The CRYSTAL Project

A sky full of stars
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Presenter profile

- Juan LLorens
- Juan.llorens@reusecompany.com / juan.llorens@uc3m.es
- Professor in SE at Universidad Carlos III de Madrid (Spain)
- CEO A at The REUSE Company

- Member of AEIS Board (Spanish Chapter of INCOSE)
- Member of INCOSE Requirements Engineering WG
- Contributor to INCOSE Guide for Writing Requirements
The REUSE Company (TRC)

Tool Manufacturer and Vendor

Knowledge-Centric solutions to Systems Engineering

The Requirements Quality Suite (RQS)
* Manages the requirements V&V

TRC’ headquarters in Madrid (Spain)
* Legatec Scientific Park
* R&D outsourced to Universidad Carlos III de Madrid
What is The Reuse Company

- The Reuse Company (TRC) is a registered trademark owned by Knowledge Centric Solutions SL that performs commercial activities around knowledge quality, traceability and reuse.

- TRC is a spin-off company created from the Knowledge Reuse research group at the Universidad Carlos III de Madrid, Spain (1999).

- In the Reuse Company’s vision, knowledge reuse is fully integrated in every organization’s productivity chain.

- TRC’s mission is to promote Systems and Information/knowledge REUSE within all organizations, by offering processes, methods, tools and services that makes it possible.
TRC - Our competences

Trace + Retrieval + Quality
Towards systematic Reuse

By means of: Repositories containing Ontologies and Assets
TRC: Strong commitment to Research

- Universidad Carlos III de Madrid
- the REUSE company

Research

Technology Development

CRYSTAL
AMASS
ITEA3
Why our Quality products?

- Committed Costs:
  - 70% at Concept
  - 85% at Design
  - 95% at Development

- Cost to Extract Defects:
  - 3-6x at Concept
  - 20-100x at Design
  - 500-1000x at Development

- Lifecycle Costs:
  - Operations through Disposal: 100%
  - Production and test: 50%
Why Our Quality Products?

WE HAVE JUST COMPLETED THE FIRST FLIGHT OF THE WORLD’S LARGEST JET. 800 PASSENGERS HAVE FLOWN IN ULTRA COMFORT AND CONVENIENCE.

TAXI!
Before CRYSTAL: Process View

Source: Software Requirements. Karl E Wiegers and Joy Beatty, Microsoft Press
Before CRYSTAL: Products View

- The **Requirements Quality Suite (RQS) V4.**
- RQS models requirements quality using Correctness

**Requirements Quality Analyzer (RQA):**
to setup, check and manage the quality of a requirements specification.

**Requirement Authoring Tool (RAT):**
to assist authors while they are creating or editing requirements.

**knowledgeMANAGER:**
to manage knowledge around a requirements specification: the ontology it is based on, the structure of the requirements to be used in the project, the communication between authors and domain architects.
TRC AFTER CRYSTAL
After CRYSTAL: Process View

- Requirements Quality Management => Requirements Verification

- Requirements Verification Vs System/Product Verification

Adapted from: karl Wiegers
After CRYSTAL: Products View

CONOPS

Product Validation

Product Verification

System Validation

System Verification

Component Validation

Component Verification

Component

System

Product

Stakeholders Requirements

System Requirements

Component Requirements

System Design

Component Design

Complexity Decomposition

Integration and V&V

6/22/2016

PUBLIC

Juan Llorens/ REUSE
After CRYSTAL: Products View

- RQS models requirements quality using the CCC approach (Correctness, Consistency and Completeness)

**Requirements Quality Analyzer (RQA):**
to setup, check and manage the quality of a requirements specification.

**Requirement Authoring Tool (RAT):**
to assist authors while they are creating or editing requirements.

**knowledgeMANAGER:**
to manage knowledge bases and knowledge models as the *ground truth* to check the quality of requirements.
After CRYSTAL: Products View

Correctness
- Text analysis metrics
- RMS metrics
- Semantic metrics
- Structural metrics

Completeness
- Terminology Incompleteness
- Incompleteness by comparison with Models
- Requirements Types Incompleteness
- Properties Incompleteness

Consistency
- Redundant Requirements
- Inconsistent Units
- Inconsistent Properties
## After CRYSTAL: Products View

### Requirements Quality Analyzer

**Worksheet selector**
- 3-Electrical Power System Reqs

**Scoreboard**
- Quality view
- Full view

**Quality Assurance**
- Correctness
- Completeness
- Consistency

**Knowledge base**

### Requirements Table

<table>
<thead>
<tr>
<th>ID</th>
<th>Text</th>
<th>Correctness</th>
<th>Score</th>
<th>Consistency</th>
<th>Issues</th>
<th>Quality date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>every 4 seconds, the power control system shall send a demand battery load level mes...</td>
<td>5stars</td>
<td>N/A</td>
<td>5stars</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>when the voltage level is below 11.5V, the battery shall send a &quot;low battery load level&quot;...</td>
<td>5stars</td>
<td>N/A</td>
<td>5stars</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>if the battery is low, the power control system shall send a &quot;show low energy level alarm&quot;...</td>
<td>5stars</td>
<td>N/A</td>
<td>5stars</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>The user must plug in the bicycle to the electrical power</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>When the bicycle is charging, the power control system shall send a &quot;Charge battery&quot; si...</td>
<td>5stars</td>
<td>N/A</td>
<td>5stars</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>6</td>
<td>When the battery is loading, the charge system shall send a &quot;charge system Loading&quot;</td>
<td>5stars</td>
<td>1.45</td>
<td>5stars</td>
<td>0</td>
<td>03/11/2015 13:5</td>
</tr>
</tbody>
</table>

**Total requirements:** 6
Interoperability: OSLC

Core
(Configuration Management, Reporting)

- Architecture Management
- Asset Management
- Automation
- Change Management
- Estimation & Measurement
- Performance Monitoring
- Quality Management
- Reconciliation
- Requirements Management
- Others
  - Mobile

New provided domains
- System KPIs
- Knowledge Management
- Semantic indexing and retrieval

Provider (P)
Consumer (C)
After CRYSTAL: Technology View: Interoperability

OSLC-KM processor

Interoperability Unified Formats and Protocols

OSLC

- Example (Selection of Model):
  - Selected Model (sequence diagram) from the SKB
After CRYSTAL: Persons View

Requirements Engineer / Analyst:
- Author Requirements

Quality Assurance:
- Adjust metrics and quality functions.
- How can metrics and quality functions be adjusted to carry on with the improvement process?

Quality Control:
- Execute assessments for individual requirements and global specifications.
- Is quality evolving as expected?

Project Manager / Quality Manager:
- Does my project requirements have the right quality?
- Do our teams need additional training?

SKB Architect:
- Evolve the requirements knowledge model.

SKR Manager:
- Leader of the Knowledge Repository
WHAT HAS CRYSTAL MEANT?
What has CRYSTAL Meant

- **HR:**
  - Author Requirements

- **Relevant Figures:**
  - More than 30 trips
  - More than 200 international meetings
  - More than 190 PM (from 60 + 85)
  - 2 PhDs
  - 4 new Jobs
  - 12 persons involved
  - 6 Scholarships
  - 9 Publications

- **Installations:**
  - 10 Installations of RQS to CRYSTAL partners

- **Unexpected Issues (Emerging properties):**
  - OSLC marriage

- **Products:**
  - 3 versions of RQS
  - New Interfaces with RMS
  - New Languages support (French, German, Swedish)
OUR WISH
Our Wish...

Let’s convert the CRYSTAL into a DIAMOND
Our Wish...