Abstract:

**Quality-Based Requirements Definition**

Richard E. Biehl, CQA, CSQE  
Data-Oriented Quality Solutions

Software engineers often participate in quality improvement programs using quality tools and techniques to identify, quantify, plan, and implement process changes in their working environments. Why don't these software professionals then apply these same techniques to their day-to-day project activities? The same techniques that most organizations easily adopt in the continuous improvement efforts to redefine organizational processes are rarely adapted for use on-the-job in defining system requirements for new business processes. This presentation shows how such techniques are readily adaptable to requirements engineering, and how such use is often aided by facilitation from quality professionals. It extends the impact of QA into the results achieved by every IT project.

Biography:

**Richard E. Biehl**

Rick is a systems analyst with 23 years of experience in information technology. He specializes in conducting requirements analysis through an integration of quality assurance and process improvement techniques with traditional data and process modeling disciplines. He holds an M.S. in Education from Walden University, and serves as an Adjunct IT Professor in Capella University's new School of Technology.

A full-color copy of this presentation, along with additional supporting and related materials and worksheets, is available at WWW.DOQS.COM under RESOURCES.
Quality-Based Requirements Definition

Session Plan

• Present a requirements process that emphasizes the application and use of quality improvement tools.
• Show examples of requirement statements generated by a team actually using this process.
• Illustrate a technique for building participant buy-in to the requirements process and its deliverables.
• Provide an agenda for running an initial large-team requirements session built around this process.
• Provide the review process and criteria used during the verification step of the process and agenda.
• Provide satisfaction metrics that can be used to manage the requirements process to completion.
The Problem

- Software engineers often participate in quality improvement programs using quality tools and techniques to identify, quantify, plan, and implement process changes in their working environments.
- Why don't these software professionals then apply these same techniques to their day-to-day project activities?
- The same techniques that most organizations easily adopt in the continuous improvement efforts to redefine organizational processes are rarely adapted for use on-the-job in defining system requirements for new business processes.

*This presentation offers a path to such an adaptation.....*

Quality-Based Requirements Process

<table>
<thead>
<tr>
<th>Events in the Business Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some Example Events</td>
</tr>
<tr>
<td>Request for Quote</td>
</tr>
<tr>
<td>Payment Received</td>
</tr>
<tr>
<td>Product Sample Taken</td>
</tr>
<tr>
<td>Employee Terminated</td>
</tr>
<tr>
<td>Order Shipped</td>
</tr>
<tr>
<td>Customer Birthday</td>
</tr>
<tr>
<td>Contract Expires</td>
</tr>
<tr>
<td>New Prices Assigned</td>
</tr>
<tr>
<td>Budgets Established</td>
</tr>
<tr>
<td>Order Modified</td>
</tr>
<tr>
<td>Flight Departs</td>
</tr>
<tr>
<td>Product Returned</td>
</tr>
<tr>
<td>Work Shift Begins</td>
</tr>
</tbody>
</table>

Common Techniques

- Brainstorming
- Nominal Group Technique

Set Scope Using Events

- Scope out the general areas for analysis by treating the business process as a black-box, focusing on events that cross system boundaries.
- List the relevant events to help define the scope of the business system, in the broadest terms.
  - Prevents focus from shifting to the current processes too early!
Quality-Based Requirements Process

Identify System Interactions
- Identify all business and system prompts, the source of events that initiate those prompts, and the approximate responses to each.
- Prompt-response loops can be mapped to requirement-conformance loops that are:
  Immediate - The system doesn’t need to interact with another stakeholder in order to fully conform to requirements.
  Deferred - The system must interact with another stakeholder in order to fully conform to requirements. [V-O-T-C]
- The ratio of immediate-to-deferred event relationships is a high-level indicator of the complexity of the business system.

Some Example Mappings
- Order Received: Shipment of Goods (Deferred)
- Payment Received: Booked to Account (Immediate)
- Application Received: Policy Issued (Deferred)
- Reservation Received: Room Nights Provided (Deferred)

Quality-Based Requirements Process

Identify & Prioritize Breakdowns
- Focus quickly on exceptions to prevent the entire effort from being spent on an exhaustive traditional exploration.
- List current problems to focus attention on the current processing exceptions; usually the justification for the effort.
- Avoid the need for large systems development effort when immediate solutions appear within existing processes.

Some Typical Breakdowns
- Unacceptable error rate
- Unacceptable lead or lag time
- Unacceptably high cost
- Workload exceeds capacity
- Missed service commitments
- Customer complaints
Quality-Based Requirements Process

Identify & Rank Causes
- Analyze each breakdown for the root cause or causes.
- Know if the causes of the problems are within scope of the project.
- If out of scope, a cost-of-nonconformance effort is needed to mitigate any damage.

Typical Cause Categories
- Management Policies
- Organizational Design
- Process Errors/Inconsistencies
- Inadequate Training/Support
- Poor Communication

Common Techniques
- Brainstorming
- Nominal Group Technique

Topical Cause Categories
- Business System
- Functions
- Stakeholder Responses

Define High-Level Functions
- Proliferation of stakeholders, prompts, and responses; and system process components to handle them; can create an unmanageable mess.
- Clustering scope into a few core business functions provides an important conceptual structure for the entire requirements process and its deliverables.
- The functions selected will be based on a balance of shared affinity and team expectations (based on the functional groups in the business).
Quality-Based Requirements Process

**Define High-Level Requirements**
- The reality of the requirements process will be rooted in the feasibility of correcting many of the identified defects.
- Potential corrective actions mapped back to the ranked breakdowns will quickly imply a workable scope.
- Solutions that don’t exist can’t be implemented!
- The 80:20 rule applies here. Look for those few subtle changes to the business environment that can reduce or eliminate the impact of the miscellaneous monsters.

**Common Techniques**
- Brainstorming
- Nominal Group Technique

**Business System Functions**

**Business System Stakeholder Responses**

**Events in the Business Cycle**

**Control Planning**

**Stakeholder**

**Business Systems**

**High Level Process Mapping**

**Affinity Analysis**

**Failure Mode Effect Analysis**

**Preliminary Requirement Statements**

**Correlation Analysis**

**Pareto Analysis**

**Cause-Effect Analysis**

**Ranked List of Breakdowns**

**Ranked List of Causes**
Preliminary Requirement Statements

Examples for Level of Detail

MKT.1 Provide strict policies and controls to assure privacy of all customer data. Management policy and system restrictions need to combine to ensure customer data security. The system will include system-user security and processes for authorization.

MKT.2 Provide the ability to integrate marketing efforts across all lines of business. The system needs to provide information showing marketing by business line to assist in optimum promotion of all products and services.

LOG.1 Provide the ability to obtain workflow history for all logistics-related customer data. The system needs to provide the content and author of all customer order changes in order to track service representative activities in logistics, and other system user-related activity against customer records.

LOG.2 Provide the ability to track individual customer compliments, complaints and resolutions. The system needs to provide information regarding complaints and compliments, as well as a record of all activity conducted to reach resolution.

SVC.1 Provide the ability to record and service customer’s temporary or alternate addresses. The system shall support processing against such address flexibility without requiring any additional changes or resetting of options for products and services continuing to use the primary address.

SVC.2 Provide the ability to process post office returns in a timely manner. The system needs to have the ability to process post office returns, capture corrected address data, and inform all departments originating mailings to that customer household.

FIN.1 Provide the ability to verify credit or debit card validity prior to posting. The system needs to have the ability to interface with online credit/debit verification services to allow for validation of funds at the time of each transaction.

FIN.2 Provide the ability to handle partial pay customers by adjusting product terms or benefits based on money received. The system needs to be able to locate partial payment customer files and adjust product contract benefits or length to correspond with the payment made.

FIN.3 Provide the ability to balance every point of sale transaction (in house and branch office closeout at end of the day). The system needs to be able to electronically validate branch deposits from banks so that accounting has all information necessary to balance and close out at the end of each business day.

REG.1 Collect and file all applicable state and local sales and use taxes on all transactions. Each state, county, and municipality in which the company operates has specific rules and regulations regarding the charging of such taxes and their filing and payment. The system needs to support geographically appropriate collection, filing, and payment of such taxes in compliance with these regulations.

REG.2 Adhere to all applicable state and local sales solicitation and privacy regulations. The system needs to implement appropriate controls, by legislative jurisdiction, to ensure compliance with these restrictions and regulations.
An additional step to secure team buy-in…

**Project Perspectives**

Relative size and overlap of scope.

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**Initial Requirements Session**

**First Day**
8:00  Start-up w/ Introductions
8:30  **Project Briefing**
9:30  Requirements Process Training
10:30 **Scoping Discussion** (A-B-C-D)
12:00 Lunch
12:45 **Breakdown Analysis** (Group A)
1:45  Breakdown Analysis (Group B)
2:45  Breakdown Analysis (Group C)
3:45  Breakdown Analysis (Group D)
4:45  Review of Action Items & Issues
5:00  Adjourn

**Second Day**
8:00  Convene with recap and questions
8:20  Requirements Process Training
9:00  **Causal Analysis** (Group A)
10:30 Causal Analysis (Group B)
12:00 Lunch
12:45 Causal Analysis (Group C)
2:15  Causal Analysis (Group D)
3:45  Review of Action Items & Issues
4:00  **Project Planning**
5:00  Adjourn

**Third Day**
8:00  Convene with recap and questions
8:20  Requirements Process Training
9:00  **Requirements Definition** (Group A)
10:30 Requirements Definition (Group B)
12:00 Lunch
12:45 Requirements Definition (Group C)
2:45  Requirements Definition (Group D)
4:45  Review of Action Items & Issues
5:00  Adjourn

**Fourth Day**
8:00  Convene with recap and questions
8:20  Project Plan Review
9:00  **Drafted Requirements Review**
12:00 Lunch
12:45 Verification & Validation Planning
2:00  Next Steps Planning
2:45  Review of Action Items & Issues
3:00  Adjourn
Draft Requirements Review Process

Each section is reviewed in sequence:
• Participants reread the entire list of Statements.
• Each Statement is then reviewed in sequence:
  – Use Review Questions to drive a 3-5 minute discussion.
  – Select a disposition for each Requirement Statement.
  – Use Parking Lot for issues unresolved and left for Further Disposition
  – Use the Suggestion Form to add to each discussion.
• The set of Requirement Statements is then discussed:
  – Additional Requirement Statements should be suggested by participants.
  – Participants should use the Suggestion Form for other additions, changes, or concerns.

Review Questions

*Does the group...*

… understand what the requirement statement is trying to say?
… agree with what the requirement statement is saying?
… feel that the requirement statement belongs in this document?
… feel that the requirement statement is technically accurate?
… agree that conformance to the requirement statement is observable?
… feel that the requirement statement is described appropriately?
… feel that there is a shared rationale for the requirement statement?

<table>
<thead>
<tr>
<th>Review Dispositions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accept</td>
</tr>
<tr>
<td>Accept as revised</td>
</tr>
<tr>
<td>Merge into requirement ______</td>
</tr>
<tr>
<td>Split into ______ requirements</td>
</tr>
<tr>
<td>Eliminate as undesired</td>
</tr>
<tr>
<td>Eliminate as out-of-scope</td>
</tr>
<tr>
<td>Further revision</td>
</tr>
</tbody>
</table>
Satisfaction Criteria

**Complete** - All items that are needed for the specification of the requirements of the solution to the problem have been identified.

**Correct** - Each item in the specification is free from error.

**Precise & Clear** - Each item is exact and not vague, there is a single interpretation of each item, the meaning of each item is understood, and the specification is easy to read.

**Consistent** - No item in the requirements specification conflicts with another item in the specification.

**Relevant** - Each item in the requirements specification is pertinent to the problem and its solution.

**Testable** - During development and acceptance testing, it will be possible to determine whether the item in the requirements specification has been satisfied.

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Satisfaction Criteria

**Feasible** - Each item in the requirements specification can be implemented with the techniques, tools, resources, and personnel that are available.

**Free of Design Detail** - The specification contains statements of the requirements that must be satisfied by the problem solution, and are not obscured by proposed solutions to the problem.

**Manageable** - The requirement statements are expressed in such a way that each item can be changed without excessive impact on other items.

**Overall** - Satisfaction with the requirements specification, within the limitations of its current scope and version.

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Numerical ratings (1-10) are collected from all project participants at intervals throughout the requirements phase in order to provide metrics for managing customer attitudes and project phase status.
Recap & Close

- An exception-based process focuses the team quickly on the *important success factors* for their project.
- Talking about breakdowns and causes encourages team members to talk about *solutions* rather than *automation*.
- Use of quality tools encourages integration of TQM principles and techniques as *real-world* disciplines.
- Review process keeps team engaged and focused on *significant changes* rather than simple wordsmithing.
- Satisfaction metrics provide *tool* for management to adjust processes based on *team and customer focus*. 
# Scoping Discussion Worksheet

<table>
<thead>
<tr>
<th>Name of System/Project</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Stakeholders (People, Functions/Organizations, Systems; Internal &amp; External)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Business Functions (Major areas of activity or responsibility)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Venn Diagram of System (Relative size and overlap of scope)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>
## Breakdown Analysis Worksheet

**Breakdown Area** (Function, Process, Event-Response): 

**Defect Areas** (Description of failures, approximate costs and impacts)

**Complaints & Concerns** (Problems, Annoyances, Inefficiencies)

**Workarounds**

**Identifiable Trends**

**Worst-Case Issues** (Defects, Concerns, Workarounds, Trends)
Causal Analysis Worksheet

Breakdown (Defect, Failure, Complaint, Concern): ________________________________

Definition (Description, Frequency, Impact/Cost)

Causes

- Environment
- People
- Training

- Methods / Tools
- Money / Budget
- Time / Schedule

Significant Causes (Random, Special, Common, Root)

Possible Fixes
**Requirements Definition Worksheet**

<table>
<thead>
<tr>
<th>Requirements Category</th>
<th>_____________________________________________________________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Statement</strong></td>
<td>(A single short well-formed sentence)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Definition</strong></td>
<td>(Full explanation expanding on Statement)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rationale</strong></td>
<td>(Justification for the requirement)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Importance</strong></td>
<td>(Circle one and explain): <strong>LOW</strong> <strong>MEDIUM</strong> <strong>HIGH</strong> <strong>CRITICAL</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Allocation</strong></td>
<td>(Circle one and explain): <strong>SYSTEM</strong> <strong>MANAGEMENT</strong> <strong>ORGANIZATION</strong> <strong>ENVIRONMENT</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Validation Strategy</strong></td>
<td>(How will we test that this requirement has been met?)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Draft Requirements Review Worksheet

Requirements Category

Key Requirements (Summarize 5-10 most significant requirements)

Impact (Map key requirements into the Venn Diagram)

Evolution of Requirements

- Retired
- New
- Retained or Revised

Observations
### Requirements Definition Suggestion Form

<table>
<thead>
<tr>
<th>Requirement:</th>
<th>Team Member:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suggested wording or phrases:</td>
<td></td>
</tr>
<tr>
<td>Suggested additional rationale:</td>
<td></td>
</tr>
<tr>
<td>Additional comments or remarks:</td>
<td></td>
</tr>
</tbody>
</table>
# Requirements Specification Quality Review

This worksheet provides ten criteria against which the Requirements Specification document is to be reviewed and assessed. The first nine criteria focus on specific quality attributes of requirements specifications, and the tenth allows for a general assessment. After reading the provided version of the Requirements Specification, please complete and return this worksheet. For satisfaction, please use a 1-10 scale; where "1" indicates strong disagreement, and "10" indicates strong agreement. Additional comments may be provided on the bottom of the worksheet or on additional pages. In particular, please try to provide at least one example for each criteria given an unusually low rating relative to the other criteria. Thank you.

### Project: _____________________________________________________________________

### Reviewer: _____________________________________  Version Number/Date: ___________

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPLETE</td>
<td>All items that are needed for the specification of the requirements for the system solution to the problem have been identified.</td>
<td></td>
</tr>
<tr>
<td>CORRECT</td>
<td>Each item in the requirements specification is free from error.</td>
<td></td>
</tr>
<tr>
<td>PRECISE &amp; CLEAR</td>
<td>Each item is exact and not vague, there is a single interpretation of each item, the meaning of each item is understood, and the specification is easy to read.</td>
<td></td>
</tr>
<tr>
<td>CONSISTENT</td>
<td>No item in the requirements specification conflicts with another item in the specification.</td>
<td></td>
</tr>
<tr>
<td>RELEVANT</td>
<td>Each item in the requirements specification is pertinent to the problem and its solution.</td>
<td></td>
</tr>
<tr>
<td>TESTABLE</td>
<td>During development and acceptance testing, it will be possible to determine whether the item in the requirements specification has been satisfied.</td>
<td></td>
</tr>
<tr>
<td>FEASIBLE</td>
<td>Each item in the requirements specification can be implemented with the techniques, tools, resources, and personnel that are available.</td>
<td></td>
</tr>
<tr>
<td>FREE OF DESIGN DETAIL</td>
<td>The specification contains statements of the requirements that must be satisfied by the problem solution, and are not obscured by proposed solutions to the problem.</td>
<td></td>
</tr>
<tr>
<td>MANAGEABLE</td>
<td>The requirement statements are expressed in such a way that each item can be changed without excessive impact on other items.</td>
<td></td>
</tr>
</tbody>
</table>

| OVERALL               | I am satisfied with the requirements specification, within the limitations of its current scope and version.                                                                                               |        |

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<no author>
# Requirements Process Checklist

This checklist can be completed at any point in the project, particularly at the end of the Requirements Phase, or else any major checkpoint where significant analysis activity has been completed. The questions presume that analysis is taking place on the project, and that some form of Requirements Deliverable is being produced, even if informally.

<table>
<thead>
<tr>
<th>Score should range from 0 (No) to 10 (Yes).</th>
<th>Score (0-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Has analysis defined and clarified the <em>business</em> problem to be solved and the rationale that determines the importance and value of the solution to the business?</td>
<td></td>
</tr>
<tr>
<td>2. Has analysis described <em>what</em> needs to happen in order to solve the defined problem; and the criteria that should be used to determine if the project reaches successful implementation?</td>
<td></td>
</tr>
<tr>
<td>3. Has analysis included data requirements, including new data elements, changes to data definitions, or new or revised relationships among data?</td>
<td></td>
</tr>
<tr>
<td>4. Has analysis included process requirements, including revision to the triggers that cause events to happen, or new steps or sequences of steps that are required in the business?</td>
<td></td>
</tr>
<tr>
<td>5. Has analysis included interface requirements, including human interfaces and system-to-system interfaces among new, revised, and legacy systems?</td>
<td></td>
</tr>
<tr>
<td>6. Has analysis included security specifications, including those related to any potential compromise of sensitive information and end-user privacy?</td>
<td></td>
</tr>
<tr>
<td>7. Has analysis included reconciling differences among requirements that create dependencies or decision points in resolving a design direction for the requirements?</td>
<td></td>
</tr>
<tr>
<td>8. Has analysis included prioritizing or clustering requirements as a basis for deciding among possible design alternatives?</td>
<td></td>
</tr>
<tr>
<td>9. Has analysis been included of any impact this project may have on previously implemented requirements?</td>
<td></td>
</tr>
<tr>
<td>10. Has the project documented and versioned the requirements to a sufficient level of detail that changes to requirements or expansion of scope will be quickly visible?</td>
<td></td>
</tr>
</tbody>
</table>

*Total Score:*

*Notes:*