Adverse Effects of Distributed Development on Product Quality

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Adverse Effects of Distributed Development on Product Quality

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Overview

- Setting the scope
- Distributed Development & Product Quality: a problem?
- Research questions
- Research results
- Application in industry
- Questions
Setting the scope

Trend:
Companies increasingly investigate opportunities for product development in close cooperation with suppliers

Reasons:
• Focusing on core activities
• Strengthening of innovative capabilities
• Reduction of costs / Reduction of Time-to-Market
• Instant access to state-of-the-art technology & knowledge
• Mitigation of product risks
• …

Consequence:
Products are being developed by separate parties across multiple disciplines at separate geographical locations (virtual product development, a.k.a. distributed, multi-site or global development).
Typically applied in the development of complex products.
Virtual Product Development (VPD) is the development of a product by a virtual team.

**A virtual team is a team distributed across space, time, and/or organisational boundaries, working interdependently with a shared goal and collaborating by webs of interactive technology.**

[Lonchamp, 2002; Gibson et al, 2003]

VPD shows a worldwide, strongly increasing trend.

[Carmel, 1998; Carmel & Tjia, 2005]
Virtual Product Development - 2

VPD is much more complex than ‘co-located’ development

In terms of:
- Geographic dispersion
- Control & coordination breakdown
- Loss of communication richness
- Loss of teamness
- Cultural differences
Virtual Product Development - 2

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- Loss of communication richness
- Loss of teamness
- Cultural differences

“One of the biggest mistakes is that senior management does see the profits of collaboration, but seems to neglect the consequences for ‘the working floor’.

Strategy-wise everything is OK, but not at the operational level; the rest of the organisation is not yet capable (or not yet trained) to collaborate, to look beyond the borders of the own organization.

Now it is often assumed just by default that the other organizations will work in a similar fashion”

[“Building Innovation”, June 2007]
What is a Complex Product?

A product or system consisting of multiple components that combines the technical capabilities of multiple engineering disciplines to fulfill its intended use.
“Observations from industry”

• Focus primarily on effects of VPD on managerial aspects: delivery on time, within budget
• Cultural differences and collaboration receive lots of attention
• Many experience reports, suggesting solution directions
• Occasionally attention to specific development processes (e.g. requirements engineering, configuration management)

• However, effects on product quality are hardly addressed, despite:
  • Evidence of adverse effects of VPD on product quality
  • Strategic importance of product quality (maintenance costs, company market profile, lawsuits, product recalls)
Perception of Quality Problems

THE EXPOSURE PYRAMID

- Major recalls
- Claims
- Injuries
- Repairs
- Forced Redesigns
- Patches
- Updates
- Release delays
- Functionality decrease

ORGANISATIONAL AWARENESS

- “Local” exposure
  - Known to the field of industry
  - Post-release impact
- “v4.1.2 still not stable”
- “Let’s solve it differently now”
- Innovation uncertainty

ORGANISATIONAL UNAWARENESS

- Issues only known to the cooperating parties
- Annoying impact
- Recognition of rework, delays
- Issues only known to the own organisation
- Ignorance of causes
- Problem denial
- Hidden rework, delays
… a “post-release defect”…
“Facts from industry”

FACT 1:
Organizations have never been very keen on disclosing their negative experiences with product quality:

“companies are extremely reluctant to provide or publish data on defects”
[N. Fenton, 1996]

“organizations are even more reluctant to provide quality data than to provide effort data”
[S. Chulani, 1999]

“release of software failure data has been equated to embarrassment”
[P. Dapena, 2002]

“project data is mostly transparent; the fog only gets in when it comes to design details and quality data”
[J.H. van Moll, 2006]

FACT 2:
“Near-misses” in industry are never documented !!
Research questions

- What typical problems with product quality occur?
  - Analysis of quality problems in 22 VPD projects across 4 product domains (18 companies)

- What are typical causes of those problems in VPD?
  - Identification of VPD-specific defect causes by teams of experts

- Can product quality problems in VPD be prevented?
  - Estimation of the number of preventable defects in a specific situation

- Identification of factors influencing defect introduction (DI) and defect detection (DD)
  - Identification, grouping, relative importance
Research questions

• What typical problems with product quality occur?
  • Analysis of quality problems in 22 VPD projects across 4 product domains (18 companies)
  • Note that VPD is not necessarily about teams globally distributed, across multiple organizations, or multiple disciplines:
    - Two separate development teams of the same company on a single site might experience product quality problems similar to those experienced by a globally distributed team.

• What are typical causes of those problems in VPD?
  • Identification of VPD-specific defect causes by teams of experts

• Can product quality problems in VPD be prevented?
  • Estimation of the number of preventable defects in a specific situation

• Identification of factors influencing defect introduction (DI) and defect detection (DD)
  • Identification, grouping, relative importance
Research results - 1

Product quality problems occur, specifically caused by the characteristics of VPD

60% of quality problems relate to VPD

23 problem types across 5 major problem areas

- Configuration Management
- Test Strategy
- Requirements Management
- System/Product Integration
- Test Environment

Project management keeps implementing development and testing practices the ‘traditional way’

Product quality problems can be prevented by taking into account the effects of distributed development on product quality (preventable defects 52% of total number)
Typical problem examples

- (System) integration problems
  - Lack of strategy
  - Blocking issues / delays
  - Integration testing forcibly cancelled/skipped

- (System) testing problems
  - Test coverage shortcomings (blind spots / overtesting / overreliance)
  - Misalignment of test objectives / strategies
  - Absence / misinterpretation of test results & reports

- Product requirements
  - Misinterpretation / misimplementation / implementation duplicates
  - Unsuitable as test basis
  - Documentation white-spots

- Configuration management
  - Change control problems
  - Version control problems

- Test environment
  - Non-availability
  - Lack of representativeness
  - Inconsistencies

Causing:
- Increase of defect introduction
- Decrease of defect detection
Research results - 2

- Identification of factors (literature research / content analysis)
  - yielding 117 DI factors and 113 DD factors
- After grouping of factors (cluster analysis / expert judgment)
  - yielding 16 DI factors and 17 DD factors
- Ranking of factors according to relative importance (world-wide survey among subject experts)
## Research results - 2

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<th>Defect Introduction Factors</th>
<th>Defect Detection Factors</th>
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<td><strong>1</strong> Test Capability</td>
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<tr>
<td><strong>2</strong> Developer Capability</td>
<td><strong>2</strong> Quality of Documentation</td>
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<tr>
<td><strong>3</strong> Domain Knowledge</td>
<td><strong>3</strong> Management Attitude</td>
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<td><strong>4</strong> Communication</td>
<td><strong>4</strong> Test Process Maturity</td>
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<td><strong>5</strong> Product Complexity</td>
<td><strong>5</strong> Testability</td>
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<td><strong>6</strong> Change Control</td>
<td><strong>6</strong> Communication</td>
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<td><strong>7</strong> Project Management Maturity</td>
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<td><strong>8</strong> Quality of Documentation</td>
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<td><strong>9</strong> Team Composition</td>
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<td><strong>11</strong> Collaboration</td>
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<td><strong>12</strong> Process Maturity</td>
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<td><strong>14</strong> Innovation</td>
<td><strong>14</strong> Adherence to Plan</td>
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<td><strong>15</strong> External Disturbance</td>
<td><strong>15</strong> Support for Testing</td>
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<tr>
<td></td>
<td><strong>17</strong> Team Distribution</td>
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Solution directions

Factor-based assessment and improvement of development and test practices in distributed projects

**REACTIVE (CORRECTIVE) APPROACH**

1. Analysis of Product Quality Problems
2. Determination of Problem Area
3. Selection of improvement measures
4. Implement & monitor execution

**PROACTIVE (PREVENTIVE) APPROACH**

1. Conduct Risk Assessment on distributed context
2. Adapt context
3. Selection of measures
4. Implement & monitor execution
Achievements

• Defect prevention, by eliminating certain defect types, compared to previous developments of the same product type
  • Project 1: 45% fewer defects
  • Project 2: 37% fewer defects
  • Project 3: 33% fewer defects
  • Project 4: 15% fewer defects
  • Project 5: 28% fewer defects

• Project lead time reduction
  • Actual estimations range up to 30% reduction (6 projects investigated)

• Reduction of Post-release Costs
  • Actual cost savings up to 60% of total yearly maintenance costs (of 4 investigated projects)
Effects of Virtual Product Development on Product Quality and their Influencing Factors

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