

# Exploring Customer's Success with Requirements Analysis

**Herman Driessen**

*Owner, Sunny Hills Consultancy*

[hbdriessen@cs.com](mailto:hbdriessen@cs.com)

**Randy Lexvold**

*President, The Emphasys Group*

[randyl@emphasysgrp.com](mailto:randyl@emphasysgrp.com)

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# Objectives

- Develop a common understanding of a “quality” requirement
- Explore how automation has helped the analysis process
- Demonstrate automated analysis of requirements



# What is Quality?

- quality |'kwälətē| (From Apple dictionary)
- noun ( pl. **-ties**)
- **1** the standard of something as measured against other things of a similar kind; **the degree of excellence of something** : *an improvement in product quality | people today enjoy a better quality of life.*
- • **general excellence of standard or level** : *a masterpiece for connoisseurs of quality | [as adj. ] a wide choice of quality beers.*



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## Dimensions of Quality

- What are characteristics of a **quality** requirement?

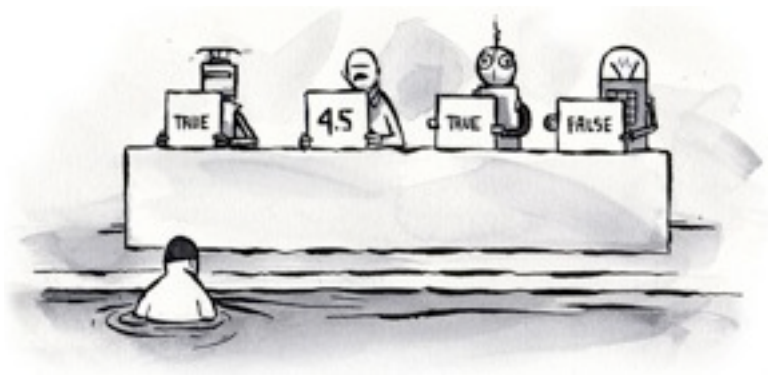


# Example Characteristics



# Example Characteristics

- Completeness
- Consistency
- Uniqueness (Non-duplicate)
- Testability
- Readability
- Accuracy
- Vagueness
- Ambiguity



# Completeness

- How do you measure completeness?
- How do you know if anything is missing?
- Need domain expertise
- Must be able to comprehend all requirements at the same time
- Not fully addressed by traceability



# Analysis Examples

- Review by Domain Expert
- Natural language processing
  - ▶ Analyze sentences
  - ▶ Case based reasoning
- Checklists
- Templates
- Traceability reports



## Problems with Manual Approaches

- How do you capture domain knowledge for the organization?
  - ▶ Lose domain knowledge as experts leave
  - ▶ Domain experts may not be available for review
  - ▶ Review knowledge is in one person's head
- How can humans analyze large requirement sets?
  - ▶ People cannot focus on a large set of requirements
  - ▶ Only the first few pages are read
  - ▶ Difficult to correlate information within and between documents
  - ▶ Hard to know what is missing
- Inconsistent (non-existent) definition of quality terms
  - ▶ When is it "complete"?

## Mars Climate Orbiter

- Designed to **orbit** Mars
- Destroyed by atmospheric friction
- Computer that underestimated the effect of the thrusters by a factor of 4.45
- This is the ratio between a pound force and a newton
- The software was working in pounds force
- The spacecraft expected figures in newtons
  
- Project cost \$327.6 million for both orbiter and lander (the lander survived)



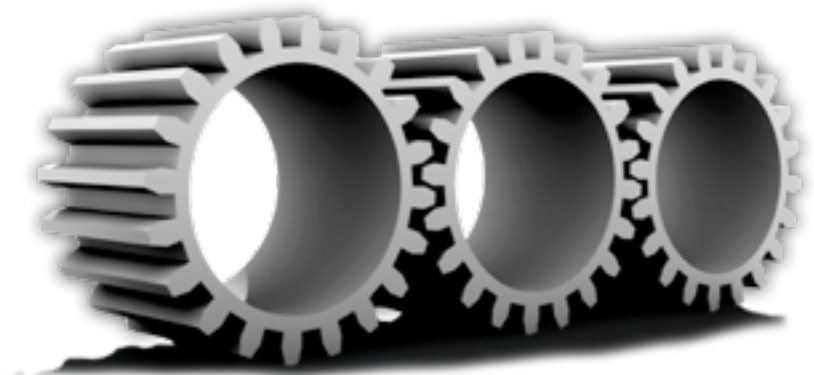
# Innovation

- Little has changed in requirements analysis in the past 40 years
- Requirements are still mostly textual
- Mostly manual, error prone
- Time for a change



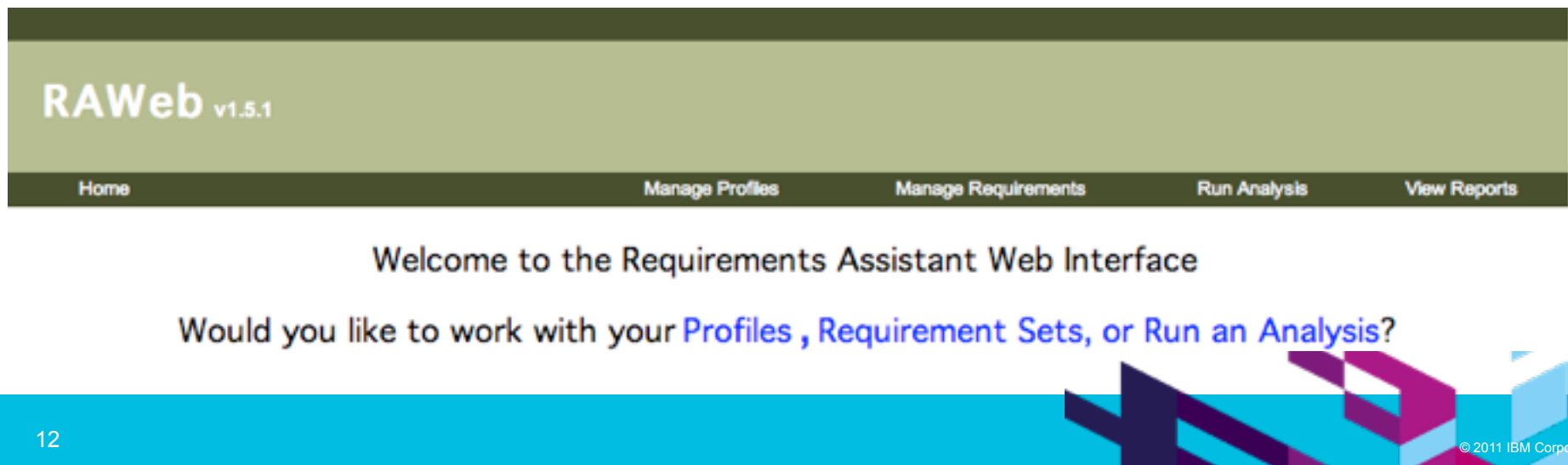
## Automated Analysis

- Decrease time to market
  - ▶ Find as many (or more) critical defects in less time
- Automate error-prone tasks
  - ▶ Using natural language analysis a greater variety of defects can be found
- Focus on real problems
  - ▶ Domain experts can now spend their time analyzing the results of analysis
  - ▶ Lets them to focus on critical defects
- Improve quality
  - ▶ Find more major defects, earlier
  - ▶ Analyze a larger set of requirements



## RAWeb - Natural Language Analysis

- Capturing 25 years of requirement analysis expertise
- Over 2000 analysis rules
- Over 160 categories of requirement issues
- Able to analyze requirements in context
  - ▶ Identify issues that span the entire requirement set
  - ▶ Unlike any other analysis tool
- Able to identify ambiguous requirements by doing single sentence analysis
- Able to use single sentence analysis to identify requirements with testability issues



# Profiles

- Capture Domain Expert Knowledge
- Improves completeness analysis
- Can grow iteratively
- RAWeb recommends words that should be in the profile
- Strengthen future domain analysis

Update Profile Delete Profile

<p style="text-align: center; margin: 0;"><b>Topics</b></p> <p>dcm doc roads performance interface contamination notification monitoring degraded degradation i2 fri warning function</p>	<p style="text-align: center; margin: 0;"><b>Actors</b></p>	<p style="text-align: center; margin: 0;"><b>Actuators</b></p>
<p style="text-align: center; margin: 0;"><b>Glossary</b></p> <p>differential orbit circle data collection management frifa radio ineke</p>	<p style="text-align: center; margin: 0;"><b>Functions</b></p>	<p style="text-align: center; margin: 0;"><b>Sensors</b></p>
<p style="text-align: center; margin: 0;"><b>Sinks</b></p>	<p style="text-align: center; margin: 0;"><b>Sources</b></p>	<p style="text-align: center; margin: 0;"><b>Subsystems</b></p>
<p style="text-align: center; margin: 0;"><b>Systems</b></p>	<p style="text-align: center; margin: 0;"><b>Attributes</b></p>	



# Requirement Set

- Scope of Analysis
- Can include multiple “documents”
- Run against different profiles
- DOORS script to export in RAWeb format
- Can import CSV and text documents

SR0001	1 Purpose.
SR0002	1.1 This specification describes a method for data acquisition consumers to request process and operational data from equipment to be c
SR0003	It could also be in an ad-hoc request from the consumer.
SR0004	It includes a mechanism for organizing related data into groups to make it more straightforward for enabling or disabling a large number
SR0005	2 Scope.
SR0006	2.1 In-scope.
SR0007	2.1.1 This specification provides a means to acquire event, exception, and trace data from semiconductor equipment through the use of
SR0008	This specification defines what form a data collection plan takes, the meaning of its contents, and an interface for managing them that is
SR0009	2.1.2 This specification defines the behavior associated with the execution of data collection plans in the form of finite state machines.
SR0010	The formats for data produced as a result of executing a data collection plan are also defined, as is the interface that must be supported f
SR0011	2.1.3 This specification defines a way for the equipment to notify consumers when the combination of activities on the equipment, includ
SR0012	2.1.4 This specification defines a way for consumers to make ad-hoc on-demand requests for data from the equipment, outside of a dat
SR0013	2.2 Out-of-scope.
SR0014	NOTICE: This standard does not purport to address safety issues, if any, associated with its use.
SR0015	It is the responsibility of the users of this standard to establish appropriate safety and health practices and determine the applicability of
SR0016	3 Limitations.
SR0017	3.1 Abstract Model.
SR0018	3.1.1 This specification does not define a convention for naming or identifying sources, parameters, events, or exceptions.
SR0019	This document assumes that all such entities can be identified separately and represented as text.
SR0020	Such conventions shall be fully specified by any implementation mapping of this specification.
SR0021	3.1.2 This specification does not define the mechanism used for identifying or authenticating consumers or enforcing privileges.
SR0022	It assumes that consumers can be uniquely identified by a text value, and that the equipment is capable of enforcing the standard privileg
SR0023	Such mechanisms shall be fully specified by any implementation mapping of this specification.
SR0024	3.1.3 This specification does not define the mechanism used for determining how to locate consumers that are to receive the events defi
SR0025	It assumes that the equipment has established a communications context with any consumers that can submit requests and has provided
SR0026	Such mechanisms shall be fully specified by any implementation mapping of this specification.
SR0027	3.1.4 This specification does not define any algorithms or heuristics to use for detecting degrading equipment operational performance.
SR0028	Such techniques are specific to the equipment's internal hardware and software architecture and will very likely be unique to each class a
SR0029	It assumes that it is possible to detect such conditions and to identify which systems comprising the equipment are affected.
SR0030	3.1.5 This specification is an abstract model only.
SR0031	Adjunct specifications must be developed to map this specification to an implementation technology.
SR0032	4 Referenced Standards.
SR0033	4.1 SEMI Standards.



## IBM Rational DOORS Integration

- DXL Script to create a Requirements Set input file
  - ▶ Retains unique DOORS identifier
  - ▶ One-click import
- DXL Script to consume RAWeb results
  - ▶ Adds a new column to requirements
  - ▶ Attaches comments per requirement

Ready for

**IBM** | **Rational**<sup>®</sup>

software

# Customer Success – Large Rail Company

- Analyzed four different subsystem specifications
- Identified differences across the specifications
- Not discovered by human review

Topic\Subsystem	Pneumatic	Climate	Electrical	Low Voltage System
Table of Contents				Sr0038
Rattle vibration	Sr0018, sr0072, sr0073		Sr0012	
Colour paint	Sr0040		Sr0022	
Diagnostic			Sr0005, sr0039, sr0068	Sr0141, sr0142
Healthcheck			Sr0122, sr0123	
Software			CCTV software	Sr0092



## Customer Success – Major Truck Manufacturer

- Analyzed a large set of requirements manually
  - Ran RAWeb against the same set of requirements
  - Discovered an inconsistency in requirements
  - Saved confusion and rework by subcontractors
  - Can you find it?
- 
- **sr0003**: However here the time and date attributes as well as a basic alarm mechanism has been broken out from the Clock and included in a TimerCtrl LDC as shown in the figure below.
  - **sr0014**: In the below there is general description of the interface of AlarmTimer provided by the TimerCtrl LDC.

# Customer Success - NASA IV&V



- After a review NASA selected RAWeb as their tool to review natural language requirements

Role	Domain Expert	Junior Analyst
<b>Method</b>	Manual review	Analyze RAWeb output
<b>Results</b>	Discovered 4 major issues	Discovered same 4 issues, plus 6 others
<b>Time</b>		33% faster

- Report results can be found at: <http://www.nasa.gov/centers/ivv/research/sas.html>  
September 2007 Findings



## In Progress

- IBM
  - ▶ Working with an IBM Distinguished Engineer on an evaluation of RAWeb versus Domain Experts
- Large Medical Device Company
- Several aircraft manufacturers
- Jet Propulsions Lab
- Johnson Space Center contractor



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