Agile Test Automation Strategy

For Anyone and Everyone!

Gerard Meszaros

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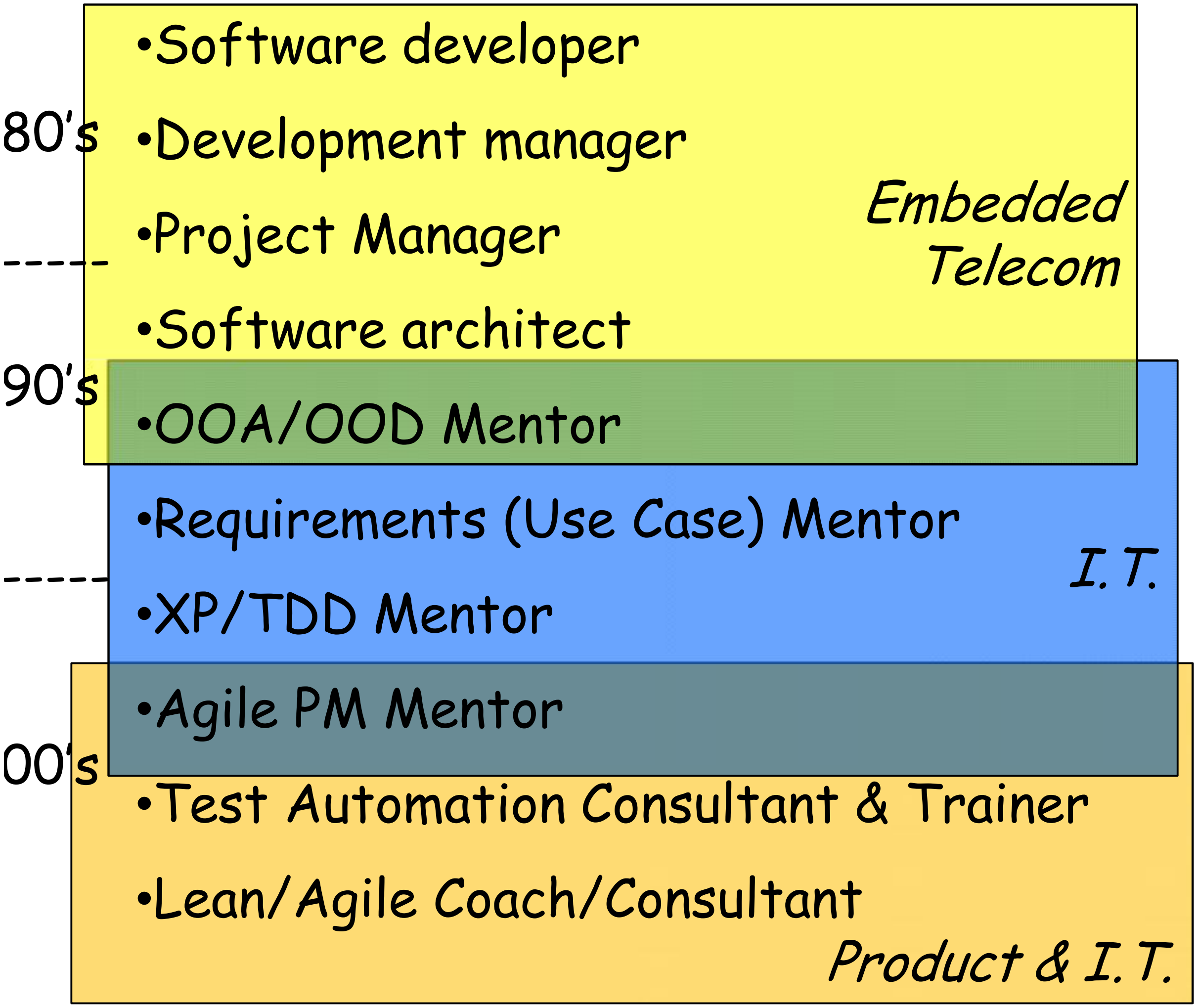
My Background



80's

90's

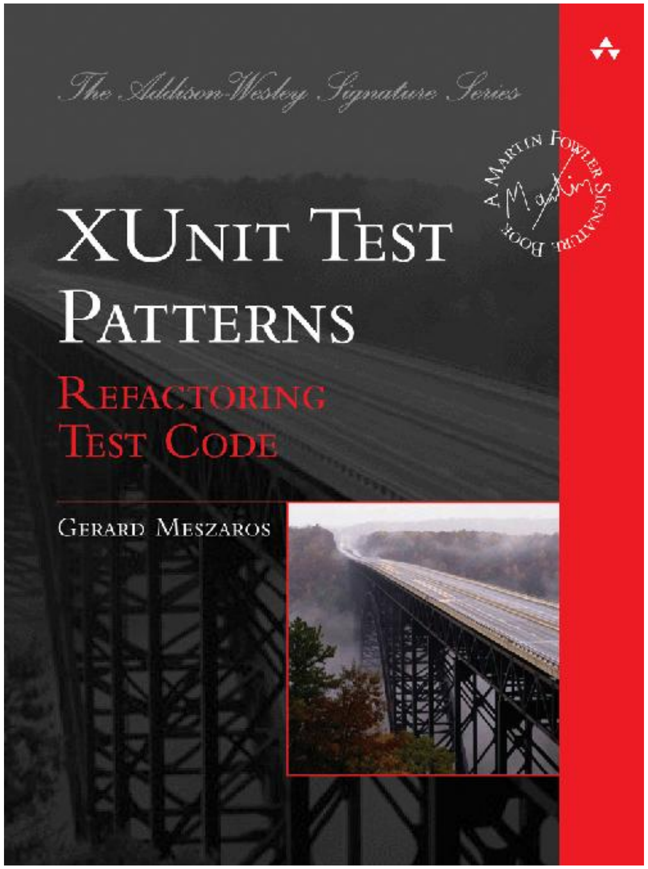
00's

- Software developer
- Development manager
- Project Manager
- Software architect
- OOA/OOD Mentor
- Requirements (Use Case) Mentor
- XP/TDD Mentor
- Agile PM Mentor
- Test Automation Consultant & Trainer
- Lean/Agile Coach/Consultant

Embedded Telecom

I.T.

Product & I.T.


The Addison-Wesley Signature Series
A Martin Fowler Signature Book
XUnit Test Patterns
Refactoring Test Code
Gerard Meszaros

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Agenda

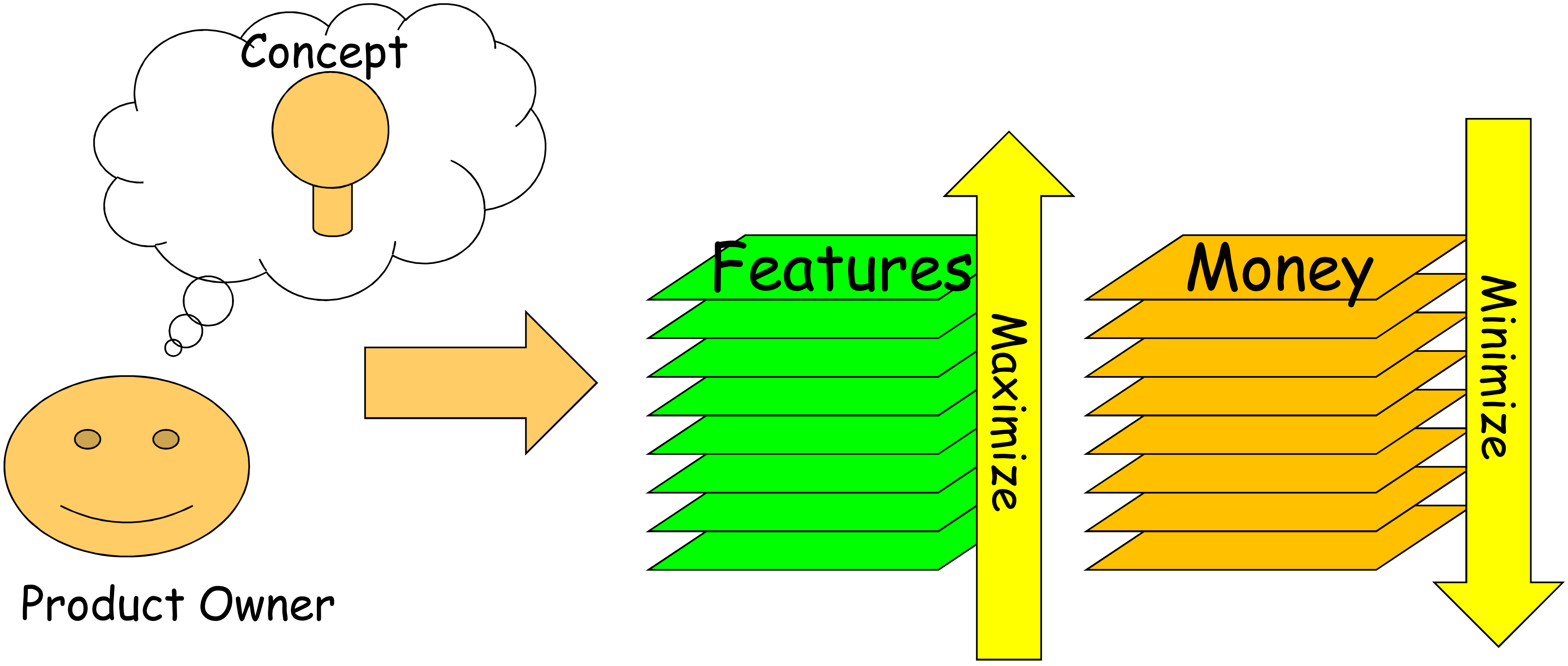
- **Motivation**
  - The Agile Test Problem
  - The Fragile Test Problem
- **Approaches to Test Automation**
- **Test Automation Strategy**

Rough timings for Agile Test Automation Strategy

Time per slide:	1.4	# of	Slide #	
		#		
Topic	**Time**	**Slides**	**Start**	**End**
Motivation	11.2	8	2	9
Exercise 1 - Automation Motivation	10	1	10	10
Intro to Automation	7	5	11	15
Exercise 2 - Why not Record & Playback?	10	1	16	16
Why Automated Tests are Fragile	8.4	6	17	22
How Agile Automation Changes Things	9.8	7	24	30
Intro to Example-Driven Development	7	5	32	36
Managing Scope vs Detail in Examples	15.4	11	38	48
How to specify workflows	8.4	6	50	55
Exercise 3 - Workflow Tests (Keyword-Driven)	15	1	56	56
Using Data-Driven Tests to specify business rules	8.4	6	55	60
Exercise 4 - Business Rules Test (Data-Driven)	15	1	61	61
How Tests Interact With the SUT	7	5	62	66
Test-Driven Architecture	5.6	4	67	70
Legacy Systems (if time permits)	19.6	14	71	84
The Role of Unit Tests	8.4	6	85	90
Test Automation Strategy	14	10	91	100
	180.2	**97**		

Product Owner Goal

- **Goal: Maximize business value received**



Concept

Product Owner

Features

Maximize

Money

Minimize

Quality is Assumed; Not Managed

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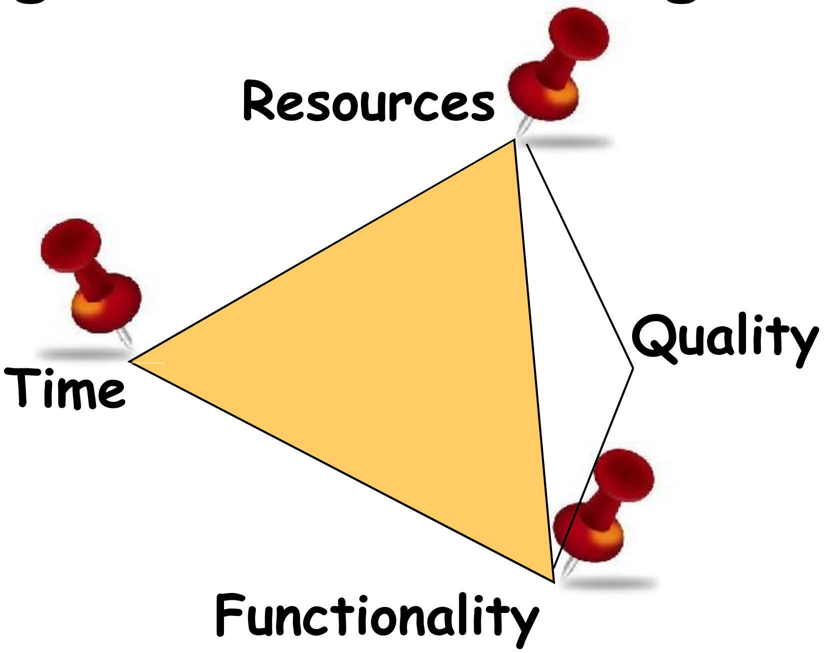
Why Quality Often Sucks

- Iron Triangle of Software Engineering:



- What about Quality?

You can fix any three; the fourth is the outcome

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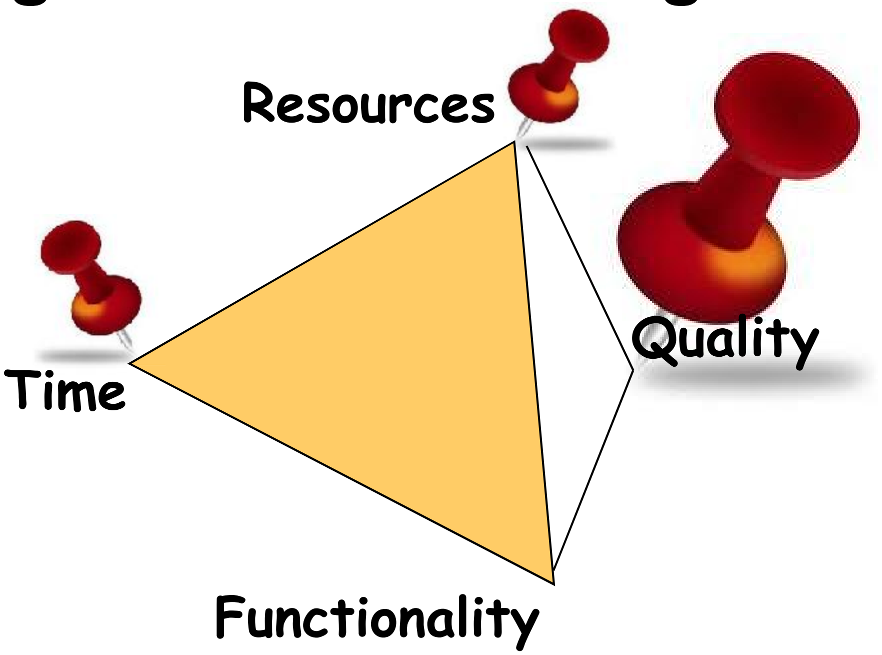
Why Quality Often Sucks

- Iron Triangle of Software Engineering:



In Agile, we "Pin" quality using automated tests

- What about Quality?

You can fix any three; the fourth is the outcome

Speaking of Quality, would you ...

... ask your doctor to reduce the cost of the operation ...

... by skipping the sterile technique ?

Test Automation is like hand washing:
Improved results but an upfront cost.

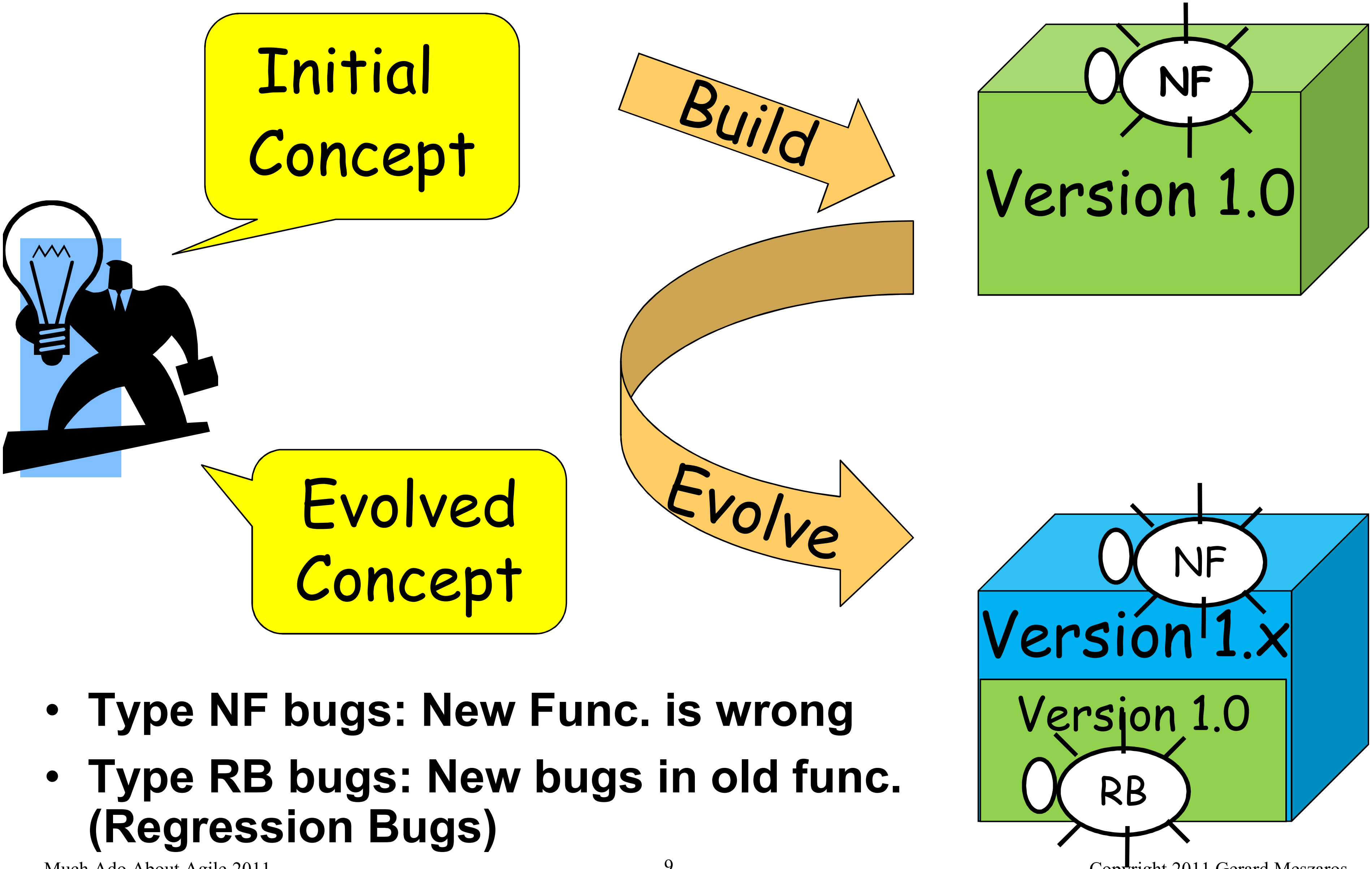
Minimizing Cost of Product

Total cost includes:

- **developing the software**
- **verifying the newly built functionality**
- **verifying old functionality still works**
- **fixing any bugs found**
- **Verifying noting was broken by fixes**

Agile Test Automation can reduce the cost of all of these activities.

Incremental Development

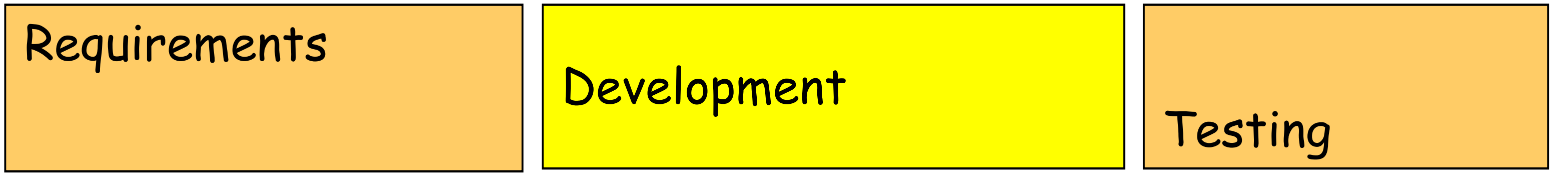


- **Type NF bugs: New Func. is wrong**
- **Type RB bugs: New bugs in old func. (Regression Bugs)**

Exercise 1

- Time to test our little application
- Oh, new build, please retest!
- Another build, please retest!

The Agile Test Problem

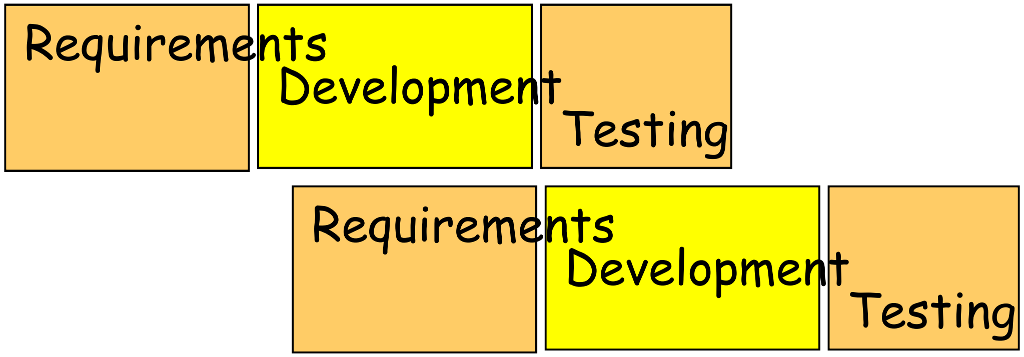


Requirements

Development

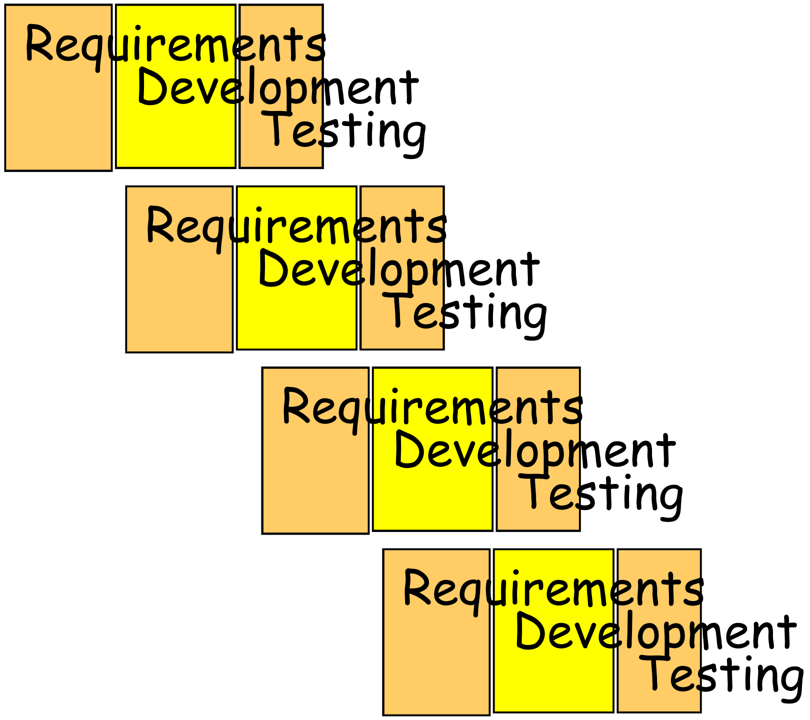
Testing

The Agile Test Problem



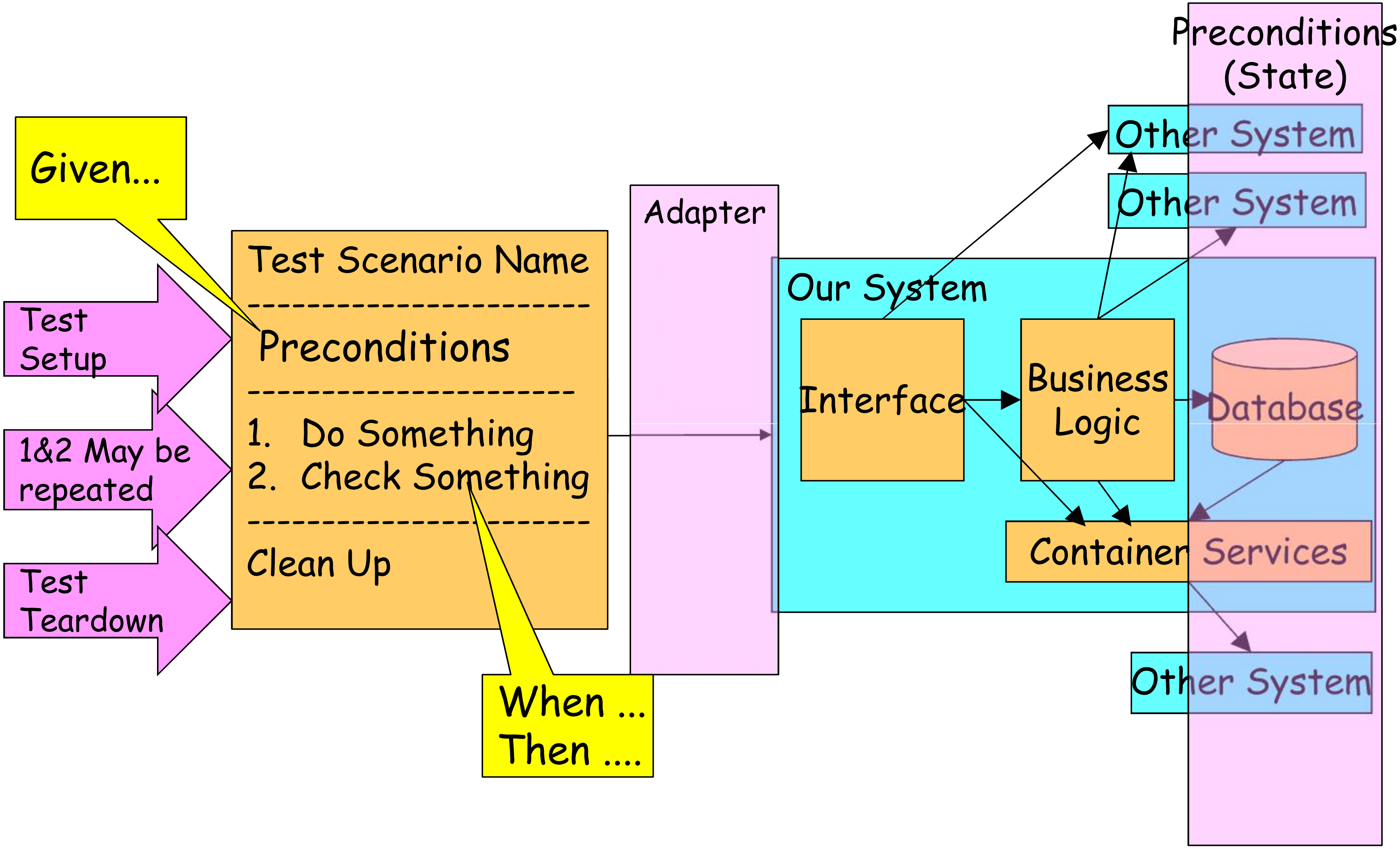
- **As development increments reduce in duration, testing needs to be reduced accordingly**

The Agile Test Problem



... and traditional approaches to testing no longer work

Anatomy of an Automated Test



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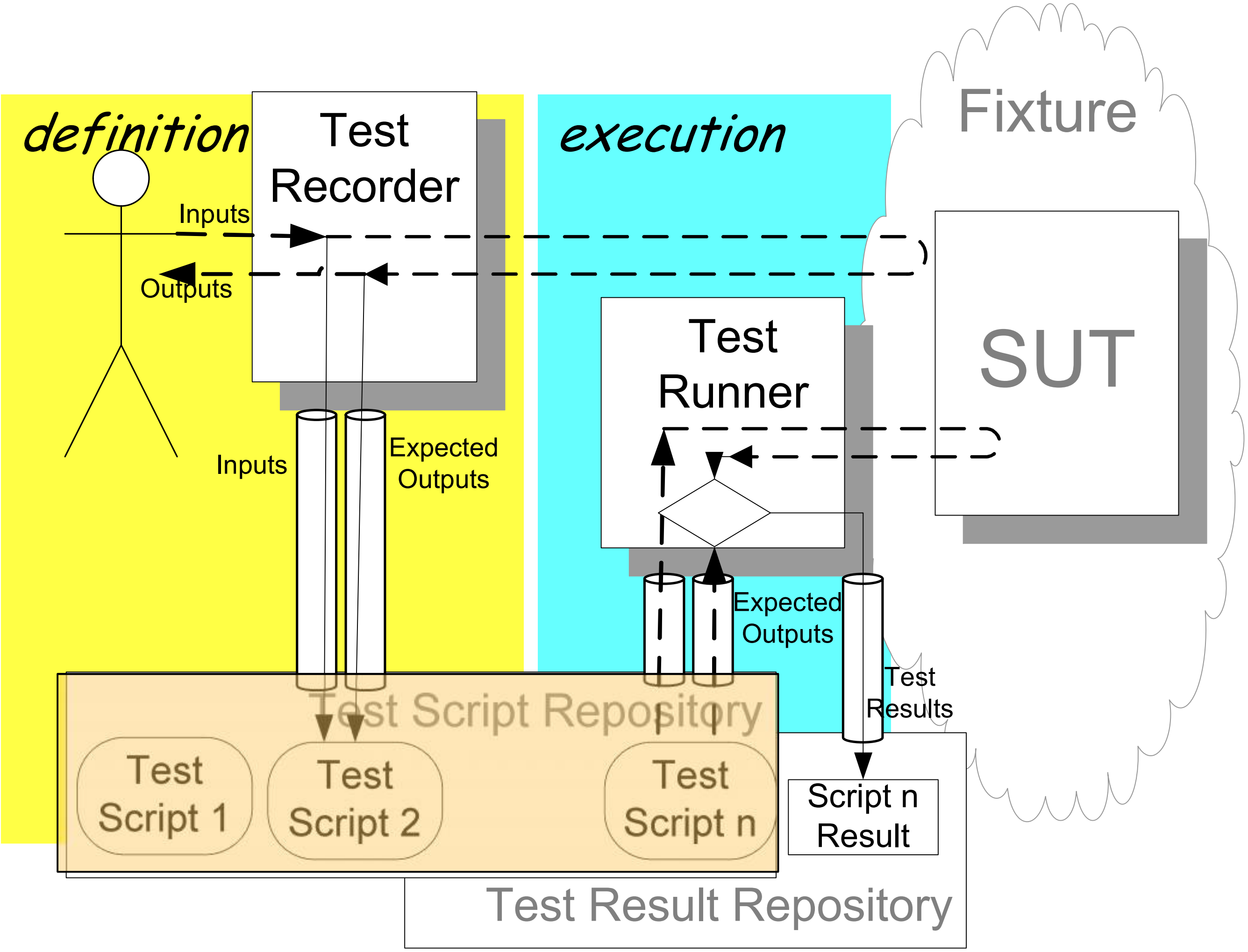
(C)OTS Record&Playback

- **User executes tests manually; tool records as tests**
- **Tool replays tests later without user intervention**

The tests are are code/data interpreted by the test runner.



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Exercise 2

- **Record & Playback Test Automation**
  - Please record a test against the System Under Test
  - Then, run the test to make sure it works

- **New build has been delivered**
  - Please run the test against new build

Agenda

- **Motivation**
  - – The Agile Test Problem
  - – The Fragile Test Problem
- **Changing the Role of Test Automation**
- **Approaches to Test Automation**
- **Test Automation Strategy**

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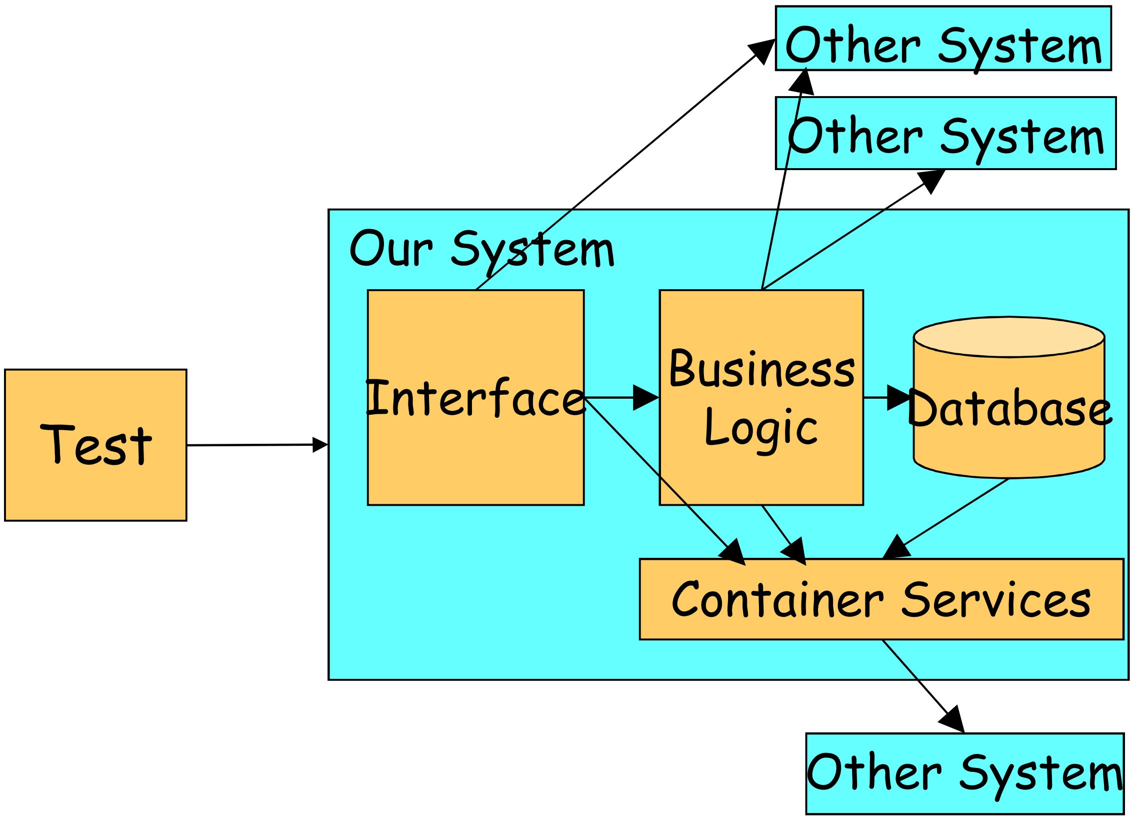
The Fragile Test Problem

What, when changed, may break our tests accidentally:

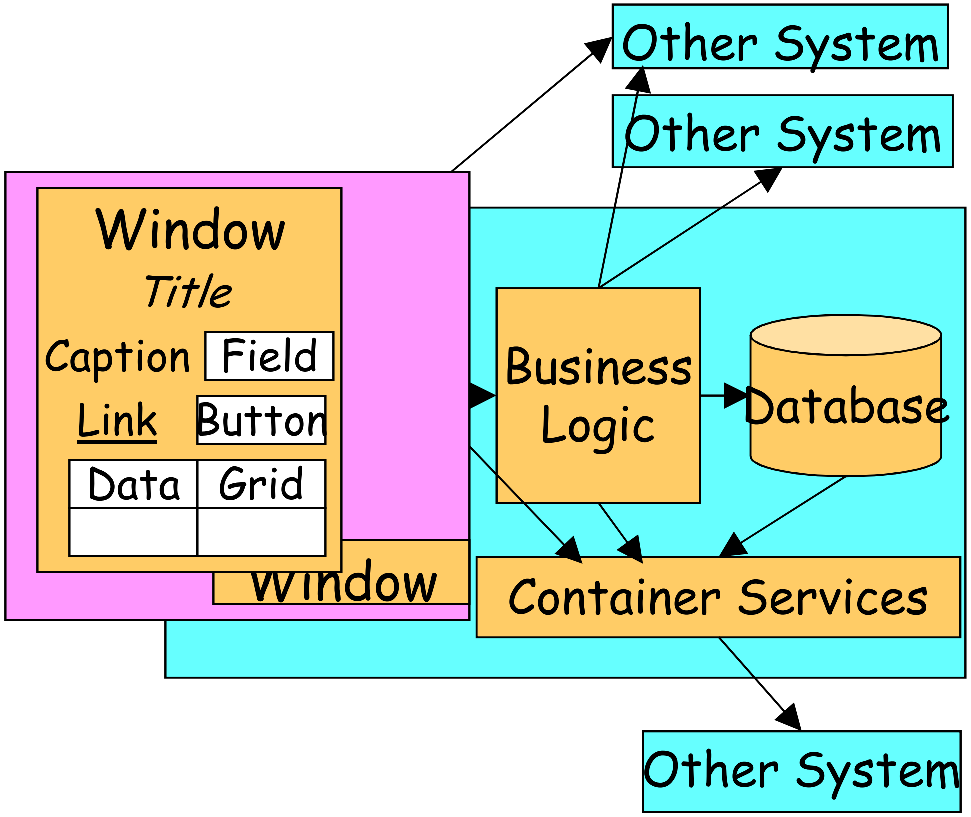
- Behavior Sensitivity
  - » **Business logic**
- Interface Sensitivity
  - » **User or system**
- Data Sensitivity
  - » **Database contents**
- Context Sensitivity
  - » **Other system state**



In Agile, these are all changing all the time!

Interface Sensitivity

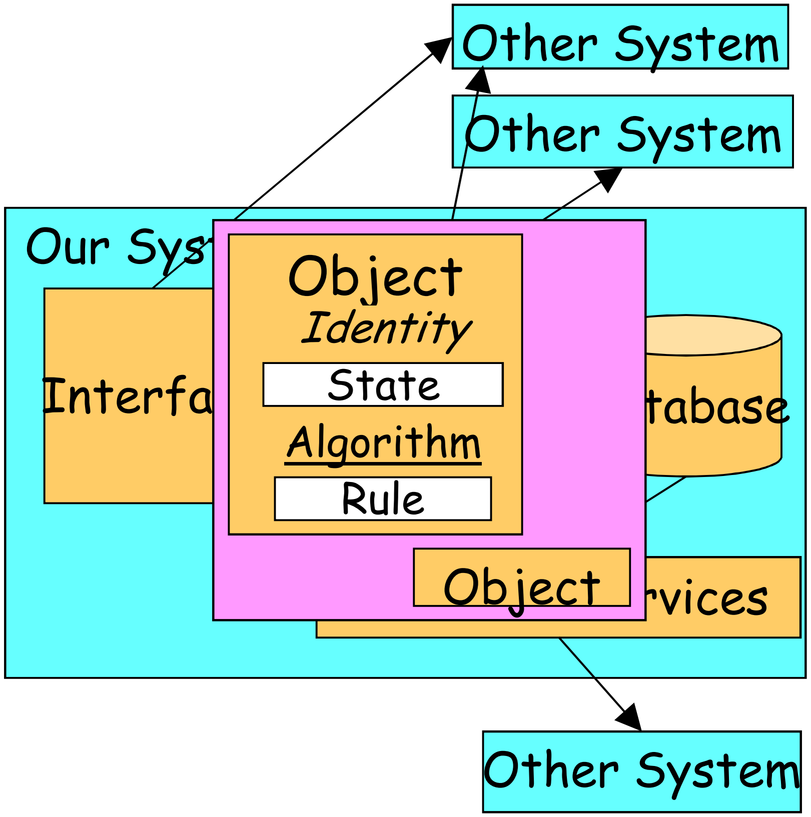
- **Tests must interact with the SUT through some interface**
- **Any changes to interface may cause tests to fail.**
  - User Interfaces:
    - » Renamed/deleted windows or messages
    - » New/renamed/deleted fields
    - » New/renamed/deleted data values in lists
  - Machine-Machine Interfaces:
    - » Renamed/deleted functions in API
    - » Renamed/deleted messages
    - » New/changed/deleted function parameters or message fields



E.g.: Move tax field to new popup window

Behavior Sensitivity

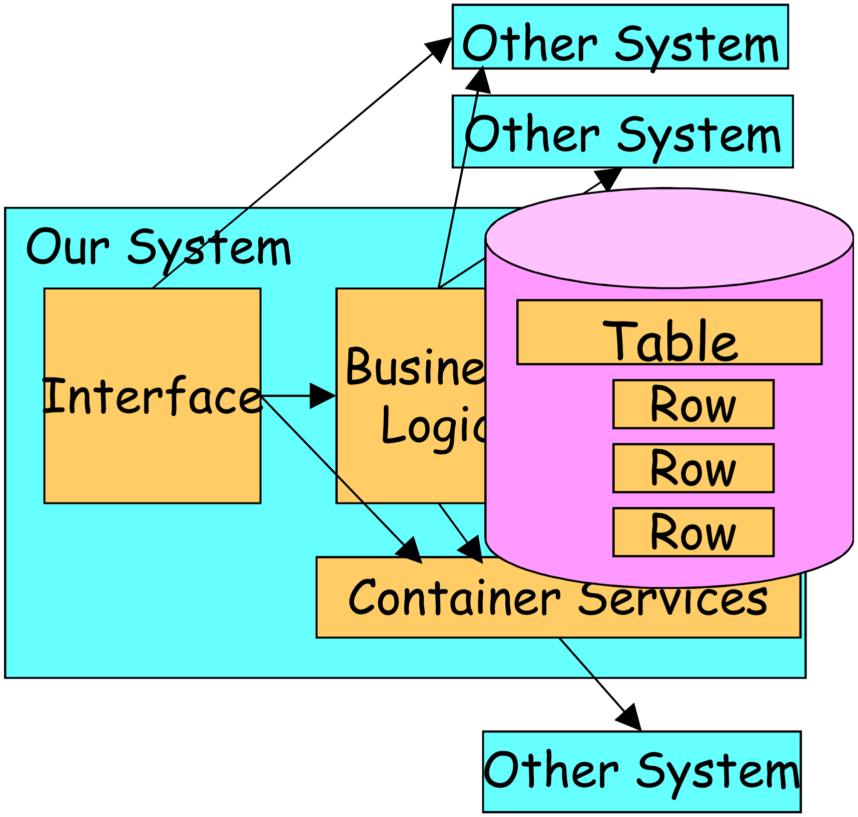
- **Tests must verify the behavior of the system.**
  - Behavior also involved in test set up & tear down
- **Any changes to business logic may cause tests to fail.**
  - New/renamed/deleted states
  - New/changed/removed business rules
  - Changes to business algorithms
  - Additional data requirements



E.g.: Change from GST+PST to HST

Data Sensitivity

- **All tests depend on “test data” which are:**
  - Preconditions of test
  - Often stored in databases
  - May be in other systems
- **Changing the contents of the database may cause tests to fail.**
  - Added/changed/deleted records
  - Changed Schema



E.g.: Change customer’s billing terms

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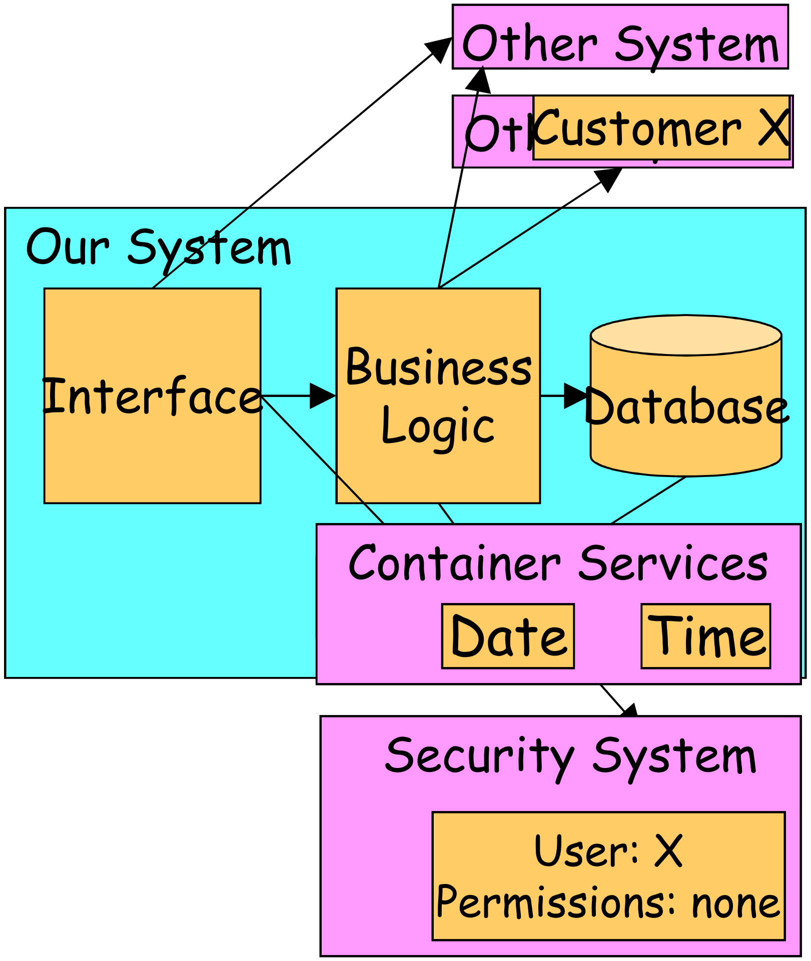
Context Sensitivity

- **Tests may depend on inputs from another system**
  - State stored outside the application being tested
  - Logic which may change independently of our system
- **Changing the state of the context may cause tests to fail.**
  - State of the container
    - » **e.g. time/date**
  - State of related systems
    - » **Availability, data contents**



E.g.: Run test in a shorter/longer month

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Agenda

- **Motivation**
- **Changing the Role of Test Automation**
  - From Defect Detection to Defect Prevention
  - Different Tests for Different Purposes
- **Approaches to Test Automation**
- **Test Automation Strategy**

The Role of Automation in Agile

- **Provide a Safety Net for Change & Innovation**
  - Provide rapid feedback to reduce cost of fixing defects.
    - » **On demand (Developer) and event driven (CI build)**
  - Rapid feedback enables experimentation
    - » **Don’t have to choose between Quick and Safe**
- **Guide Development of the Product**
  - Provide executable examples of what “done” looks like
- **Support Manual Testing**
  - Remove the repetitive drudgery so testers can focus on high value activity by:
  - Automating entire tests, or by
  - automating the steps that can be automated.

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How is Agile Test Automation Different?

- **We automate the tests for a different reason**
  - Defect Prevention vs. Detection
  - To communicate requirements
  - To "Pin" the functionality once it's built
- **We automate the tests a different way**
  - Many different kinds of tests
    - » **E.g. We don't rely solely on GUI-based automation**
  - Using tools that support collaboration & communication
    - » **in addition to confirmation**
- **We plan the automation based on ROI**
  - Goal isn't: 100% automation
  - Goal is: To maximize benefit while minimizing cost

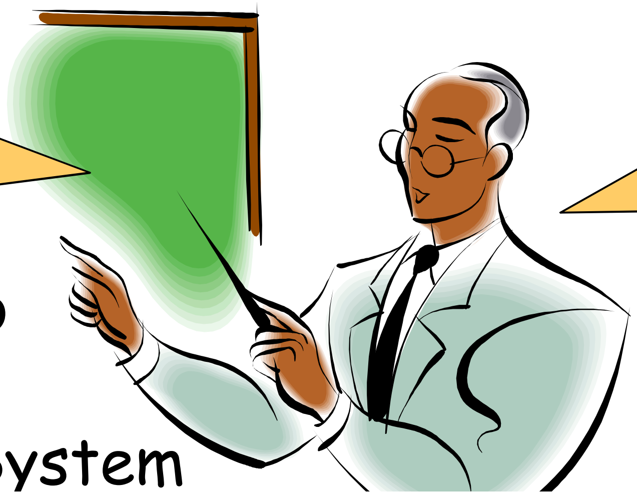
Traditional Role of Testing

Critique Product

Business Facing	Acceptance Tests Regression Tests	Usability Tests Exploratory Tests
Technology Facing	Unit Tests Component Tests	Property Tests (Response Time, Security, Scalability)

Report Card	
Functionality	B
Usability	C
Scalability	A
Response	B
Availability	C

Inspection to find defects is *Waste*

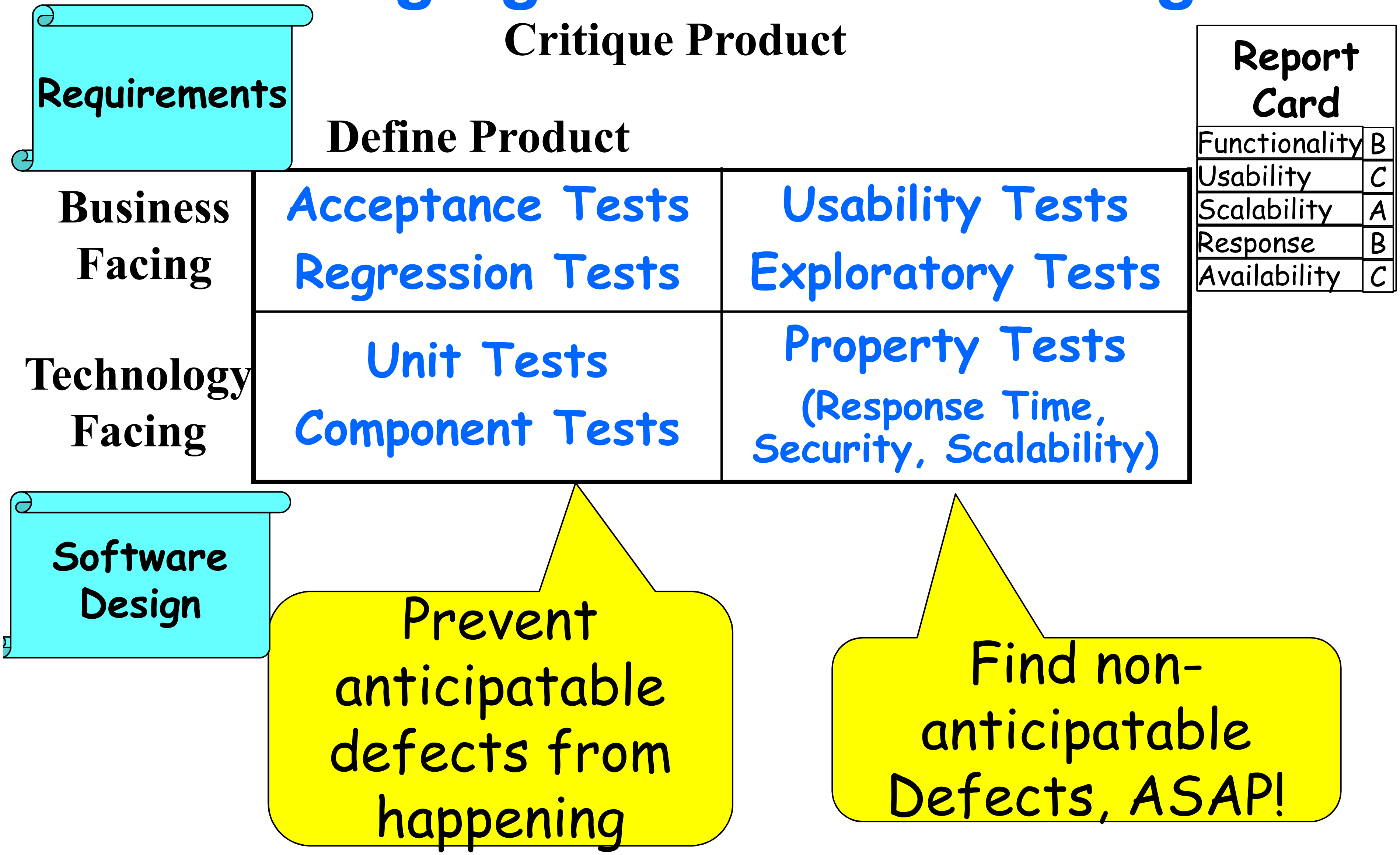


Inspection to prevent defects is *essential*

Shigeo Shingo
Co-inventor of
Toyota Production System

Quadrants courtesy of Brian Marrick and Mary Poppendieck

Changing the Role of Testing



Critique Product

Requirements

Define Product

Business Facing	Acceptance Tests Regression Tests	Usability Tests Exploratory Tests
Technology Facing	Unit Tests Component Tests	Property Tests (Response Time, Security, Scalability)

Software Design

Prevent anticipatable defects from happening

Find non-anticipatable Defects, ASAP!

Report Card

Functionality	B
Usability	C
Scalability	A
Response	B
Availability	C

Quadrants courtesy of Brian Marrick and Mary Poppendieck

Changing the Role of Testing

Requirements

	Define Product	Critique Product
Business Facing	Acceptance Tests Regression Tests	Usability Tests Exploratory Tests
Technology Facing	Unit Tests Component Tests	Property Tests (Response Time, Security, Scalability)

Software Design

Report Card	
Functionality	B
Usability	C
Scalability	A
Response	B
Availability	C

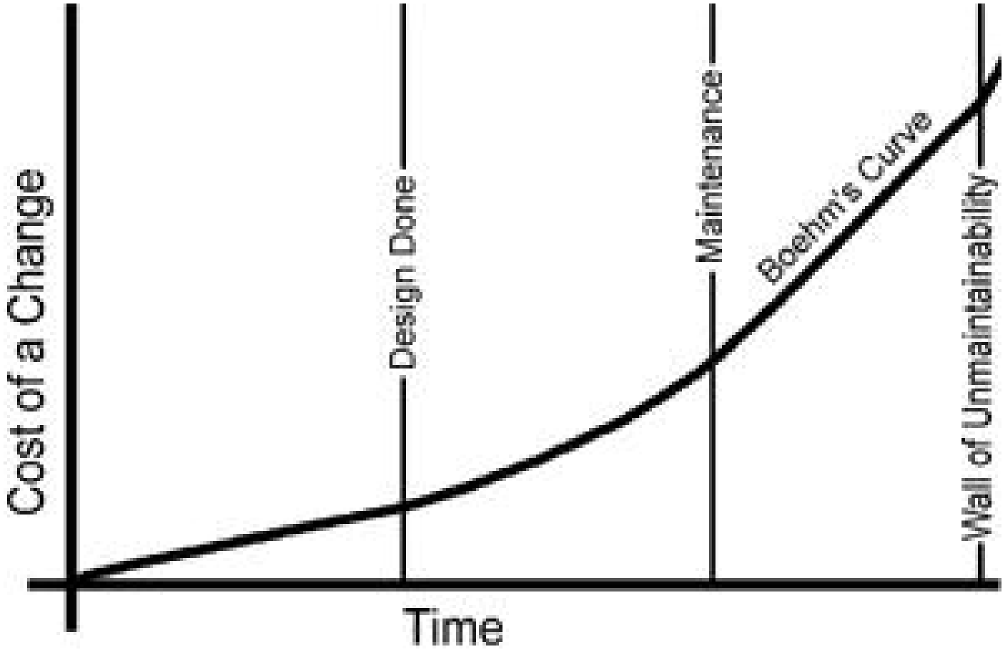
For effective prevention:

1. Tests must be available before development
2. Developers must be able to run tests before check-in

Quadrants courtesy of Brian Marrick and Mary Poppendieck

Reducing the Cost to Fix Defects

Cost to understand and fix a defect goes up with the time it takes to discover it.



- **Why?**
- **We can remember where we put the newly inserted defect because**
  1. We know what code we were working on
  2. The design of the code is still fresh in our minds
- **We may have to change less code**
  – Because we wrote less code based on the defect

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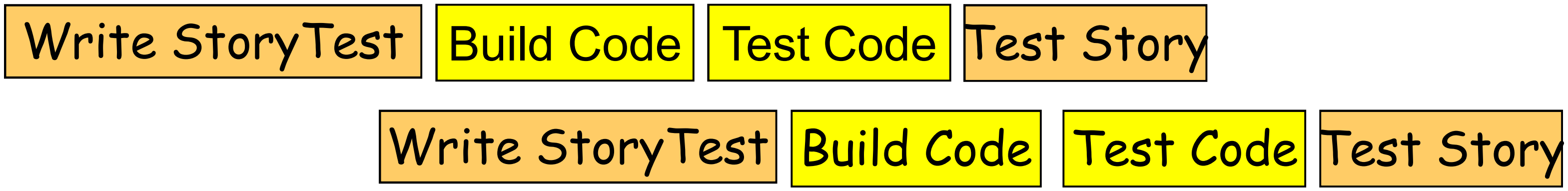
Continuous Acceptance Testing!

- **Defines what "Done Looks Like"**
  - Several to many tests per User Story / Feature

- **Tests executed as soon developer says "It's Ready"**
  - End-of-iteration: OK
  - Mid-iteration : Better



Write StoryTest | Build Code | Test Code | Test Story

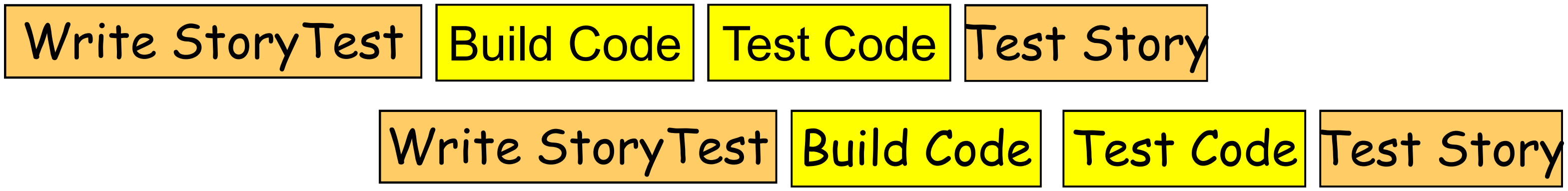
Write StoryTest | Build Code | Test Code | Test Story

Continuous Readiness Assessment!

- **Defines what "Done Looks Like"**
  - Several to many tests per User Story / Feature

Readiness Assessment

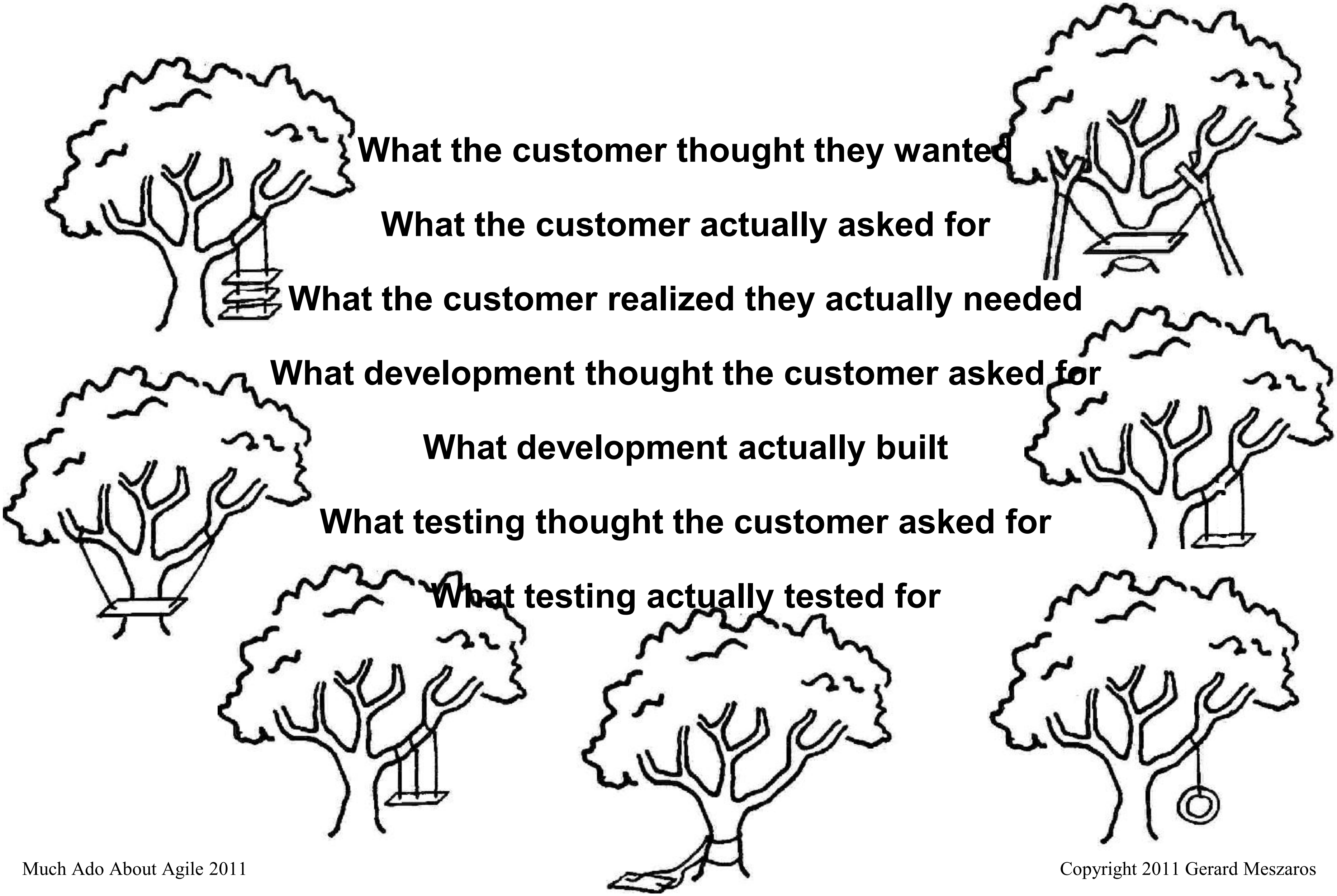
- **Executed by developers during development**
  - To make sure all cases are implemented
  - To make sure it works before showing to business
- **Tests executed as soon developer says "It's Ready"**
  - End-of-iteration: OK
  - Mid-iteration : Better



Write StoryTest | Build Code | Test Code | Test Story

Write StoryTest | Build Code | Test Code | Test Story

Prevention: - Building the Right Product



What the customer thought they wanted

What the customer actually asked for

What the customer realized they actually needed

What development thought the customer asked for

What development actually built

What testing thought the customer asked for

What testing actually tested for

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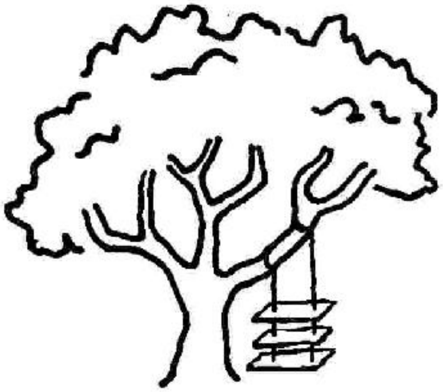
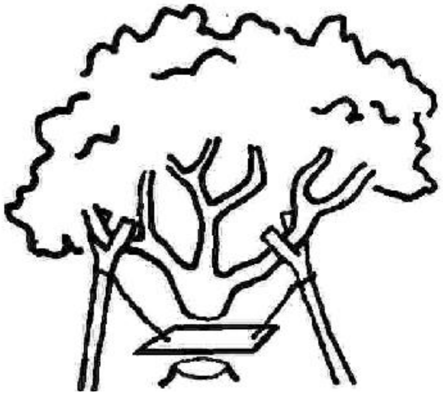
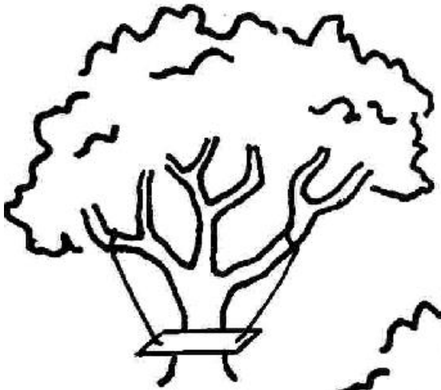
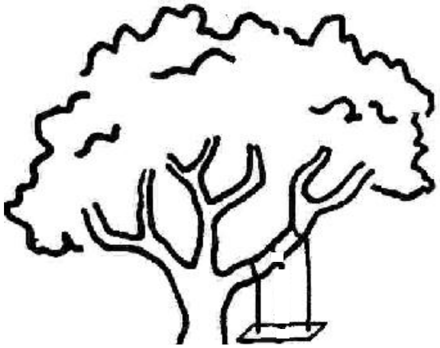
Building the Right Product

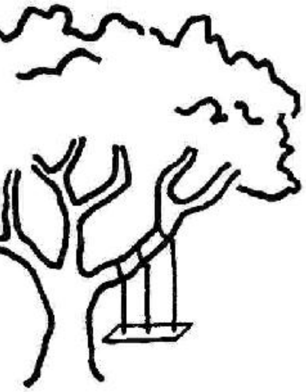


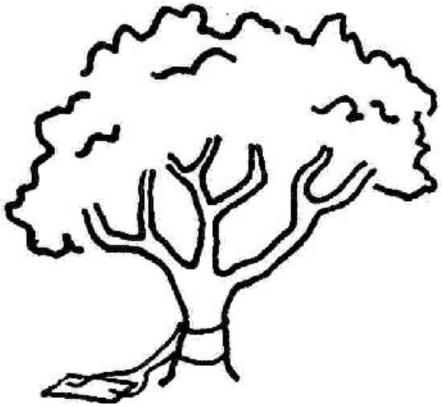


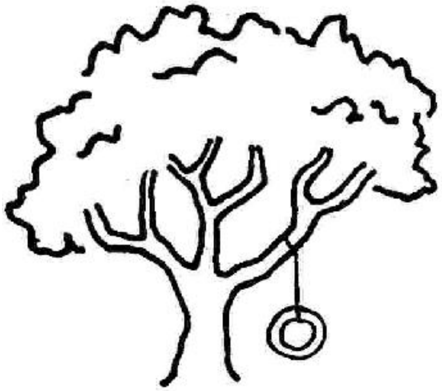
- **How do we eliminate the waste caused by building the wrong product?**
  - Missed requirements?
  - Misunderstood requirements?
  - Unneeded functionality?











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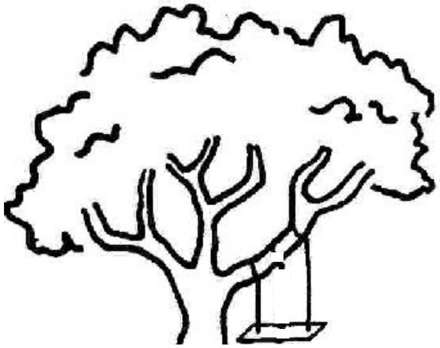
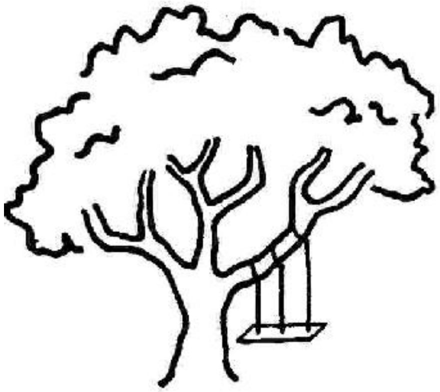
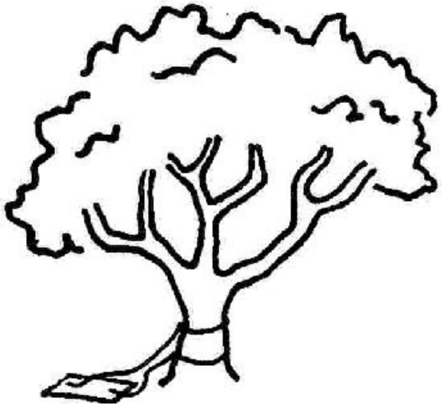
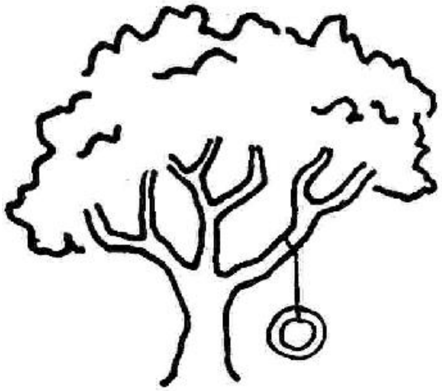
Building the Right Product

- **How do we eliminate the waste caused by building the wrong product?**
  - Missed requirements?
  - Misunderstood requirements?









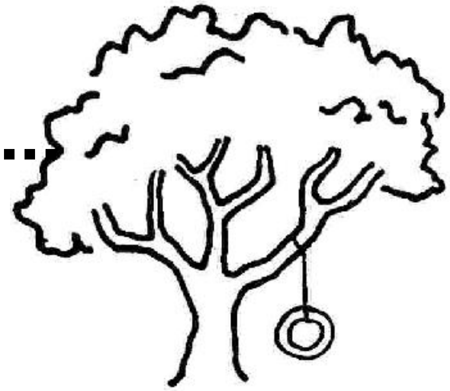
Example-Driven Development

- **A.K.A.**
  - Acceptance Test Driven Development
  - Behaviour-Driven Development
  - Executable Specification
  - StoryTest-Driven Development

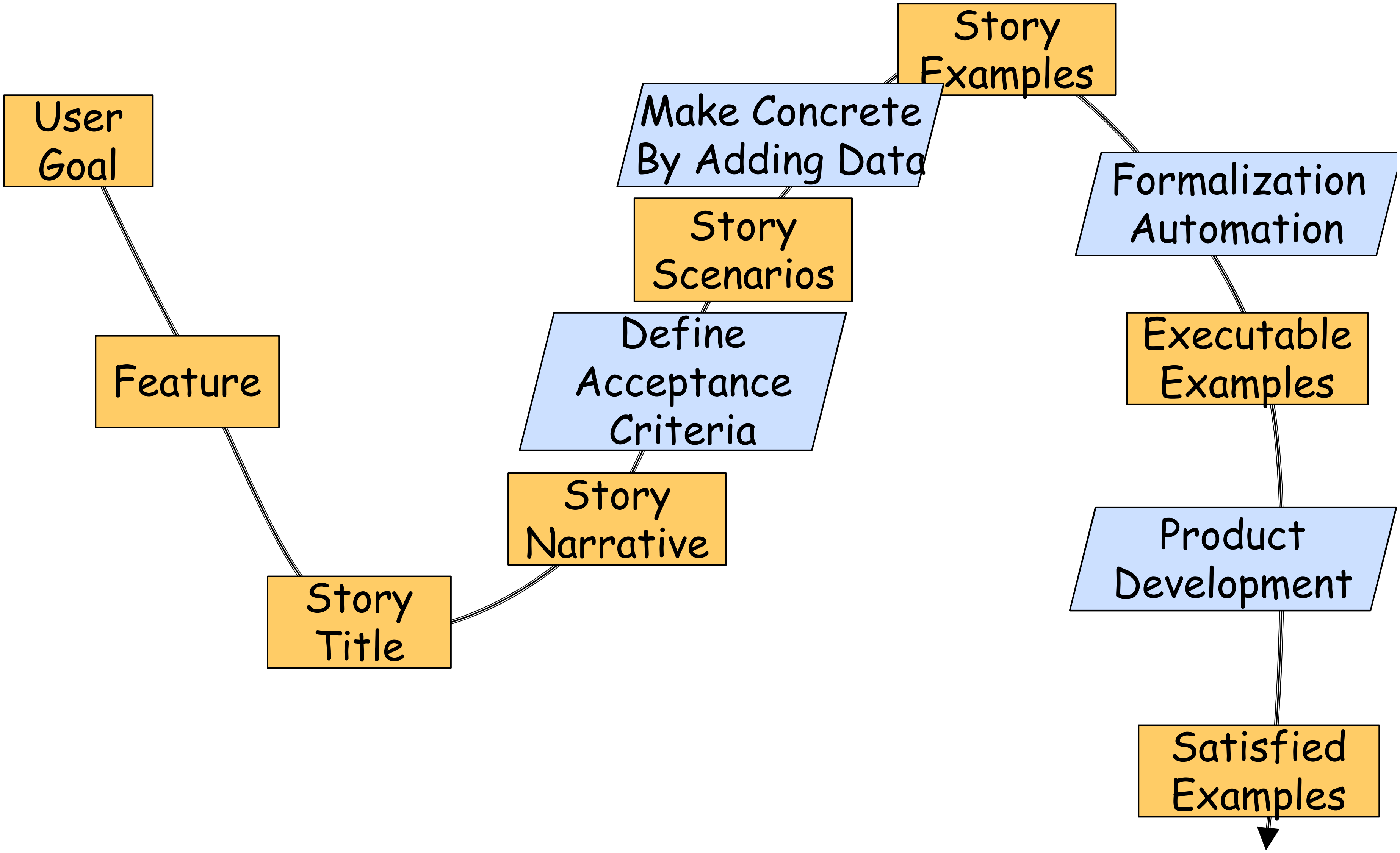
- **Concrete examples *flesh* out requirements**

- **Testers *flush* out missed scenarios...**

  ...before development starts



Life Cycle of an Example / Test



User Goal

Feature

Story Title

Story Narrative

Define Acceptance Criteria

Story Scenarios

Make Concrete By Adding Data

Story Examples

Formalization Automation

Executable Examples

Product Development

Satisfied Examples

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  - From Defect Detection to Defect Prevention
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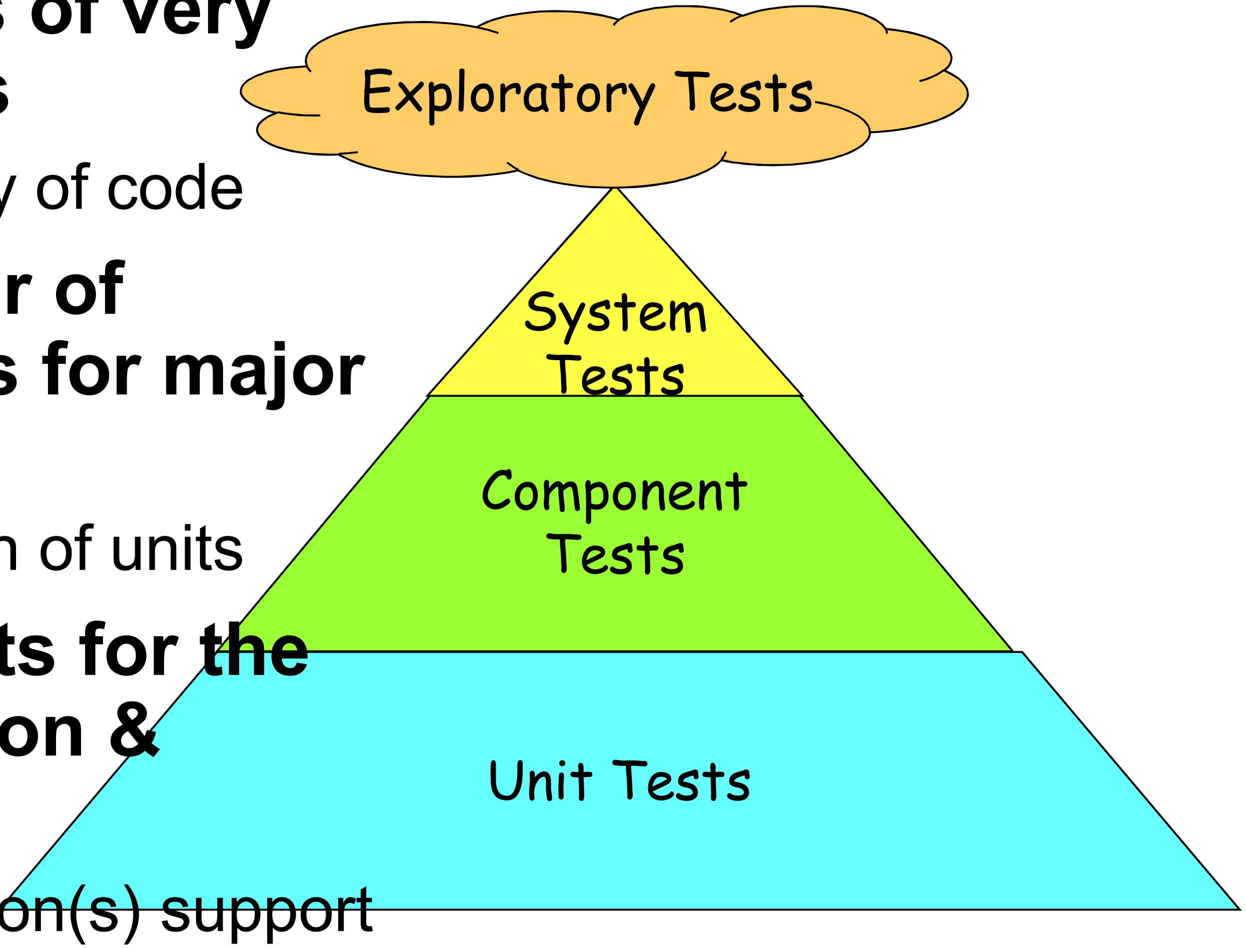
Test Automation Pyramid

- **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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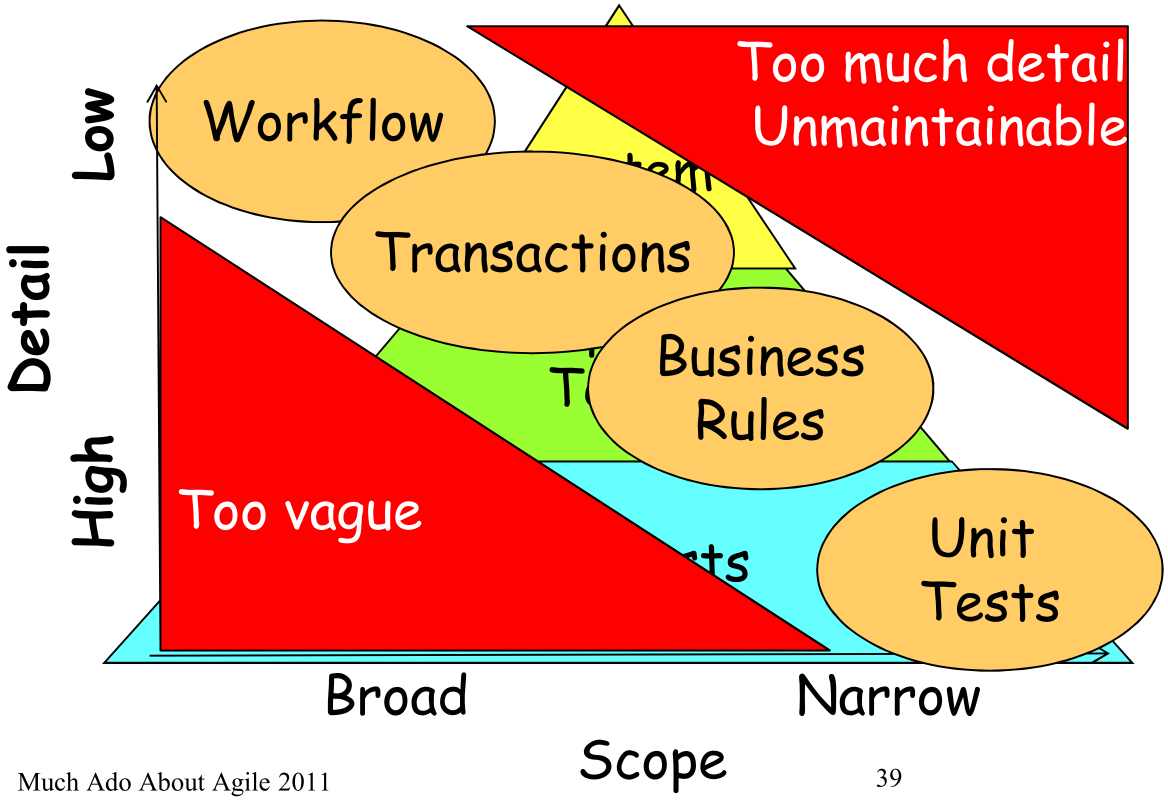
Behavior Specification at Right Level

- **Specify broad scope at minimum detail**
  - E.g. Use least detail when specifying workflow
- **Specify most detailed req'ts at narrowest scope**
  - E.g. Don't use workflow when specifying business rules

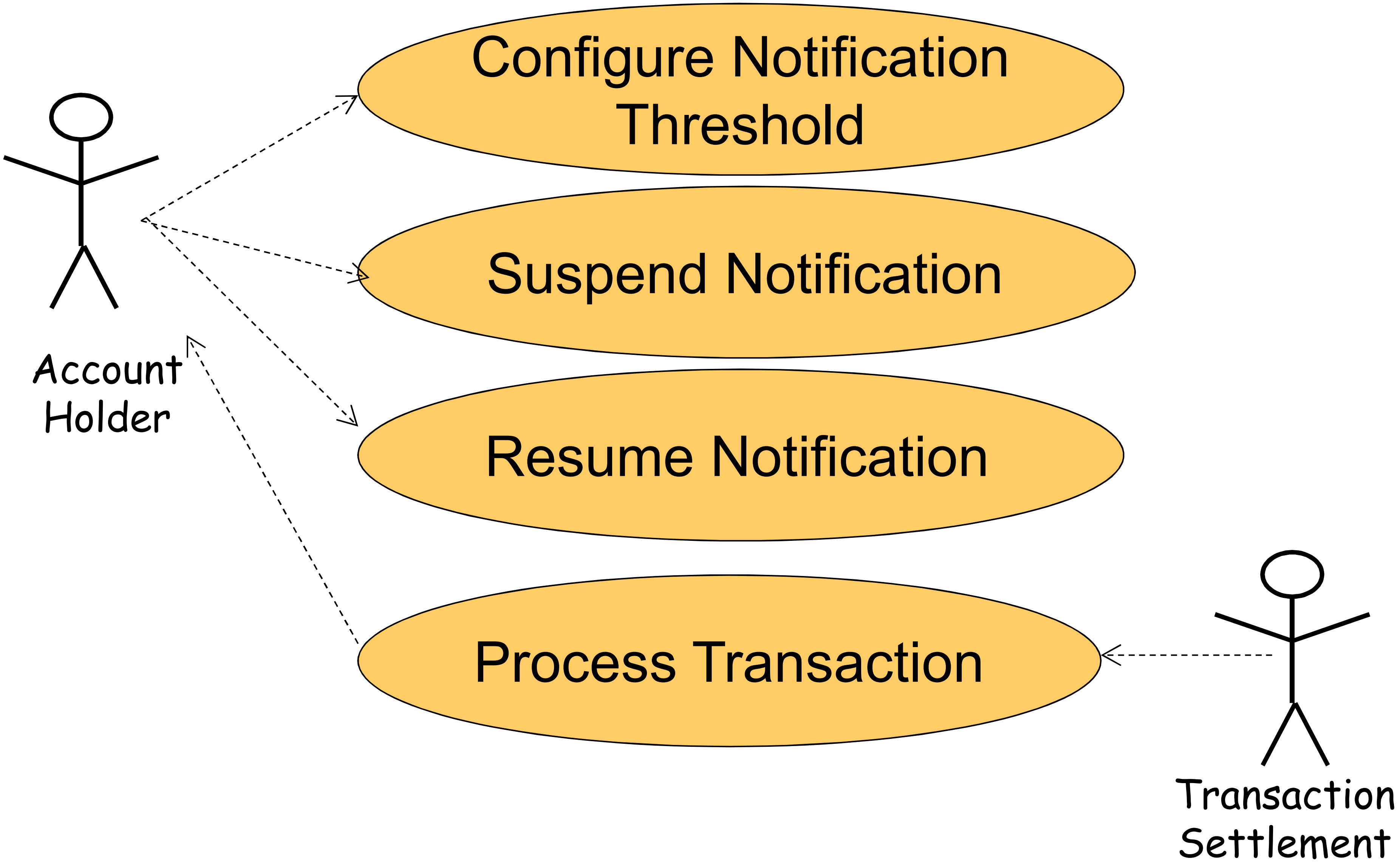


Make examples / tests easy to understand and easy to write

Example: Mega Bank Requirements

- **Notify user of transactions against their accounts.**
- **User can configure threshold amount for notification based on any/all of account, transaction type or region, charge category**
- **Notification can be sent via e-mail, voice-mail or SMS/IM**
- **User can suspend notifications indefinitely or for a defined period of time.**

Example: Mega Bank Use Cases



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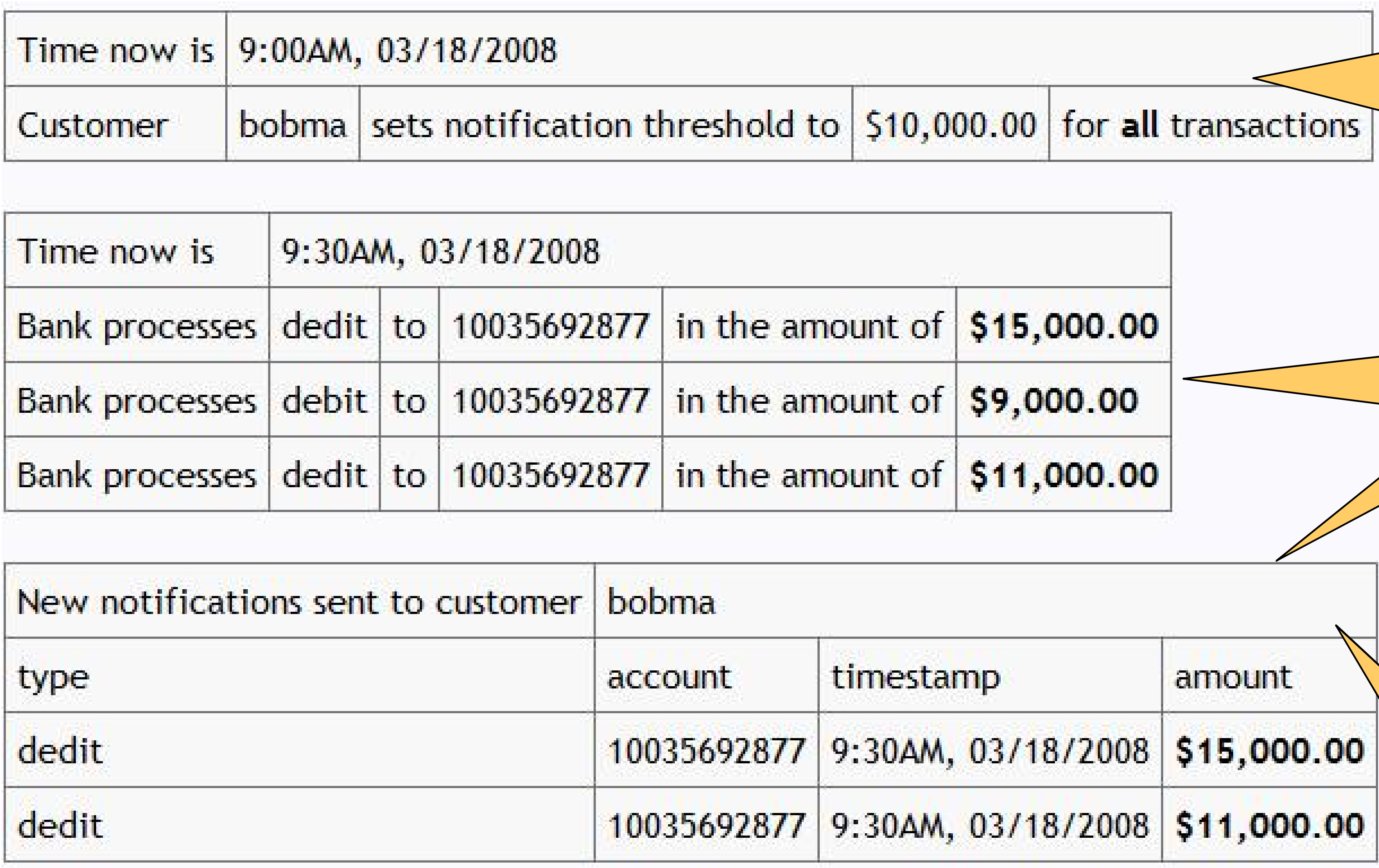
Example:

Specifying Notification Workflow



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

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

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

Use Case: Manage Notification Thresholds

Use Case: Process Transaction

Check output of Use Case: Process Transaction

Broad Scope; Minimum Detail;
No mention of User Interface!

Copy

Alternate form of Workflow Test:

Given Bobma has account 1003592877

And BobMa sets notification threshold to $10,000 for all transactions

When the bank processes debit for 15,000 to account 1003592877

And the bank processes debit for 9,000 to account 1003592877

And the bank processes debit for 11,000 to account 1003592877

Then bobma receives notification for debit 15,000 to account 1003592877

And bobma receives notification for debit 11,000 to account 1003592877

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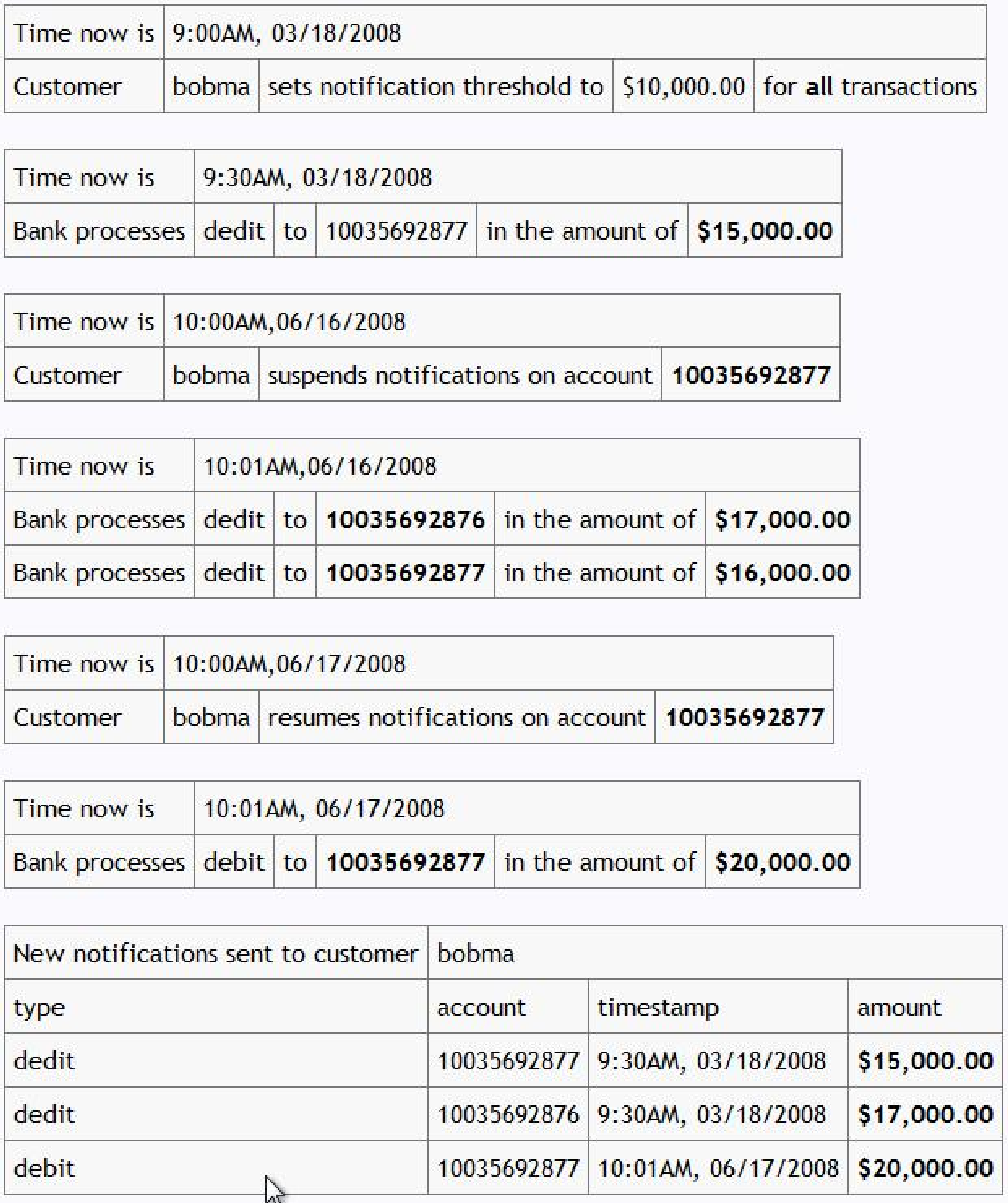
Example:

Specifying Suspension Workflow



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

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

Time now is	10:00AM,06/16/2008		
Customer	bobma	suspends notifications on account	**10035692877**

Time now is	10:01AM,06/16/2008				
Bank processes	dedit	to	**10035692876**	in the amount of	**$17,000.00**
Bank processes	dedit	to	**10035692877**	in the amount of	**$16,000.00**

Time now is	10:00AM,06/17/2008		
Customer	bobma	resumes notifications on account	**10035692877**

Time now is	10:01AM, 06/17/2008				
Bank processes	debit	to	**10035692877**	in the amount of	**$20,000.00**

New notifications sent to customer	bobma		
type	account	timestamp	amount
dedit	10035692877	9:30AM, 03/18/2008	**$15,000.00**
dedit	10035692876	9:30AM, 03/18/2008	**$17,000.00**
debit	10035692877	10:01AM, 06/17/2008	**$20,000.00**

Use Case: Manage Notification Thresholds

Use Case: Process Transaction

Use Case: Suspend Notification

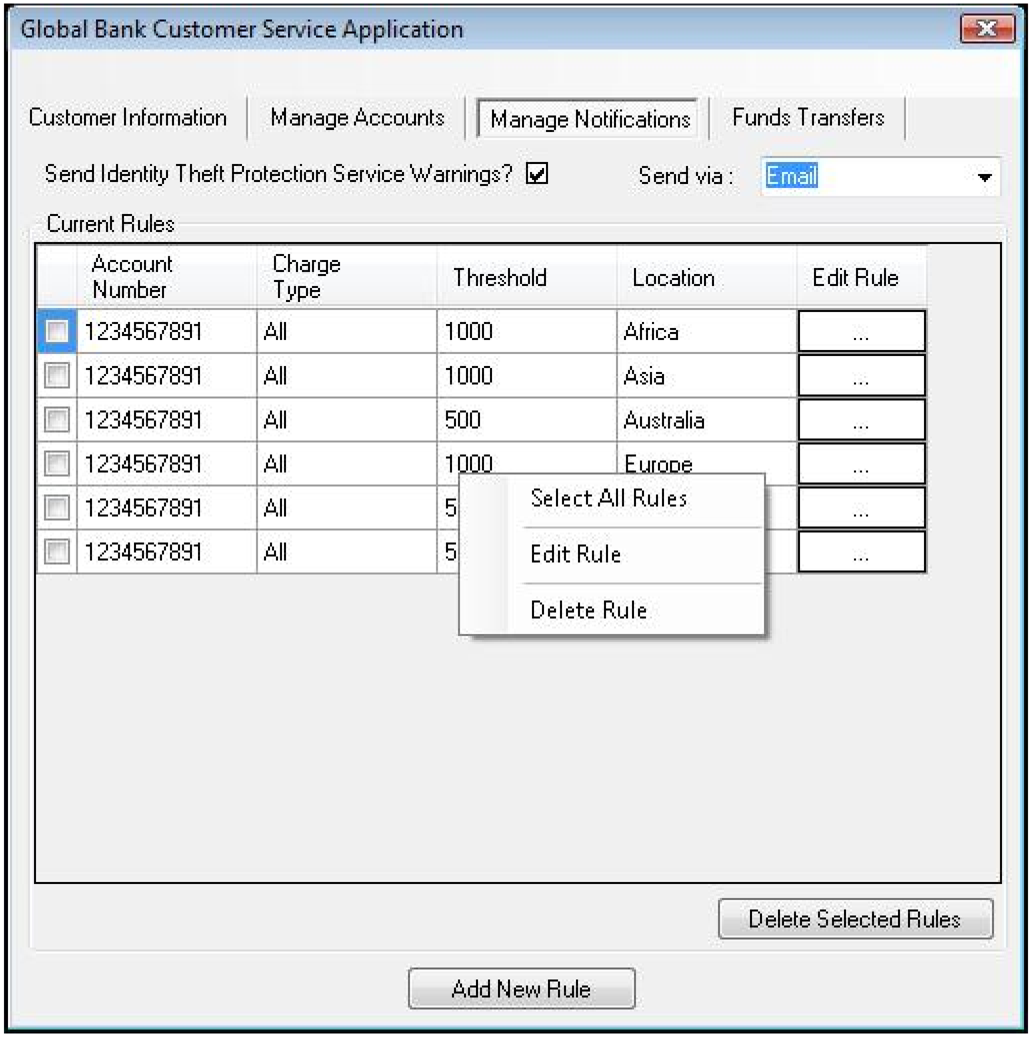
Use Case: Resume Notification

Use Case: View Notifications

Example:

GUI for Manage Notifications Tx

- **User Interface implies specific functionality:**
  - List of accounts
  - Ability to make changes to notifications
  - List of active notifications
- **This functionality can be tested independently of UI**



Send Identity Theft Protection Service Warnings? ☑ Send via : Email

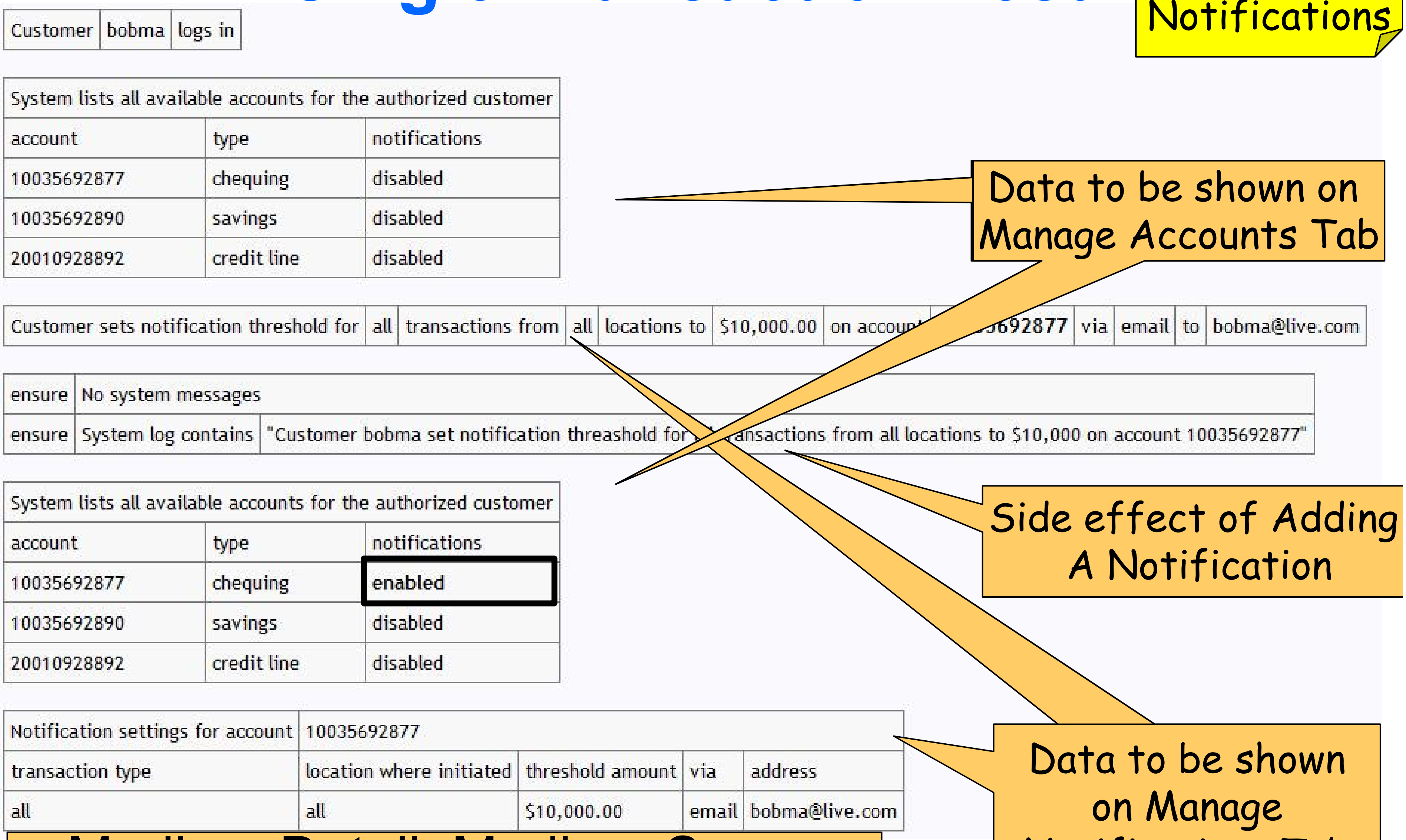
Current Rules

	Account Number	Charge Type	Threshold	Location	Edit Rule
☐	1234567891	All	1000	Africa	...
☐	1234567891	All	1000	Asia	...
☐	1234567891	All	500	Australia	...
☐	1234567891	All	1000	Europe	...
☐	1234567891	All	5		...
☐	1234567891	All	5		...

Example:

Single Transaction Test

Use Case: Manage Notifications



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 threashold 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

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

Data to be shown on Manage Accounts Tab

Side effect of Adding A Notification

Data to be shown on Manage Notifications Tab

Medium Detail; Medium Scope
Still no mention of User Interface!

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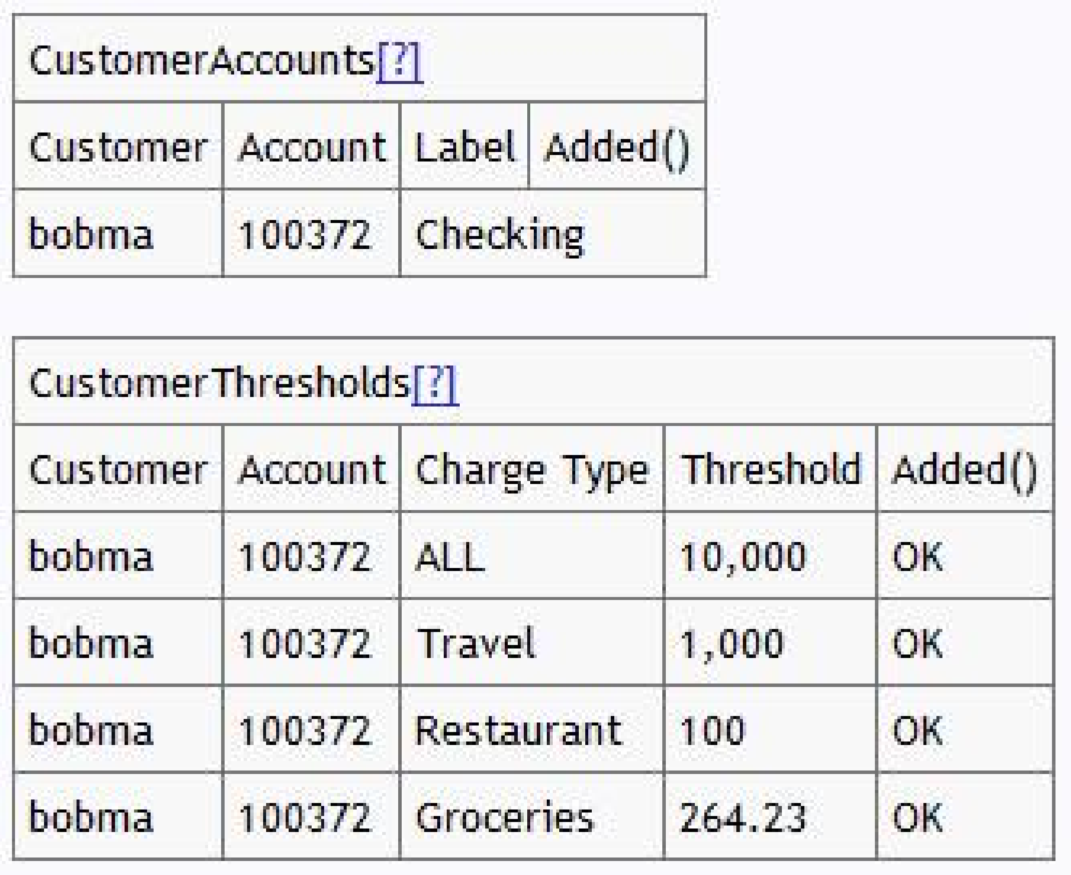
Example:

Business Rule Specs

Threshold per Charge Type

Configuration



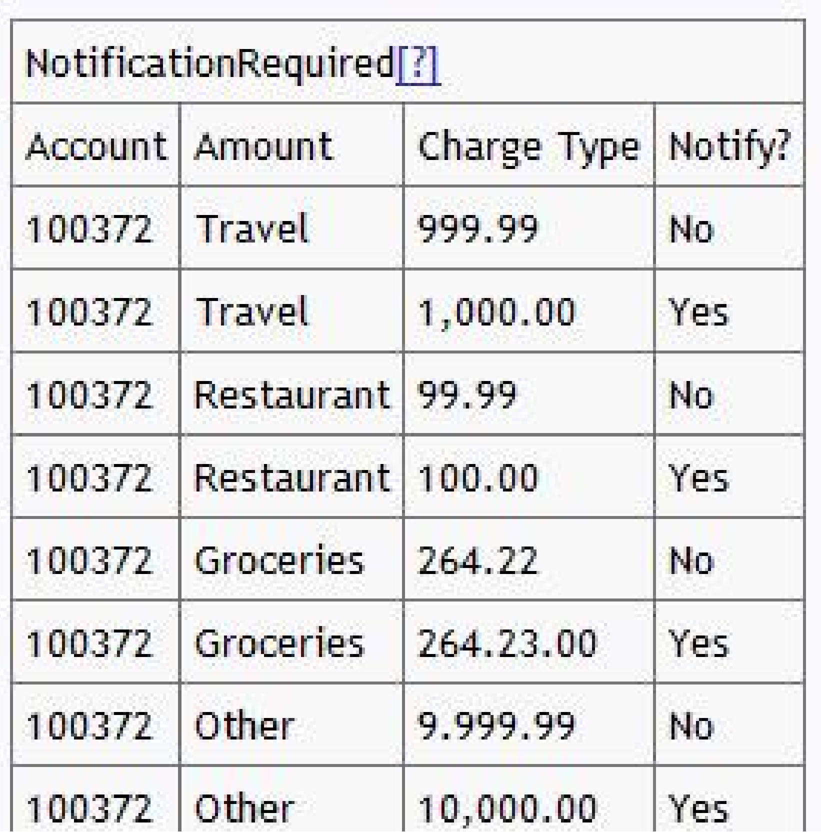
CustomerAccounts[?]

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	Amount	Charge Type	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	264.23.00	Yes
100372	Other	9.999.99	No
100372	Other	10,000.00	Yes

High Detail; Narrow Scope
Completely ignores UI!

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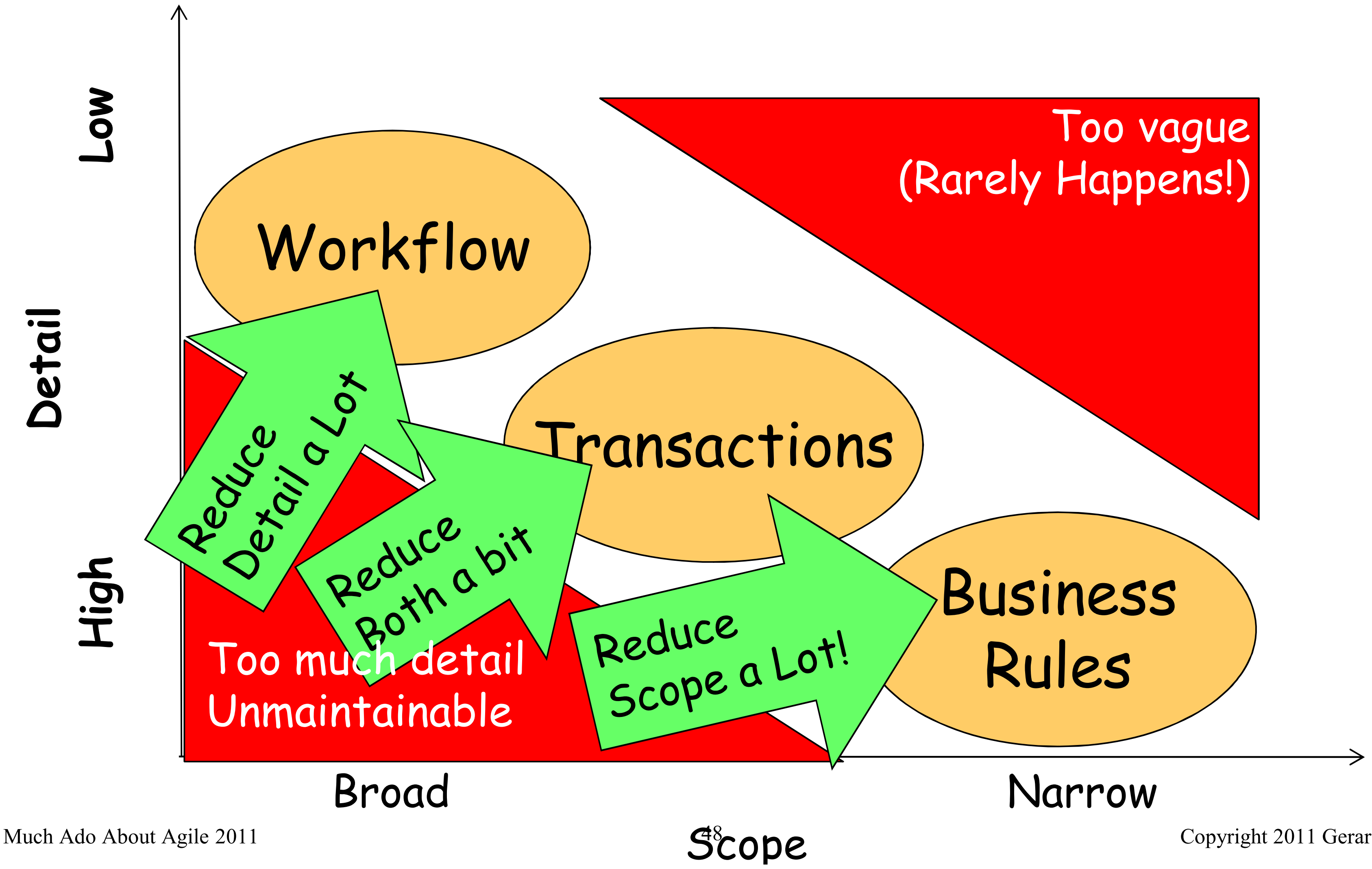
Changing Level of Abstraction/Detail

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



Agenda

- **Motivation**
- **Changing the Role of Test Automation**
- **Approaches to Test Automation**
  - Test Preparation Approach
  - Test Definition Language
  - Test Execution Interface
- **Test Automation Strategy**

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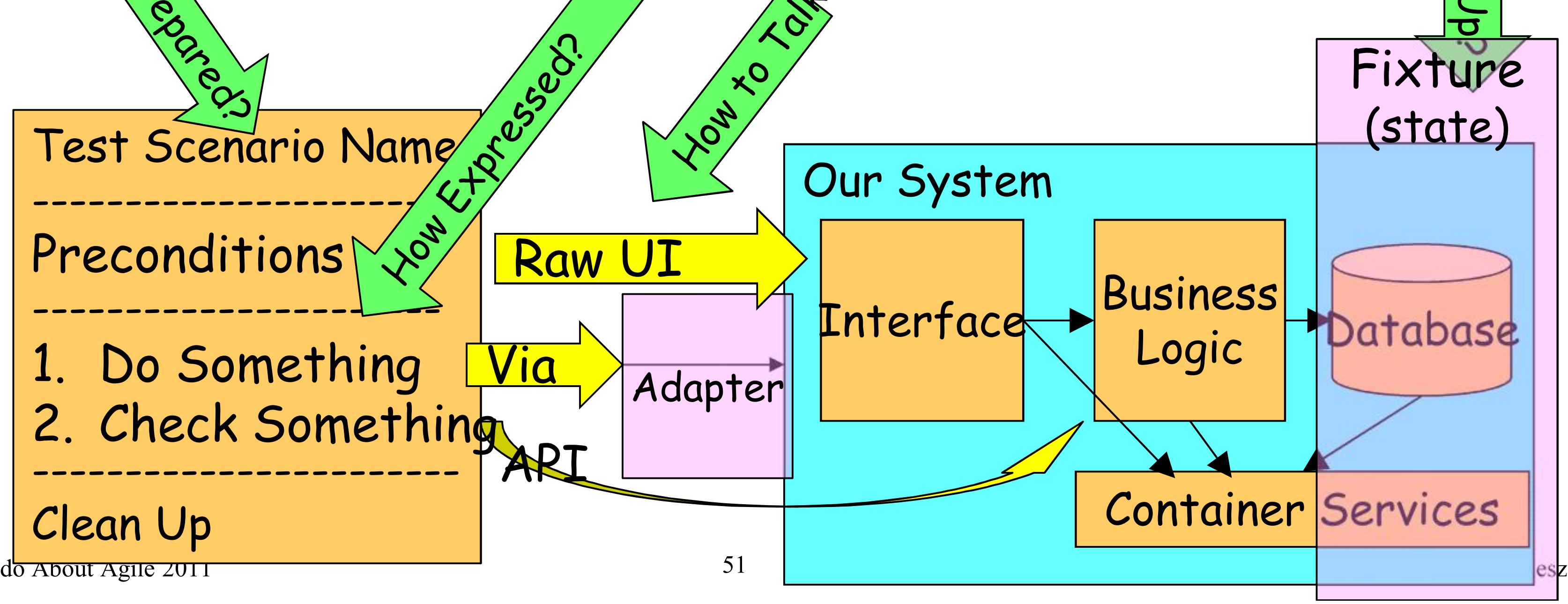
Why is Automation Approach Important?

- **Common Failure Mode:**
  - Choose tools, then try to make them work
  - Wrong tools can prevent achieving goals
- **Better Approach:**
  - Choose automation approach to achieve goals
  - Then, select tools to support it

Common Approaches to Test Automation

Test Preparation	Test Language	Test Interface	Test Data
Recorded	Code	Raw UI	Global, Static
Refactored	Keyword	Adapter	Per Run
Handwritten	Data	API	Per Test



(C)OTS Record&Playback

Test Preparation	Test Language	Test Interface	Test Data
Recorded	Code	Raw UI #	Global, Static
Refactored	Keyword*	Adapter	Per Run
Hand-written	Data	API	Per Test

		Poor	OK	Good
	Example Driven	X		
Legacy	Workflow			X
	System			X
	Business Rules		X	
	Component	X		
	Unit	X		
New	Workflow	X		
	System	X		
	Component	X		
	Business Rules	X		
	Unit	X		

Notes:

* Keywords, if used, tend to be very low level:

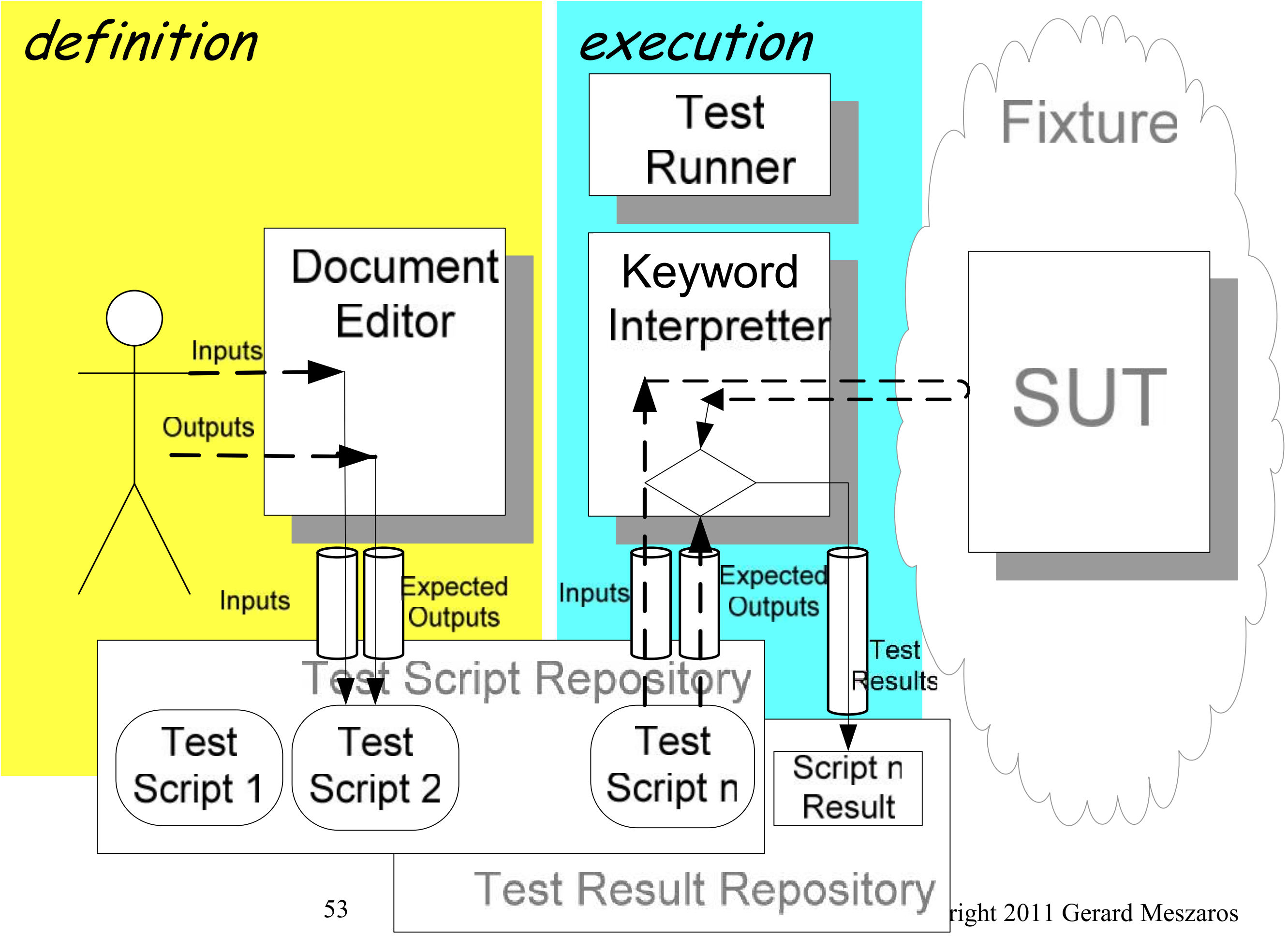
- •GotoWindowNamed: *name*
- •SelectFieldNamed: *name*
- •EnterText: *text*
- •(Not the same as true Keyword-Driven testing)

# Most COTS Tools operate at UI or HTTP interface; many open-source tools do so as well

Keyword-Driven Tests

- **The tests are expressed in domain-specific vocabulary.**
- **The tests are read & executed by a test interpreter written by techies.**

Prepared like Hand-Coded Tests but with a much more limited vocabulary.



Keyword-Driven Tests

Test Preparation	Test Language	Test Interface	Test Data
Recorded	Code	Raw UI *	Global, Static
Refactored	Keyword	Adapter	Per Run
Hand-written	Data	API	Per Test

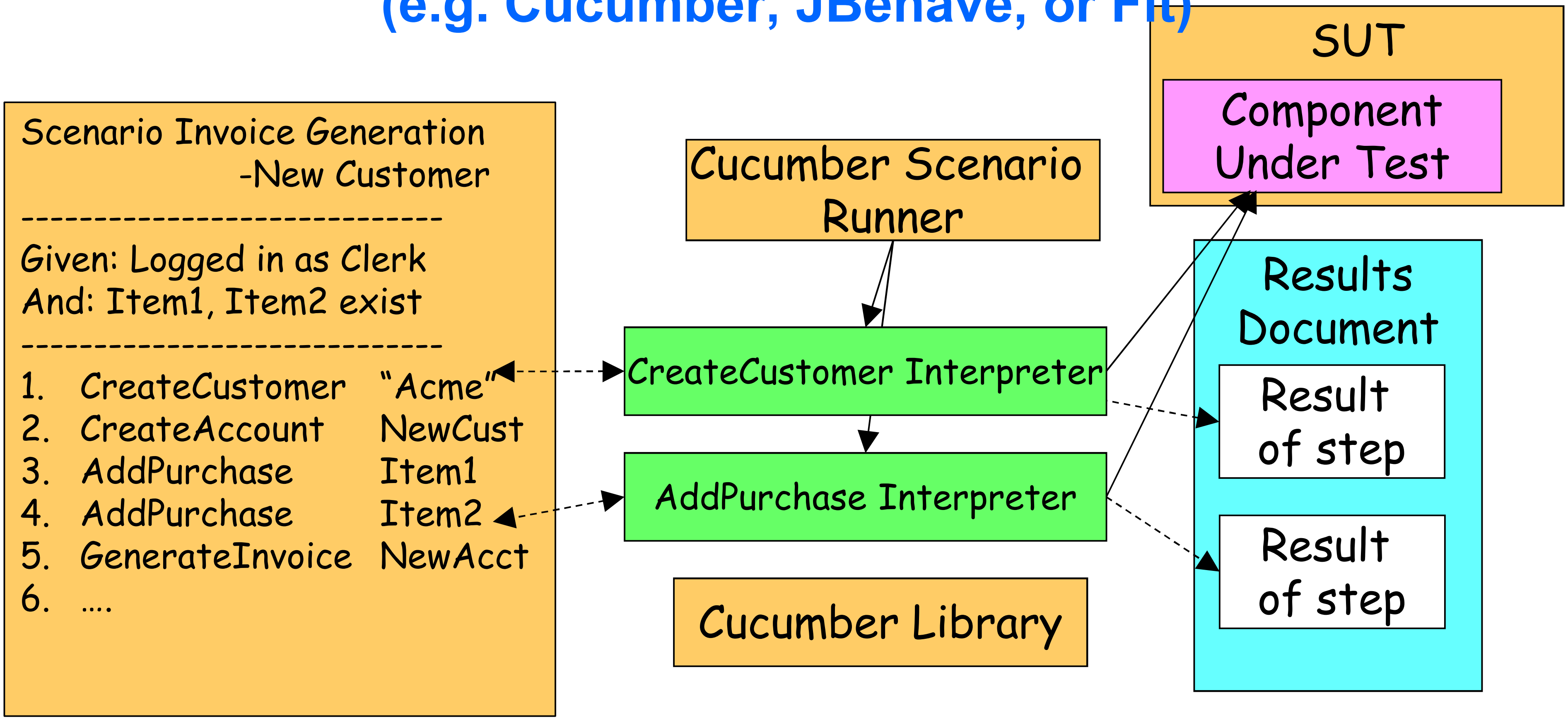
Notes:

- While the Keyword Interpreter may go against the Raw UI, it is better to delegate to an adapter if no API is available.

		Poor	OK	Good
	Example Driven			X
Legacy	Workflow		X	
	System		X	
	Business Rules		X	
	Component		X	
	Unit	X		
New	Workflow			X
	System			X
	Component		X	
	Business Rules		x	
	Unit	x		

Sample Keyword-Driven Test

(e.g. Cucumber, JBehave, or Fit)



Scenario Invoice Generation
-New Customer

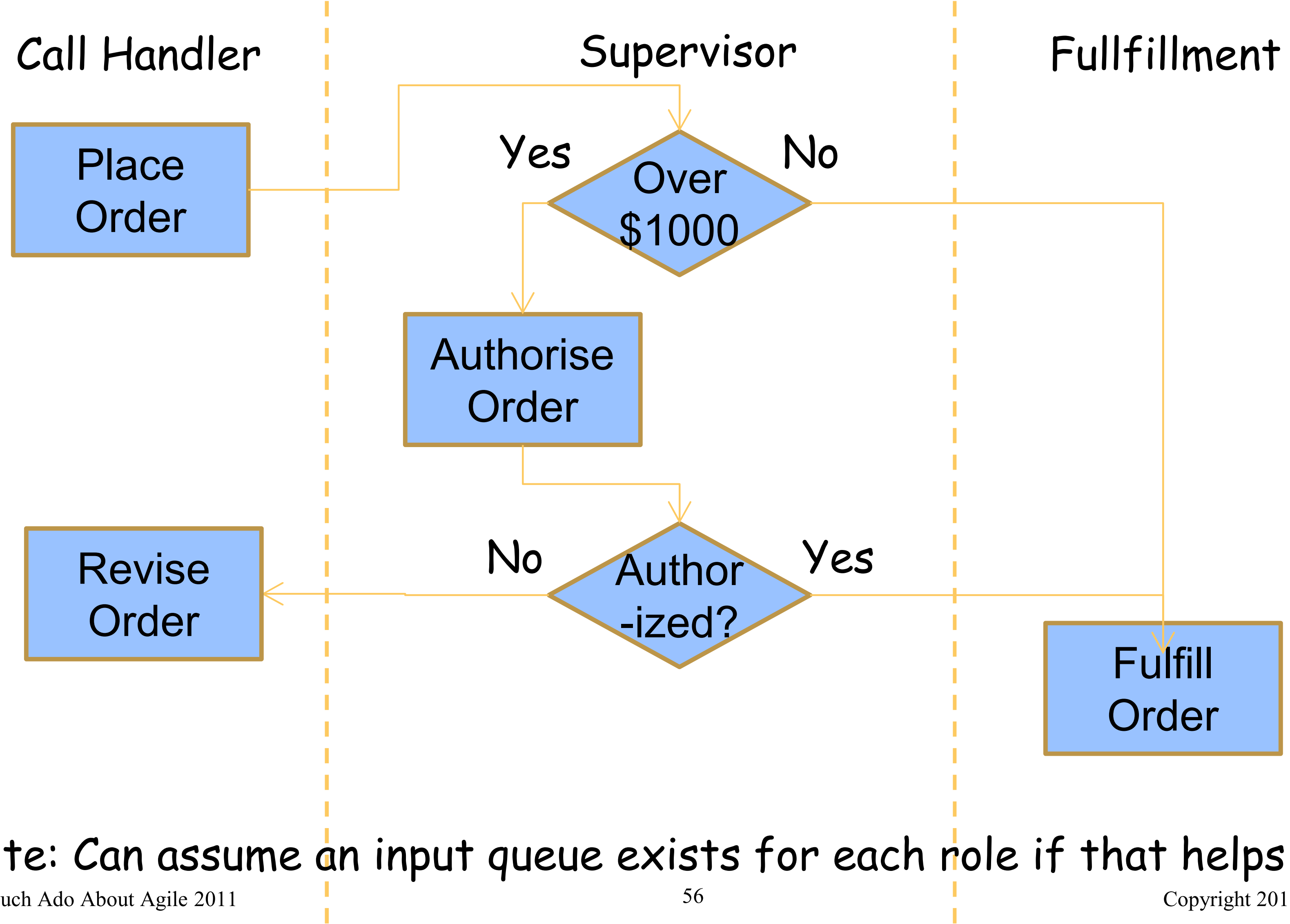
Given: Logged in as Clerk
And: Item1, Item2 exist

1.	CreateCustomer	“Acme”
2.	CreateAccount	NewCust
3.	AddPurchase	Item1
4.	AddPurchase	Item2
5.	GenerateInvoice	NewAcct
6.	….	

- Test script defined using keywords
- Keyword Interpreter invokes underlying code
- Can go direct to API or via an Adapter

Exercise 3 – Keyword-Driven Test

- **Provide examples for the following workflow (Min. detail)**



Note: Can assume an input queue exists for each role if that helps checking.

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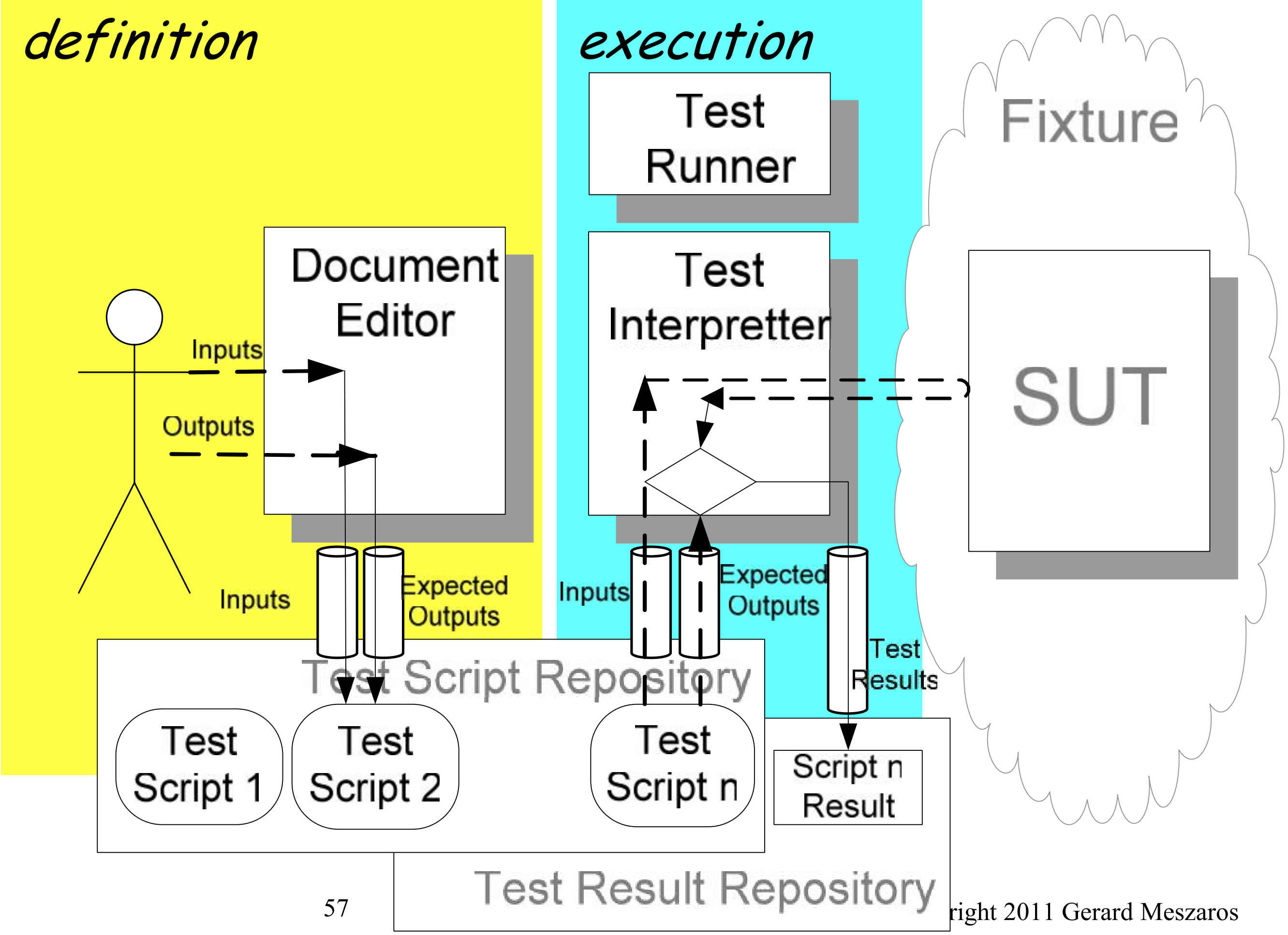
Data-Driven Tests

- **The tests are expressed as tabular data by users.**
- **The tests are read & executed by a test interpreter written by techies.**

Runs the same test script many times; once per set of data.



Data-Driven Test

Test Preparation	Test Language	Test Interface	Test Data
Recorded *	Code *	Raw UI	Global,Static#
Refactored	Keyword	Adapter	Per Run
Hand-written	Data	API	Per Test

Notes:

* The underlying script may be either hand-written or recorded and parameterized. But the data scenarios (input values and expected outputs) are almost always prepared by hand.

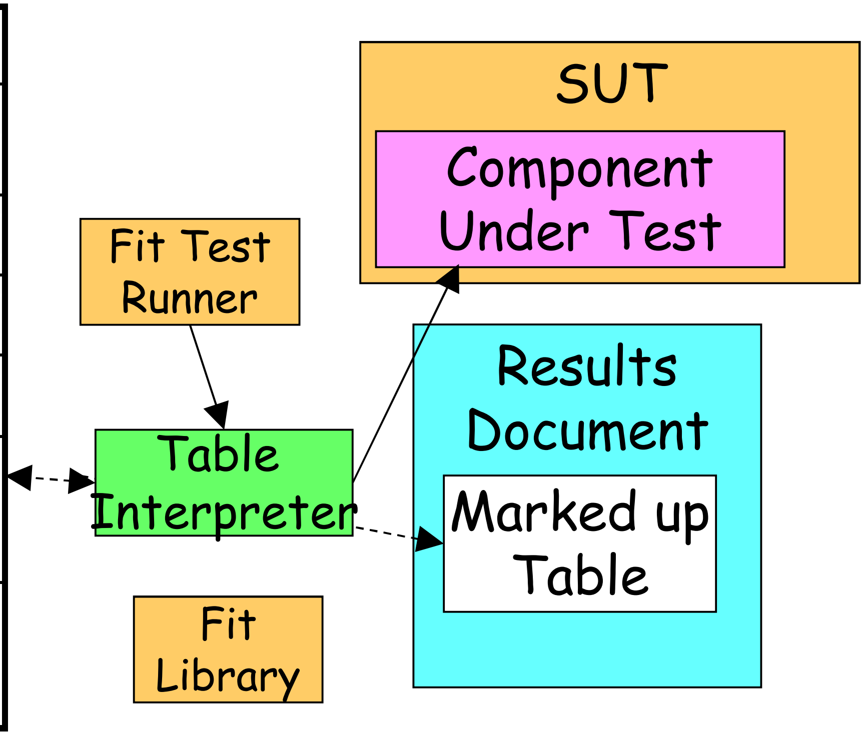
# The inputs/outputs are per test (per row) but there may be global or per-run data used as reference data by the underlying script.

		Poor	OK	Good
	Example Driven			X
Legacy	Workflow	X		
	System	X		
	Business Rules		X	
	Component		X	
	Unit	X		
New	Workflow	X		
	System	X		
	Component		x	
	Business Rules			x
	Unit	x		

Sample Data-Driven Test in FIT

PayrolFixtures.WeeklyCompensation			
Standard Hours	Holiday Hours	Hourly Wage	Pay( )
40	0	10	$400
40	0	20	$800
41	0	20	$830
40	1	20	$840
41	1	20	$870

←---Inputs---→ ←Outputs→



- Same script is run for each row of table
- Avoids duplication of test script.
- Compact summary of input values & results
- Sometimes called “Business Unit Test” or “Business Rule Test”

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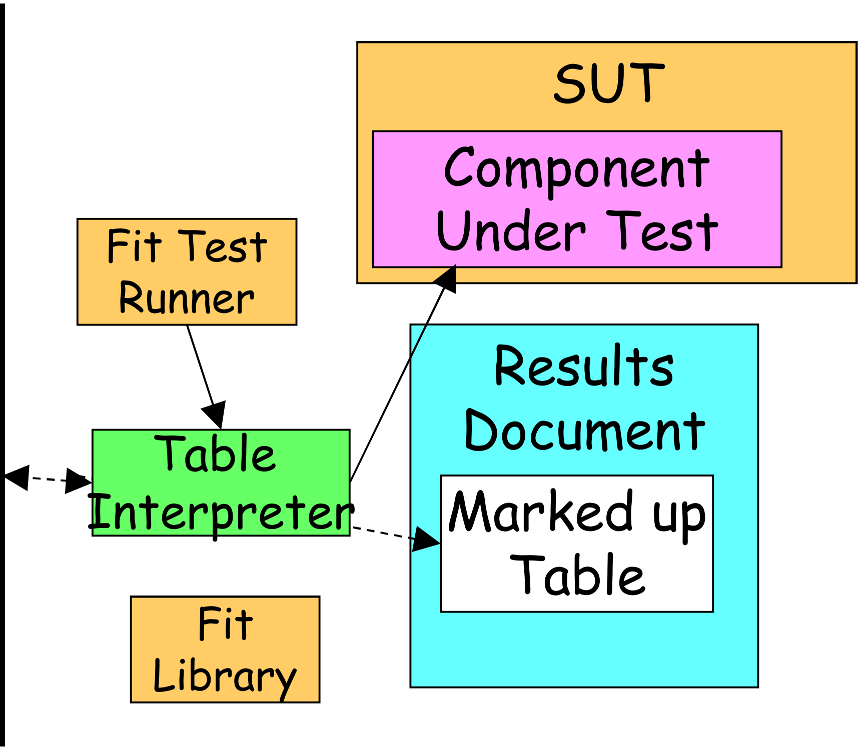
Sample Data-Driven Test in FIT

PayrolFixtures.WeeklyCompensation			
Standard Hours	Holiday Hours	Hourly Wage	Pay( )
40	0	10	$400
40	0	20	$800
41	0	20	$830
40	1	20	$840 *expected* $800 *actual*
41	1	20	$870 *expected* $830 *actual*

←---Inputs---→ ←Outputs→



- Same script is run for each row of table
- Avoids duplication of test script.
- Compact summary of input values & results
- Sometimes called "Business Unit Test" or "Business Rule Test"

Exercise – Business Unit Test

- **Rewrite the tests for the Invoice Total logic using a Data-Driven Business Unit Test that talks directly to the component that calculates the total.**
- **Focus on single-item invoices.**
  - E.g. Each row describes the total expected for one line item.
- **Suggested test cases are in the Testers' Package**
- **You may use the template provided by "Test Automation" or you may invent your own.**

Agenda

- **Motivation**
- **Changing the Role of Test Automation**
- **Approaches to Test Automation**
  - Test Preparation Approach
  - Test Definition Language
  - Test Execution Interface
- **Test Automation Strategy**

What Does It Take...?

- to be able to write tests like this?
- We need some technical skills to implement the “fixtures” or “interpretters” of our testing language, and either
- the right programming interfaces in the system, or
- we need to do extensive wrappering to simulate them

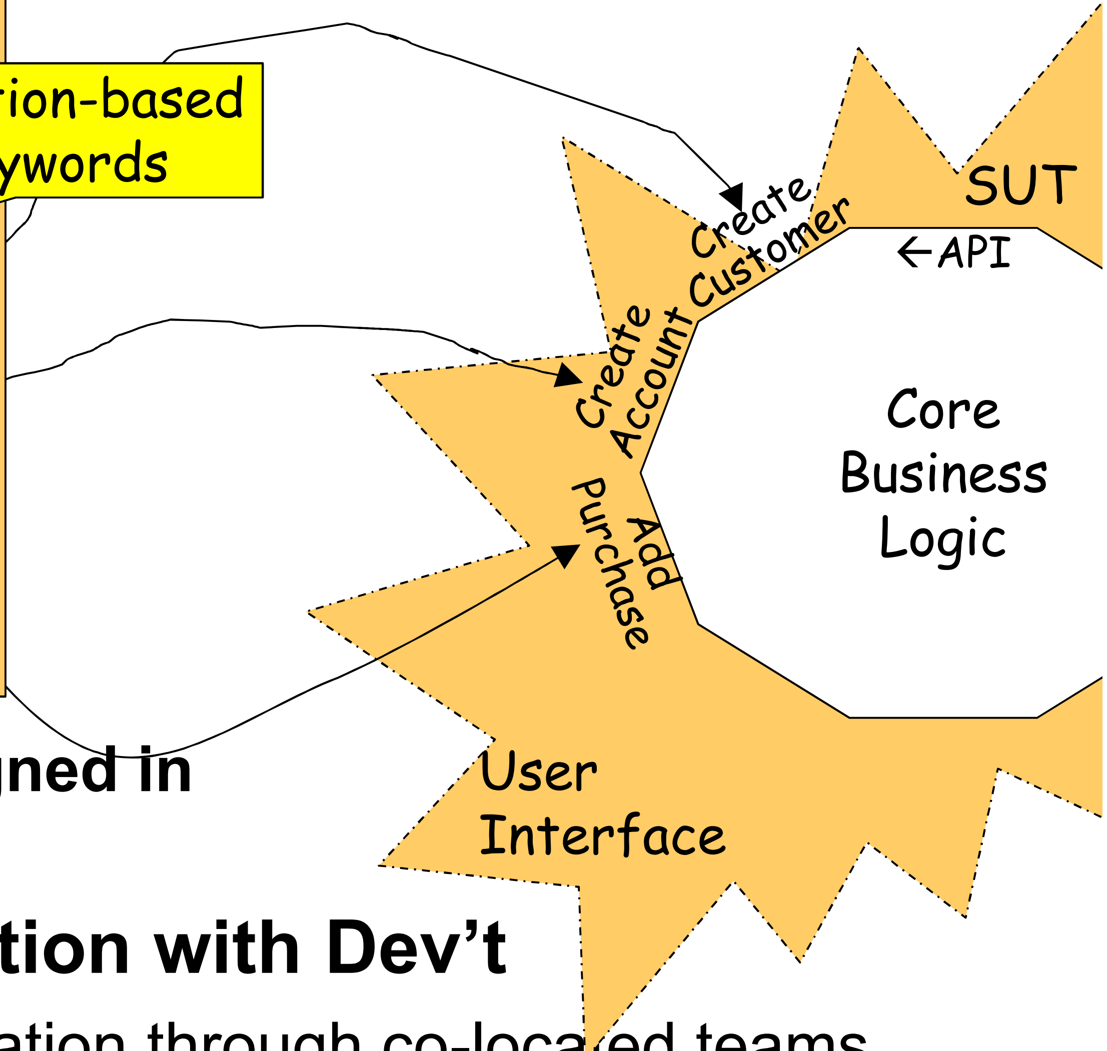
Keeping Tests Simple: Testing via API

What we want to write:

Test Invoice Generation
-New Customer

Logged in as Clerk
Item1, Item2 exist
----
1. CreateCustomer "Acme"
2. CreateAccount NewCust
3. AddPurchase Item1
4. AddPurchase Item2
5. GenerateInvoice NewAcct
6. ….

Intention-based Keywords



- **API's need to be designed in**
  - Design for Testability
- **Requires collaboration with Dev't**
  - Agile fosters collaboration through co-located teams

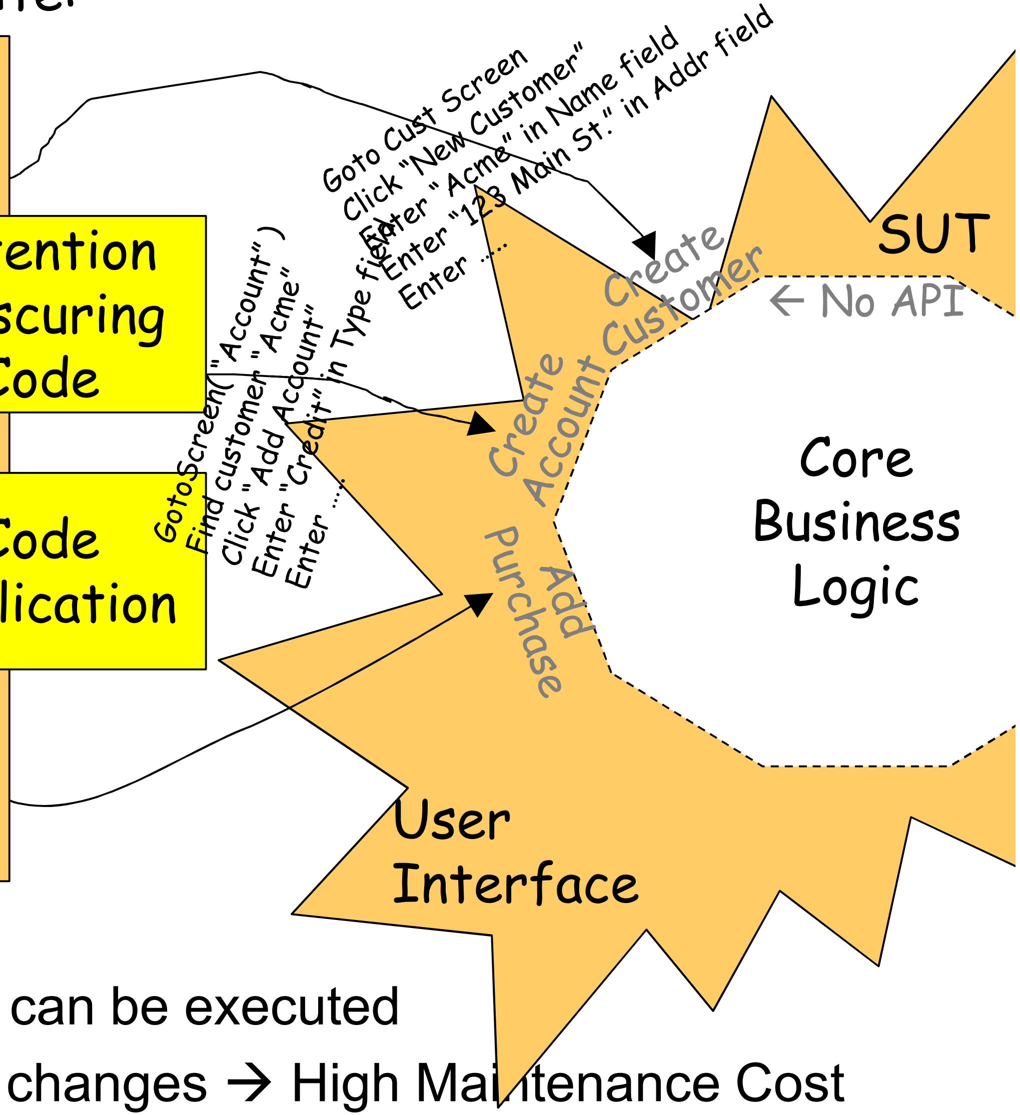
When There’s No API Available

Without a test API we have to write:

```
Test Invoice Generation
                    -New Customer
-----------------------------
Goto Login creen
Enter “Clerk” in UserName field
Enter “Pw123Secret” in Password field
Enter .....
-----------------------------
Goto Cust Screen
Click “New Customer”
Enter “Acme” in Name field
Enter “123 Main St.” in Addr field
Enter .....
GotoScreen( “Account” )
Find customer “Acme”
Click “Add Account”
Enter “Credit” in Type field
Enter .....
```

Intention Obscuring Code

Code Duplication



- **Large gap between:**
  - what we want to write & what can be executed
  - Many tests to adjust when UI changes → High Maintenance Cost

Keeping Tests Simple: Testing via Adapters

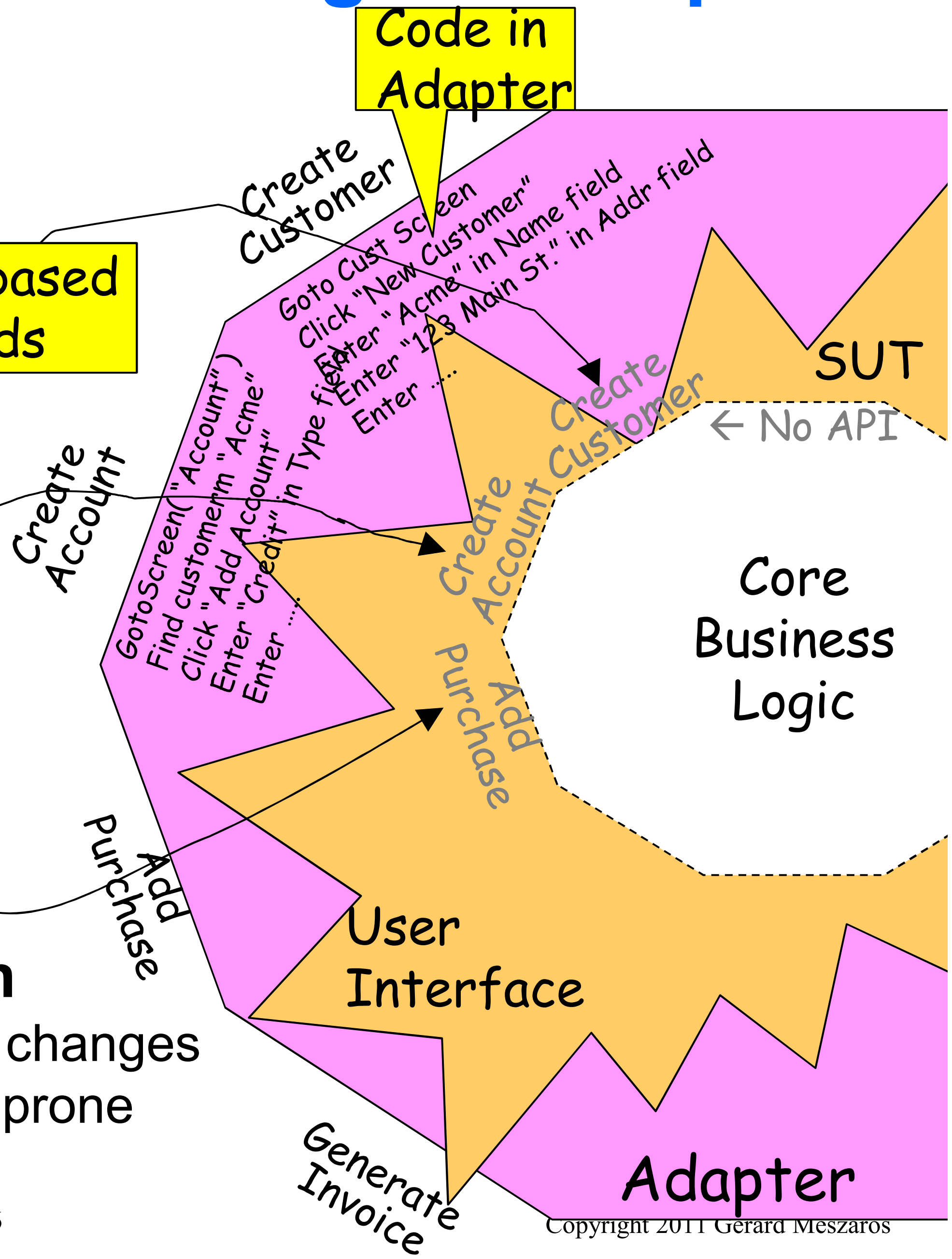
What we want to write:

Test Invoice Generation
-New Customer

Logged in as Clerk
Item1, Item2 exist

1.	CreateCustomer	"Acme"
2.	CreateAccoun	NewCust
3.	AddPurchase	Item1
4.	AddPurchase	Item2
5.	GenerateInvoice	NewAcct
6.	....	

Intention-based Keywords



- **Adapters can be tacked on**
  - Single place to adjust when UI changes
  - But may be complex and error prone

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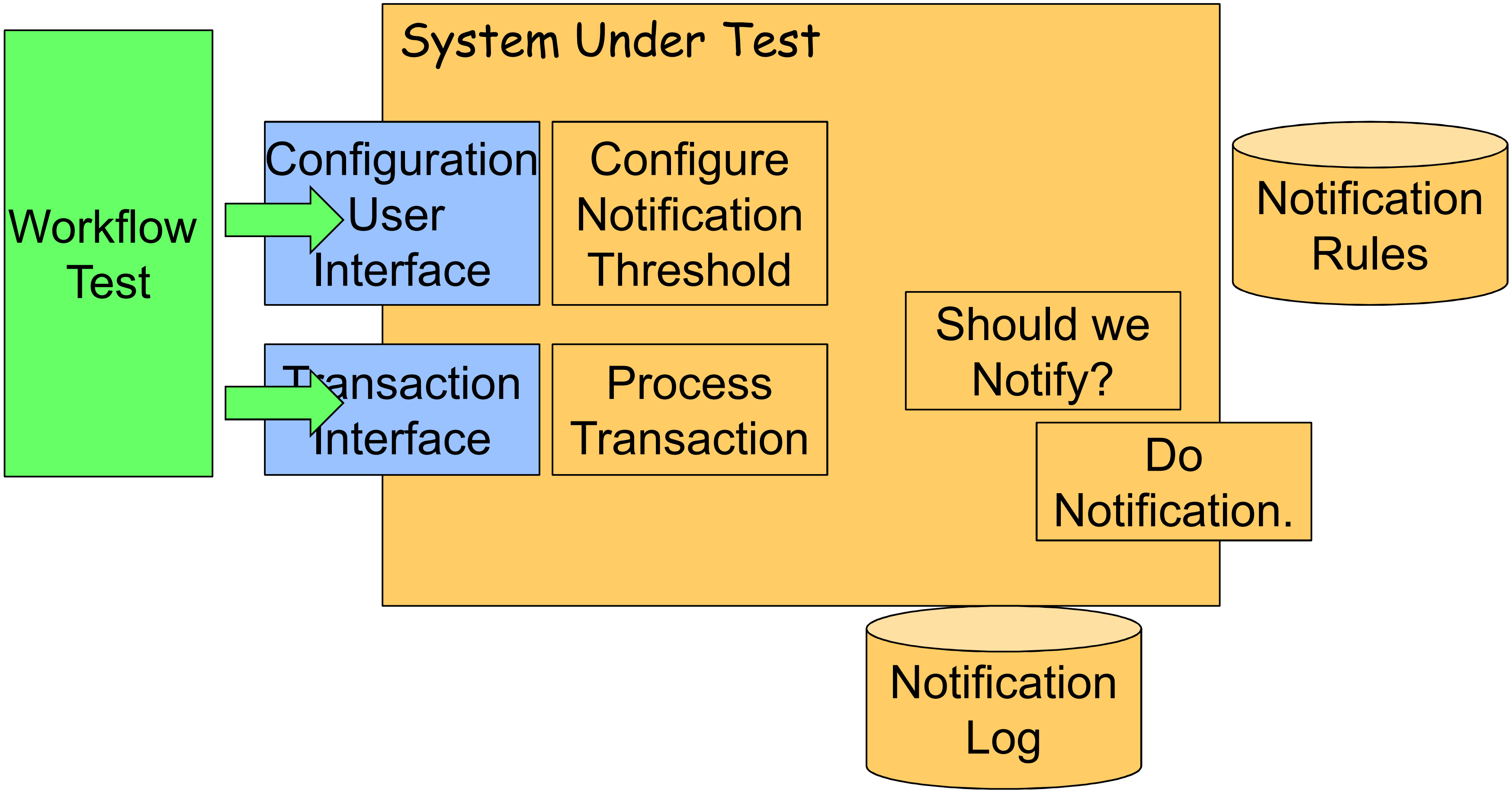
Test - After Architecture

- **Must test through User Interface**



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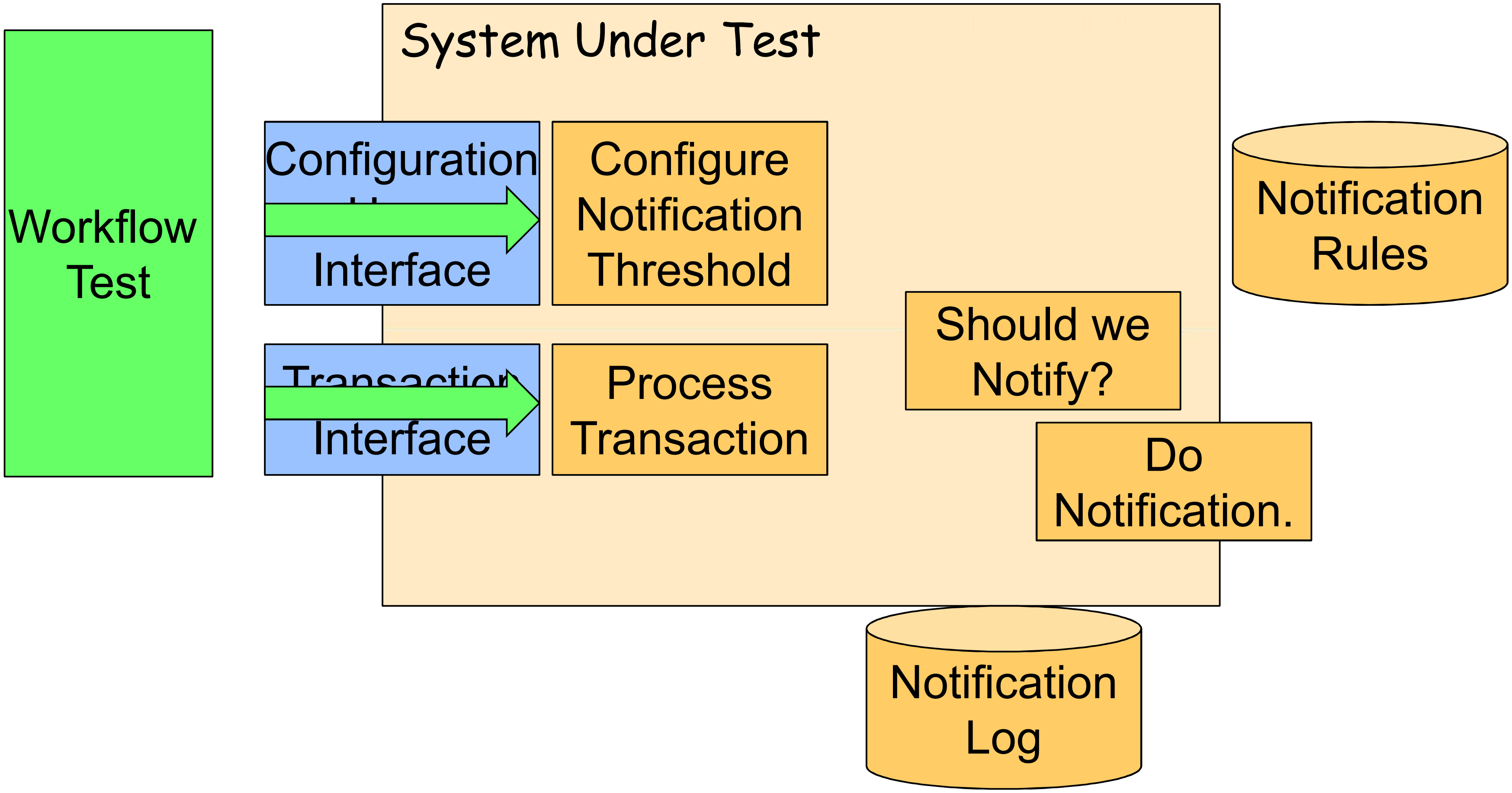
Test-Driven Architecture

- **Need to provide API's to invoke functionality directly**



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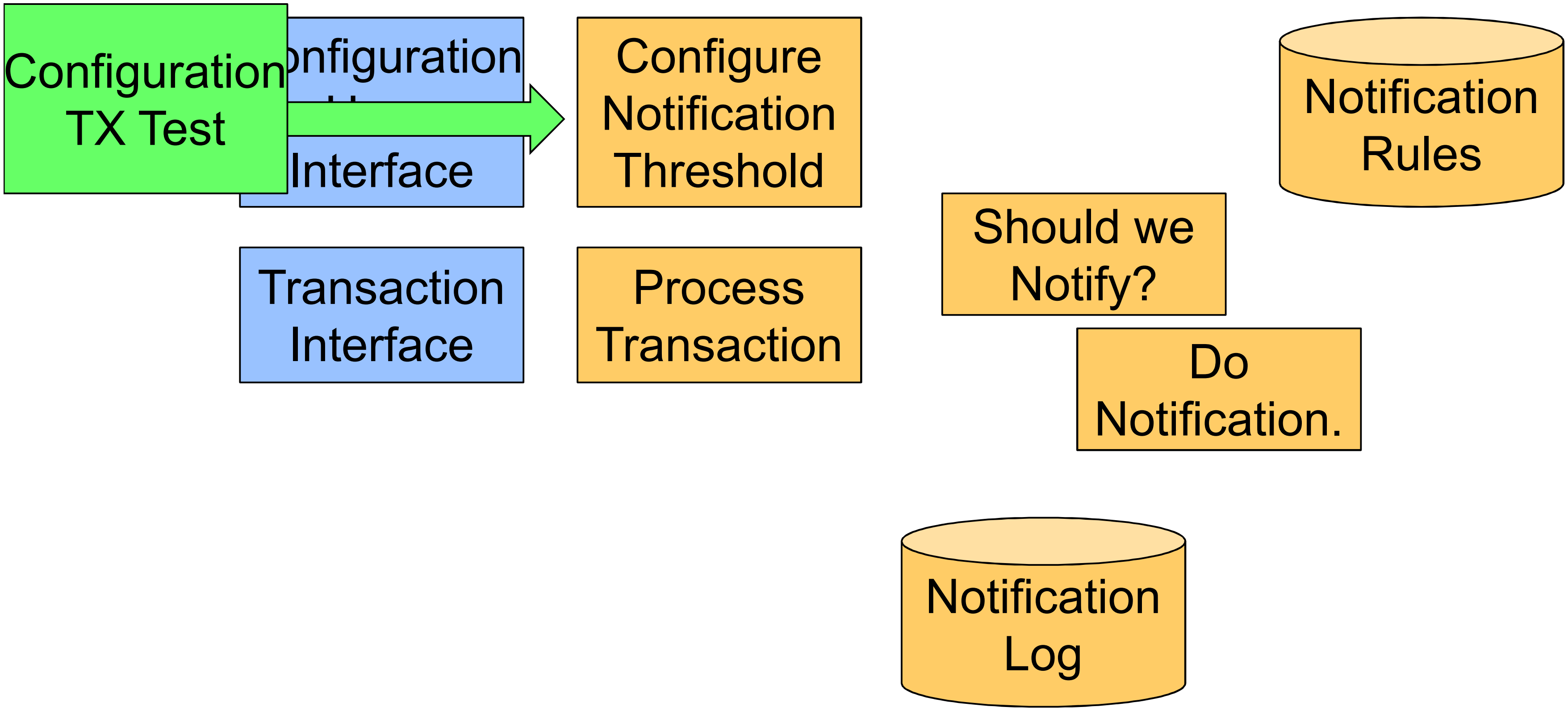
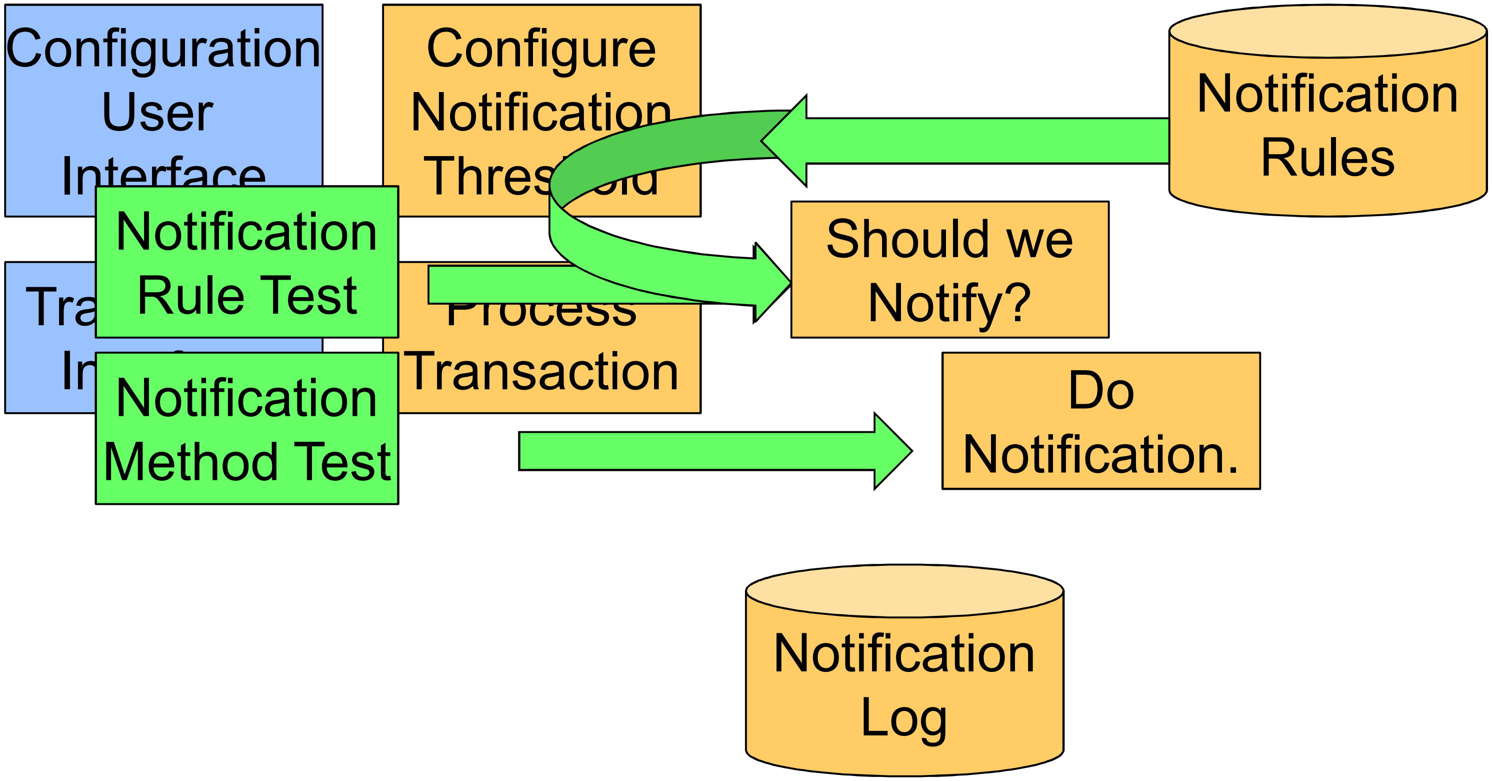
Test-Driven Architecture



Test-Driven Architecture

- **With the right architecture, automating these tests is trivial**



What About Legacy Systems?

- **How can we get automated regression tests in place quickly?**

Sample Recorded Test

```
@@ Login()
Browser("Inf").Page("Inf").WebButton("Login").Click
@@ GoToPage(“MaintainTaxonomy”)
Browser("Inf").Page("Inf_2").Check CheckPoint("Inf_2")
Browser("Inf").Page("Inf_2").Link("TAXONOMY LINKING").Click
Browser("Inf").Page("Inf_3").Check CheckPoint("Inf_3")
Browser("Inf").Page("Inf_3").Link("MAINTAIN TAXONOMY").Click
Browser("Inf").Page("Inf_4").Check CheckPoint("Inf_4")
@@ AddTerm("A","Top Level", "Top Level Definition")
Browser("Inf").Page("Inf_4").Link("Add").Click
wait 4
Browser("Inf_2").Page("Inf").Check CheckPoint("Inf_5")
Browser("Inf_2").Page("Inf").WebEdit("childCodeSuffix").Set "A"
Browser("Inf_2").Page("Inf").WebEdit("taxonomyDto.descript").Set "Top Level"
Browser("Inf_2").Page("Inf").WebEdit("taxonomyDto.definiti").Set "Top Level Definition"
Browser("Inf_2").Page("Inf").WebButton("Save").Click
wait 4
Browser("Inf").Page("Inf_5").Check CheckPoint("Inf_5_2")
@@ SelectTerm("[A]-Top Level")
Browser("Inf").Page("Inf_5").WebList("selectedTaxonomyCode").Select "[A]-Top Level“
@@ AddTerm("B","Second Top Level", "Second Top Level Definition")
```

Manually Added Comment

Manually Added

Manually Added

Manually Added

Manually Added

Manually Added

Refactored Recorded Test

```
Login()

GoToPage(“MaintainTaxonomy”)

AddTerm("A","Top Level", "Top Level Definition")

SelectTerm("[A]-Top Level“)
```

Refactored Recorded Test

```
Login()

GoToPage(“MaintainTaxonomy”)

AddTerm("A","Top Level", "Top Level Definition")

SelectTerm("[A]-Top Level“)

AddChildToCurrentTerm( “A.1”, “Definition of  1st Child Term  of A”)

AddChildToCurrentTerm( “A.2, “Definition of 2nd Child Term  of A”)
```

Now we hand-write additional tests using the resulting adapter (library)

Record, Refactor, Playback

- **Use Test Recording as a way to capture tests**
- **Remove duplication by replacing with calls to domain-specific Test Utility Methods**
  - using Extract Method refactorings
- **Make Test Utility Methods reusable**
  - Replace Hard-Coded Literal Values with variables/parameters
- **Effectively turns recorded tests into programmed or keyword-driven test scripts**
  - But, still through UI Adapter & original tool choice

Most appropriate with legacy systems
Especially with many interfaces

Record, Refactor, Playback

Test Preparation	Test Language	Test Interface	Test Data
Recorded	Code	Raw UI	Global, Static
Refactored	Keyword	Adapter #	Per Run
Hand-written	Data	API	Per Test

Notes:

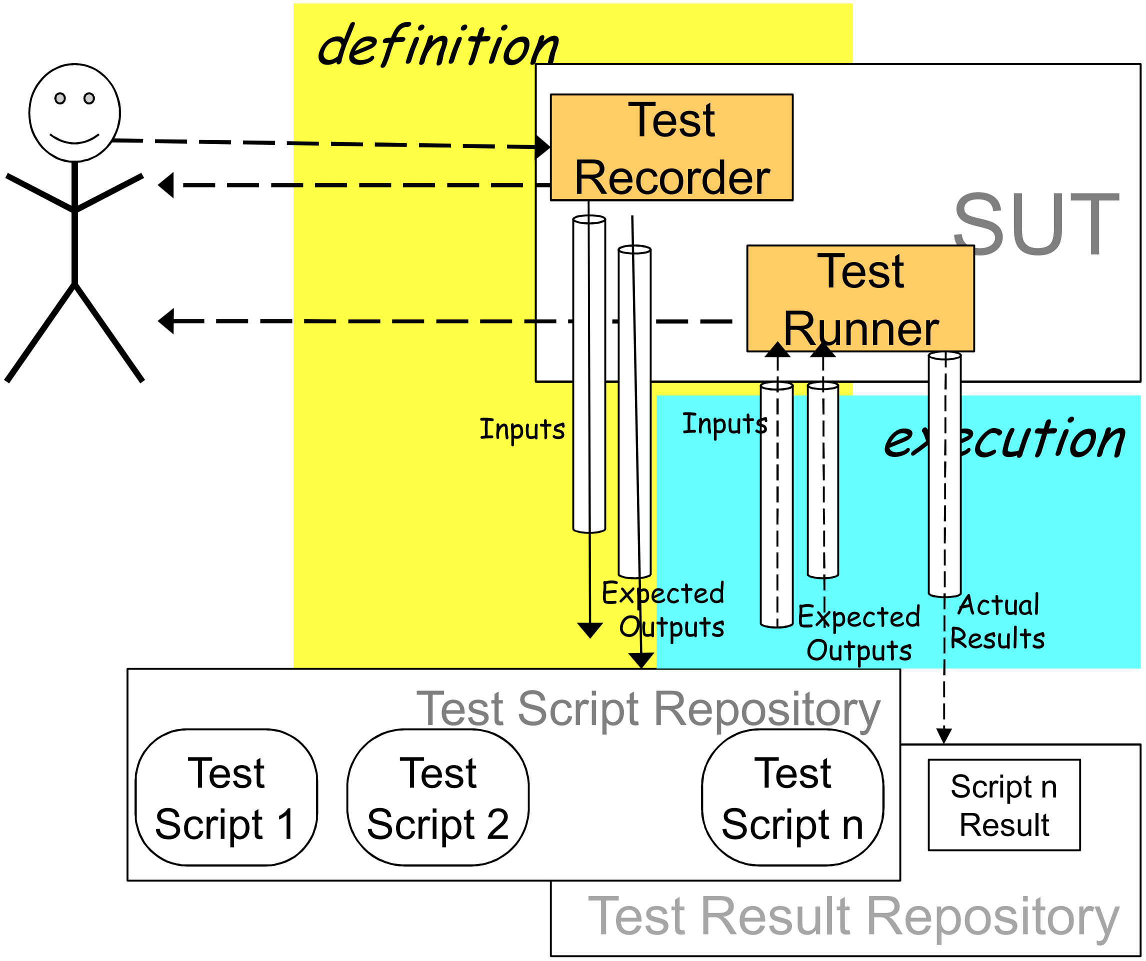
# The result of refactoring is an adapter between the test script and the SUT's UI.

		Poor	OK	Good
	Example Driven	X		
Legacy	Workflow			X
	System			X
	Business Rules		X	
	Component	X		
	Unit	X		
New	Workflow	X		
	System	X		
	Component	X		
	Business Rules	X		
	Unit	X		

Built-In Record&Playback

- User executes tests manually; SUT records as tests
- Tool replays tests later without user intervention

The tests are data interpreted by the test runner.



Built-in Record&Playback

Test Preparation	Test Language	Test Interface	Test Data
Recorded	Code	Raw UI	Global, Static
Refactored	Keyword	Adapter	Per Run
Hand-written	Data	API	Per Test

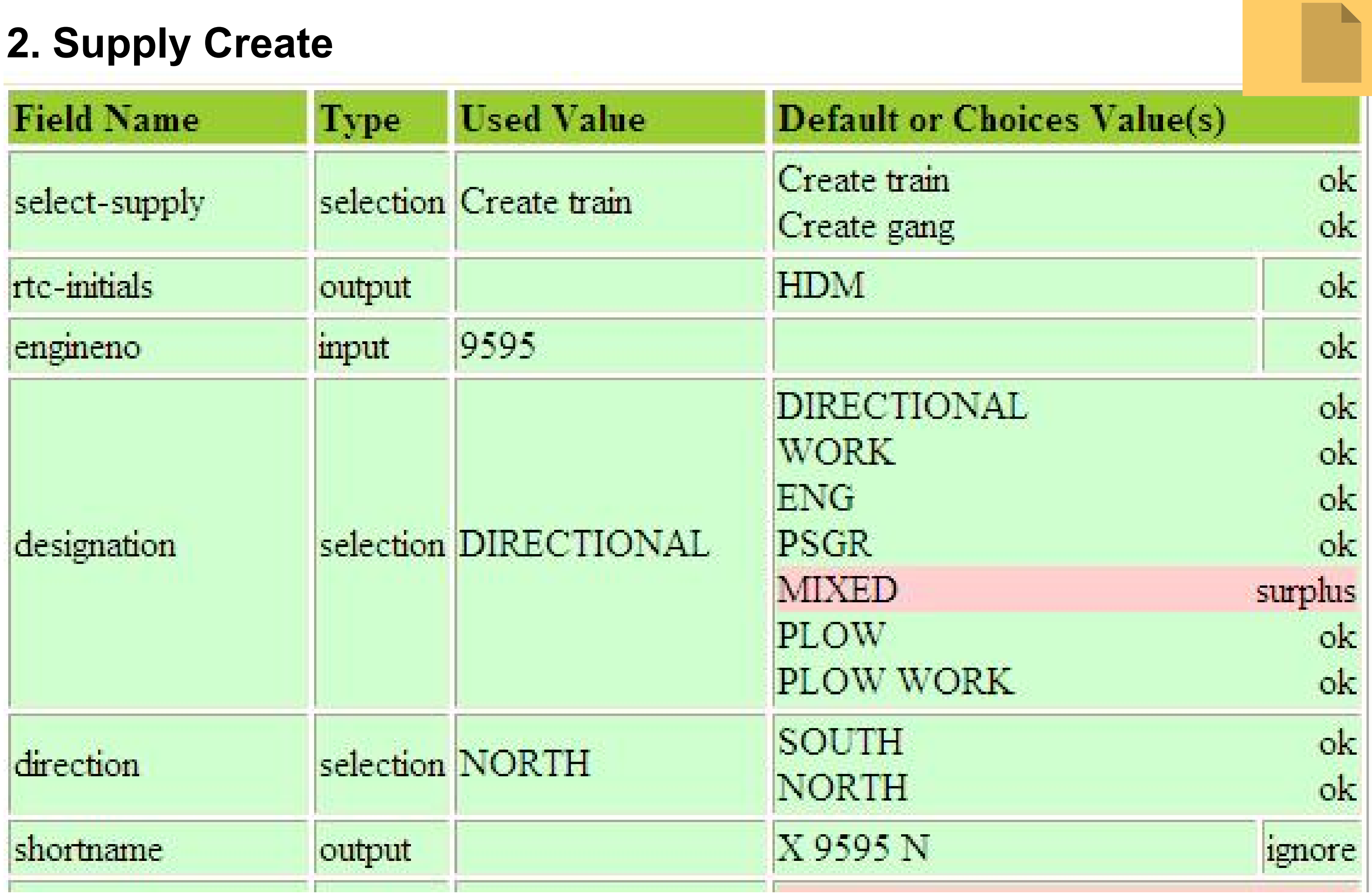
Notes:

- Needs to be implemented within SUT
- Can sometimes be retrofitted to legacy systems

Most appropriate with legacy systems when playing “automation catch-up”

		Poor	OK	Good
	Example Driven	X		
Legacy	Workflow			X
	System			X
	Business Rules		X	
	Component			X
	Unit	X		
New	Workflow		x	
	System		x	
	Component		x	
	Business Rules		x	
	Unit	x		

Sample Built-in R&PB Test Recording



2. Supply Create

Field Name	Type	Used Value	Default or Choices Value(s)	
select-supply	selection	Create train	Create train Create gang	ok ok
rtc-initials	output		HDM	ok
engineno	input	9595		ok
designation	selection	DIRECTIONAL	DIRECTIONAL WORK ENG PSGR MIXED PLOW PLOW WORK	ok ok ok ok surplus ok ok
direction	selection	NORTH	SOUTH NORTH	ok ok
shortname	output		X 9595 N	ignore

Raw XML for “Designation” Field

```
<field name="designation" type="selection">
        <used-value>DIRECTIONAL</used-value>
        <expected>
          <value>DIRECTIONAL</value>
          <value>WORK</value>
          <value>PSGR</value>
          <value>PLOW</value>
          <value>PLOW WORK</value>
          <value>ENG</value>
        </expected>
        <actual>
          <value status="ok">DIRECTIONAL</value>
          <value status="ok">WORK</value>
          <value status="ok">ENG</value>
          <value status="ok">PSGR</value>
          <value status="surplus">MIXED</value>
          <value status="ok">PLOW</value>
          <value status="ok">PLOW WORK</value>
        </actual>
      </field>
```

Prev. Rec. User Input

Previously recorded choices

Actual choices plus test results

Recording

Playback

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Sample R&PB Test Hooks

```
choice  = display_dialog(choices_list, row,
                col, title, key);
```

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Sample R&PB Test Hooks

```
   choice   = display_dialog(choices_list, row,
                 col, title, key);
```

```
if (recording_is_on())  {
   record_choice(dialog_id, choice_list,
                 choice, key);
}
```

Sample R&PB Test Hooks

```
if (playback_is_on()) {
  choice = get_choice_for_playback(dialog_id,
            choices_list);
} else    {
  choice  = display_dialog(choices_list, row,
            col, title, key);
}

if (recording_is_on())  {
   record_choice(dialog_id, choice_list,
            choice, key);
}
```

Hand-Coded Tests

Test Preparation	Test Language	Test Interface	Test Data
Recorded	Code	Raw UI	Global, Static
Refactored	Keyword	Adapter	Per Run
Hand-written	Data	API	Per Test

Notes:

- Hand-written code requires software development skills and test automation skills.
- API preferred but can script browser-based (UI) tests.
- Code can be primitive or abstract therefore...
  - Developers need training on writing clear tests!

		Poor	OK	Good
	Example Driven			X
Legacy	Workflow	X		
	System	X		
	Business Rules	X		
	Component	X		
	Unit	X		
New	Workflow		X	
	System		X	
	Component			X
	Business Rules		X	
	Unit			X

Changing the Role of Testing

Requirements

	Define Product	Critique Product
Business Facing	Acceptance Tests Regression Tests	Usability Tests Exploratory Tests
Technology Facing	Unit Tests Component Tests	Property Tests (Response Time, Security, Scalability)

Software Design

Report Card

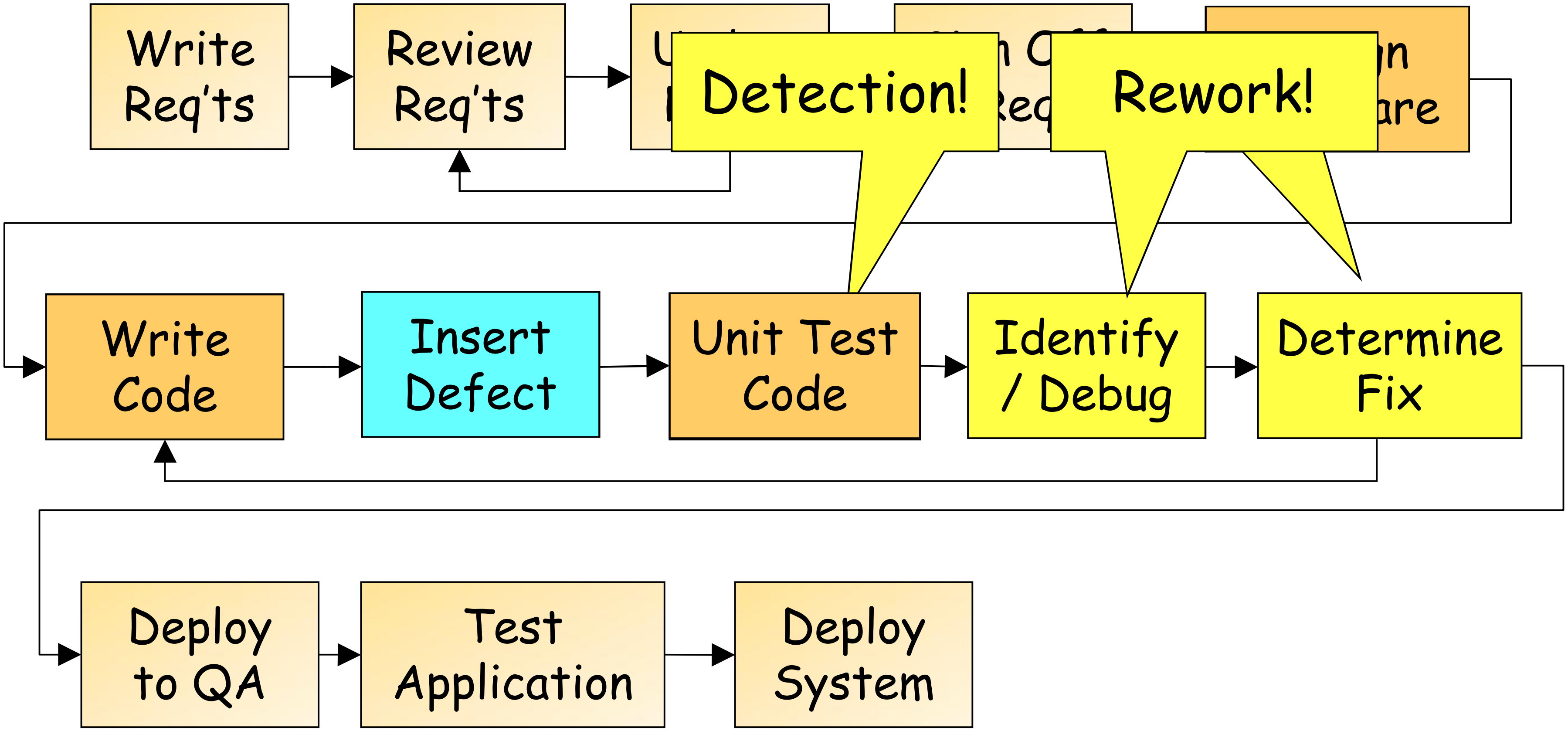
Functionality	B
Usability	C
Scalability	A
Response	B
Availability	C

For effective prevention:

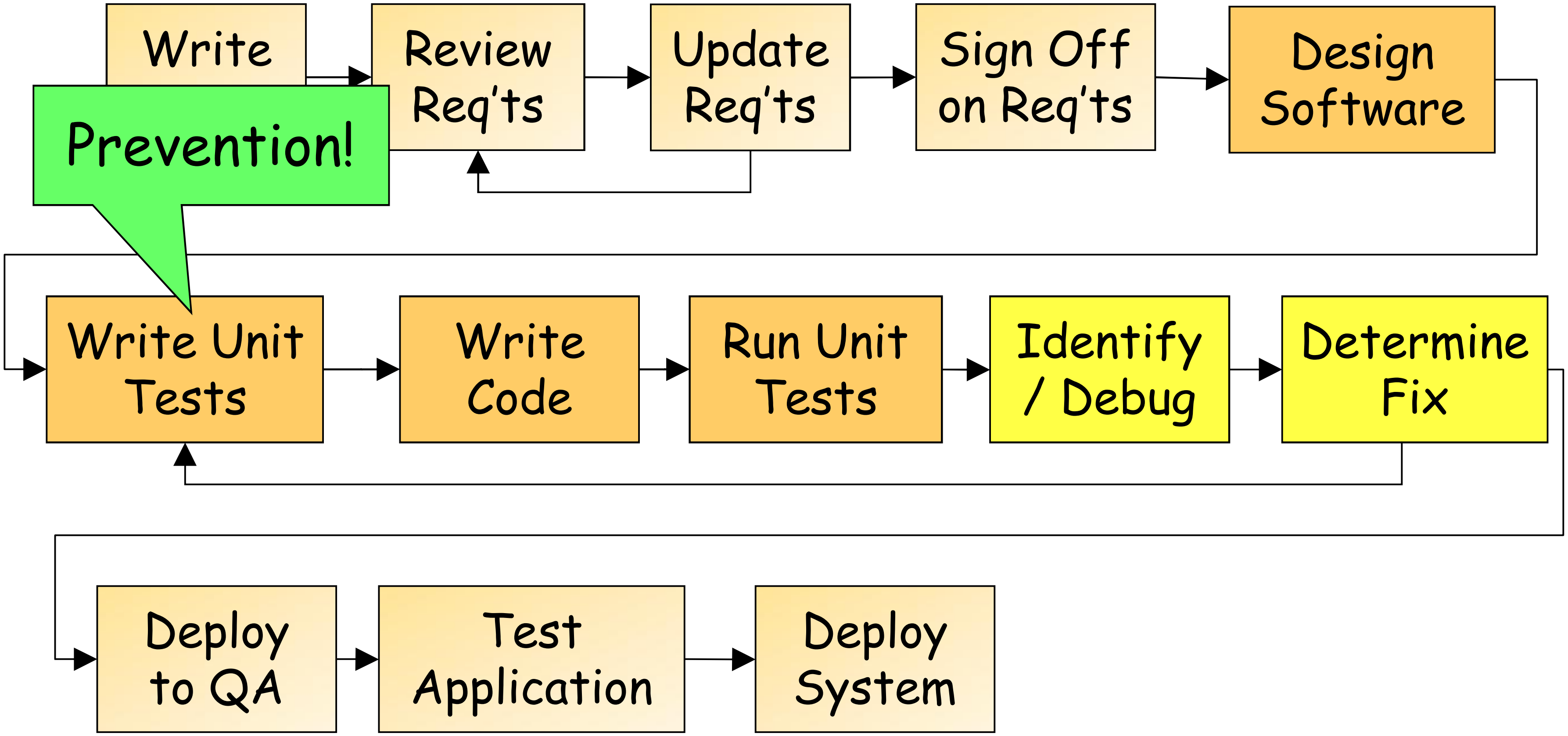
1. Tests must be available before development
2. Developers must be able to run tests before check-in

Thanks to Brian Marrick and Mary Poppendieck

Preventing Coding Defects
(Building the Product Right)



Preventing Coding Defects
(Building the Product Right)



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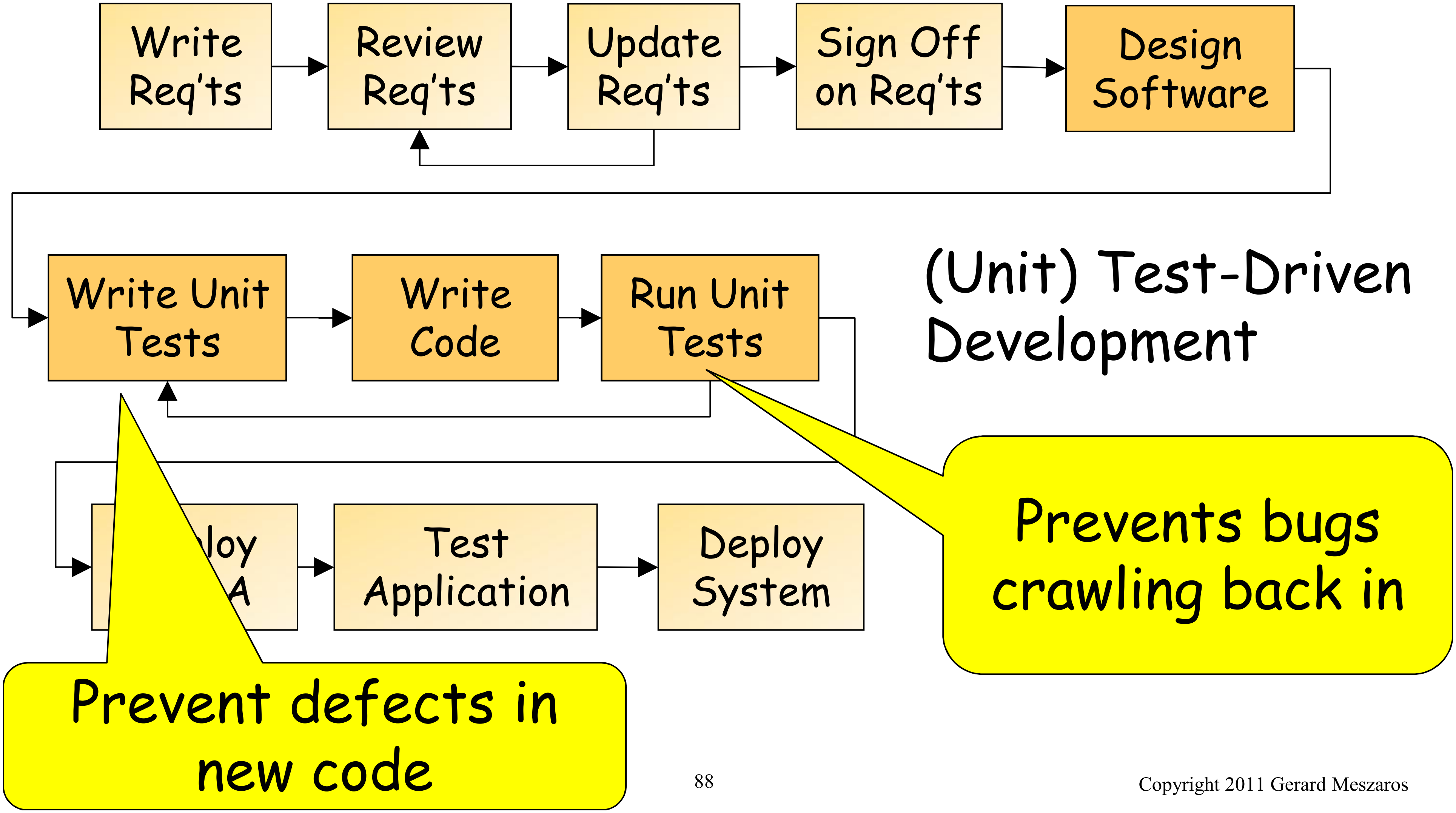
Preventing Coding Defects
(Building the Product Right)



Write Req'ts

Review Req'ts

Update Req'ts

Sign Off on Req'ts

Design Software

Write Unit Tests

Write Code

Run Unit Tests

loy A

Test Application

Deploy System

(Unit) Test-Driven Development

Prevents bugs crawling back in

Prevent defects in new code

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Hand-Coded Test – w/ Primitive Obsession

```
public void testAddItemQuantity_severalQuantity () {
   // Setup Fixture
   final int QUANTITY = 5;
   Address billingAddress = new Address("1222 1st St SW", "Calgary",
        "Alberta", "T2N 2V2", "Canada");
   Address shippingAddress = new Address("1333 1st St SW", "Calgary",
        "Alberta", "T2N 2V2", "Canada");
   Customer customer = new Customer(99, "John", "Doe", new
        BigDecimal("30"), billingAddress, shippingAddress);
   Product product = new Product(88, "SomeWidget", new
        BigDecimal("19.99"));
   Invoice invoice = new Invoice(customer);
   // Exercise SUT
   invoice.addItemQuantity(product, QUANTITY);
   // Verify Outcome
   List lineItems = invoice.getLineItems();
   if (lineItems.size() == 1) {
     LineItem actualLineItem = (LineItem)lineItems.get(0);
     assertEquals(invoice, actualLineItem.getInvoice());
     assertEquals(product, actualLineItem.getProduct());
     assertEquals(quantity, actualLineItem.getQuantity());
     assertEquals(new BigDecimal("30"),
        actualLineItem.getPercentDiscount());
     assertEquals(new BigDecimal("19.99"),
        actualLineItem.getUnitPrice());
     assertEquals(new BigDecimal(“69.96"),
        actualLineItem.getExtendedPrice());
   } else {
     assertTrue(“Invoice should have exactly one line item“, false);
   }
```

Hand-Coded Test – Appropriately Abstracted

```
public void testAddItemQuantity_severalQuantity () {

   // Fixture set up:
   final int QUANTITY = 5 ;
   Product product = createAnonymousProduct();
   Invoice invoice = createAnonymousInvoice();

   // Exercise SUT
   invoice.addItemQuantity(product, QUANTITY);

   // Verify
   LineItem expectedLineItem = newLineItem( invoice,
      product, QUANTITY, product.getPrice()*QUANTITY );

   assertExactlyOneLineItem( invoice, expectedLineItem );
}
```

Developers need training on effective unit testing!

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Agenda

- **Motivation**
- **Changing the Role of Test Automation**
- **Approaches to Test Automation**
- **Test Automation Strategy**
  - Selecting the right Approach(es)
  - Maximizing Automation ROI

So What’s the Point?

Why is the approach to test automation significant?

Because test automation is hard work

And the approach effects the nature of the benefits of the automation.

How Effective is our Automation?

- **Are the tests fully automated?**
  - Can they run unattended?
  - Are they fully self-checking?
- **Are the tests low maintenance?**
  - How often do we need to adjust them?
  - How many tests are affected by a change in the SUT?
- **Do the tests describe the requirements clearly?**
  - Can everyone understand them?
  - Could we (re)build the system from them?
- **Can anyone run them?**
  - Can developers run them before checking in code?

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For Success, Focus on Intent

- **Choose the approach first, then pick tools**
  - Tools must support the approach chosen
- **Write the tests using the best language for expressing the requirement being validated.**
  - Not necesarily the language provided by the System Under Test's interface
  - May require different approaches for different tests
- **Close any gap using an adapter if necessary**

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Which Automation Approach?

Depends heavily on Context

- **Legacy Systems:**
  - Stabilize with Recorded Tests while you refactor to enable Component testing.
  - Only do hand-written unit tests for new components.
- **Greenfield Development:**
  - Keyword-Driven workflow and system tests.
  - Data-Driven tests for business rules
  - TDD via hand-written Unit Tests

Which Automation Approach?

- **Recorded tests:**
  - implies a “Test After” approach; won’t help define the requirements
  - Typically results in tests with Primitive Obsession → Fragile Tests with high test maintenance cost
  - Best for: Playing “Catch-up” on Legacy Systems
- **Hand-Written Tests:**
  - Amenable for use in Example-Driven Development
    - » But must use Domain-Specific terminology to be effective
  - Can be written in code or keywords depending on who’s preparing the tests
  - Best for: Workflow tests (Keyword) and unit tests (code)

Which Automation Approach?

- **Keyword-Driven Tests:**
  - Good separation between business and technical work involved in automating tests.
  - Easy to prepare before development.
  - Best for expressing workflow or system tests.
- **Data-Driven Tests:**
  - Best for repeating same test script with many combinations of inputs
  - Best for: Verifying Business Rules & Algorithms
    - » (A form of Component Testing)

Maximizing Test Automation ROI

- **Need to Treat Automation as an Investment**
- **Need to Prioritize / Triage Which Tests to Automate**
- **At least 3 Approaches to Choose From:**
  - Traditional QA-Based “Test After” Automation
  - Collaborative Critical Path Automation
  - Collaborative Selective Automation

Automation After Dev Complete

A.K.A. Traditional Approach to Automation

Summary:

- Done by QA/SV Department (i.e. Testers)
- After Product is Built
- Typically done using (C)OTS Record & Playback tools

Issues:

- **Too Late for Defect Prevention**
  - Tests aren’t available to development team
- **Too Late to Ensure Easy Automation**
  - System not Designed for Testability
- **Tools Create Fragile Tests**
  - Unreadable due to Primitive Obsession and too much duplication

Collaborative Automation on Critical Path

A.K.A. Dogmatic (A)TDD Approach

Summary:

- Goal: 100 % automation
- Automate Tests Before Building Functionality
  - » **Test automation task for each User Story**

Issues:

- **Some Tests are MUCH Harder to Automate**
- **May Increase Costs and Delay Benefits of Functionality**
- **May Cause EDD to be Abandoned**

Collaborative Automation based on ROI

A.K.A. Pragmatic Approach

Summary:

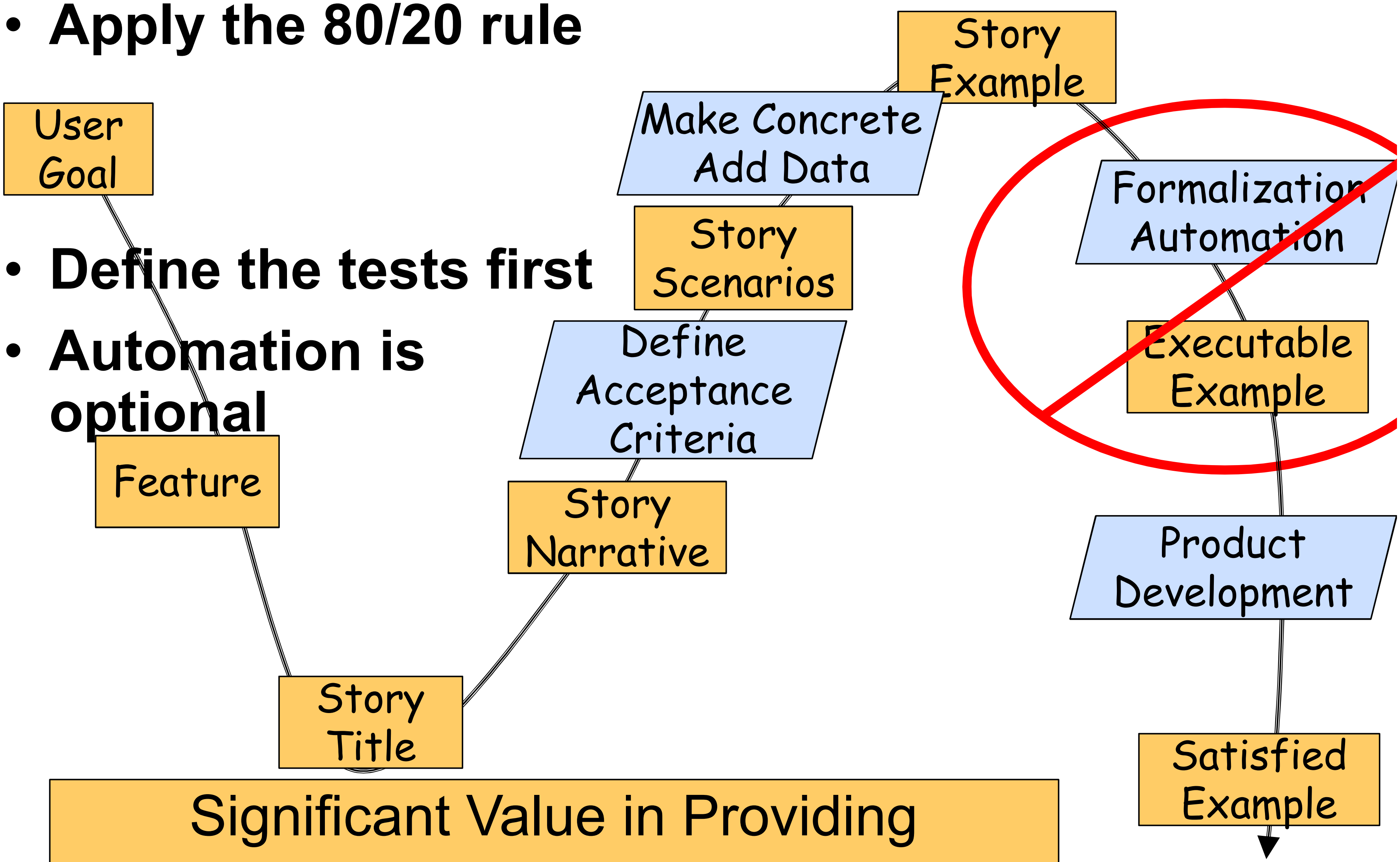
- Goal: Just Enough Automation
- Apply Agile Principles to Implementation of Automation

Issues:

- **Won’t Have Complete Test Coverage**
- **Can Lead to Automation Being Dropped in Favour of More Functionality**
  - Requires a Disciplined Product Owner, or,
  - A Fixed Budget for the Automation

What if Automation is Really Hard?

- Apply the 80/20 rule
- Define the tests first
- Automation is optional



Significant Value in Providing Examples / Tests Before Development

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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?
- **Can anyone run the tests at any time?**
  - Can the developers run the tests on-demand *before* they check their code in?
  - What would you have to change to make that possible?

Thank You!

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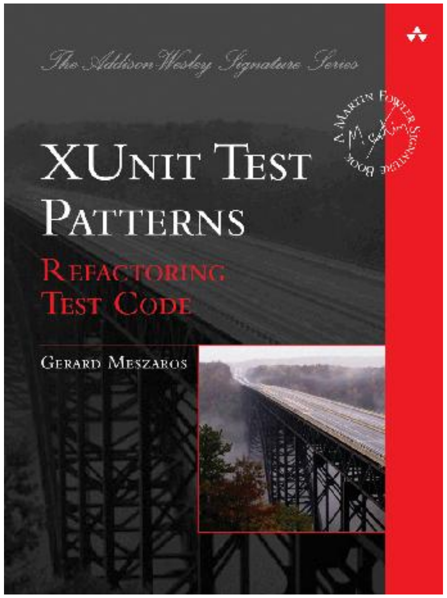
http://www.xunitpatterns.com


The Addison-Wesley Signature Series
XUnit Test Patterns
Refactoring Test Code
Gerard Meszaros
A Martin Fowler Signature Book

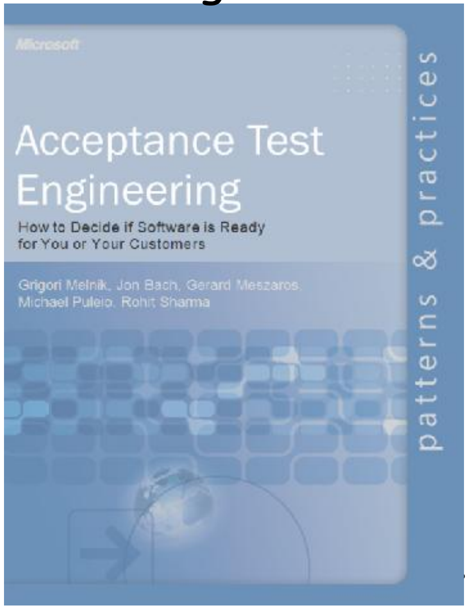
Jolt Productivity Award winner - Technical Books

Slides: http://Agile2011ATAS.xunitpatterns.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**

Coming Soon:


Microsoft
Acceptance Test Engineering
How to Decide if Software is Ready for You or Your Customers
Grigori Melnik, Jon Bach, Gerard Meszaros, Michael Puleio, Rohit Sharma
patterns & practices

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  - http://builtinrecordandplayback.xunitpatterns.com

- These Slides:
  - http://strategy.testAutomationPatterns.com