

Discovering the Unexpected, or Confirming the Known?

Influences on Regression Testing
Strategies in Diverse Software
Development Environments

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- ◉ "Discovering the unexpected is more important than confirming the known".
 - George Box (statistician)

Regression Testing

- Change of status and emphasis with popularity of agile methods
- No single template for introducing regression testing into a software development environment
 - External factors
 - Internal factors
- Impact on
 - Change and risk management
 - Quality control of the test process
 - Organizational testing philosophy
 - Investment in staff, training and infrastructure

This Presentation

- Industrial experience reports
- Results of an on line survey
- Impact of external and internal factors on regression testing practice
- Strategic level
 - Less well explored in the literature than the operational and organizational levels
- Results
 - Organizational maturity has an important role to play in the effectiveness of regression testing
 - Regulatory compliance may be one factor driving this

What is Regression Testing?

- Tests run against a previous version of the component under test, following maintenance or enhancement
 - Progressive (for changes to the software specification)
 - Corrective (for other changes)
- 2 objectives
 - To find failures introduced by changes
 - To fail to reproduce old failures claimed to be fixed by maintenance
- (almost) always automated
- Pragmatic selection of a test suite from tests developed from other parts of the test process

Regression Testing in Agile Environments

- Agile methods have brought regression testing to the center of software development
 - Emphasis on continuous integration and test driven development
- Refactoring merges corrective v. progressive
- TDD changes role of regression testing as the most likely place to find errors
- Changes to frequency of testing

Challenges in Agile Regression Testing

- Setting up a viable automated test framework
- Tests are subject to a number of issues in remaining valid and consistent - challenges in
 - Behavior sensitivity
 - Interface sensitivity
 - Data sensitivity
 - Context sensitivity
- Agile environment may reveal different issues to those in some earlier studies

Outline of the study

- How is regression testing currently applied in increasingly complex and diverse software development environments?
- Regression testing practice identified at operational, organizational and strategic levels
 - Strategic level investigated
- Analytical framework based on internal and external forces and regression testing practices
- Examine these factors
 - Experience reports
 - On-line survey

Characteristics of Regression Testing Practice

Regression Testing (Operational)

Test Coverage

Test Prioritization

Test Frequency

Test Selection



Regression Testing (Organizational)

Test Plans

Test Data

Test Standards

Test Metrics



Regression Testing (Strategic)

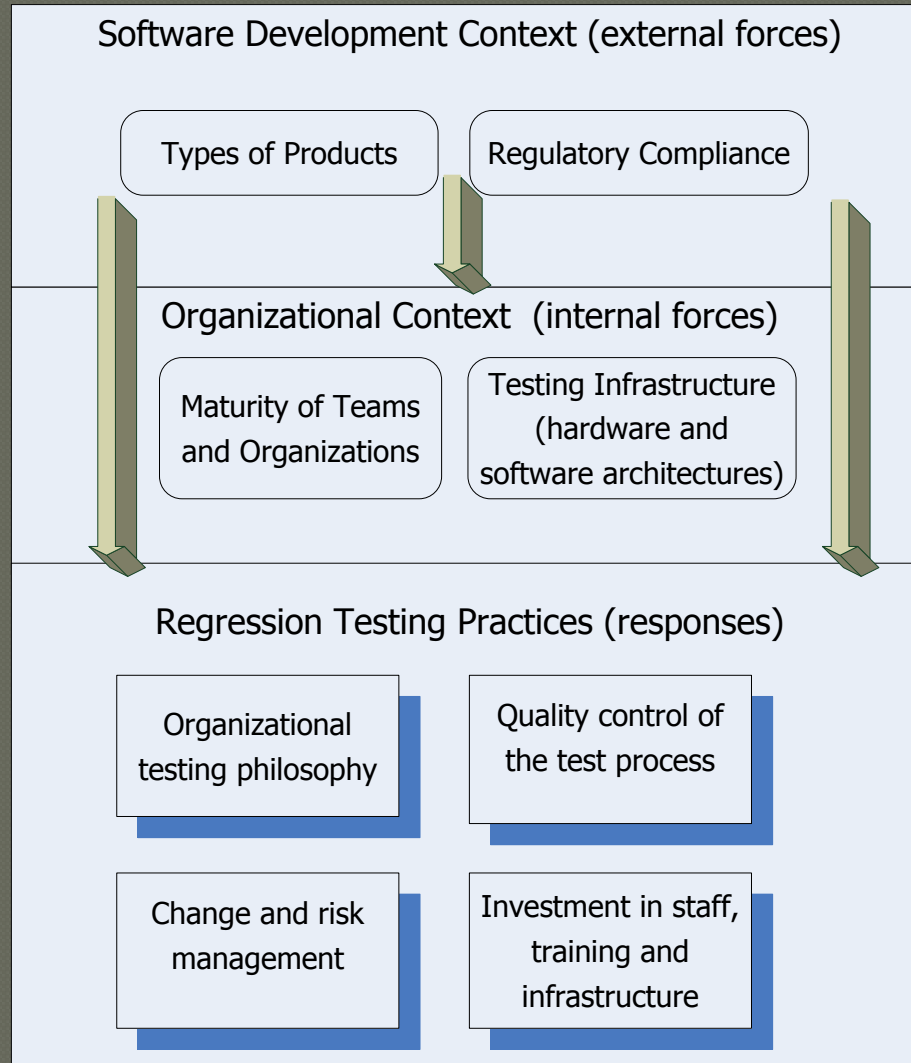
Test Context

Test Process

Test Infrastructure

Risk Management

Analytical Framework for Strategic Regression Testing



Industrial experience reports

- ◉ Three industrial experience reports
- ◉ Reflect in particular on:
 - Change management
 - Quality control
 - Testing philosophy
 - Investment
 - Forces
- ◉ Level of maturity of the regression testing process is a key factor in its effectiveness

Experience Report 1- Immature Process

- Change management
 - Development and testing approach top down
 - Inadequate buy in from the team
 - Inadequate support
- Quality Control
 - Tests not identifying manually encountered errors
- Testing Philosophy
 - No automated tests of the web layer
 - Many unit tests were integration tests
- Investment
 - Limited resources
 - Poor quality environment and software
- Forces
 - External forces were relatively strong
 - High levels of compliance, possible third party clients
 - Put pressure on the internal forces

Experience Report 2 – Building Maturity

- Change management
 - Long term effort to remove technical debt
 - Optimizing the architecture of the codebase to enable greater test coverage
- Quality Control
 - Dedicated tester
 - Acceptance test tool
 - Site trials
 - Independent code review.
- Testing Philosophy
 - Proactive change
 - Test Driven Development, refactoring legacy code, integration of mock objects
- Investment
 - Training and tools
 - Test infrastructure included both computing resources and physical machinery
- Forces
 - Not subject to any regulatory compliance
 - Test infrastructure appropriate for the environment

Experience Report 3 – Process Maturity

- Change management
 - Configurable environment
- Quality Control
 - Metrics: coverage, build time, code duplication, defect arrival rate
 - Test beds modeled most popular and critical live deployments
- Testing Philosophy
 - TDD
- Investment
 - Hardware and software
 - Complete set of refactoring and coverage tools
 - Home-grown test bed controller
 - Network bandwidth increased
 - Customized screens
- Forces
 - Regulatory compliance for accounting
 - Ergonomic requirements
 - Complex product line caused by acquisitions

Survey Design







- Online survey
- Administered by invitation and specialist mailing list
 - What were the external forces experienced?
 - software development context
 - What were the internal forces experienced?
 - organizational maturity, infrastructure
 - How did regression testing operate?
 - Testing philosophy, quality control, change and risk management, investment

Response

- 35 valid respondents (after all empty responses removed)
- 16 completed every section
 - Many were optional text entry
 - Some questions could not be answered by the respondent
 - Some responses were withheld due to confidentiality issues

Types of Products

- Many involved in multiple markets
 - Complex external forces

#	Answer		Response	%
1	System software		12	34%
2	Middleware / Infrastructure		11	31%
3	Application software (for in-house use)		20	57%
4	Application software (commercial off-the-shelf)		9	26%
5	Application software (for third party clients)		17	49%
6	Other (please specify)		3	9%

Other (please specify)





Customizations for our own commercial off-the-shelf products

Web Applications (for third party clients)

websites






Regulatory Compliance

◉ Range of responses

#	Answer		Response	%
1	<u>Minimal or None (only general legal compliance is required)</u>		6	22%
2	<u>Limited (some external regulations have to be complied with but the overhead is small)</u>		10	37%
3	<u>Significant (there is significant regulatory compliance required that impacts on the development process)</u>		8	30%
4	<u>Major (regulatory compliance is a major concern and an essential aspect of the software)</u>		3	11%
Total			27	100%

Organizational Maturity

◉ Various levels of external forces

#	Answer		Response	%
1	Initial (ad hoc, chaotic)		6	20%
2	Managed (processes are planned and controlled)		8	27%
3	Defined (practices are standardized and embedded across the organization)		8	27%
4	Quantitatively Managed (performance data is gathered and analyzed)		3	10%
5	Optimizing (culture of continuous improvement)		5	17%
	Total		30	100%

Product Type and Compliance

- Compliance is a significant external force
- Software for known clients is likely to require a higher level of compliance

Level of Maturity	Types of Software Products					Other	Total
	System	Middleware	Application (in-house)	Application (COTS)	Application (3 rd Party)		
Minimal or None	2 (0.00)	1 (-0.78)	1 (-2.33)	1 (-0.33)	1 (-1.11)	2 (1.33)	4
Limited	3 (-0.33)	2 (-0.98)	5 (-0.56)	1 (-1.22)	4 (-1.19)	1 (-0.11)	8
Significant	3 (-0.33)	4 (1.63)	6 (1.56)	1 (1.22)	6 (1.85)	0 (-0.89)	7
Major	1 (0.00)	1 (0.11)	3 (1.33)	3 (0.33)	2 (0.44)	0 (0.33)	3
Total	98		15	6	14	3	

Compliance and Maturity

- There seems to be a relationship between the level of compliance and the level of maturity

Level of Maturity	Level of Regulatory Compliance				Total
	Minimal or None	Limited	Significant	Major	
Initial	3 (2.11)	1 (-0.48)	0 (-1.19)	0 (-0.44)	4
Managed	1 (-0.78)	3 (0.04)	3 (0.63)	1 (0.11)	8
Defined	1 (-0.56)	3 (0.41)	3 (0.93)	0 (-0.78)	7
Quantitatively Managed	0 (-0.67)	1 (-0.11)	2 (1.11)	0 (-0.33)	3
Optimizing	1 (-0.11)	2 (0.15)	0 (-1.48)	2 (1.44)	5
Total	6	10	8	3	27

Infrastructure

- Wide range of tools and configurations in use
- Each regression testing context is different and operating under unique requirements
- A number of respondents indicated that their test systems are virtualized
- Only one referred to hosting in the cloud
- One respondent said their regression testing was still being done manually

Change and Risk Management

- Difficult to answer
 - Lack of personal experience
 - Automated regression testing there from the start
- Some organizations had moved in a planned and managed way from manual to automated testing
- Continually evolving technology and tool set
 - Ways of upgrading their processes to incorporate these

Quality Controls

● Three categories

1. General aspects of process management

- Formal code reviews, business sign off on all changes, regression matrices, clear demarcation on system access, release procedures within a controlled environment

2. Application of specific quality criteria

- Process, performance and integrity criteria including minimum code coverage, build time, metrics, and only merging tested, unduplicated code

3. Tools used to support quality

- Range of automated processes including application lifecycle management tools, source code analysis and code coverage

Testing Philosophy

- A number of respondents based their responses around test driven development
- Reinforced core practices of agile methods in testing
 - “customers dictate the quality assurance, we have the full support of management for test automation”
 - “Testers are part of the development team rather than being an independent unit working after items are developed”
- Other less expected responses
 - “There are also cultural issues at play within a global organization like ours. Development teams in the far east do not necessarily understand automated testing in the same way as western teams.”

General Responses

- Importance of commitment to the process from all stakeholders
 - Management, customers, developers, testers
- Dedicated resources required to organize and maintain test environments
 - One person must have overall responsibility for the integrity of those environments
- Tool support is central
 - For automated testing and test quality
 - Certain development tools encourage testing more than others
- A process of continuous improvement is required
 - based on concrete measures (benchmarks, metrics and service levels)

External Factors and Regression Testing Practices.

- No close relationship between types of software application and regression testing practices
- Main differences in infrastructure driven by size of software development operation, rather than type of software being written
- Tendency for teams working on COTS or third party software, particularly where customization was included, to have a testing philosophy that emphasized the use of TDD
- A high level of regulatory compliance did not seem to suggest that organizations would have a greater focus on risk management or investment

Internal Factors and Regression Testing Practices

- ◉ Higher the level of organizational maturity =...
 - more processes in place for risk management
 - higher level of investment in regression testing
- ◉ Most respondents referred to investment in infrastructure
 - More mature organizations also reported investment in training

Conclusions

- The level of maturity of an organization has a significant impact on the effectiveness of the regression testing process
- This maturity has some kind of relationship with the levels of regulatory compliance, though these relationships cannot be interpreted as causal