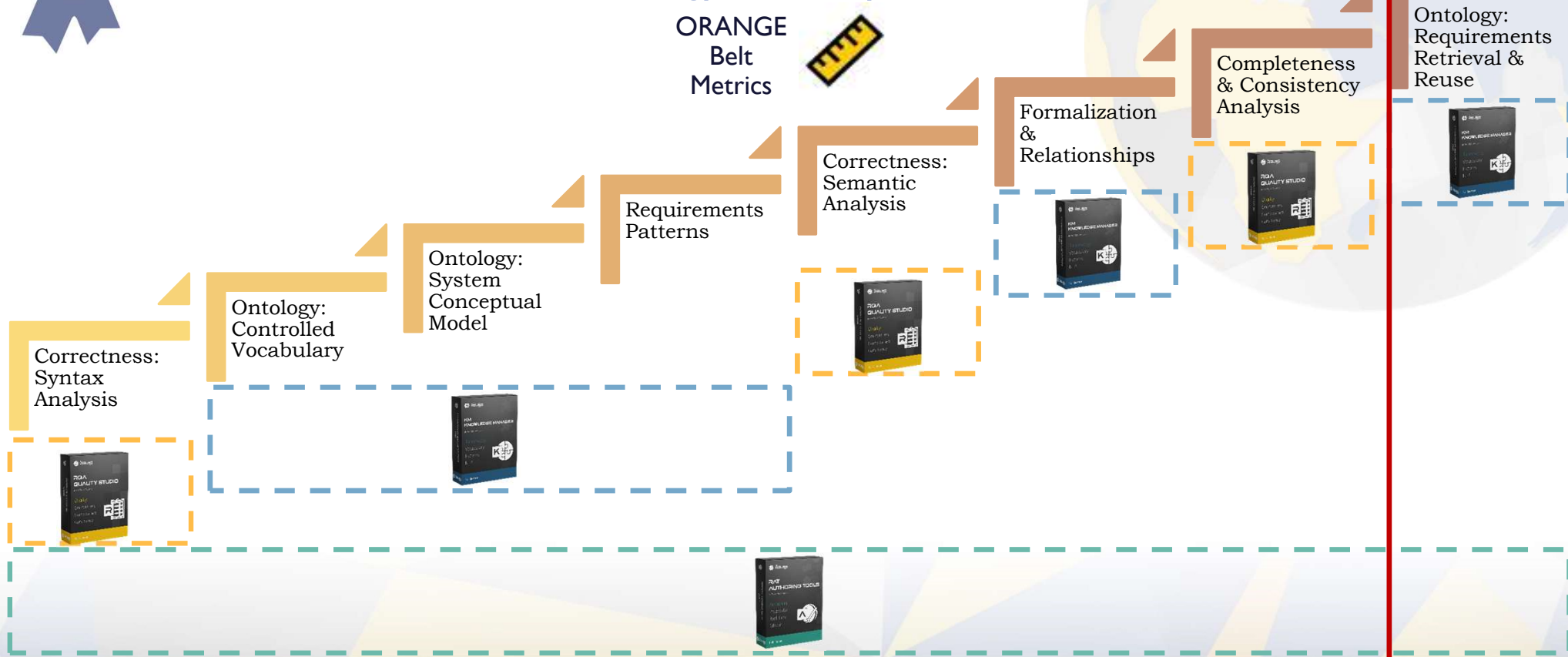


## Solution: Incremental methodology – Quality belts



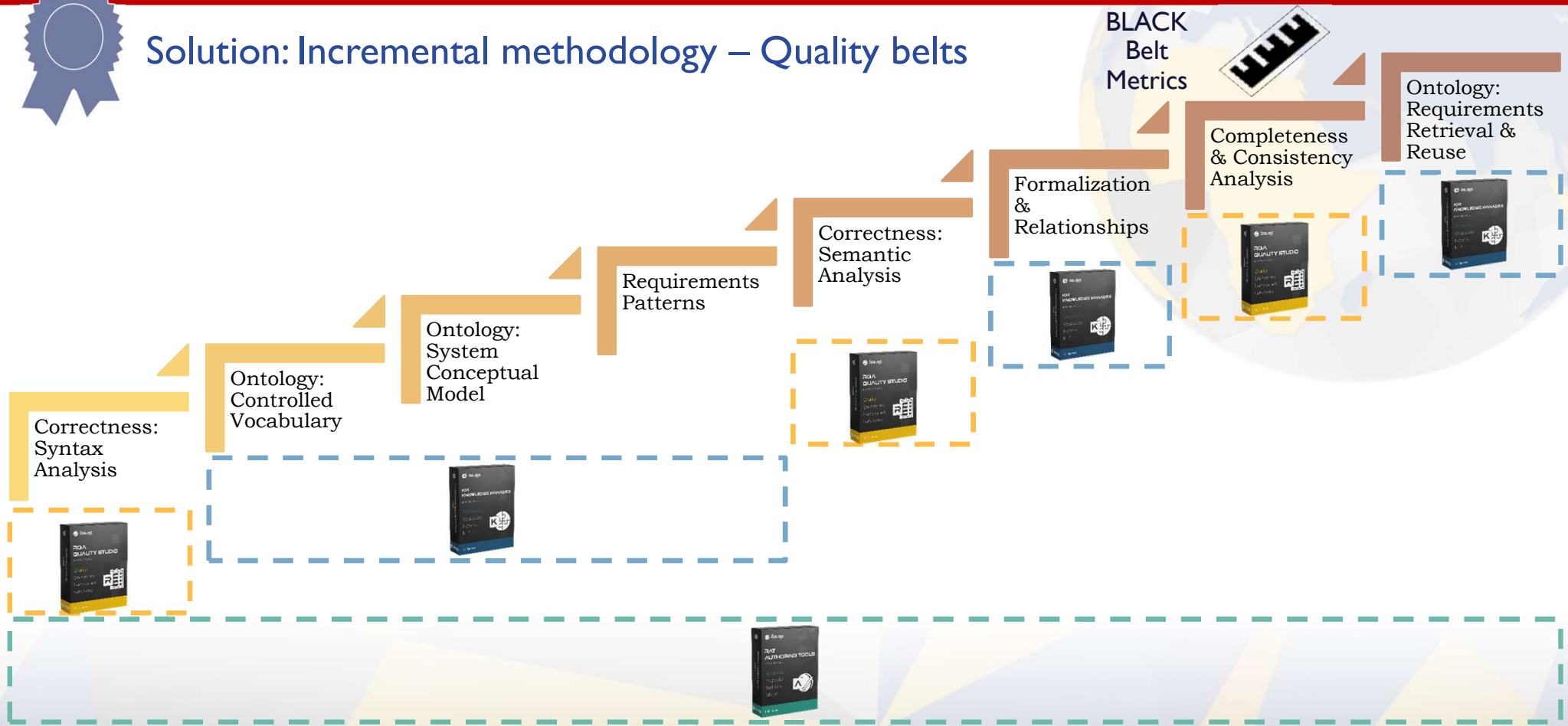


## Solution: Incremental methodology – Quality belts





## Solution: Incremental methodology – Quality belts





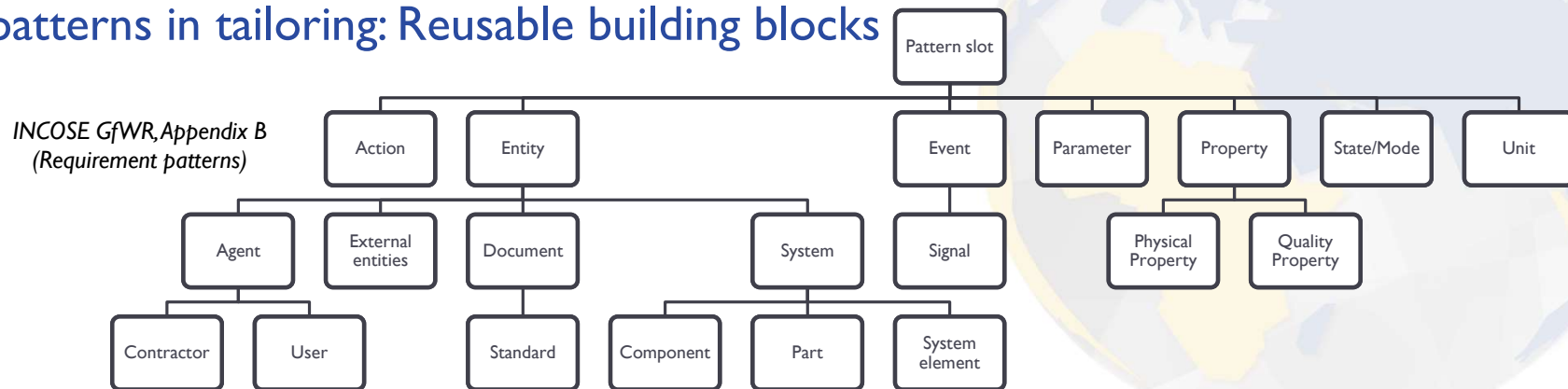
## Challenges: The role of patterns in the tailoring



- Some rules of the INCOSE GfWR (for example R1 and R39) rely on requirement patterns (or boilerplates), but patterns are not addressed in great detail
- 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.



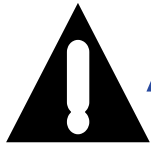
## Role of patterns in tailoring: Reusable building blocks



The INCOSE GfWR does not mention patterns lists, 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 GfVR can apply to all types of requirements, ...
- ... but some of them should only apply to specific types of requirements

### Example : Rule 16 – Avoid Not (Negations)

Functional  
requirements



- The car shall **not** start until the driver turns the ignition



Safety  
Requirements



- When the car speed is higher than 10 km/h, the passengers shall **not** open the doors





## Solution: Quality checking for authors, not only quality inspections

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

File View Log

Authoring without patterns

< No pattern group >

No selected pattern group implies no writing assistance

Font Arial Font Size 12

When the alarm is activated, the train shall be redirected to the closest station

Metric: Accuracy R02 / TRC-M040: Avoid the use of Passive Voice out of the condition block

N/A

Correctness metrics summary:

Metric	Value
Accuracy R02 / TRC-M040: Avoid the use of Passive Voice out of the condition block	1

Edit manual assessment

Ready

When / After  
/ If ...

[Condition]

<Subject>

Shall

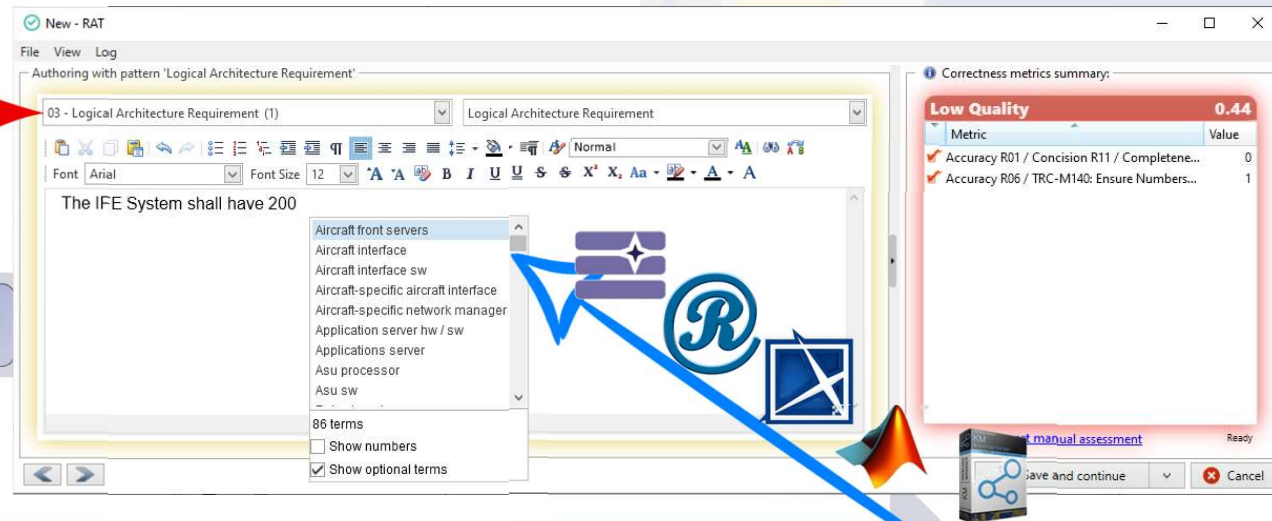
<Action>

<Object>

[Constraint]



### Solution: Requirements authoring supported by Pattern-based writing



When / After / If ... [Condition] <Component>

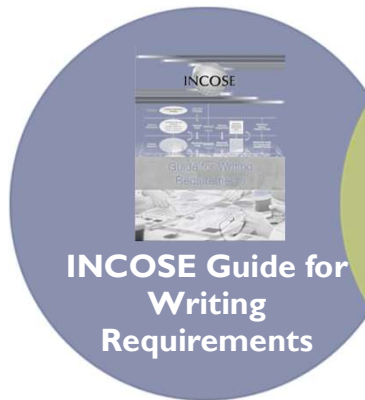
<Component> Shall Have a/NUMBER <Component>

The <Property> Of <Component> Shall be [Value]



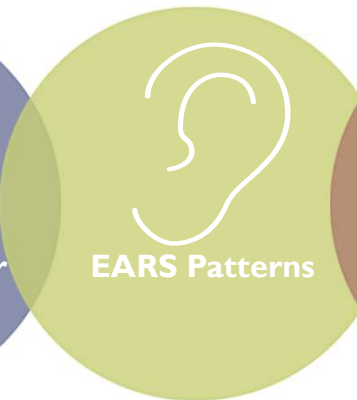
## Solution: Domain-specific Libraries

### Challenges & Proposed Solutions – Raising the Ante



**INCOSE Guide for Writing Requirements**

**INCOSE**  
Quality rules for the analysis of textual requirements



**EARS Patterns**

**EARS**  
Requirements patterns

**ECSS and NASA**  
Glossary, patterns and rules

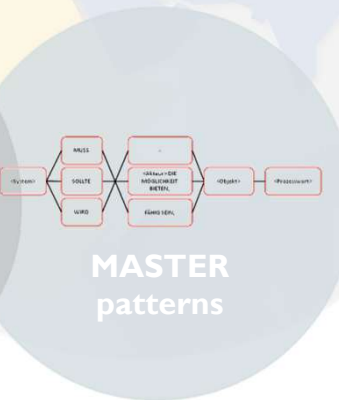


**ECSS and NASA Libraries**



**ISO 26262 Library**

**ISO 26262**  
Glossary, patterns and rules



**MASTER patterns**

**MASTER**  
Quality rules for requirements and requirements patterns



TRC WEBINARS

Link to TRC webinar section:

<https://www.reusecompany.com/webinars>



## Solution: The Systems Engineering Suite

- **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

<http://www.reusecompany.com>



## Challenges & Proposed Solutions – Raising the Ante







## Solutions: Summary of GfVR tailoring benefits

- Provides support for **requirements authors**, not only for **quality analysts**, to **apply the rules at the earliest Life Cycle stages**
- Adopts the **CCC** (Correctness, Consistency & Completeness) approach to analyse requirements
- Enables an **incremental methodology** (Quality Belts) to adapt to the overall context
- Provides automated support for **time-consuming activities**:
  - Pattern-based authoring
  - Distinguishing between requirements writing and quality inspection activities
  - Natural Language Processing (NLP) for advanced semantics
  - Domain-specific libraries to adapt the rules to the requirements domain





## Solution: The Systems Engineering Suite + AI

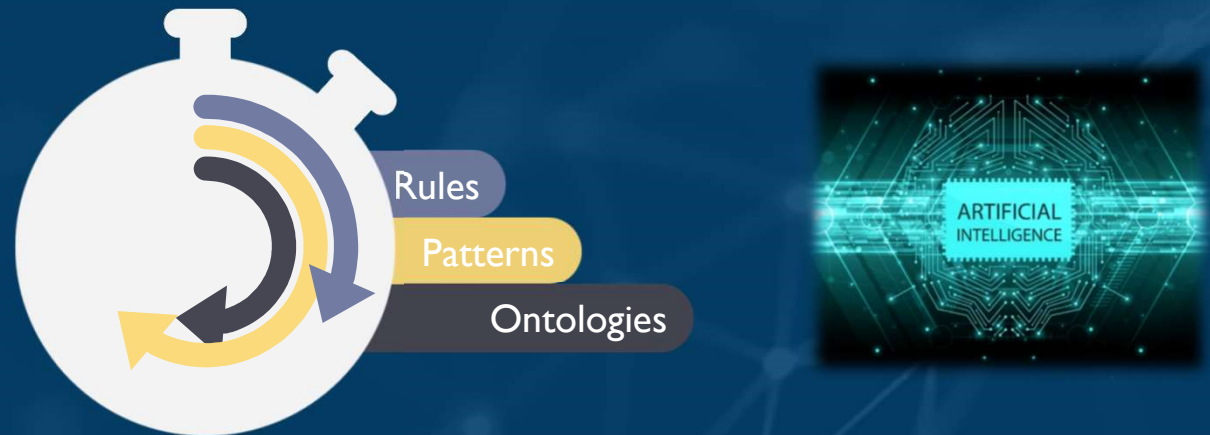
### Manual Inspection

- Requires time
- Requires intensive SME support



### Automated Assessment (AI + NLP)

- Reduction of time
- Less support from SME





# Raising the Ante

## Demo



## Real-time quality assessment of the INCOSE GfWR Rules: A Tailoring Guide

- Fill out this form: <https://share.hsforms.com/1NhlzIZaRRwG53dvfUHgb6Q2lpn5>



- ....and request your personal copy
- plus a complimentary licence for the SES Suite to evaluate the library that implements this tailoring guide
- The licence is valid for a period of 30 days from date of issue

<https://www.reusecompany.com/webinars>







# ***Upcoming Webinars (tentative schedule)***



Who	What	When
Jose Fernandez and Carlos Hernandez	ISE&PPOOA a MBSE Methodology from System to Software Architecture	Wednesday 18 <sup>th</sup> November 2020 at 11am EST

Invitations will be emailed in advance and informational updates will be placed on [www.incose.org](http://www.incose.org)

Go to <http://www.incose.org/products-and-publications/webinars> for more info on the webinar series, including a way to view the last 143 Webinars and soon – this one!

Information on the webinars is now being posted in INCOSE Connect, in the INCOSE Library area, at

<https://connect.incose.org/Library/Webinars/Pages/INCOSE-Webinars.aspx> .

Joining instructions will added around two weeks before the webinar is scheduled to take place.



1-Sep-20



Save the Dates

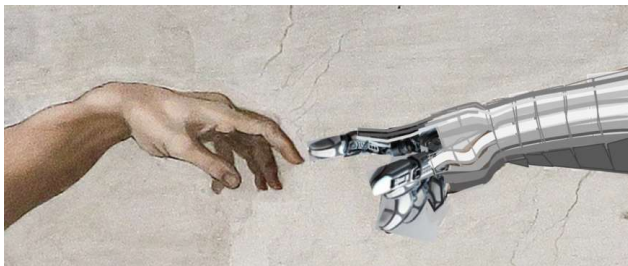
**HSI WG – IW2020**

**Tuesday-Thursday, 27-29.10.2020**

International Workshop:

**Human System Integration in the Era of Global Crises Challenges and Opportunities.**

You are invited to take part in Developing and Advancing the HSI Awareness and Practices in the Systems Engineering Community. Join us to reinforce the HSI community and inspire to persistent dialogue on HSI.



**Virtual event** for about 4 hours a day.

13:15 UTC/GMT on 27.10 and 13:55 UTC/GMT on 28, 29.10.

Free Registration. Pre-registration is required.

[https://forms.office.com/Pages/ResponsePage.aspx?id=vCENNyqVPkmiyRPPoeY1IC3ta8YTwnNChCe4fC\\_MqhNUN1NPSFQ0VzZZSIJXOTU1WDRHWEdYRUtVTi4u](https://forms.office.com/Pages/ResponsePage.aspx?id=vCENNyqVPkmiyRPPoeY1IC3ta8YTwnNChCe4fC_MqhNUN1NPSFQ0VzZZSIJXOTU1WDRHWEdYRUtVTi4u)

# INCOSE System of Systems Engineering Mini-Event

## 4 November 2020



### INCOSE presents a System of Systems Engineering mini event!

The event will be virtual, taking place 4 November 2020.

Hosted by Garry Roedler, INCOSE Immediate Past President.

Topics from various speakers include:

- Systems of Systems Engineering: Past, Present, and Future (Judith Dahmann)
- The Systems Challenge of Quantum Technologies (Michael Henshaw)
- A Mindset Shift from SoS to IoTs and Back Again (Kerry Lunney)
- From the Roads to the Skies – Transferring Insights Between Systems of Systems Domains (Alan Harding).

Register now!



Register now!

<http://incose.informz.net/z/cjUucD9taT0zMTA4NDY0JnA9MSZ1PTM3Njg1Mzk3MyZsaT0yNjA3Mjc5MA/index.html>

# INCOSE Systems Engineering Professional PDU Credit



Please note that you can claim 1PDU credit towards your Systems Engineering Professional re-certification by attending this webinar. The webinars may also apply to the PDU requirements of other organizations, depending on the subject matter

To qualify, you must have attended through at least 75% of the webinar for webinars that last less than one hour, or through 45 minutes of the webinar for webinars that last for 1 hour or longer.

You can also claim credit for previous webinars you have attended; please contact [info@incose.org](mailto:info@incose.org) if you wish to know which webinars you attended and if you met the qualification requirements



With thanks to our Sponsor for 2020

