

# Example Driven Architecture

Moving beyond the fragile test problem once and for all

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These Slides: <http://pnsqc2014.gerardm.com>

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## My Background

- Software developer
- Development manager
- Project Manager
- Software architect

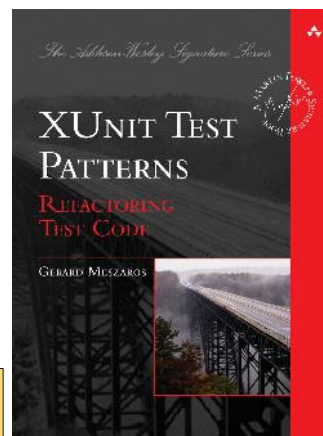
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- OOA/OOD Mentor
- Requirements (Use Case) Mentor
- XP/TDD Mentor

*I. T.*

- Agile PM Mentor
- Test Automation Consultant & Trainer
- Lean/Agile Coach/Consultant

*Product & I. T.*



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## My Background

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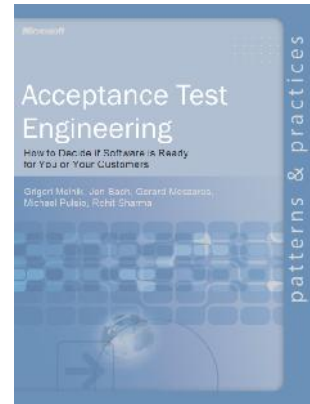
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## Agenda

- **Survey**
  - The State of Your Test Automation
- **Challenges of Test Automation**
  - Why is Test Automation So Hard
- **Rethinking the Development Process**
  - Example-Driven Development
- **Managing Scope vs Detail**
  - How to Define Effective Examples
- **Achieving a Test-Friendly Architecture**
  - Example-Driven Architecture

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## **Functional Test Automation?**

**Please stand up if you are automating:**

- ... tests for all user-visible functionality?**
- ... tests for all business logic (but not the UI)?**
- ... tests for key subset of business logic?**

**Please stand up if you are not automating any tests.**

## **Unit Test Automation**

**Please sit down if you are:**

- ... not automating any unit tests.**

**Please sit down if you are automating**

- ... unit tests for core business logic only.**
- ... unit tests for all business logic.**
- ... unit tests for all code.**

## **Effectiveness of Automation**

**Please stand up if your automated tests are:**

- ...hard to prepare?**
- ...difficult to understand?**
- ...expensive to maintain?**

## **Happiness With Test Automation?**

**Please sit down if you are:**

- ...very unhappy with your test automation**
- ...somewhat unhappy with your test automation.**
- ...somewhat happy with your test automation.**

**So those of you still standing are very happy with your test automation??**

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## So Why Is This So Hard To Do?

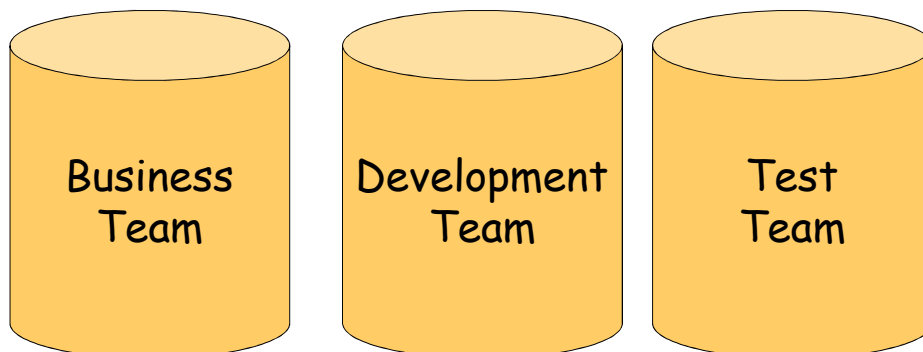
- Is it because we aren't smart enough?
- Is it because the tools aren't good enough?
- Is it because of factors beyond our control?
  
- Are we set up to fail?

## Problems With Test Automation

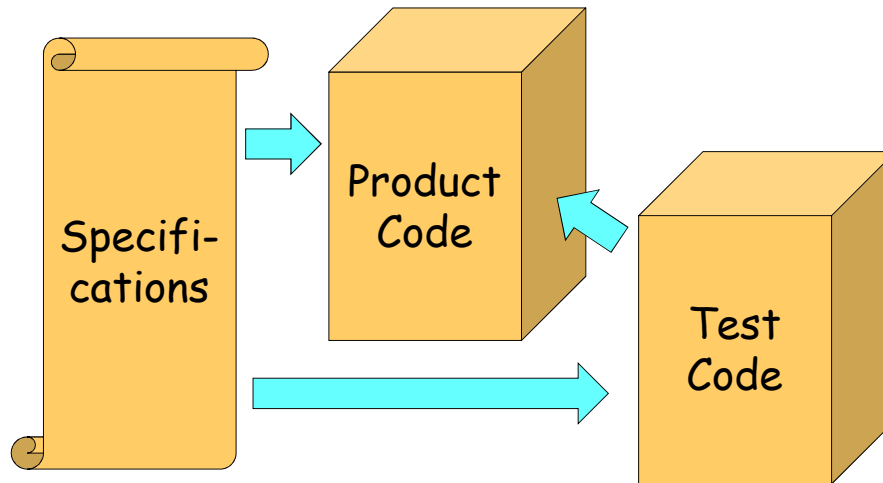
- Tests are written separately from specification
- Tests are written separately from product code
- Functional Tests Interact with System via UI
- Tests are very detailed and repetitive
- Tests have to work around constraints of system and environment

## Conway's Law

- “The Architecture of System will resemble the Organization that Built it.”



## Resulting Architecture



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## Resulting Tests Are:

- **Forced to find sub-optimal ways to interact with the Product Code**
  - Via interfaces not designed for tests
  - Can only test the whole system, not the parts that contain the logic we want to test
- **Forced to find ways to control the state of the system**
  - Can't set state directly; must use convoluted paths to set the state

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## Where Does This Leave Us?

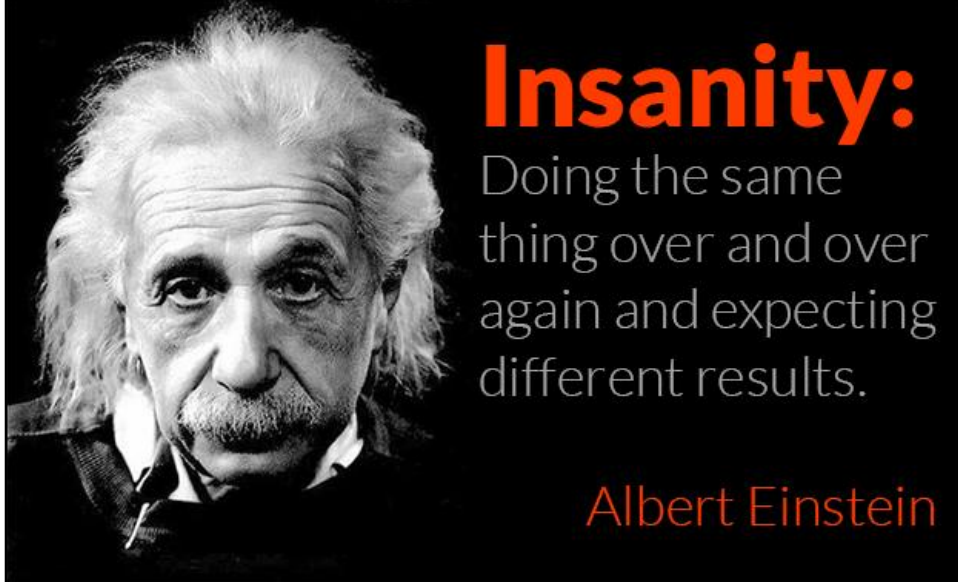
- Tests are more complex than they should be
- Tests take longer to run
- Tests are fragile with frequent “false positive” test failures
- Tests require frequent, expensive maintenance

## The Fragile Test Problem

- Kind of changes that break tests:
- Changes to the interface used to interact with system (e.g. UI)
- Changes to state of system (e.g. database contents)
- Changes to things system depends on:
  - Runtime container (user permissions, time/date)
  - Dependencies on other system (messaging, SQL, RMI)



## Insanity:



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  - Example-Driven Architecture

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## **This is not a technology problem!**

- **Our tools are very good**
  - But they cannot overcome the obstacles
- **Our people are very good**
  - But they cannot overcome the obstacles

## **This is a System Design Problem**

- **We Have to Change the System we use to Build the Software**
- **To Remove the Obstacles**

## What Are the Obstacles?

- **Business People:**
  - ... don't know what developers need to be told
  - ... don't know what to ask for (what is possible)
  - ... focus on success paths
- **Developers:**
  - ... don't know what would provide real value
  - ... don't understand testability requirements of system
- **Testers and automaters:**
  - ... cannot communicate testability requirements
  - ... are forced to use existing interfaces not designed for testing

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## What Are The Solutions

- **T-B-D need to collaborate in preparing specifications before building the product.**
  - T-B-D = Testers, Business & Development
- **Specifications need to include concrete “potentially executable” examples at several levels, including**
  - Workflow sequences
  - Transaction interactions
  - Business rules and algorithms
- **Development needs to be responsible for automation of their execution**
  - Directly from the business-readable specification

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## Example-Driven Development

- Business & Testers come up with examples; Developers help them formalize it.
- Developers write interpreters for examples; design product code to support them
- Developers write product code guided by execution of the examples

This is Like TDD but at a Very Large Scale

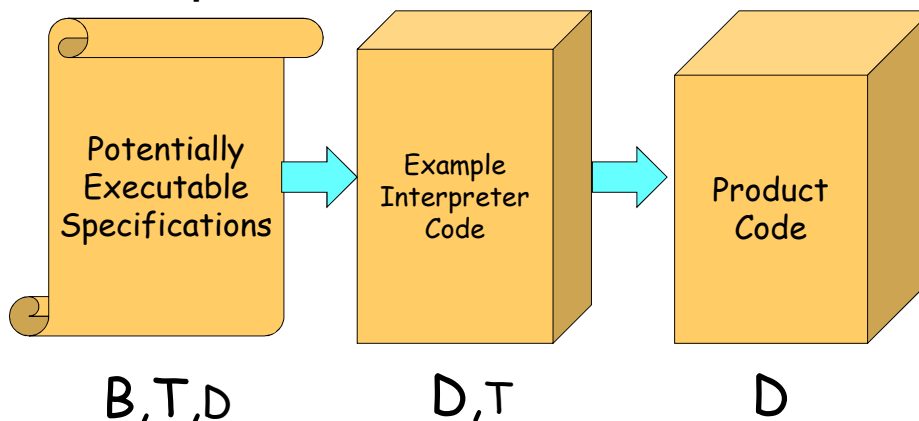
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## Example-Driven Development

- Development flow



This is Like TDD but at a Very Large Scale

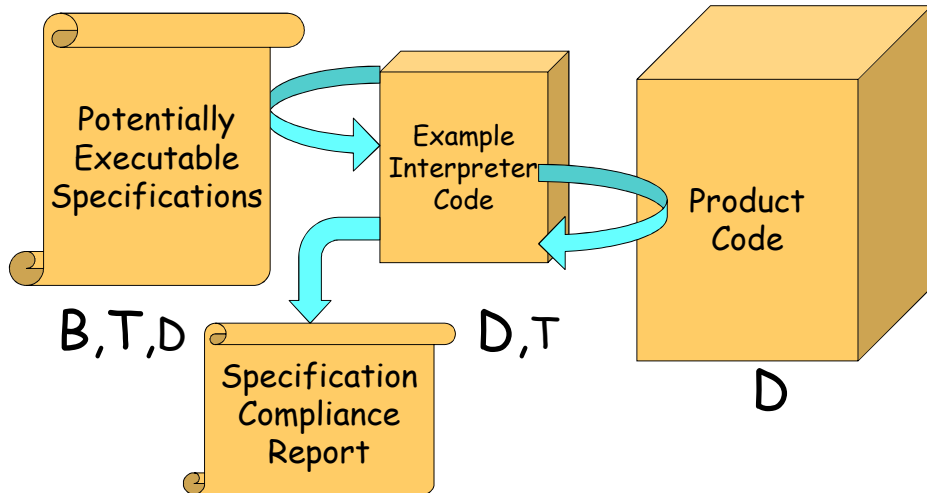
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## Example-Driven Development

- Runtime View:



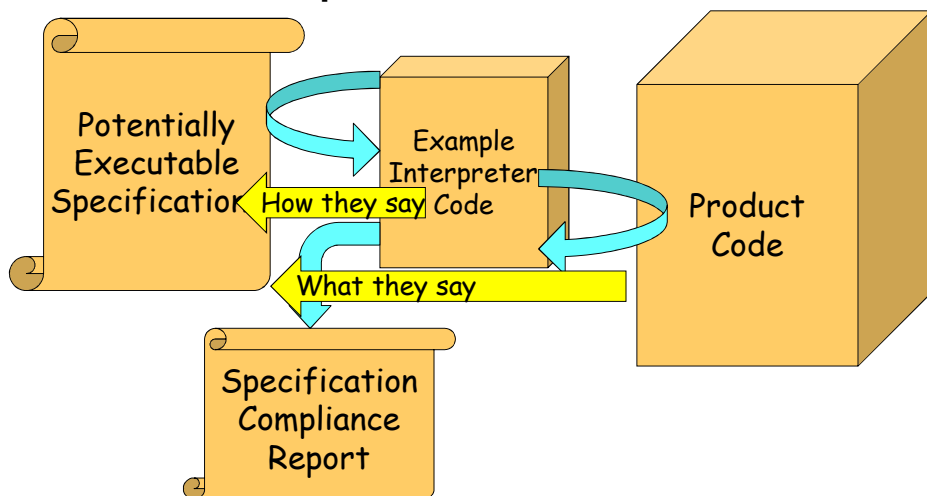
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## Example-Driven Development

- Feedback Loops:



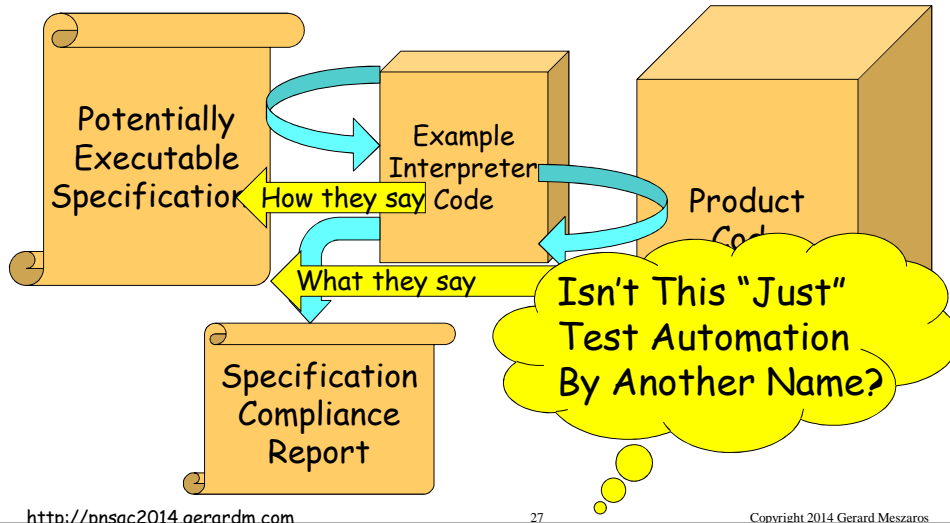
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## Example-Driven Development

- **Feedback Loops:**



## Testing by An Another Name

**Yes, it is "just" testing but naming is everything.**

**It changes our perceptions and expectations**

**Tests don't need to be readable.**

**Examples and Specifications do!**

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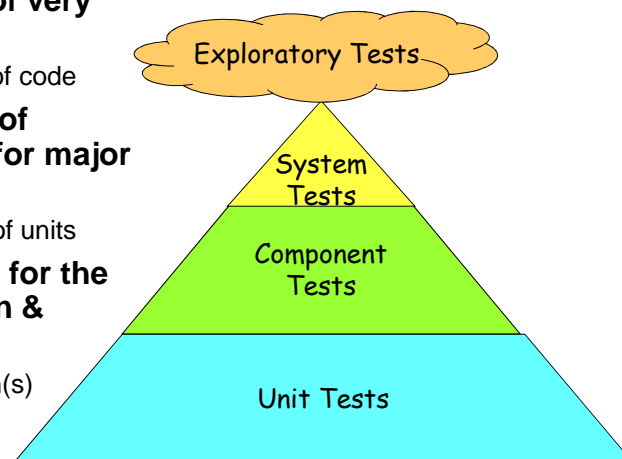
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## Test Automation Pyramid

- **Large numbers of very small unit tests**
  - Ensures integrity of code
- **Smaller number of functional tests for major components**
  - Verify integration of units
- **Even fewer tests for the entire application & workflow**
  - Ensure application(s) support users' requirements
- **Tools to support effective exploratory testing**



Pyramid originally proposed by Mike Cohn

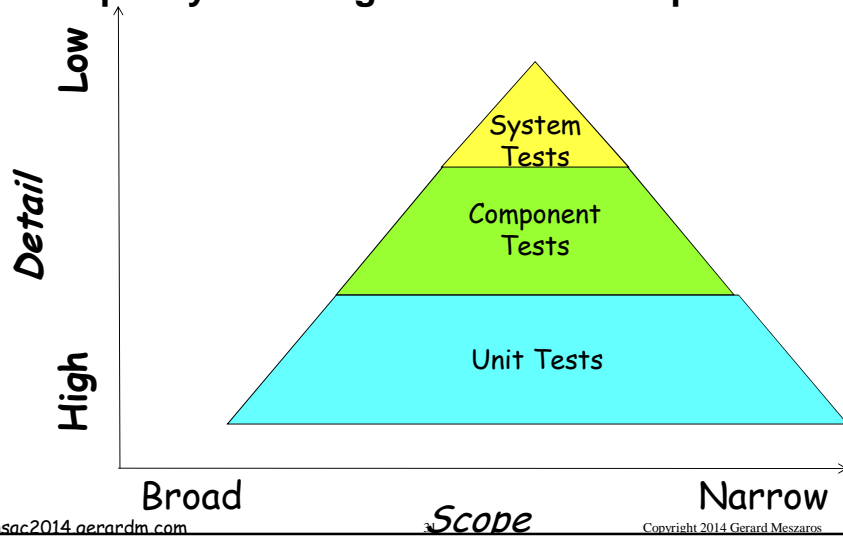
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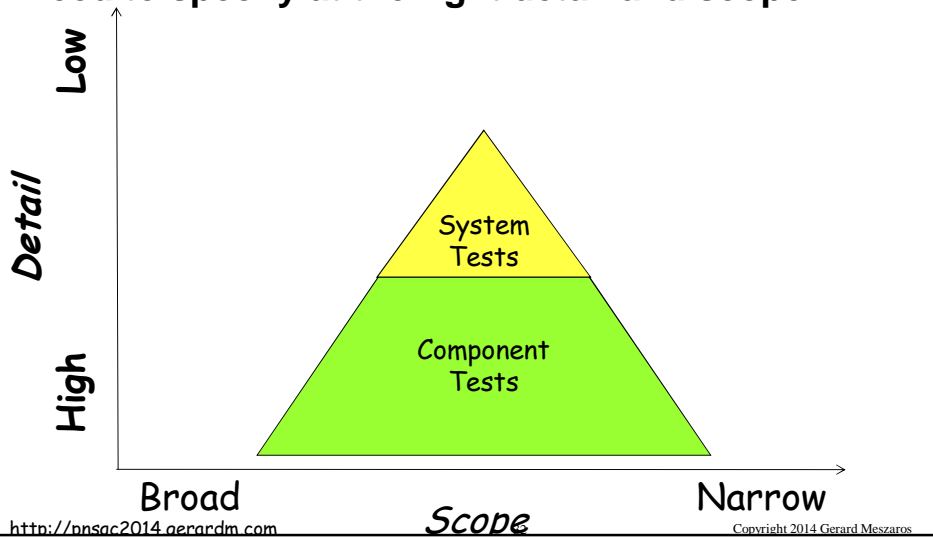
## Behavior Specification at Right Level

Need to specify at the right detail and scope.



## Behavior Specification at Right Level

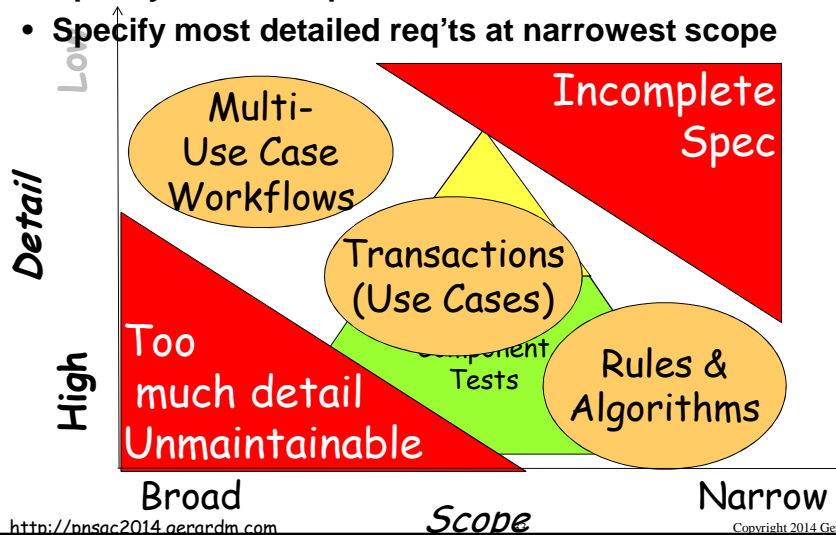
Need to specify at the right detail and scope.





## Behavior Specification at Right Level

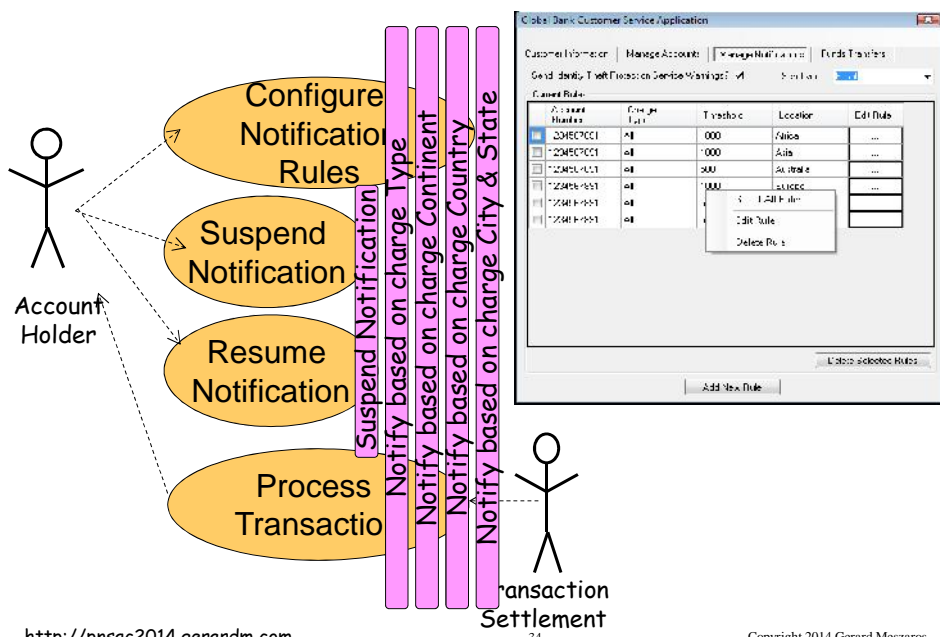
- Specify broad scope at minimum detail
- Specify most detailed req'ts at narrowest scope



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## Use Cases & User Stories



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Example: **Testing Notifications - 1**

Customer bobma logs in

System lists all available accounts for the authorized customer

account	type	notifications
10035692877	chequing	disabled
10035692890	savings	disabled
20010928892	credit line	disabled

Customer sets notification threshold for all transactions from all locations to \$10,000.00 on account 10035692877 via email to bobma@live.com

ensure No system messages

ensure System log contains "Customer bobma set notification threshold for all transactions from all locations to \$10,000 on account 10035692877"

System lists all available accounts for the authorized customer

account	type	notifications
10035692877	chequing	<b>enabled</b>
10035692890	savings	disabled
20010928892	credit line	disabled

Notification settings for account 10035692877

transaction type	location where initiated	threshold amount	via	address
all	all	\$10,000.00	email	bobma@live.com

**Given: User and Accounts**

**When: Notification Rule is Configured**

**Then: Notification Rule is Active**

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Example: **Testing Notifications - 2**

Use Case: Process Transactions

Time now is 9:30AM, 03/18/2008

Bank processes	debit	to	10035692877	in the amount of	\$15,000.00
Bank processes	debit	to	10035692877	in the amount of	\$9,000.00
Bank processes	debit	to	10035692877	in the amount of	\$11,000.00
Bank processes	debit	to	20010928892	in the amount of	\$12,000.00
Bank processes	credit	to	10035692877	in the amount of	\$13,000.00
Bank processes	credit	to	10035692877	in the amount of	\$9,999.99
Bank processes	charge	to	10035692877	in the amount of	\$9,999.99
Bank processes	charge	to	10035692877	in the amount of	\$11,000.00

**When: The Transactions to be processed**

New notifications sent to customer bobma

type	account	timestamp	amount	via	address
debit	10035692877	9:30AM, 03/18/2012	\$15,000.00	email	bobma@live.com
debit	10035692877	9:30AM, 03/18/2012	\$11,000.00	email	bobma@live.com
credit	10035692877	9:30AM, 03/18/2012	\$13,000.00	email	bobma@live.com
charge	10035692877	9:30AM, 03/18/2012	\$11,000.00	email	bobma@live.com

**Then: Expected Notifications**

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## Issues With This Test

- **Difficult to understand which TX's should notify**
  - because cause (rules) and effect (notification) are far apart
- **Only verifies one simple combination of rules**
  - We will require many more tests to test all the other combinations
  - Lots of repetition of workflow & data across test cases
- **Simplest workflow;**
  - More complex workflows will be even longer and harder to understand
- **Tests will take a long time to run**
  - Due to need to configure first, then run transaction processing

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## How Can We Improve Tests?

- **Make tests shorter**
  - Fewer steps
- **Make tests less detailed**
  - Omit unnecessary information
- **Focus tests on specific aspects of behaviour**
  - Test/Spec Algorithms & Rules directly
  - Test less functionality, but more thoroughly

Fine advice, but too vague

Difficult without Test-Friendly Architecture

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## How Can Spec. Mindset Help

- **Describe overall workflow**
  - with much less detail
- **Provide more details**
  - For individual transactions
- **Provide even more details**
  - For business rules.
- **But not embedded in the workflow**

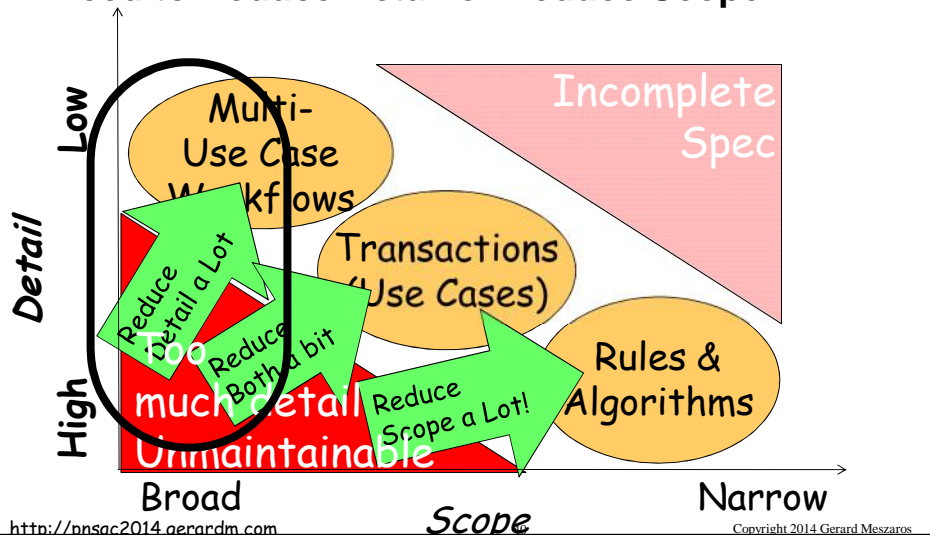
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## Changing Level of Abstraction/Detail

- **Need to Reduce Detail or Reduce Scope**



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## Omitting Unnecessary Information

- Ask not what you can include in an example...
- Ask instead:
- What can I leave out of this example?

“If it isn’t essential to conveying the essence of the behavior, it is essential to not include it.”

Example: **Specifying Workflow**

~~Customer bobma logs in~~

**Given: User and Accounts**

account	type	notifications
10035692877	chequing	disabled
10035692890	savings	disabled
20010928892	credit line	disabled

**When: Notification Rule is Configured**

Customer sets notification threshold for all transactions from all locations to \$10,000.00 on account 10035692877 via email to bobma@live.com

~~ensure No system messages~~

~~ensure System log contains "Customer bobma set notification threshold for all transactions from all locations to \$10,000 on account 10035692877"~~

~~System lists all available accounts for the authorized customer~~

account	type	notifications
10035692877	chequing	enabled
10035692890	savings	disabled
20010928892	credit line	disabled

**Then: Notification Rule is Active**

transaction type	location where initiated	threshold amount	via	address
all	all	\$10,000.00	email	bobma@live.com

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Example:

## Specifying Workflow

Customer sets notification threshold for all transactions from all locations to \$10,000.00 on account 10035692877 via email to bobma@live.com

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Example:

## Specifying Workflow

Use Case:  
Process  
Transactions

Time now is	9:30AM, 03/18/2008				
Bank processes	debit	to	10035692877	in the amount of	\$15,000.00
Bank processes	debit	to	10035692877	in the amount of	\$9,000.00
Bank processes	debit	to	10035692877	in the amount of	\$11,000.00
Bank processes	debit	to	20010928892	in the amount of	\$12,000.00
Bank processes	credit	to	10035692877	in the amount of	\$13,000.00
Bank processes	credit	to	10035692877	in the amount of	\$9,999.99
Bank processes	charge	to	10035692877	in the amount of	\$9,999.99
Bank processes	charge	to	10035692877	in the amount of	\$11,000.00

When: The  
Transactions to  
be processed

Then: Expected  
Notifications

New notifications sent to customer		bobma			
type	account	timestamp	amount	via	address
debit	10035692877	9:30AM, 03/18/2012	\$15,000.00	email	bobma@live.com
debit	10035692877	9:30AM, 03/18/2012	\$11,000.00	email	bobma@live.com
credit	10035692877	9:30AM, 03/18/2012	\$13,000.00	email	bobma@live.com
charge	10035692877	9:30AM, 03/18/2012	\$11,000.00	email	bobma@live.com

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Example:

## Specifying Workflow

Time now is	9:30AM, 03/18/2008				
Bank processes	debit	to	10035692877	in the amount of	\$15,000.00
Bank processes	debit	to	10035692877	in the amount of	\$9,000.00
Bank processes	debit	to	10035692877	in the amount of	\$11,000.00

New notifications sent to customer bobma					
type	account	timestamp	amount	via	address
debit	10035692877	9:30AM, 03/18/2012	\$15,000.00	email	bobma@live.com
debit	10035692877	9:30AM, 03/18/2012	\$11,000.00	email	bobma@live.com

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Example:

## Specifying Workflow

Customer sets notification threshold for ~~all~~ transactions ~~from all~~ ~~accounts~~ to \$10,000.00 on account 10035692877 ~~via email~~ ~~to bobma~~

Time now is	9:30AM, 03/18/2008				
Bank processes	debit	to	10035692877	in the amount of	\$15,000.00
Bank processes	debit	to	10035692877	in the amount of	\$9,000.00
Bank processes	debit	to	10035692877	in the amount of	\$11,000.00

New notifications sent to customer bobma					
type	account	timestamp	amount	via	address
debit	10035692877	9:30AM, 03/18/2012	\$15,000.00	<del>email</del>	<del>bobma@live.com</del>
debit	10035692877	9:30AM, 03/18/2012	\$11,000.00	<del>email</del>	<del>bobma@live.com</del>

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Example:

## Specifying Notification Workflow

Given:  
User &  
Thresholds

Time now is	9:00AM, 03/18/2008		
Customer	bobma	sets notification threshold to	\$10,000.00 for all transactions to 10035692877

Time now is	9:30AM, 03/18/2008		
Bank processes	debit	to 10035692877	in the amount of \$15,000.00
Bank processes	debit	to 10035692877	in the amount of \$9,000.00
Bank processes	debit	to 10035692877	in the amount of \$11,000.00

When:  
Transactions  
Are Processed

New notifications sent to customer bobma			
type	account	timestamp	amount
debit	10035692877	9:30AM, 03/18/2008	\$15,000.00
debit	10035692877	9:30AM, 03/18/2008	\$11,000.00

Then:  
We Expect  
Notifications

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Example:

## Specifying Notification Workflow

Given:  
User &  
Thresholds

Time now is	9:00AM, 03/18/2008		
Customer	bobma	sets notification threshold to	\$10,000.00 for all transactions to 10035692877

Time now is	9:30AM, 03/18/2008		
Bank processes	credit	to 10035692877	in the amount of \$15,000.00
Bank processes	debit	to 10035692877	in the amount of \$9,000.00
Bank processes	credit	to 10035692877	in the amount of \$11,000.00
Bank processes	debit	to 9991113333	in the amount of \$11,000.00

When:  
Transactions  
Are Processed

New notifications sent to customer bobma			
type	account	timestamp	amount
debit	10035692877	9:30AM, 03/18/2008	\$15,000.00
credit	10035692877	9:30AM, 03/18/2008	\$11,000.00

Then:  
We Expect  
Notifications

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Example:

## Specifying Notification Workflow

Time now is 9:00AM, 03/18/2008

Customer **bobma** sets notification threshold to \$10,000.00 for all transactions to 10035692877

Given:  
User &  
Thresholds

Time now is 9:30AM, 03/18/2008

Bank processes	credit	to	10035692877	in the amount of	\$15,000.00
Bank processes	debit	to	10035692877	in the amount of	\$9,000.00
Bank processes	credit	to	10035692877	in the amount of	\$11,000.00
Bank processes	debit	to	9991113333	in the amount of	\$11,000.00

When:  
Transactions  
Are Processed

New notifications sent to customer **bobma**

type	account	timestamp	amount
debit	10035692877	9:30AM, 03/18/2008	\$15,000.00
credit	10035692877	9:30AM, 03/18/2008	\$11,000.00

Then:  
We Expect  
Notifications

Broad Scope (Multi-Actor);  
Minimum Detail (per Actor/Transaction);

## Specifying Suspension Workflow

**Given BobMa has set notification threshold to \$10,000 for all transactions on his account**

**When the bank processes debit for 15,000 to his account**

**Then BobMa receives notification for debit 15,000**

**When BobMa suspends notification on his account**

**And the bank processes debit for 15,000 to his account**

**Then BobMa receives no notification**

**When BobMa resumes notification on his account**

**And the bank processes debit for 15,000 to his account**

**Then BobMa receives notification for debit 15,000**

## Specifying Suspension Workflow

Given BobMa has set notification threshold to ~~\$10,000~~  
for all transactions on his account

When the bank processes debit for ~~15,000~~ <sup>Over threshold</sup> to his account  
Then BobMa receives notification for debit ~~15,000~~

When BobMa suspends notification on his account  
And the bank processes debit for ~~15,000~~ <sup>Over threshold</sup> to his account  
Then BobMa receives no notification

When BobMa resumes notification on his account  
And the bank processes debit for ~~15,000~~ <sup>Over threshold</sup> to his account  
Then BobMa receives notification for debit ~~15,000~~

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## Specifying Suspension Workflow

Given BobMa has set up notification for all transactions  
on his account

When the bank processes an over-threshold-tx to his account  
Then BobMa receives notification for that tx

When BobMa suspends notification on his account  
And the bank processes an over-threshold-tx to his account  
Then BobMa receives no notification for that tx

When BobMa resumes notification on his account  
And the bank processes an over-threshold-tx to his account  
Then BobMa receives notification for that tx

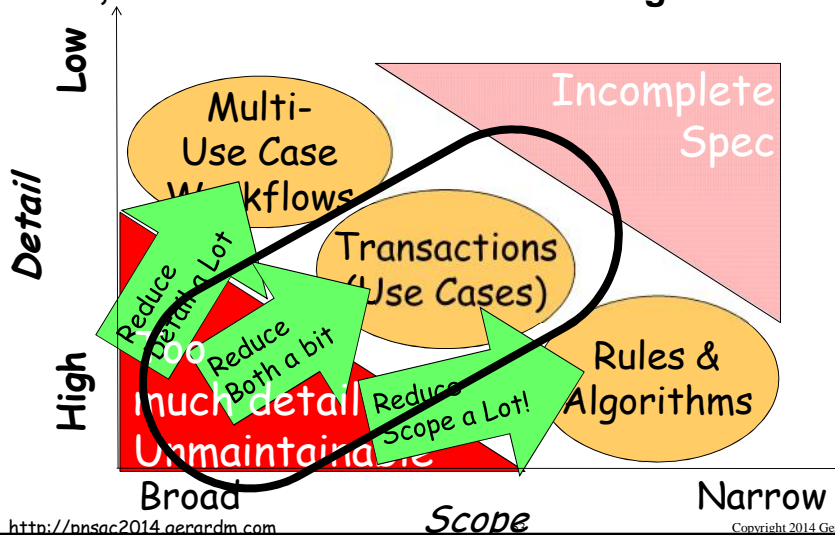
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# Specifying Transaction Details

- So, where should omitted details go?



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Example:

**Use Case:**  
 Manage Notifications

## Single Use Case Test

Customer	bobma	logs in
System lists all available accounts for the authorized customer		
account	type	notifications
10035692877	checking	disabled
10035692890	savings	disabled
20010928892	credit line	disabled

**Given: User & Accounts**

Customer sets notification threshold for all transactions from all locations to \$10,000.00 on account 10035692877 via email to bobma@live.com

ensure: No system messages  
 ensure: System log contains "Customer bobma set notification threshold for all transactions from all locations to \$10,000 on account 10035692877"

Customer	bobma	logs in
System lists all available accounts for the authorized customer		
account	type	notifications
10035692877	checking	<b>enabled</b>
10035692890	savings	disabled
20010928892	credit line	disabled

**When: Customer sets up threshold**

**Then: We Expect Logging & Updated Statuses**

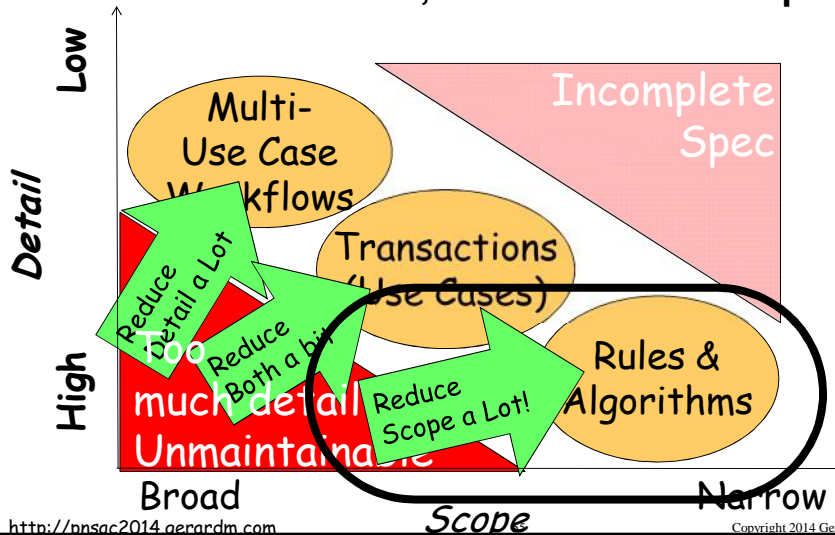
Notification settings for account: 10035692877					
transaction type	location where initiated	threshold amount	via	address	
all	all	\$10,000.00	email	bobma@live.com	

**Medium Scope (Single Actor)**  
**Medium Detail (Transaction, not UI):**

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# Specifying Business Rules

- Need the more detail; need to reduce scope



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Example:

## Business Rule Spec

### Threshold per Charge Type

#### Configuration

CustomerAccounts			
Customer	Account	Label	Added()
bobma	100372	Checking	

CustomerThresholds				
Customer	Account	Charge Type	Threshold	Added()
bobma	100372	ALL	10,000	OK
bobma	100372	Travel	1,000	OK
bobma	100372	Restaurant	100	OK
bobma	100372	Groceries	264.23	OK

#### Process Transaction

NotificationRequired			
Account	Charge Type	Amount	Notify?
100372	Travel	999.99	No
100372	Travel	1,000.00	Yes
100372	Restaurant	99.99	No
100372	Restaurant	100.00	Yes
100372	Groceries	264.22	No
100372	Groceries	264.23	Yes
100372	Other	9.999.99	No
100372	Other	10,000.00	Yes

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Example: **Business Rule Spec**

Threshold per Charge Type

When we ask NotificationRequired? with this transaction:

Given these rules

Configuration

Customer	Account	Label	Added()
bobma	100372	Checking	

Process Transaction

Account	Charge Type	Amount	Notify?
100372	Travel	999.99	No
100372	Travel	1,000.00	Yes
100372	Restaurant	99.99	No
100372	Restaurant	100.00	Yes
100372	Groceries	264.22	No
100372	Groceries	264.23	No
100372	Other	9,999.99	No
100372	Other	10,000.00	No

Customer	Account	Charge Type	Threshold	Added()
bobma	100372	ALL	10,000	OK
bobma	100372	Travel	1,000	OK
bobma	100372	Restaurant	100	OK
bobma	100372	Groceries	264.23	OK

Narrow Scope (Single Rule)  
High Detail (Everything that matters)

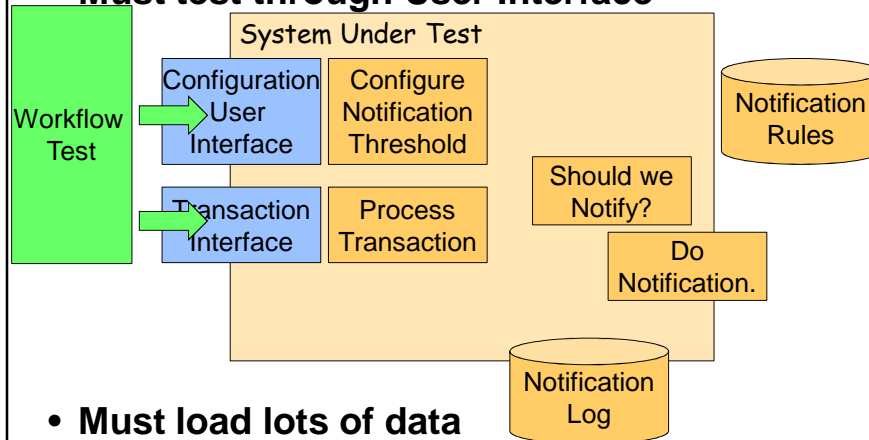
Then: The answer should be

## Agenda

- **Survey**
  - The State of Your Test Automation
- **Challenges of Test Automation**
  - Why is Test Automation So Hard
- **Rethinking the Development Process**
  - Example-Driven Development
- **Managing Scope vs Detail**
  - How to Define Effective Examples
- **Achieving a Test-Friendly Architecture**
  - Example-Driven Architecture

## Test-After Architecture

- Must test through User Interface



- Must load lots of data

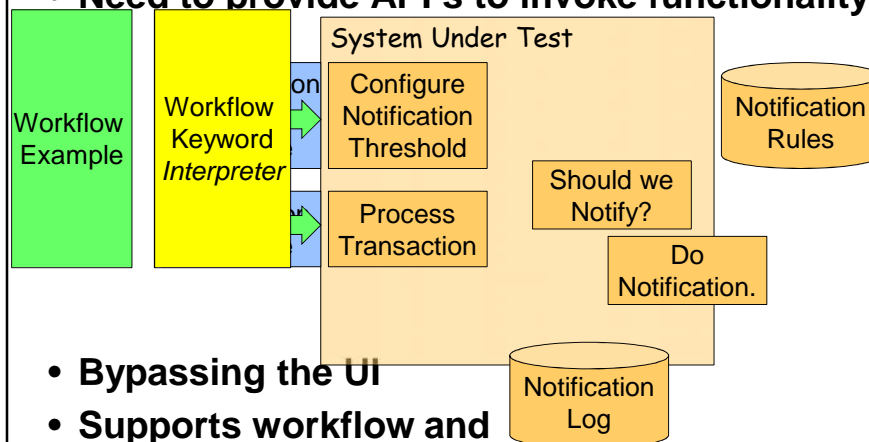
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## Example-Driven Architecture

- Need to provide API's to invoke functionality



- Bypassing the UI
- Supports workflow and use case / transaction example automation

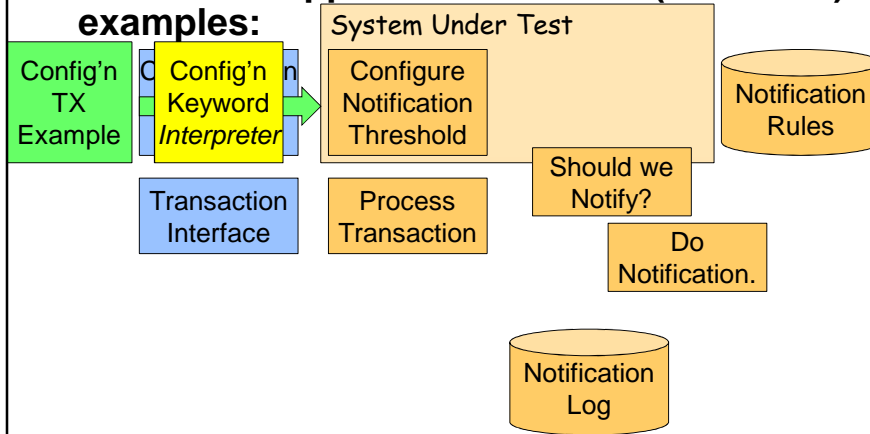
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## EDA – Single Tx Examples

- Same API supports Transaction (Use Case) examples:



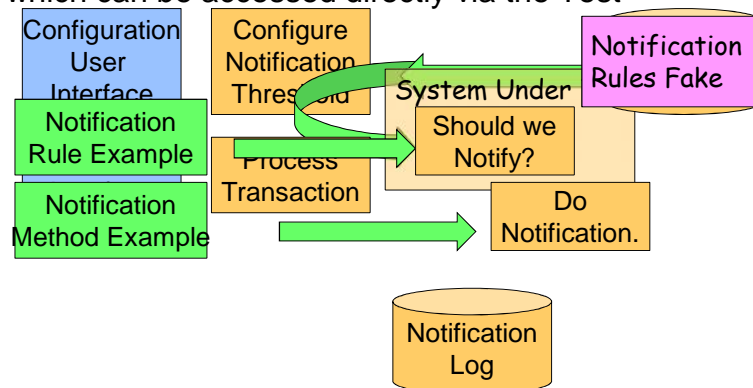
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## EDA – Business Rules

- Encapsulation of Rules in “Rules Component”
  - which can be accessed directly via the Test



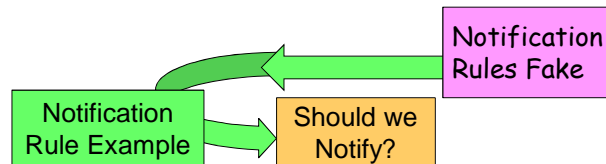
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## EDA – Business Rules

- **Encapsulation of Rules in “Rules Component”**
  - which can be accessed directly via the Test



- **Component Accepts Rules via “Data Injection”**
  - Simplify Automation by avoiding need to configure
- **Ensures Design-for-testability**
  - But Only When Automation is a Dev’t Responsibility

## Quick Demo



## Summary of Approach

- **Business & Testers come up with examples; Developers help them formalize it.**
  - Ensures everyone agrees on what needs to be built
- **Manage Scope vs. Detail in examples**
  - » Workflow sequences
  - » Transaction interactions
  - » Business rules and algorithms
  - Avoids long, hard-to-understand examples

## Summary of Approach

- **Developers write interpreters for examples; design product code to support them**
  - Ensures the architecture supports automation
- **Developers write product code guided by execution of the examples**
  - They know what needs to be built
  - They can run the examples frequently to know how they are doing

## Summary of Benefits

- **Examples force collaboration between all project roles.**
- **Built-in automation helps avoid Fragile Tests**
- **Automated Examples help us prevent defects being introduced through misunderstanding of requirements**
- **Automated Examples ensure complete “test” coverage of functionality**

## Closing Thoughts

- **Are you automating to find defects or prevent them?**
- **Are your automated tests good examples?**
  - Why not? What would you need to change?
- **Are your tests low maintenance?**
  - Why not? What causes them to break?
  - What could you change...
  - ... to make them break less often?
  - .... to reduce the impact of breakage?

# Thank You!

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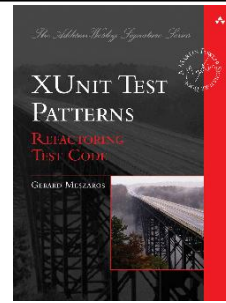
Slides: <http://PNSQC2014.gerardm.com>

Call me when you:

- Want to transition to Agile or Lean
- Want to do Agile or Lean better
- Want to teach developers how to test
- Need help with test automation strategy
- Want to improve your test automation

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