Effective Quality Management of Automotive ECU’s

Kyle Perkuhn  
*Platform Marketing Engineer: National Instruments* 
kyle.perkuhn@ni.com

Paul Urban  
*Business Development Manager* 
IBM 
purban@us.ibm.com
The complexity is growing at an increasing pace
Smarter Products Require New Technology

### Traditional Product & Systems Development

- Focused on CAD/CAM and BoM
- Slower to react to change
- Silos of engineering disciplines

### Next Generation Product & Systems Development

- More focus on software and electronics
- Responsive to change
- Systems engineering methods optimize product designs and engineering collaboration

**Physical Design and Bill of Materials (BoM) Centric Approach**

**Integrated Electronic, Mechanical, and Software Engineering**
Managing the Cost of Software Errors

<table>
<thead>
<tr>
<th></th>
<th>Smart Washing Machine</th>
<th>Commercial Aircraft</th>
<th>Luxury Automobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lines of Code</td>
<td>100k</td>
<td>6.5 Mil</td>
<td>10 Mil</td>
</tr>
</tbody>
</table>

10-20 defects produced per 1,000 lines of code*

<table>
<thead>
<tr>
<th>Defects</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>10-20</td>
<td>1k – 2k</td>
<td>65k - 130k</td>
<td>100k – 200k</td>
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</tbody>
</table>

...a bug which costs $1 to fix on the programmer's desktop costs $100 to fix once it is incorporated into a complete program, and many thousands of dollars if it is identified only after the software has been deployed in the field.

The quality challenge is growing, but timelines and budgets are not increasing proportionally. Engineers must continue to innovate and harness the latest technologies to remain competitive.
Build in quality from concept to launch
using Rational Quality Manager

• Make high quality decisions based on quantitative information
• Integrate defect tracking and change management
• Smooth the information flow between testers and developers
• Improve quality by managing complexity across multiple product configurations

Reduce errors through automated reuse of information

“We have greater control to improve processes, greater test coverage and traceability, plus, vastly improved navigation and user friendliness.”

– Beta test participant
Rational Quality Manager: A Closer Look

<table>
<thead>
<tr>
<th>Test Planning</th>
<th>Test Construction</th>
<th>Test Execution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive test plan</td>
<td>Requirement driven testing</td>
<td>Manual test execution</td>
</tr>
<tr>
<td>Shared objectives</td>
<td>Test environments coverage</td>
<td>Use test automation tools</td>
</tr>
<tr>
<td>Scope, Timeline, Resources</td>
<td>Manual test authoring</td>
<td>Record test results</td>
</tr>
<tr>
<td>Risk assessment</td>
<td>Test lab management</td>
<td>Submit &amp; track defects</td>
</tr>
</tbody>
</table>

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<tr>
<th>Team Collaboration</th>
<th>Reporting &amp; Dashboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process enactment and enforcement</td>
<td>Status and progress tracking</td>
</tr>
<tr>
<td>Review and approval</td>
<td>Customizable live dashboard</td>
</tr>
<tr>
<td>Task management</td>
<td>Real-time metrics and reports</td>
</tr>
<tr>
<td>Rapid team member on-boarding</td>
<td>Compliance and quality audit</td>
</tr>
</tbody>
</table>
Introduction to National Instruments
Tools for Next Generation Development

- Modeling
- Graphical Programming
- Real-Time Testing
- Test Automation
- Analysis and Reporting
- Enterprise Connectivity

Multi-Chassis Systems
- PXI
- PC
- NI CompactRIO
- NI CompactDAQ
Diversity of Applications

No Industry >15% of Revenue in 2012

Academic
Advanced Research
Automotive
Big Physics
Consumer Electronics

Defense/Aerospace
Energy
Life Sciences
Mobile Devices
Semiconductors
The NI TestStand Ecosystem

1000+ companies worldwide
10000+ existing developers
20+ partner products

100+ consultants and integrators
2 levels of development certification

500+ new developers trained annually since 2007
40+ worldwide branches providing support
10+ programming languages supported
NI TestStand—Test Management Software

- Graphical sequence editor environment
- Automate tests written in any language
- Multithreaded sequence execution
- ASCII, HTML/Web, XML, and ATML report generation
- Access, Oracle, SQL Server database connectivity
Embedded Software Quality Challenge
Traditional Development Process

**Project Manager**
- Create change request
- Assess progress

**Systems Engineer**
- Modify requirements and evaluate impact
- Derive software requirements

**Software Engineer**
- Software Development

**Quality Engineer**
- Plan tests and link to requirements
- Schedule tests
- Submit defect

**Test Engineer**
Quality Engineer

- Plan tests and link to requirements
- Schedule tests
- Submit defect

Test Engineer
IBM Rational
Automotive
Engineering
Symposium 2013
National Instruments Test Components
(.seq, .vi, .nivs, …)
Requirements Documents
(DOORS, .docx, .xlsx, …)
Execution Records, Defect Management, Test Plan Documentation
Test Plans
Test Cases
Test Schedules
Execution Records
Requirement Links
Quality Dashboards
Test Results
(.html, .pdf, .tdms, .jpg, …)
Sequences
Parameter Files
Code Modules
Execution Records
Requirement Links
Quality Dashboards
NI TestStand
Test Engineer
Requirements Documents (DOORS, .docx, .xlsx, ...)

IBM Rational Quality Manager
- Test Plans
- Execution Records
- Test Cases
- Requirement Links
- Test Schedules
- Quality Dashboards

Execution Records, Defect Management, Test Plan Documentation

National Instruments Test Components (.seq, .vi, .nivs, ...)

NI TestStand
- Sequences
- Execution Records
- Parameter Files
- Requirement Links
- Code Modules
- Quality Dashboards

Test Results (.html, .pdf, .tdms, .jpg, ...)

IBM Rational Automotive Engineering Symposium 2013
Requirements Documents
(DOORS, .docx, .xlsx, ...)

IBM Rational
Automotive
Engineering
Symposium 2013

National Instruments Test Components
(.seq, .vi, .nivs, ...)

National Instruments Test Integration Adapter for IBM Rational Quality Manager

IBM Rational Quality Manager
Test Plans, Execution Records, Requirement Links, Quality Dashboards

Test Plans, Test Cases, Test Schedules

NI TestStand
Sequences, Execution Records, Requirement Links, Quality Dashboards

Execution Records, Defect Management, Test Plan Documentation

Test Results
(.html, .pdf, .tdms, .jpg, ...)

National Instruments Test Integration Adapter for IBM Rational Quality Manager
Demo
Demonstration Overview

- Validation of **Adaptive Speed Control Unit (ASCU)**
  - Intended operation in multiple Vehicle Powertrains (Truck, SUV, Luxury, …)
  - Validate performance in all systems against multiple driving scenarios
    (Cruise Set Points / Road Loads)
Defect Management

IBM Rational Quality Manager
- Test Plans
- Test Cases
- Test Schedules
- Execution Records
- Requirement Links
- Quality Dashboards

Defect Resolution
Collaboration

Defect Results and Verification Items
Project Documentation and Tracking

IBM Rational Quality Manager

- Test Plans
- Test Cases
- **Test Schedules**
- Execution Records
- Requirement Links
- Quality Dashboards

Project Dashboards

Test Results
IBM Rational and National Instruments are teaming together to provide an **end-to-end quality management solution**

- **Traceability** all the way to test and back
- **Collaboration** between ALL teams, including test
- All **test results available** to all teams and **linked** to test cases and requirements
- Quality and test considered from the outset, not an afterthought, reducing **cost and risk** of identifying and correcting defects
- **Test component re-use** throughout project phases and between projects providing operational efficiency and accuracy
Learn More:

- **Web pages:**
  - IBM.com: IBM Rational and National Instruments
  - NI.com: Integrating Test Into Development Cycle
  - NI Test Integration Adapter Product page

- **References:**
  - Solution Brief: Break down engineering silos to improve quality
  - Article: To Build a Smarter Product, Stop Separating Design & Test  
  Ian Cannings, Danfoss Power Electronics
  - Blog: Design News blog

- **Media:**
  - Webinar: Integrating National Instruments testing with RQM (demo starts at min 24)
  - Webcast: Embedded System Quality: Top Competitive Techniques Revealed
  - Video: Interview Innovate 2013- Chris Washington, National Instruments...
  - Video: Innovate 2013 Interview and Demo at NI Booth
  - Video: NI Week 2012 Keynote: Embedded Software Quality Management
  - Webcast: Taming the Complexities of Software Driven Innovation to Reduce Project Cost and Risk
  - Podcast: Integrate testing into the development lifecycle