



2018 Annual INCOSE  
**Great Lakes Regional Conference**  
**SYSTEMS AT THE CROSSROADS**  
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# Using Cognitive Computing to Elevate Requirements Quality and Test Case Accuracy

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**Bob Parro**, VP Business Development & Product Development, River North Solutions  
**Steve Denman**, Principal Consultant, Stephen D. Denman Consulting, LLC  
**Kevin McHugh**, Senior Managing Consultant, IBM Watson IoT Lab Services

[www.incose.org/glrc2018](http://www.incose.org/glrc2018)

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# Agenda



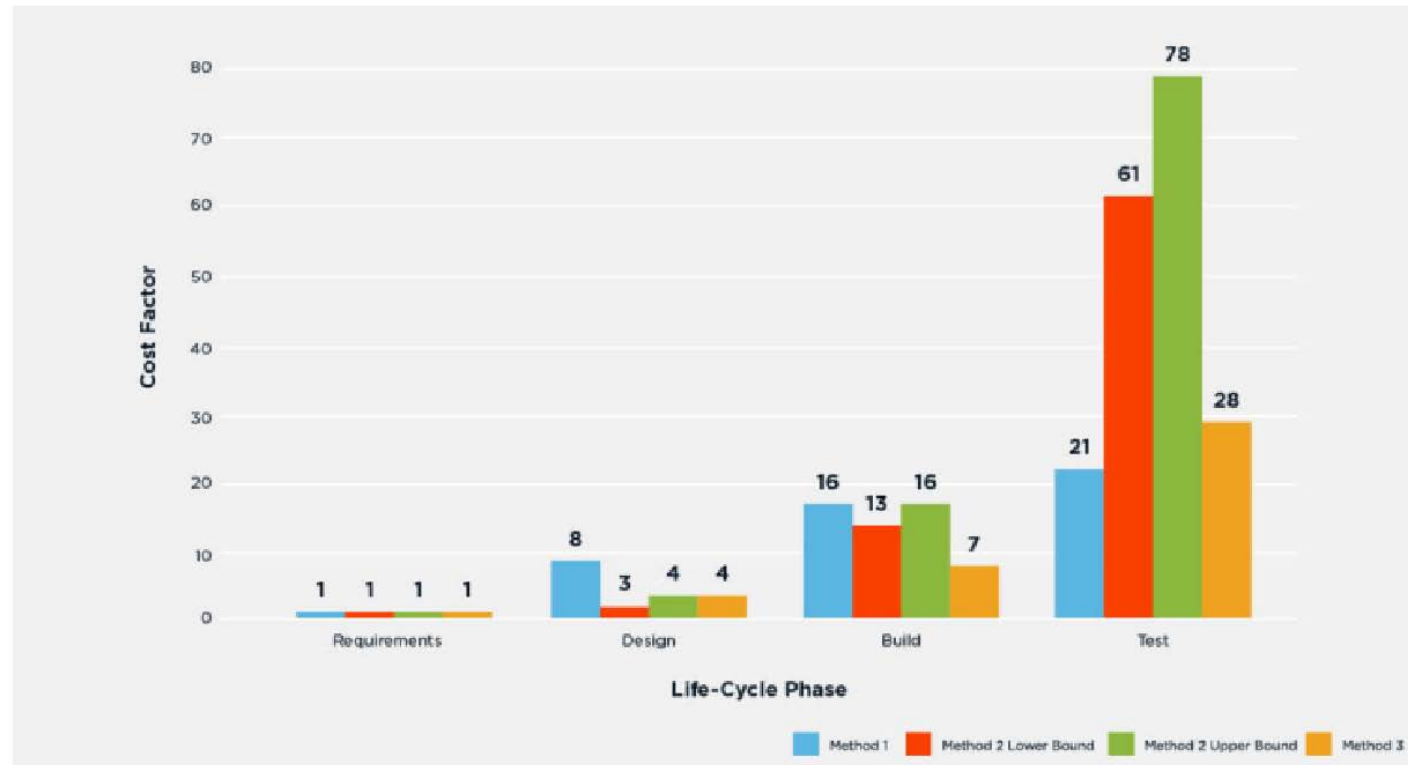
- The problem
- Cognitive approaches
- Cognitive engineering
- Cognitive requirements and test offerings
- Benefits of cognitive tools
- Future of cognitive engineering
- Summary & challenge
- Q&A

# The problem



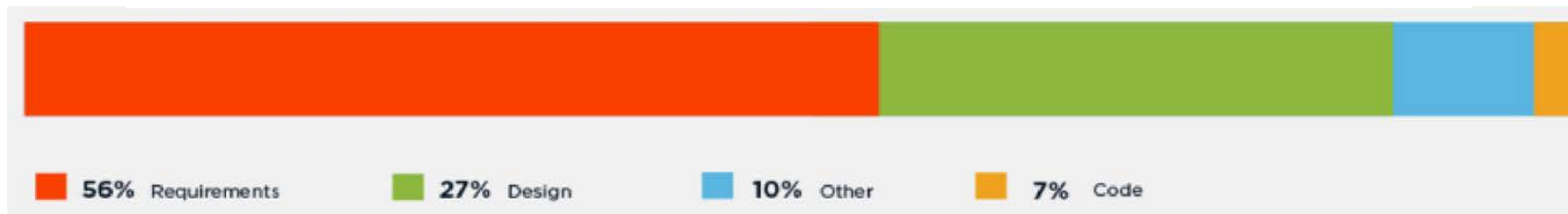
- Poor requirements are widely understood to be the cause of numerous project/product failures
  - Schedule delays, cost overruns, poor quality, going to market with reduced functionality compared to the original plan, going to market with the wrong product or solution
  - These impacts have been studied and long understood

# The problem



Cost to Fix Errors  
Increases Exponentially  
the Later They are  
Found in the  
Development Lifecycle

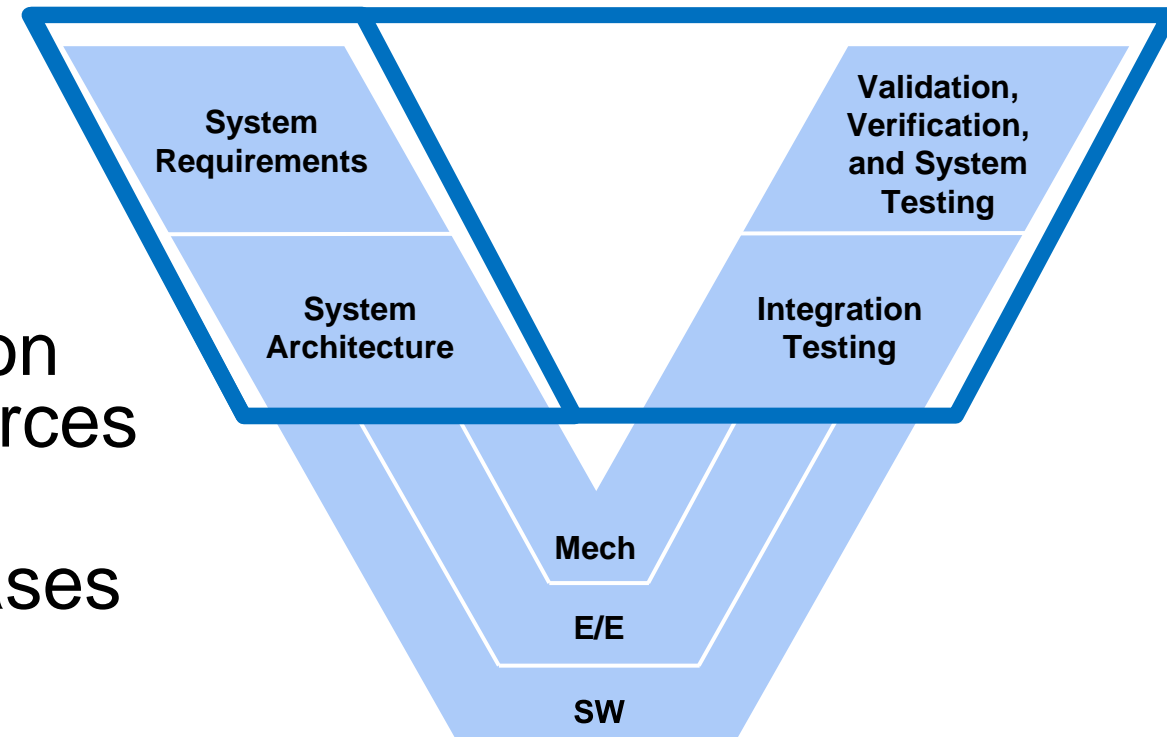
Comparison of System Cost Factors – Excluding Operations [Jonette]



Distribution of defects  
in software projects by  
development phase  
(Martin)

# The problem

- But, there's more to this picture
  - Poor validation & verification practices also lead to failures
  - Test development and execution typically consume lots of resources and schedule
    - Only amplified when test cases are written poorly
  - Poor requirements result in poor test cases
    - Compounded by poor test case development practices



# The problem underlying the problem



- Human language, aka natural language (NL), **still** the primary engineering specification language
  - Ambiguous by nature, even for humans
  - Computer comprehension still far behind human
- 60+ years developing computer comprehension of NL
  - Procedural
  - Formal specification
  - Cognitive computing
  - Combinations of above

# Procedural approaches



- Conventional programming and information models to process natural language
  - Text parsed based on rules-based and/or pattern recognition techniques
    - Rules/patterns based on linguistics knowledge
  - Graph of text parts and relationships created and used to “understand” current and new text
  - Works better when requirements written within constraints
    - The <entity> shall <action verb> <object> <per some measure>

# Formal specification



- Avoid issues with natural language by not using it
  - Formal languages
    - Structured, rigorous textual expressions
    - Range from sets of rules/constraints to highly formal expressions
    - Difficult to write - even more difficult to read
  - Modeling (graphical languages)
    - Graphical expression of structure, relationships, behavior, constraints, etc., e.g., SysML
    - Valuable but limited ability to express richness available in NL
    - Use of modeling + NL specifications expanding rapidly



# Cognitive computing & deep learning



- Cognitive computing
  - Technology apps/services/platforms based on Artificial Intelligence (AI) techniques, including deep learning
- Deep learning
  - A non-procedural computing approach based on neural network model of human brain
  - Training needed to “teach” the network to recognize patterns
    - Supervised learning stage: Guided by SMEs
    - Requires input corpus of known “good” and “bad” patterns
    - Semi-supervised and unsupervised learning

# Natural Language Understanding and Processing (NLU/NLP)



- NLU
  - Machine comprehension of parts of speech, interrelationships, and meaning in a body of text
  - Based on deep learning over a corpus of knowledge
- NLP: Apps and services that utilize NLU
  - Ex: Digital assistants: Apple Siri, Amazon Alexa
  - Ex: Sentiment analysis: IBM Watson, MS Azure
  - Language translation: Google Translate

# Cognitive engineering



- Cognitive computing in engineering tool chains
- Tools can *finally* begin to *assist* engineers
  - Improving quality
  - Reducing errors, oversights, time, cost, ...
  - Requirements are getting most of focus currently
  - Testing is next logical choice
    - Also based heavily on NL
    - Derived directly from requirements
- Cross-domain, cross-lifecycle traceability next

# Cognitive engineering

## Improving quality of requirements & test



- Requirements
  - Numerically score quality – Rationale behind it
  - Recommendations – Rationale behind them
- Test
  - Numerically score quality – Rationale behind it
  - Recommendations – Rationale behind them

# Cognitive engineering

## Cognitive requirements and test offerings



A sample of the available offerings:

- QRA Corp QVscribe
- Argosim STIMULUS
- Qualicen Scout
- The Reuse Company offerings

# QVscribe from QRA Corp

## Requirements analysis for quality & consistency



Uses Natural Language Processing (NLP)

- Auto-detects requirements
- IDs and corrects ambiguities
- IDs duplicate or conflicting requirements
- Checks terminology and units consistency
- Quality Indicators
  - Imperatives (e.g. shall), Options (e.g. can, may), Vagueness (e.g. pronouns), Weaknesses (e.g. adequate), Subjectiveness (e.g. larger), Continuances (e.g. below), Universal quantifiers (all)
- Produces quality scorecard

# QVscribe from QRA Corp

## Requirements analysis for quality & consistency

CSA-ESM-RD-0004\_Rev A\_Prototype Lunar Exploration Light Rover\_Requirements Document - Word

Home Insert Design Layout References Mailings Review View Add-ins Tell me what you want to do Share

Sign in

QVscribe

Quality Analysis Consistency Similarity

Last Analyzed: November 14, 2017 at 9:07AM View: All

Overall Quality Score 23 Quality Warning

Requirement	Score & Warnings
[EC-LMR-PRF-010] Range: The Lunar Exploration Light Rover shall have a range...	Score: 5/5
[EC-LMR-PRF-018] Maximum Speed on Prepared Surface: The Lunar Exploration...	Score: 5/5
[EC-LMR-PRF-120] Maximum Speed on Natural Terrain: The Lunar Exploration Li...	Score: 5/5
[EC-LMR-PRF-068] Rock Hazard: The Lunar Exploration Light Rover running gear...	Score: 5/5
[EC-LMR-PRF-069] Soil Properties: The Lunar Exploration Light Rover shall be abl...	Score: 5/5
[EC-LMR-PRF-150] Reverse speed: The speed requirements apply in forward and...	Score: 5/5
[EC-LMR-PRF-063] Minimum Speed: The Lunar Exploration Light Rover shall be c...	Score: 5/5
[EC-LMR-PRF-065] Acceleration: The Lunar Exploration Light Rover, at maximum...	Score: 5/5
[EC-LMR-PRF-170] Stopping distance: The Lunar Exploration Light Rover, at maxi...	Score: 5/5
[EC-LMR-PRF-059] Consecutive Stops: The Lunar Exploration Light Rover, loaded...	Score: 5/5
[EC-LMR-PRF-017] Gradeability: The Lunar Exploration Light Rover shall drive at...	Score: 5/5
[EC-LMR-PRF-040] Obstacle Crossing: The Lunar Exploration Light Rover shall dri...	Score: 5/5
[EC-LMR-PRF-040] Obstacle Crossing: The Lunar Exploration Light Rover shall be...	Score: 5/5

Quality Warnings

Contains vague words

Contains universal quantifiers

QVscribe Marked Requirement

[EC-LMR-PRF-040] Obstacle Crossing: The Lunar Exploration Light Rover shall drive at low speed over obstacles of up to 0.3 m wide, 0.3 m long, and up to 0.3 m high with edges rounded to a radius of 0.05m. Note that if wheels are not the design solution, then the intent is that whatever the ground interaction, be it tracks, hovering, etc., the Lunar Exploration Light Rover can pass over this obstacle size.

Rationale: The Lunar Sourcebook mentions rock sizes up to 80cm (p32). The Lunar Science Working group found that the largest rock that would have to be crossed would be 30cm (Qizinski et al. Manned Lunar Mission (MLM) Science Working Group (SWG) Technical Note 1, p48). Rounding the edges gives the obstacle a more rock-like shape.

QVscribe Marked Requirement

[EC-LMR-PRF-060] Ground Clearance: The Lunar Exploration Light Rover shall be able to pass over an obstacle with a height of 0.35 m and a width of 0.7 m. No projection of the Lunar Exploration Light Rover shall be closer to the ground than 0.35 m, other than the wheels, suspension and drivetrain components.

Rationale: The Lunar Sourcebook mentions rock sizes up to 80cm (p32). The Lunar Science Working group found that the largest rock that would have to be crossed would be 30cm (Qizinski et al. Manned Lunar Mission (MLM) Science Working Group (SWG) Technical Note 1, p48). Rounding the edges gives the obstacle a more rock-like shape.

QVscribe Marked Requirement

[EC-LMR-PRF-090] Maximum Gradient: The Lunar Exploration Light Rover shall be able to stop in a controlled fashion while ascending or descending a slope.

Comment: Note that this requirement is not intended to be applied for low-friction surfaces such as concrete, which would require rubber for traction.

8

March 4, 2010

## Quality Analysis



# QVscribe from QRA Corp

## Requirements analysis for quality & consistency

CSA-ESM-RD-0004Revision A  
March 4, 2010

*Rationale: This function is required to support the non-locomotion functions of the Exploration System. The specific requirements are in RD-2.*

QVscribe Marked Requirement

[EC-LMR-DNT-010] Payload power: The Lunar Exploration Light Rover shall be capable of providing a total average power of 250 W to all payloads and instruments during all mission phases.

*Rationale: Payloads and instruments cover a wide range of systems from payloads that only require keep-alive warmth (minimal in normal analogue environments) to power-hungry subsystems like drills. The value was chosen somewhat arbitrarily. Note a single automotive battery contains about 100 W-hr.*

[EC-LMR-DNT-011] Payload power boost: When parked, the Lunar Exploration Light Rover shall increase the available power to the payloads and tools by at least 100%. The Lunar Exploration Light Rover should be capable of providing all unused power to the payloads.

*Rationale: Some subsystems such as a drill or robot arm, will require substantial power to operate, and when parked the Rover should not need its full power capacity. The value of 100% is selected to allow considerable leeway to the payloads. Initial estimates of rolling resistance for rover locomotion suggest that the cruise power of the rover will be in the 5 to 20 kW range, so the payload power boost is quite small relative to this, and will not affect rover range significantly.*

### 3.4 Safety

[EC-LMR-SMA-002] Maximum Speed: For safety requirements in this document, the speed to be used shall be the maximum speed achievable by the vehicle.

[EC-LMR-SMA-001] Safe Environment: When upgraded to transport astronaut, the Lunar Exploration Light Rover shall provide a safe environment to crew and maintenance personnel who are on-board or working on the exterior.

[EC-LMR-SMA-350] All-Stop: Upon command, the Lunar Exploration Light Rover shall conduct a graceful stop of all mechanical Payloads.

*Rationale: All-stop is required for safety. Several situations could cause a hazard which would require safing the system. (a) a loss of situational awareness by the operator, especially in tele-operation, due to camera malfunction or poor lighting or other confusing situation, (b) an internal failure, (c) concurrent*

### QVscribe

- Quality Analysis
- Consistency
- Similarity

- Units
- Terms

#### Unit Consistency

Unit	Count
meter	13
centimeter	5
[EC-LMR-PRF-068] Rock Hazard: The Lunar Exploration Light Rover running gear shall sur...	
[EC-LMR-FNC-044] Imaging: The Lunar Exploration Light Rover shall, upon command, tak...	
[EC-LMR-FNC-049] Basic Digital Terrain Mapping: The Lunar Exploration Light Rover shall, ...	
[EC-LMR-HSI-120] Crew Contact Loads: If applicable, Lunar Exploration Light Rover comp...	
[EC-LMR-PRF-380] Sensor Payload Accommodation: The Lunar Exploration Light Rover sh...	
time   3 Units	
hour	3
second	5
minute	3
angle   3 Units	
minute	3
degree	11
second	3
power, radiant flux   1 Units	
	1
Lunar Exploration Light Rover shall be capable of...	
	3
force   1 Units	
newton	1

## Unit and Term Consistency



# Argosim STIMULUS



- *Requirements-in-the-loop*
  - Executable requirements and system specs
- Automated requirements validation and verification
  - Based on formal requirements specification language and system models
  - Conflicting/missing requirements and functional coverage
- Formal language and system models automatically converted to software-in-the-loop (SIL) validation tests
  - Based on conversion to executable SIL test code via the Functional Mockup Interface (FMI) standard

# Argosim STIMULUS for Requirements

Stimulus Editor

File Edit View Navigate Layout Transform Insert Tools Help

Start page X Analog\_Switch\_SM X Analog\_Switch\_R X Landing\_System\_R X

Projects Libraries

Filter

Landing\_Gears\_System\_v2018\_01\_26

- src
  - Libraries
    - Glossary
    - Functions
    - Types
    - Constants
    - Whitespace
  - Components
    - Landing\_Gear\_System
      - Text
        - Landing\_System\_R
      - Architecture
        - Landing\_System\_Block\_Diagram
    - Digital\_Part\_IHM
      - Text
        - Digital\_Part\_IHM\_R
    - Analog\_Part
      - Text
        - Analog\_Part\_R
      - Architecture
        - Analog\_Part\_Block\_Diagram
    - Analog\_Switch
      - Text
        - Analog\_Switch\_R
      - State\_Machine
        - Analog\_Switch\_SM
      - SUT
        - FMI\_import
        - FMI\_wrapper
    - Pressure\_Detector
      - Text
        - Pressure\_Detector\_R
    - Doors
      - Text
        - Doors\_R
      - Architecture
        - Doors\_Block\_Diagram
      - subcomponents
        - Doors\_reaction
    - Gears
      - Text
        - Gears\_R

functional requirements

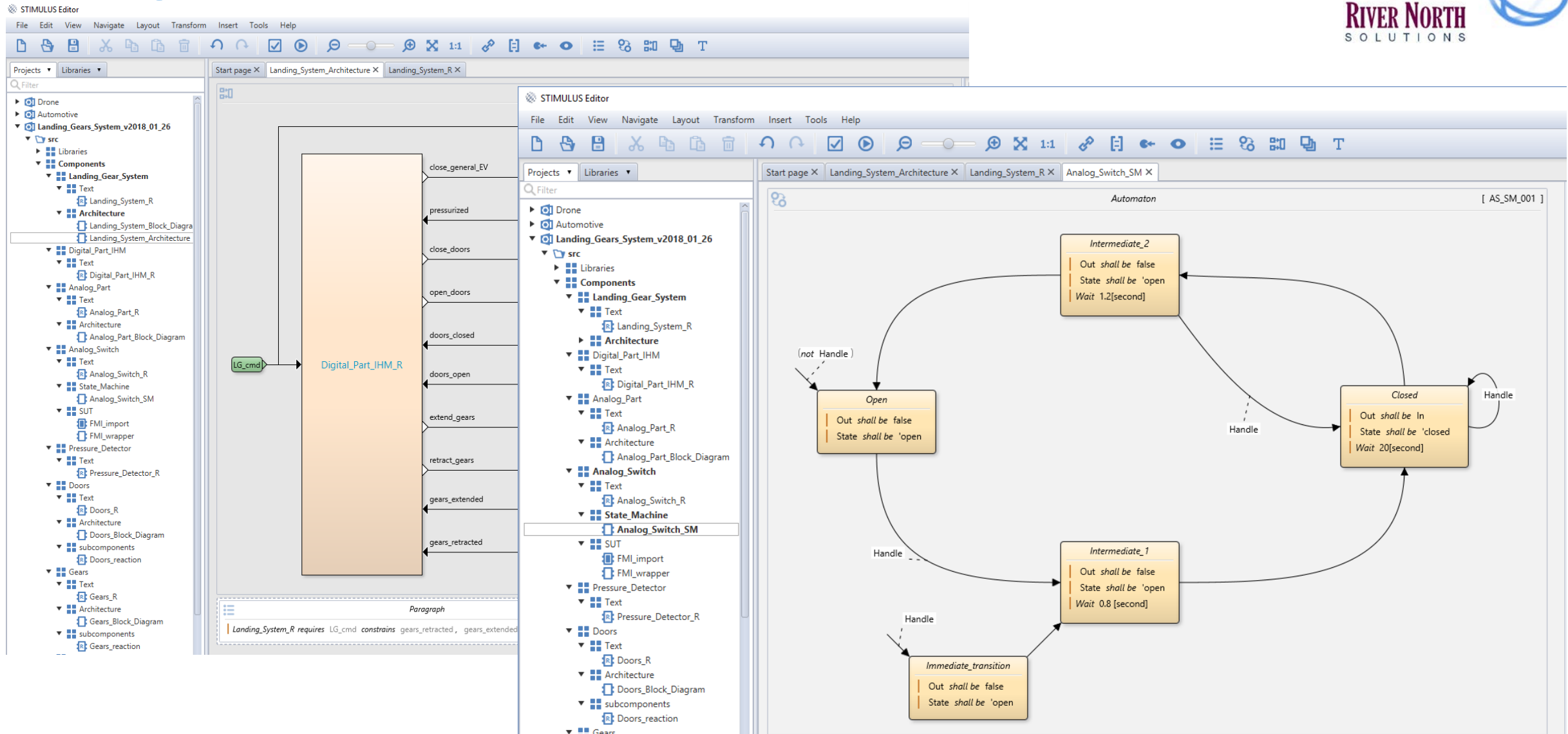
```
[ LS_RQ_001 ]When LG_cmd is 'DOWN',  
Do  
    gears_extended shall be true and doors_closed shall be true within 15[second]  
afterwards  
    gears_extended shall be true  
    doors_closed shall be true
```

```
[ LS_RQ_002 ]When LG_cmd is 'UP',  
Do  
    gears_retracted shall be true and doors_closed shall be true within 15[second]  
afterwards  
    gears_retracted shall be true  
    doors_closed shall be true
```

```
[ LS_RQ_003 ]When LG_cmd is 'DOWN',  
Do  
    gears_extended shall be true within 12[second]  
afterwards  
    gears_extended shall be true
```

```
[ LS_RQ_004 ]When LG_cmd is 'UP',  
Do  
    gears_retracted shall be true within 12[second]  
afterwards  
    gears_retracted shall be true
```

# Argosim STIMULUS for Requirements



# Argosim STIMULUS for Requirements

Stimulus Editor

File Edit View Navigate Layout Transform Insert Tools Simulation Help

Projects Libraries

Filter

Landing\_Gears\_System\_v2018\_01\_26

- src
  - Libraries
  - Components
  - Tests
- Automotive
  - src
    - Library
    - Requirements
      - glossary
      - LLR
        - LLR\_v1
        - LLR\_v2
        - LLR\_v3
  - Tests
    - World
    - Scenario
    - SUT
    - TestSuite

Start page X World X LLR\_v2 X

When headLight was 'ON and lightIntensity is greater than 70[percent] ,  
has been true for more than 3[second]  
headLight shall be 'OFF

REQ\_003.3

Do

If initially ( lightIntensity is less than or equal to 70[percent] ) then  
headLight shall be 'ON

afterwards

When ( lightIntensity is less than or equal to 70[percent] ),  
headLight shall be 'ON

REQ\_003.4

Do

If initially ( lightIntensity is greater than 70[percent] ) then  
headLight shall be 'OFF

afterwards

When ( lightIntensity is greater than or equal to 60[percent] ),  
headLight shall be 'OFF

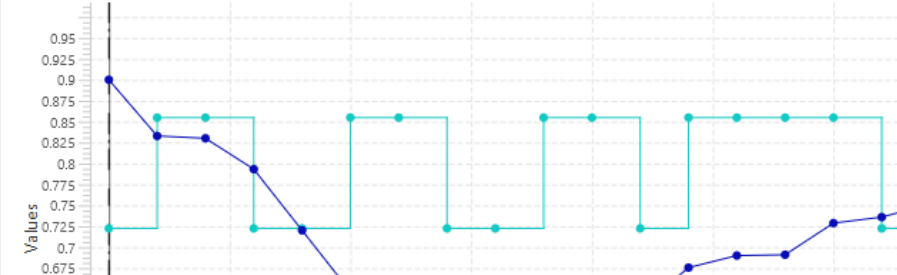
World/simu X

Runs 10 Steps 40 Clear Before Runs Current Run = 9 Current step = 33 Period = 0.1 second

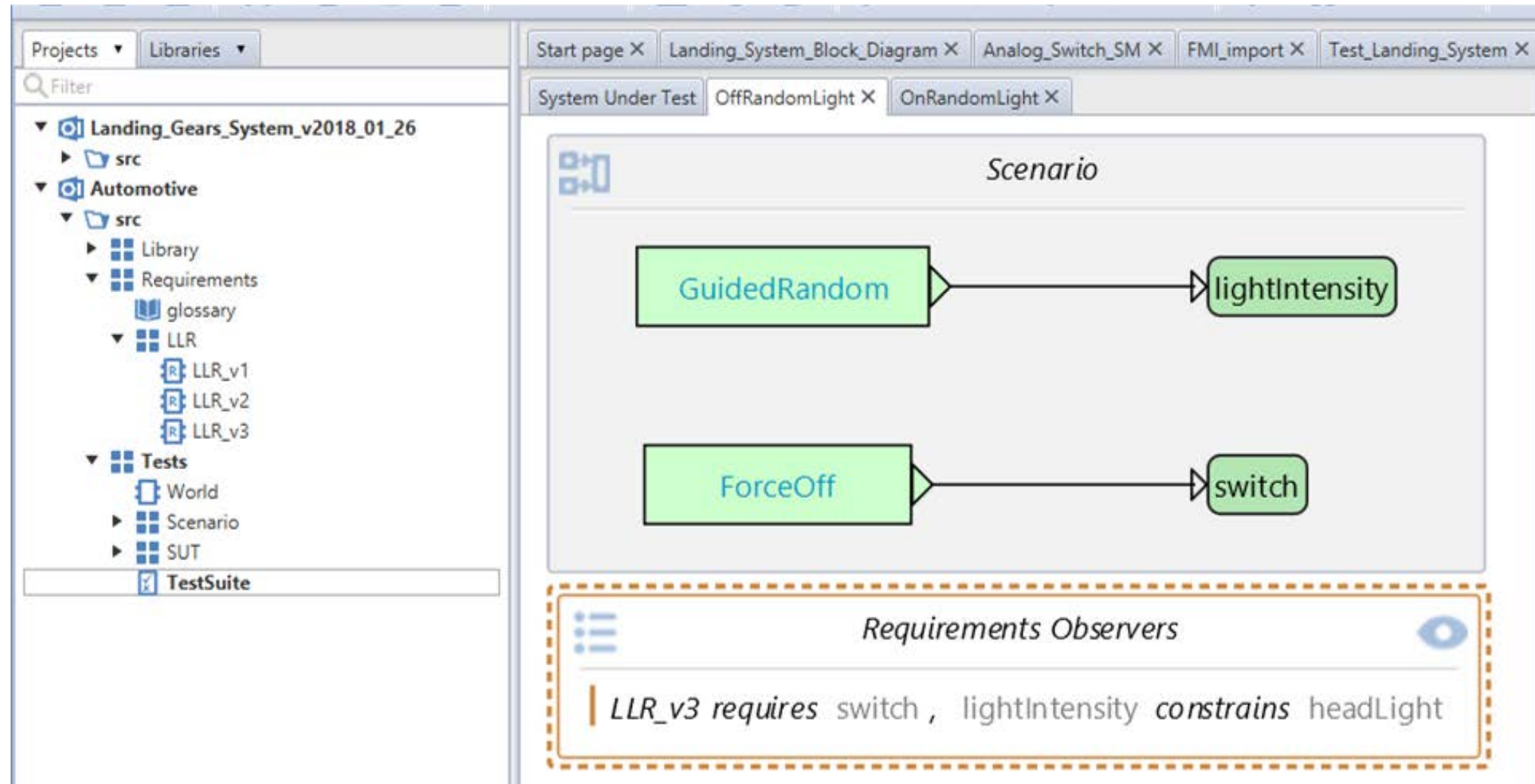
Runs [ 9 , 9 ] Show all runs

Filter

Name	Value	Observers	Coverage	Color
World			83.33%	
Ports				
lightIntensity	0.6259...			
switch	'AUTO			
headLight				
Variables				



# Argosim STIMULUS for Tests



# Scout from Qualicen



Rapid user feedback  
provides strongest learning

Integrations

- Word, DOORS, PTC Integrity

Trend analysis key capability

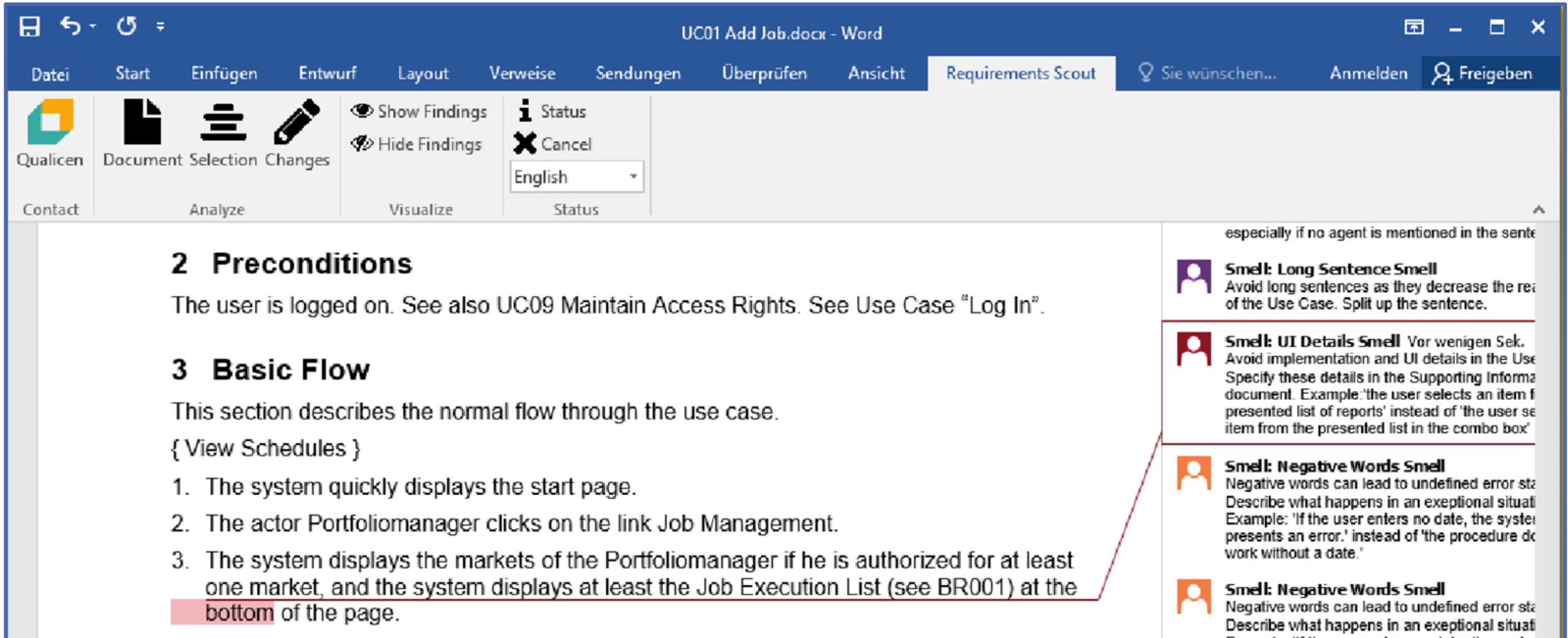
- Users want quality improvement over time

Key quality indicators

- Long, complicated sentences
- Passive voice
- Multiple negations
- Vague phrases and pronouns
- Comparatives and superlatives
- Dangerous slash
- UI details
- Cloning (same data not in sync)
- Todos



# Scout from Qualicen



The screenshot shows the Qualicen Scout application interface. The top ribbon includes tabs for Datei, Start, Einfügen, Entwurf, Layout, Verweise, Sendungen, Überprüfen, Ansicht, Requirements Scout, and a search bar. Below the ribbon is a toolbar with icons for Qualicen, Document Selection Changes, Show Findings, Hide Findings, Status, and Cancel. The main document area displays the text of a use case, with sections 2 and 3 highlighted. The sidebar on the right lists several quality smells, each with an icon and a description. A red line connects the text 'at the bottom' in the use case to the 'Smell: Negative Words Smell' entry in the sidebar.

UC01 Add Job.docx - Word

Qualicen Document Selection Changes Show Findings Hide Findings Status Cancel English

2 Preconditions

The user is logged on. See also UC09 Maintain Access Rights. See Use Case "Log In".

3 Basic Flow

This section describes the normal flow through the use case.

{ View Schedules }

1. The system quickly displays the start page.
2. The actor Portfoliomanager clicks on the link Job Management.
3. The system displays the markets of the Portfoliomanager if he is authorized for at least one market, and the system displays at least the Job Execution List (see BR001) at the bottom of the page.

especially if no agent is mentioned in the sentence

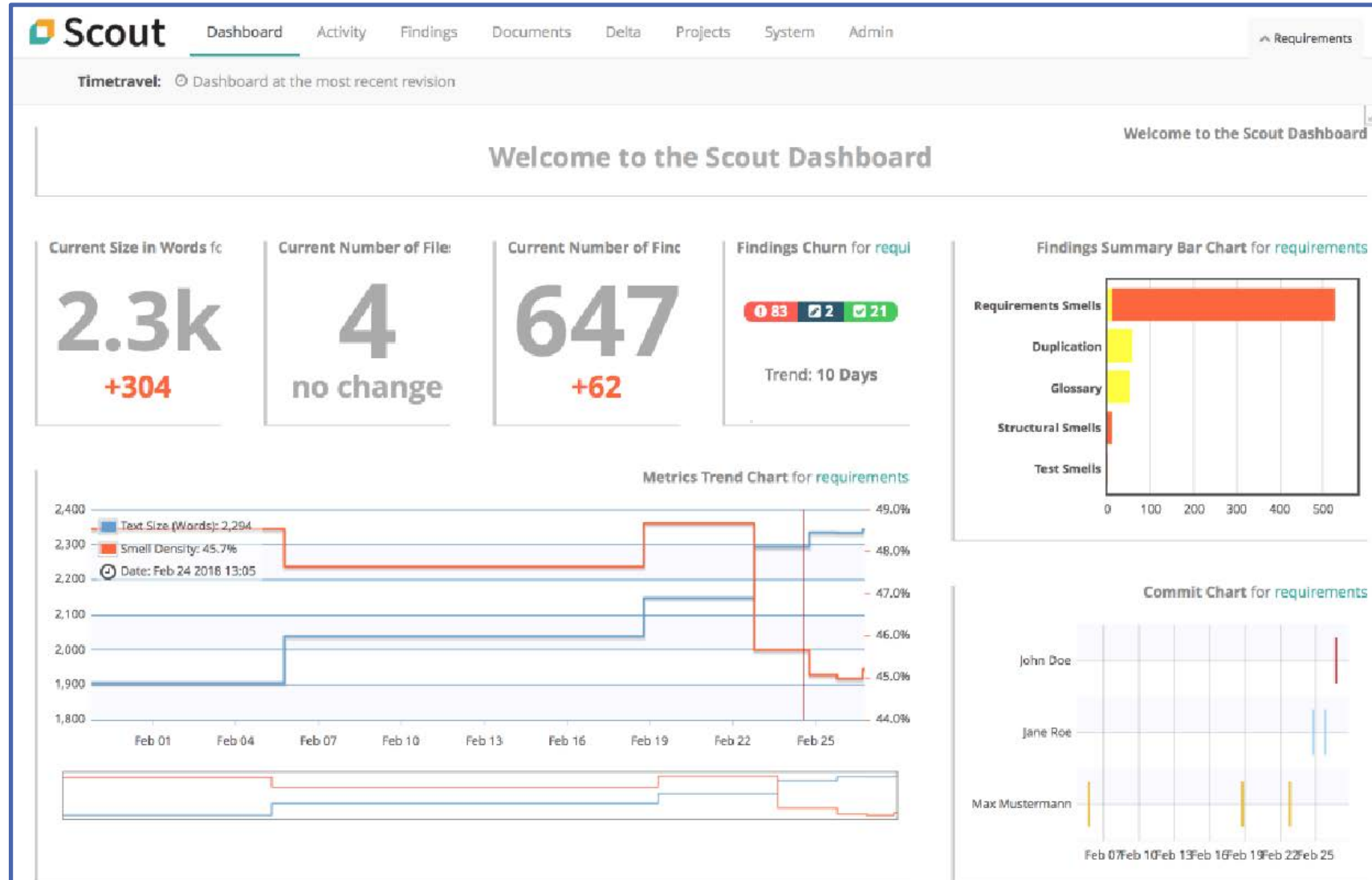
**Smell: Long Sentence Smell**  
Avoid long sentences as they decrease the readability of the Use Case. Split up the sentence.

**Smell: UI Details Smell** Vor wenigen Sekunden  
Avoid implementation and UI details in the Use Case. Specify these details in the Supporting Information document. Example: 'the user selects an item from the presented list of reports' instead of 'the user selects an item from the presented list in the combo box'.

**Smell: Negative Words Smell**  
Negative words can lead to undefined error states. Describe what happens in an exceptional situation. Example: 'If the user enters no date, the system presents an error.' instead of 'the procedure does not work without a date.'

**Smell: Negative Words Smell**  
Negative words can lead to undefined error states. Describe what happens in an exceptional situation.

# Scout from Qualicen



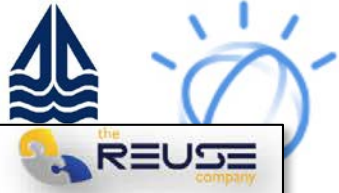


# The REUSE Company



- Offerings
  - Requirements Authoring Tools (RAT)
  - V&V Studio
  - Traceability Studio
  - Knowledge Manager (KM)
- Unified model
  - Based on a single, integral, underlying graph
  - NLU is used to unify textual assets with modeling and simulation assets

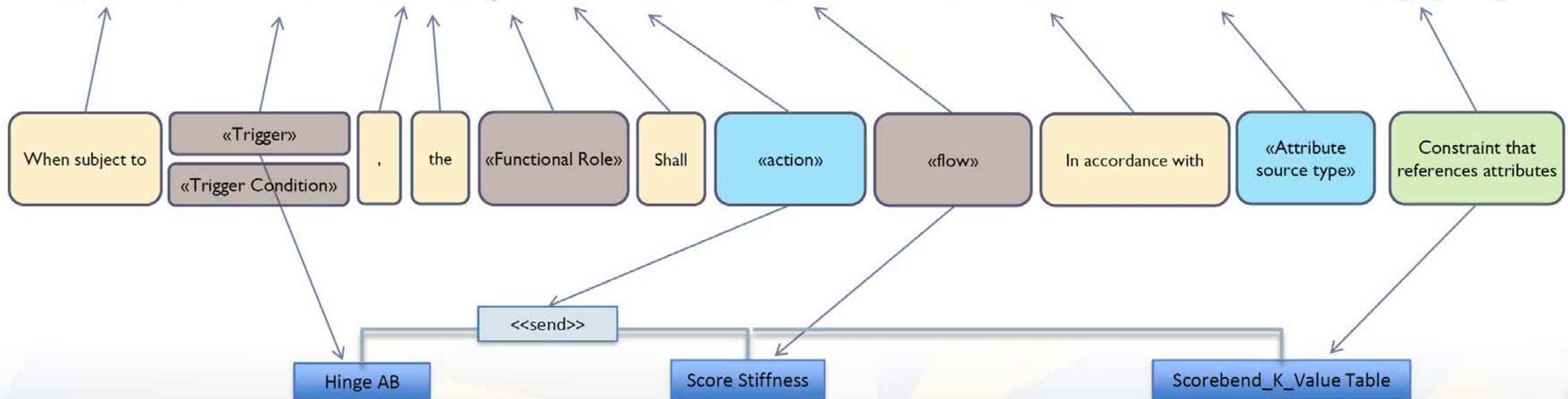
# The REUSE Company



## Structuring Requirements A formal representation

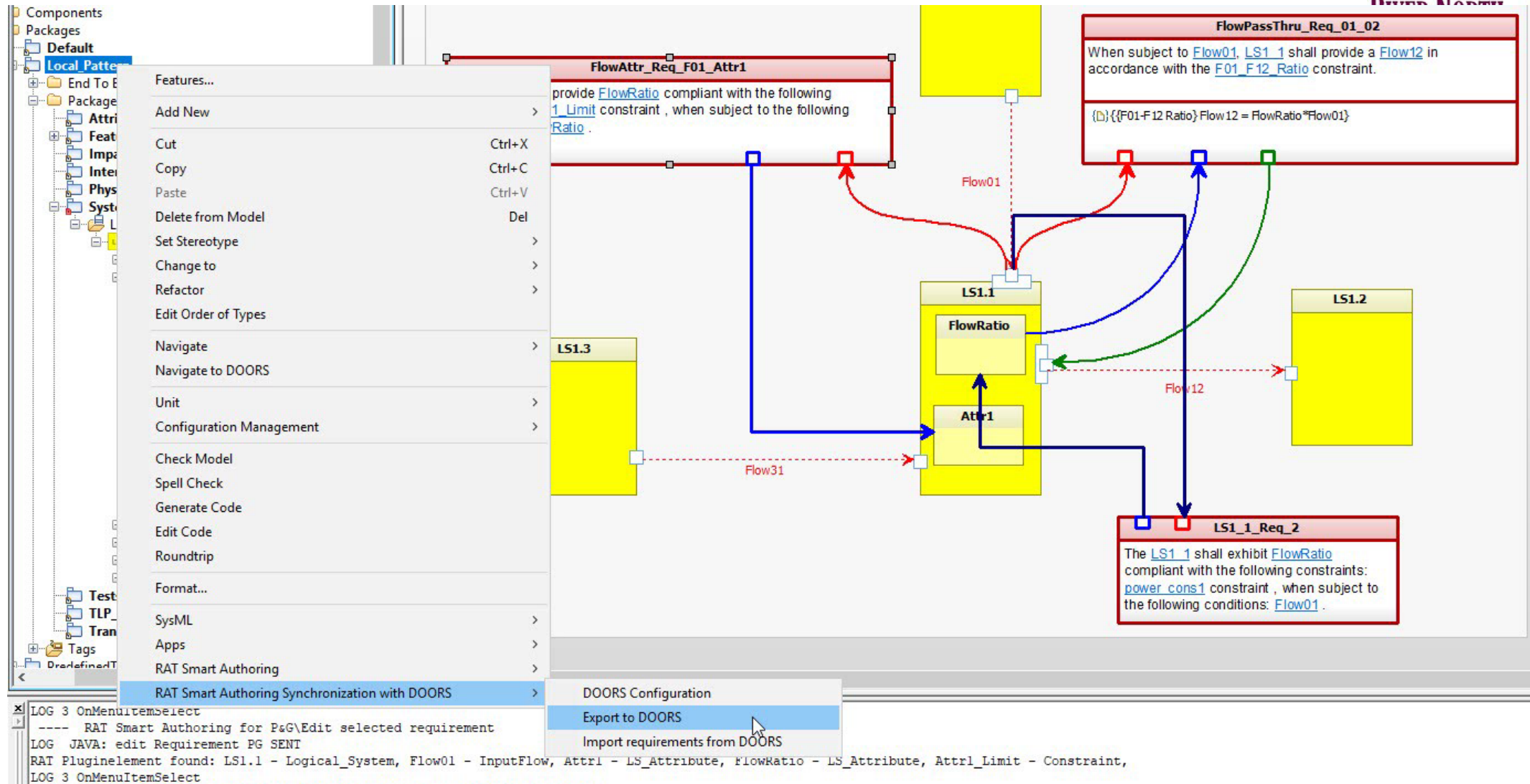
When subject to **Vacuum Picker Moment A**, **Hinge AB** shall **transmit Score Stiffness Moment AB** in accordance with **attribute table: Scorebend\_K\_Value\_Table**.

When subject to Vacuum Picker Moment A , the Hinge AB shall transmit Score Stiffness Moment AB in accordance with attribute table: Scorebend\_K\_Value\_Table





# The REUSE Company





# The REUSE Company



System' current 0.0 in /PnG (Formal module) - DOORS

File Edit View Insert Link Analysis Table Tools Discussions Authoring user Change Management Help

View Systems View All levels

Entire Model View

RC\_Testing

- Attribute\_Value\_Trees
- Attribute\_Value\_Workspaces
- Components
- Packages
- Default
- Local\_Pattern
  - End To End Diagrams
  - Package\_stms
  - Attribute\_Couplings
  - Feature\_Framework
  - Impacts\_and\_Failures
  - Interaction\_Framework
  - Physical\_Architecture
  - System\_Environment
  - Logical\_Systems
    - LS1
      - Components
      - Interactions
        - INT12
          - Has\_Roles
          - Input\_Outputs
          - Interaction\_Diagrams
          - IO\_Flows
          - Occurs\_During\_States
          - Requirement\_Stms
            - FlowAttr\_Req\_F01\_Attr1
            - FlowPassThru\_Req\_01\_02
            - LS1\_1\_Req\_2
          - Tags
            - INT23
            - INT34
          - Logical\_Systems
          - Offers\_Features
          - State\_Diagram\_Stm
          - Tags

- Tests
- TLP\_Items
- Transformation\_Flows
- Tags

Binding found: INT12\_Flow01\_from\_1  
Proxy port found: Flow01

intbd [Interaction] INT12 [INT12]

FlowAttr\_Req\_F01\_Attr1

the LS1\_1 shall provide FlowRatio compliant with the following constraints: Attr1\_Limit constraint, when subject to the following conditions: FlowRatio.

LS1.3

Flow31

1 Local\_Pattern

1.1 INT12

1.1.1 LS1.1

1.1.2 Attr1

1.1.2.1 FlowAttr\_Req\_F01\_Attr1

the LS1\_1 shall provide FlowRatio compliant with the following constraints: Attr1\_Limit constraint, when subject to the following conditions: Flow01.

1.1.2.1.1 Attr1\_Limit

1.1.3 FlowRatio

1.1.3.1 LS1\_1\_Req\_2

The LS1\_1 shall exhibit FlowRatio compliant with the following constraints: power\_cons1 constraint, when subject to the following conditions: Flow01.

1.1.3.1.1 power\_cons1

1.1.4 Flow12

1.1.4.1 FlowPassThru\_Req\_01\_02

When subject to Flow01, LS1\_1 shall provide a Flow12 in accordance with the F01\_F12\_Ratio constraint.

1.1.4.1.1 F01-F12 Ratio

$Flow12 = FlowRatio * Flow01$

1.1.5 Flow01

1.1.6 Flow31

1.1.7 LS1.2

1.1.8 Flow12

1.1.9 LS1.0

1.1.10 Flow01

1.2 INT23

1.2.1 LS1.2

1.2.2 Flow12

1.2.3 LS1.3

ID	Element Type	IO
2980	System	
2981	Interaction	
2982	System	[1.1.5] Flow01
2983	Attribute	
2984	Requirement	[1.1.5] Flow01
2985	Constraint	
2986	Attribute	
2987	Requirement	[1.1.5] Flow01
2988	Constraint	
2989	IO	
2990	Requirement	[1.1.5] Flow01
2991	Constraint	
2992	IO	
2993	IO	
2994	System	
2995	IO	
2996	System	
2997	IO	
2998	Interaction	
2999	System	
3000	IO	
3001	System	

# The REUSE Company



'System' current 0.0 in /PnG (Formal module) - DOORS

File Edit View Insert Link Analysis Table Tools Discussions Authoring user Change Management Help

View Systems View

All levels

System

- 1 Local\_Pattern
  - 1.1 INT12
    - 1.1.1 LS1.1
    - 1.1.2 Attr1
      - 1.1.2.1 FlowAttr\_Re
      - 1.1.3 FlowRatio
      - 1.1.4 Flow12
      - 1.1.5 Flow01
      - 1.1.6 Flow31
      - 1.1.7 LS1.2
      - 1.1.8 Flow12
      - 1.1.9 LS1.0
      - 1.1.10 Flow01
    - 1.2 INT23
    - 1.3 INT34

ID	ElementType		IO
2980	System	1 Local_Pattern	
2981	Interaction	1.1 INT12	
2982	System	1.1.1 LS1.1	[1.1.5] Flow01
2983	Attribute	1.1.2 Attr1	
2984	Requirement	1.1.2.1 FlowAttr_Re	[1.1.5] Flow01
2985	Constraint	1.1.2.1 FlowAttr_Re	
2986	Attribute	1.1.3 FlowRatio	
2987	Requirement	1.1.3 FlowRatio	[1.1.5] Flow01
2988	Constraint	1.1.3 FlowRatio	
2989	IO	1.1.4 Flow12	
2990	Requirement	1.1.4 Flow12	[1.1.5] Flow01
2991	Constraint	1.1.4 Flow12	
2992	IO	1.1.5 Flow01	
2993	IO	1.1.6 Flow31	
2994	System	1.1.7 LS1.2	
2995	IO	1.1.8 Flow12	
2996	System	1.1.9 LS1.0	
2997	IO	1.1.10 Flow01	

Authoring

- Insert
- Edit
- Link
- Cut
- Copy
- Copy URL
- Paste
- Undelete
- Delete
- Purge...
- New Object Discussion...
- Submit Change Proposal...
- Properties...
- Table properties...
- Lock
- Unlock
- Clear Suspicion...

# The REUSE Company



New - Authoring Tool for Rhapsody

File Suggestions View Log

## Authoring Tool for Rhapsody

By The REUSE Company

Authoring with pattern 'P&G multi trigger multi behaviour'

P&G (10) P&G multi trigger multi behaviour

Font Times New Roman Font Size 12 Normal

the LS1 1 shall provide FlowRatio compliant with the following constraints: Attr1 Limit constraint , when subject to the following conditions (FlowRatio)

Matching patterns elements:

Weight	Pattern name
The   «Logical_System»   MODAL VERB «MODAL COMPULSORY»   Exhibit   «LS_Attribute»   Compliant with the following constraints:   «Constraints»	
The   «Logical_System»   MODAL VERB «MODAL COMPULSORY»   Provide   «OutputFlow»   Compliant with the following constraints:   «Constraints»	

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New - Authoring Tool for Rhapsody

File Suggestions View Log

## Authoring Tool for Rhapsody

By The REUSE Company

Authoring with pattern 'P&G multi trigger multi behaviour'

P&G (10) P&G multi trigger multi behaviour

Font: Times New Roman Font Size: 12

the LS1 1 shall provide FlowRatio compliant with the following constraints: Attr1 Limit constraint , when subject to the following conditions:

Matching patterns elements:

Weight	Pattern name
The   «Logical_System»   MODAL VERB «MODAL COMPULSORY»   Exhibit   «LS_Attribute»   Compliant with the following constraints:   «Constraint»	
The   «Logical_System»   MODAL VERB «MODAL COMPULSORY»   Provide   «OutputFlow»   Compliant with the following constraints:   «Constraint»	



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the LS1\_1 shall provide FlowRatio compliant with the following constraints: Attr1 Limit constraint , when subject to the following conditions:

Matching patterns elements:

The | «Logical\_System» | MODAL VERB «MODAL COMPULSORY» | Exhibit | «LS\_Attribute» | Compliant with the following constraints: | «Constraint»  
The | «Logical\_System» | MODAL VERB «MODAL COMPULSORY» | Provide | «OutputFlow» | Compliant with the following constraints: | «Constraint»

The

Attr1

Attr1\_Limit

Flow01

FlowRatio

LS1\_1

6 terms

☐ Show numbers

☒ Show optional terms

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the LS1\_1 shall provide FlowRatio compliant with the following constraints: Attr1 Limit constraint , when subject to the following conditions: Flow01.

Matching patterns elements:

- The | «Logical\_System» | MODAL VERB «MODAL COMPULSORY» | Exhibit | «LS\_Attribute» | Compliant with the following constraints: | «Constraints»
- The | «Logical\_System» | MODAL VERB «MODAL COMPULSORY» | Provide | «OutputFlow» | Compliant with the following constraints: | «Constraint»

The

- Attr1
- Attr1\_Limit
- Flow01
- FlowRatio
- LS1\_1

6 terms

☐ Show numbers

☒ Show optional terms

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'System' current 0.0 in /PnG (Formal module) - DOORS (Not Responding)

File Edit View Insert Link Analysis Table Tools Discussions Authoring user Change Management Help

View Systems View All levels

ID	Element Type		IO
2980	System	<b>1 Local_Pattern</b>	
2981	Interaction	<b>1.1 INT12</b>	
2982	System	<b>1.1.1 LS1.1</b>	◀ [1.1.5] Flow01
2983	Attribute	<b>1.1.2 Attr1</b>	
2984	Requirement	<b>1.1.2.1 FlowAttr_Req_F01_Attr1</b> the LS1_1 shall provide FlowRatio compliant with the following constraints: Attr1_Limit, when subject to the following conditions: FlowRatio .	◀ [1.1.5] Flow01
2985	Constraint	<b>1.1.2.1.1 Attr1_Limit</b>	
2986	Attribute	<b>1.1.3 FlowRatio</b>	
2987	Requirement	<b>1.1.3.1 LS1_1_Req_2</b> The LS1_1 shall exhibit FlowRatio compliant with the following constraints: power_cons1 constraint , when subject to the following conditions: Flow01 .	◀ [1.1.5] Flow01
2988	Constraint	<b>1.1.3.1.1 power_cons1</b>	
2989	IO	<b>1.1.4 Flow12</b>	
2990	Requirement	<b>1.1.4.1 FlowPassThru_Req_01_02</b> When subject to Flow01, LS1_1 shall provide a Flow12 in accordance with the F01_F12_Ratio constraint.	◀ [1.1.5] Flow01
2991	Constraint	<b>1.1.4.1.1 F01-F12 Ratio</b> $Flow12 = FlowRatio * Flow01$	
2992	IO	<b>1.1.5 Flow01</b>	▶
2993	IO	<b>1.1.6 Flow31</b>	
2994	System	<b>1.1.7 LS1.2</b>	
2995	IO	<b>1.1.8 Flow12</b>	
2996	System	<b>1.1.9 LS1.0</b>	
2997	IO	<b>1.1.10 Flow01</b>	

System View

- System
  - 1 Local\_Pattern
    - 1.1 INT12
      - 1.1.1 LS1.1
      - 1.1.2 Attr1
        - 1.1.2.1 FlowAttr\_Re
          - 1.1.3 FlowRatio
            - 1.1.4 Flow12
              - 1.1.5 Flow01
              - 1.1.6 Flow31
              - 1.1.7 LS1.2
              - 1.1.8 Flow12
              - 1.1.9 LS1.0
              - 1.1.10 Flow01
  - 1.2 INT23
  - 1.3 INT34

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'System' current 0.0 in /PnG (Formal module) - DOORS

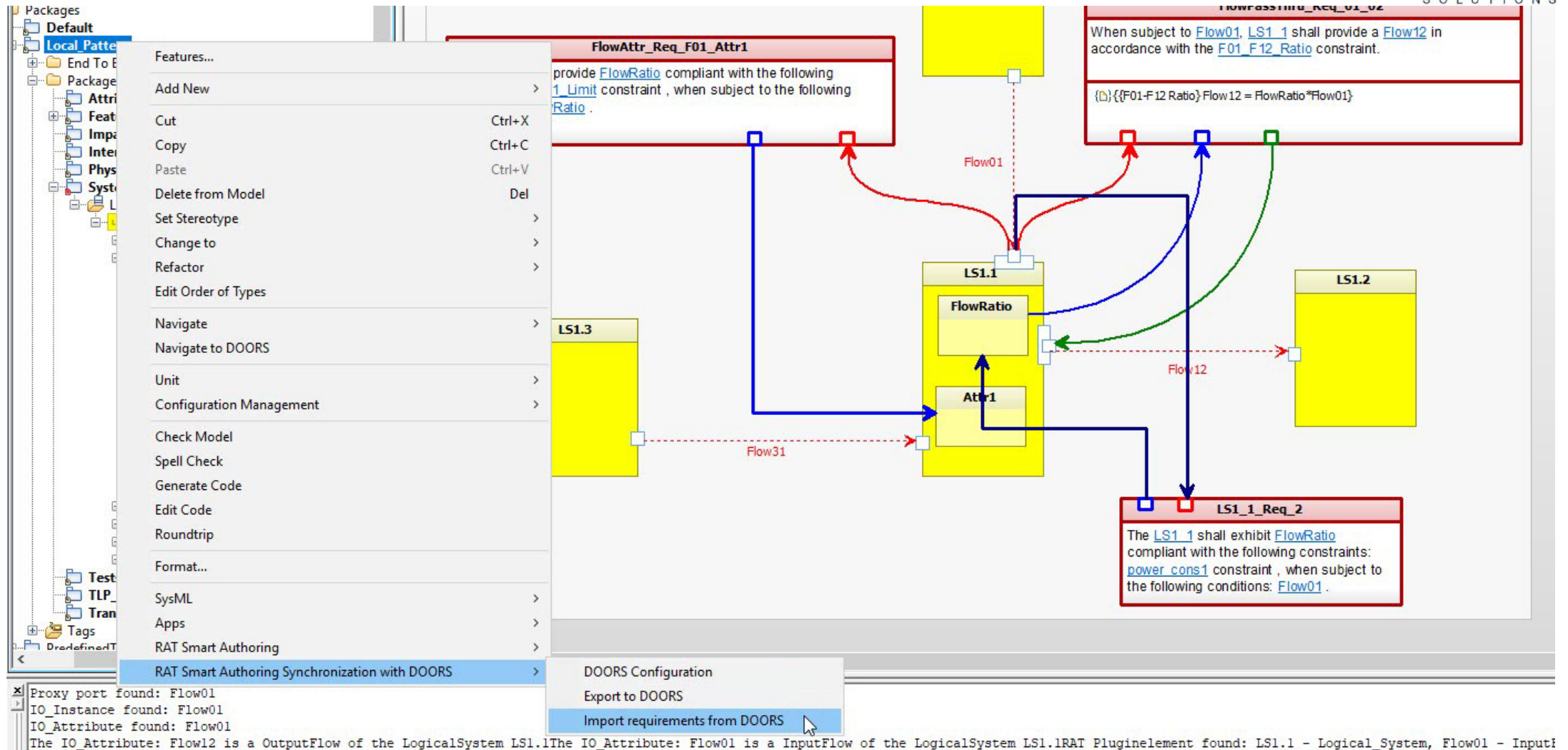
File Edit View Insert Link Analysis Table Tools Discussions Authoring user Change Management Help

View Systems View All levels

ID	Element Type		IO
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2985	Constraint	<b>1.1.2.1.1 Attr1_Limit</b>	
2986	Attribute	<b>1.1.3 FlowRatio</b>	
2987	Requirement	<b>1.1.3.1 LS1_1_Req_2</b> The LS1_1 shall exhibit FlowRatio compliant with the following constraints: power_cons1 constraint, when subject to the following conditions: Flow01.	◀ [1.1.5] Flow01
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2993	IO	<b>1.1.6 Flow31</b>	
2994	System	<b>1.1.7 LS1.2</b>	
2995	IO	<b>1.1.8 Flow12</b>	
2996	System	<b>1.1.9 LS1.0</b>	
2997	IO	<b>1.1.10 Flow01</b>	



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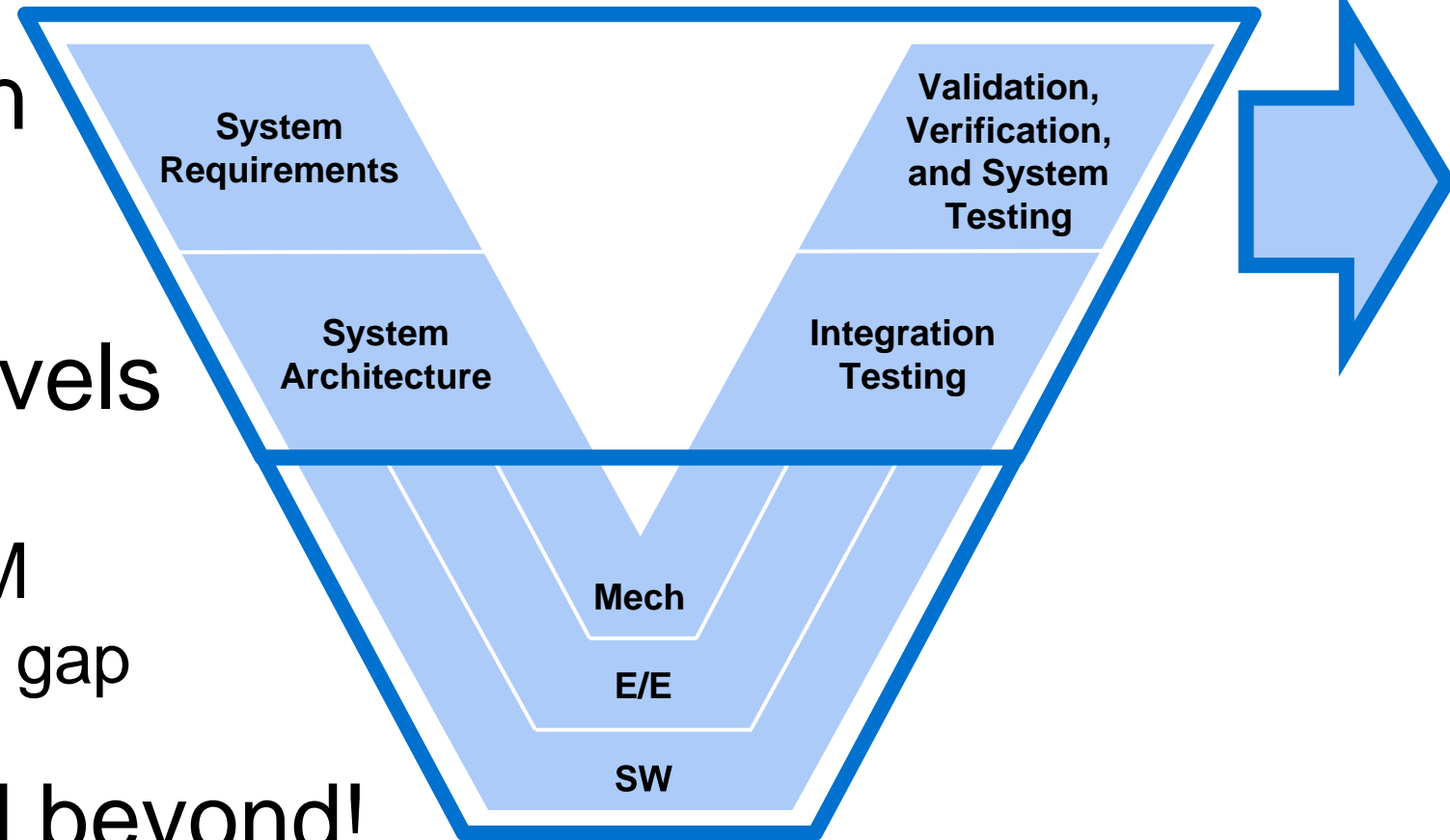
# General benefits of cognitive requirements and test offerings



- Automation of time-intensive, error-prone tasks
- Pinpoints where focus needs to be delivered
- Prioritizes work
- Configurable for domain-specific applications
- Customizable to company policies and best practices
- Accelerates good requirements training for new users
- Accelerates high-quality requirements authoring even for experienced requirements engineers
- Accelerates review of customer requirements specs

# Future of cognitive engineering

- Current focus is on top left/right of V
- Moving to lower levels
  - All product data
  - Cognitive ALM-PLM
    - To help bridge the gap
  - To the V and beyond!
    - Including manufacturing, service, and operations





# Summary



- Cognitive engineering is maturing and growing rapidly
- Cognitive requirements and test tools can enable:
  - Higher productivity and efficiency
  - Immediate feedback to author for faster learning
  - Moving defect discovery to early development phases
  - Less downstream churn for requirements, design, test
  - Reducing product development cost and schedule
- Technology is moving fast in this space
- Expect rapid developments in the near term

# Challenge



Pilot these capabilities

Report back next year

- at IW, IS, and/or GLRC

# Questions?



2018 Annual INCOSE  
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17 - 20 October 2018 | Indianapolis, Indiana

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**Bob Parro**, River North Solutions - [bparro@rivernorthsolutions.com](mailto:bparro@rivernorthsolutions.com)

**Steve Denman**, Stephen D. Denman Consulting, LLC - [stephen@sddenmanconsulting.com](mailto:stephen@sddenmanconsulting.com)

**Kevin McHugh**, IBM Watson IoT Lab Services - [mchughm@us.ibm.com](mailto:mchughm@us.ibm.com)

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