





Ken Pugh



- Fellow Consultant
- OOA&D, Design Patterns, Lean, Scrum, Test-Driven Development
- Over 2/5 century of software development experience
- Author of seven books, including:
 - Prefactoring: Extreme Abstraction, Extreme Separation, Extreme Readability (2006 Jolt Award)
 - Interface Oriented Design
 - Lean Agile Acceptance Test-Driven Development: Better Software Through Collaboration

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*No code goes in till the test goes on.
A journey of two thousand miles begins with a single step.*

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Overall Rule

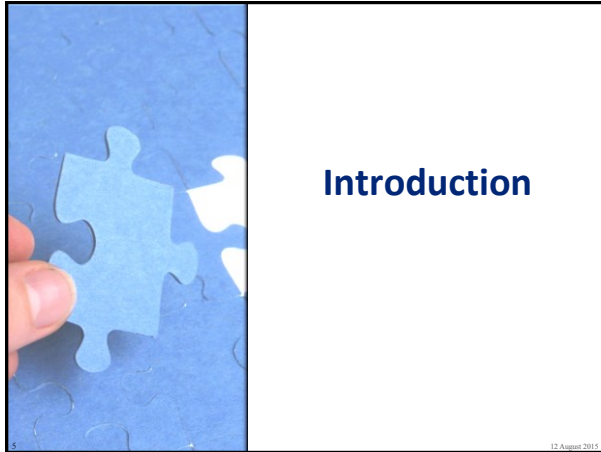
- There are exceptions to every statement, except this one

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Flow

- Introduction
- Acceptance Test Examples
- Test Anatomy
- Supplemental

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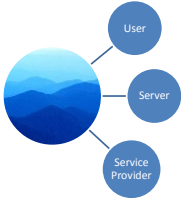
5 W's and an H

- ATDD
 - What are they
 - Why use them
 - Who creates and uses them
 - When are they created
 - Where are they used
 - How to create them

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What Are Acceptance Tests?

- Acceptance Tests:
 - External view of system
- Examine externally visible effects
 - Inputs and outputs
 - State changes
 - External interfaces



A diagram showing a large blue circle on the left connected by lines to three smaller blue circles on the right labeled "User", "Server", and "Service Provider".

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Definitions

- Acceptance criteria
 - General ideas
- Acceptance tests
 - Specific tests that either pass or fail
 - Implementation independent
- Triad – customer unit, developer unit, tester unit

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Fast Car Example

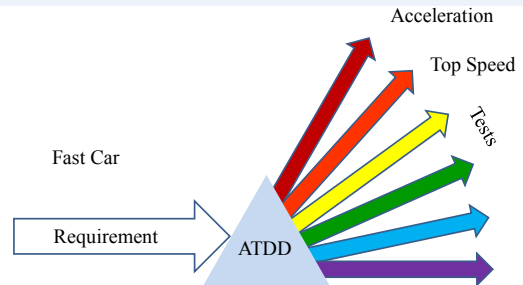
- Who wants a fast car?
- Criteria
 - Run on a closed course, measure acceleration
- Test
 - Detail acceleration (0 to 60 mph in X seconds)

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ATDD as a Prism



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Why?

- Rework Down from 60% to 20%
- Workflows Working First Time
- Little Room for Miscommunication
- Saving Time
- Getting Business Rules Right
- Game Changing
- Tighter Cross-Functional Team Integration
- Crisp Visible Story Completion Criteria
- Automation Yields Reduced Testing Time

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Requirements and Tests

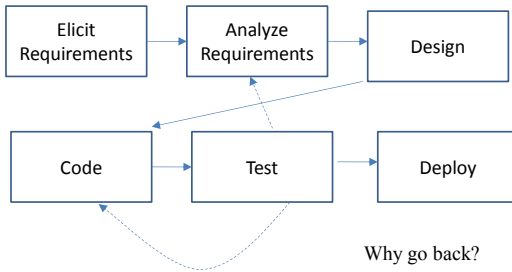
- Requirements and tests are inter-related
 - You can't have one without the other
- A failing test is a requirement
 - Passing test denotes specification on how system works

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Value Stream Map – Classical Development



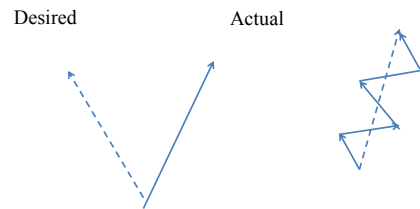
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Why Mistakes?

- Misunderstandings, missed requirements, mis-other
- Feedback helps to correct misunderstandings
- Quick feedback better than slow feedback

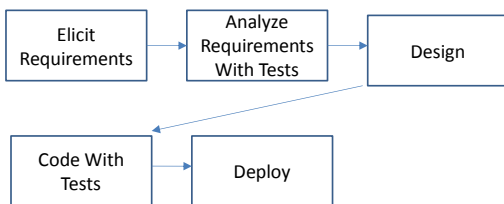


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Value Stream Map – Agile Development



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Move Testing Forward

- Two types of testing
 - Attempting to find defects – is WASTE
 - Attempting to prevent defects – is ESSENTIAL
- When are defects found?
 - Prevention is just early detection

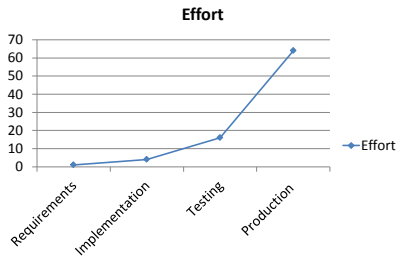


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Cost of a Requirement Issue



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Who Does What

- Author the tests (write)
 - Triad - customer, tester, developer
- Connect tests to system (bind)
 - Developer
- Run the tests (run)
 - Developers, testers, customers
 - Automated – part of build



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ATDD, TDD, BDD

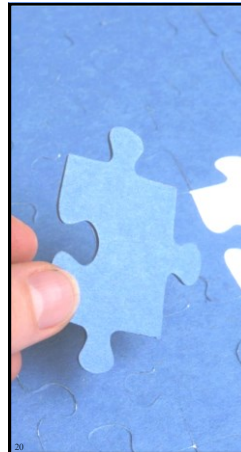
- ATDD
 - Tests written by triad prior to implementation
 - Implementation independent, can be automated or manual
 - Usually uses Given/When/Then template
- TDD – Test Driven Development/ Test Driven Design
 - Done by developer while coding
 - Implementation dependent, always automated
 - Write unit test, see it fail, implement code to pass
- BDD – Behavior Driven Development
 - Started as replacement for TDD unit testing framework
 - Usually associated with Cucumber-like languages (Given/When/Then)
 - Otherwise, like ATDD
- SPE – Specification by Example
 - Like ATDD, except uses “examples”, rather than “tests”

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Acceptance Test Examples



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First Example

- Input Temperature in Celsius, Output Temperature in Fahrenheit
- What tests would you run?

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Input and Output Example (continued)

Celsius	Fahrenheit	Notes
0	32	
100	212	How many needed?
-273.15	-459.67	2 digits precision
-273.151	Error	Below 0 Kelvin
500	932	Maximum – Needed?

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Input and Output – “Unit Tests”

Formula Tests

Celsius	Fahrenheit	Notes
0	32	
100	212	How many needed?

Precision Tests

Celsius	Fahrenheit	Notes
-273.15	-459.67	Precision

Limit Tests

Celsius	Fahrenheit	Notes
-273.15	-459.67	0 Kelvin
-273.151	Error	Below 0 Kelvin
500	932	Maximum – Needed?

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A Business Rule Example

If Customer Rating is Good and the Order Total is less than or equal \$10.00,

Then do not give a discount,

Otherwise give a 1% discount.

If Customer Rating is Excellent,

Then give a discount of 1% for any order.

If the Order Total is greater than \$50.00,

Then give a discount of 5%.

Given a customer whose rating is Good and an order total of \$50.01, what should be the discount?

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Business Rule Table = Test

Discount		
Order total	Customer rating	Discount percentage?
\$10.00	Good	0%
\$10.01	Good	1%
\$50.01	Good	1%
\$.01	Excellent	1%
\$50.00	Excellent	1%
\$50.01	Excellent	5%

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Ways To Implement Test

- Testing script
- Program interface
- Xunit framework
- ATDD framework

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Testing script

- Tester creates script (usually GUI based)
- Example:
 - Logon as Customer who is rated Good
 - Start order
 - Put items in the order until the total is exactly \$10.01
 - Complete order
 - Check it shows a \$.10 discount
- Repeat for other five cases

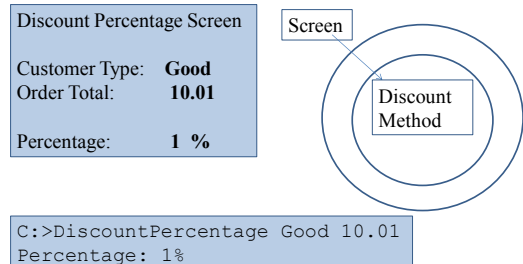
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Program interface

- Create a command line or graphic user interface



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XUnit Test

```
class TestCase {
    testDiscountPercentageForCustomer() {
        SomeClass o = new SomeClass()
        assertEquals(0, o.computeDiscount(10.0, Good));
        assertEquals(1, o.computeDiscount(10.01, Good));
        assertEquals(1, o.computeDiscount(50.01, Good));
        assertEquals(1, o.computeDiscount(.01, Excellent));
        assertEquals(1, o.computeDiscount(50.0, Excellent));
        assertEquals(5, o.computeDiscount(50.01, Excellent));
    }
}
```

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Fit (Table = Test)

Discount		
Order total	Customer rating	Discount percentage?
10.00	Good	0
10.01	Good	1
50.01	Good	1
.01	Excellent	1
50.00	Excellent	1
50.01	Excellent	5

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Fit Test

Discount		
Order total	Customer rating	Discount percentage?
10.00	Good	0
10.01	Good	1
50.01	Good	
.01	Excellent	1
50.00	Excellent	1
50.01	Excellent	5

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Tables As Requirement and Test

Requirement	Discount Rule		
	Customer Rating	Order Total	Discount Percentage
	Good	<= \$10.00	0%
		Otherwise	1%
	Excellent	Any	1%
		> \$50.00	5%

Test	Discount Test		
	Order total	Customer rating	Discount percentage?
	\$10.00	Good	0%
	\$10.01	Good	1%
	\$50.01	Good	1%
	\$.01	Excellent	1%
	\$50.00	Excellent	1%
	\$50.01	Excellent	5%

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Cucumber Version

Scenario Outline: Compute discount
Given total is <OrderTotal> and rating is
 <CustomerRating>
When I compute discount
Then percent is <DiscountPercentage>

Examples:

OrderTotal	CustomerRating	DiscountPercentage
10.00	Good	0
10.01	Good	1
50.01	Good	1
10.01	Excellent	1
50.00	Excellent	1
50.01	Excellent	5

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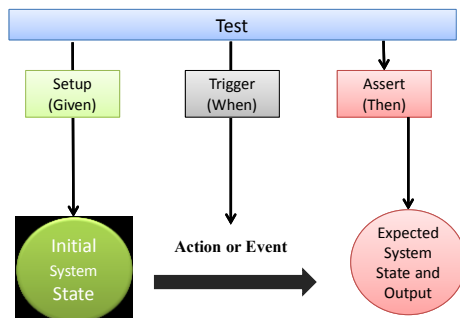
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Test Anatomy

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Scenario Flow



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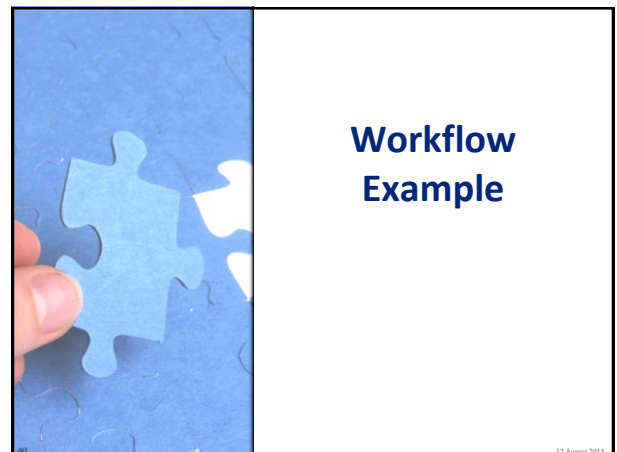
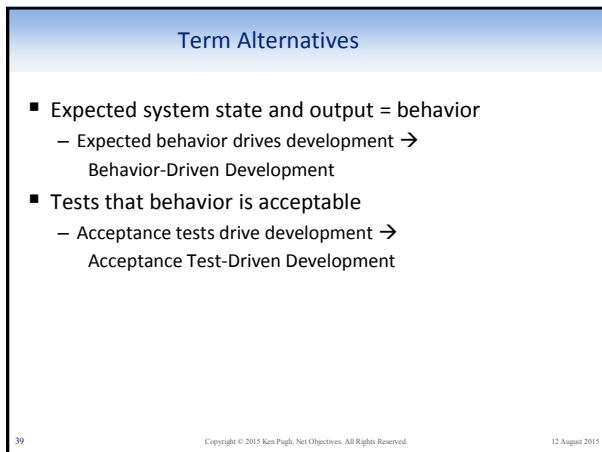
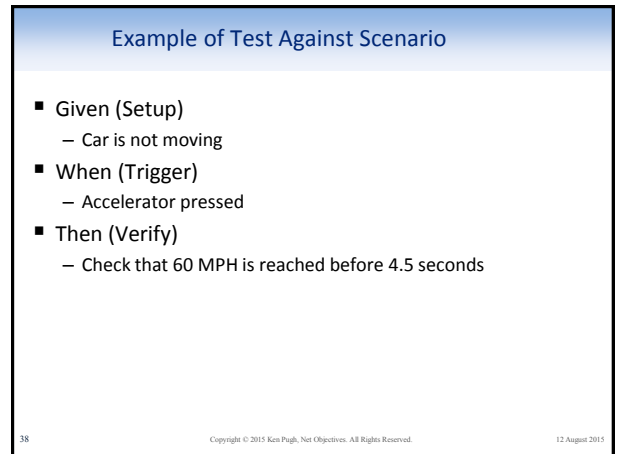
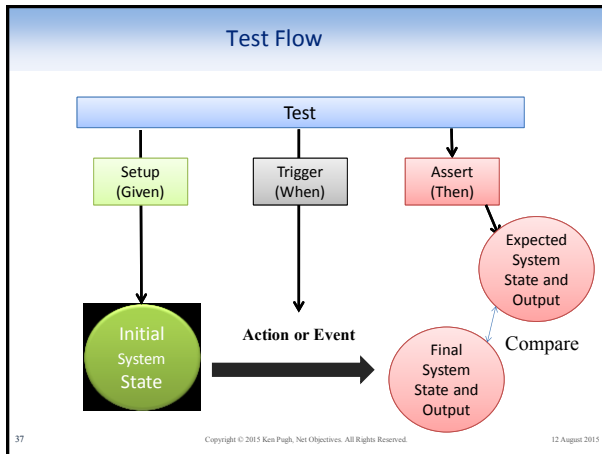
Example of Scenario

- Given (Setup)
 - Car is not moving
- When (Trigger)
 - Accelerator pressed
- Then (Assert)
 - 60 MPH reached before 4.5 seconds

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Given / When / Then Example

- Context: Sam's Lawn Mower Repair and CD Rental Store
- Given (Setup)
 - Customer has ID (initial system state)
 - CD has ID (initial system state)
 - CD is not currently rented (initial system state)
- When (Trigger)
 - Clerk checks out CD (action)
- Then (Verify)
 - CD recorded as rented (final system state)
 - Rental contract printed (output)

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Full Example (1)

Check Out CD

- Given Customer has ID
and CD has ID
and CD is not currently rented

Customer Data	
Name	ID
James	007

CD Data		
ID	Title	Rented
CD2	Beatles Greatest Hits	No

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Full Example (2)

- When a clerk checks out a CD:

Check Out CD		
Enter	Customer ID	007
Enter	CD ID	CD2
Execute	Rent	

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Full Example (3)

- Then the CD is recorded as rented and a rental contract is printed:

CD Data			
ID	Title	Rented	Customer ID
CD2	Beatles Greatest Hits	Yes	007

Rental Contract			
Customer ID	Customer Name	CD ID	CD Title
007	James	CD2	Beatles Greatest Hits

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Full Example – Extended

Given

Rental Fee Business Rule	Rental Time Business Rule
Fee	Time
\$3	2 days

When a clerk checks out a CD on:

Today
1/1/2014

Then a rental contract is printed:

Rental Contract					
Customer ID	Customer Name	CD ID	CD Title	Due	Fee
007	James	CD2	Beatles Greatest Hits	1/3/2014	\$3

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The Action

Can drive a GUI

Or a method

```
Rent (CustomerID aCustomer, CDID aCD);
```

Or an Interactive Voice Response (IVR)

– “Enter the customer id followed by the pound sign”

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Example of Business Rule

CD Rental Rates Business Rule

Regular \$2 / 2 days plus \$1 / day

Golden Oldie \$2 / 4 days plus \$.50 / day

Hot Stuff \$2 / 1 days plus \$2 / day

CD Rental Rates As Table

Type	Base Rental Period Days	Base Rental Fee	Extra Day Fee
Regular	2	\$2	\$1
Golden Oldie	4	\$2	\$.50
Hot Stuff	1	\$2	\$2

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Example of Business Rule Test

CD Rental Rates Business Rule

Regular \$2 / 2 days plus \$1 / day

Golden Oldie \$2 / 4 days plus \$.50 / day

Hot Stuff \$2 / 1 days plus \$2 / day

CD Rates Test

Type	Days	Cost?
Regular	2	\$2
Golden Oldie	5	\$2.50
Hot Stuff	6	\$12
Hot Stuff	50	IGBTYOT

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Business Rule and Flow Tests

- Use cases / scenarios usually include business rules
- Test every business rule separately
- Flow test of scenario
 - Uses one variation of business rule

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Full Flow Example Revisited

Check Out CD

Given Customer has ID; CD has ID and not currently rented

Customer Data		CD Data			
Name	ID	ID	Title	Rented	Type
James	007	CD2	Beatles Greatest Hits	No	Regular

and one variation of business rule for Rental Rates

CD Rental Rates As Table			
Type	Base Rental Period Days	Base Rental Fee	Extra Day Fee
Regular	2	\$2	\$1

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Full Flow Example – Extended

- When a clerk checks out a CD on:

Today	Check Out CD		
1/1/2014	Enter	Customer ID	007
	Enter	CD ID	CD2
	Execute	Rent	

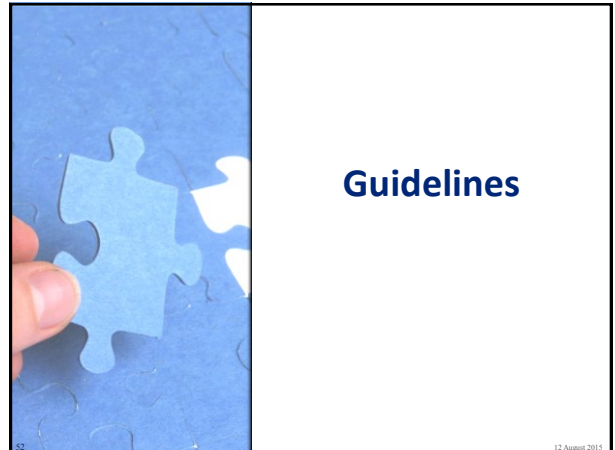
- Then a rental contract is printed:

Rental Contract					
Customer ID	Customer Name	CD ID	CD Title	Due	Fee
007	James	CD2	Beatles Greatest Hits	1/3/2014	\$2

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Guidelines

Tests

- Acceptance tests are not a substitute for interactive communication
 - They can provide focus for that communication
- Tests in business domain terms
 - Shared between customer unit and developer unit

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Guidelines

- Tests and automation should be developed separately
 - Understand the test first
 - Then explore how to automate it
- Automate tests for regression
 - Use in continuous build
- As much as practical, cover 100% of the functional requirements by acceptance tests
- Can break down stories by acceptance tests
 - One acceptance test per story

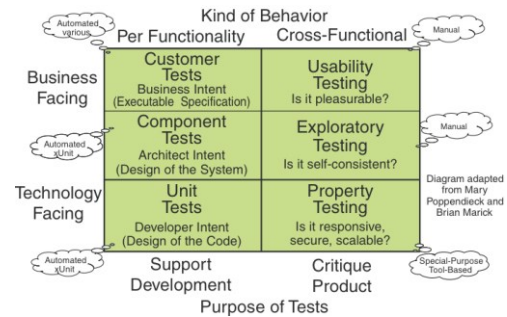
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A Few Other Thoughts

Testing Strategies



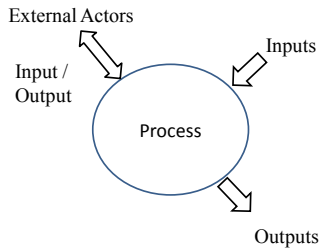
Mossano, *XUNIT TEST PATTERNS: REFACTORED TEST CODE*, Fig 6.1 "Purpose of Tests" p. 51, © 2007 Pearson Education, Inc.
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Context Diagram

- A context diagram shows scope

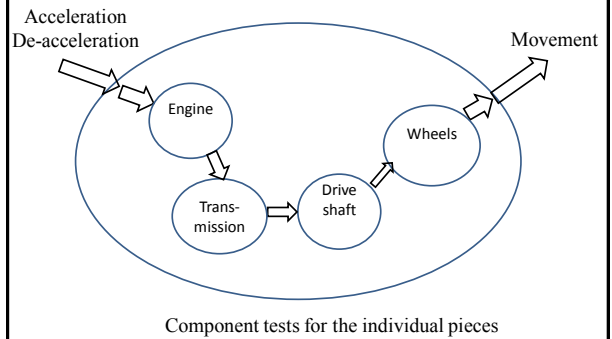


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Context of Automobile



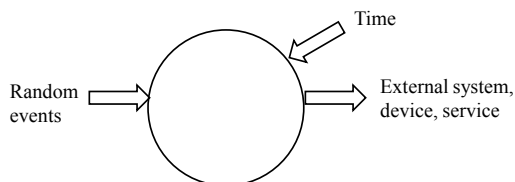
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External Interfaces

- Connections to external systems need to have test doubles (mocks)
 - They are stand-ins for real system during testing
 - Random events may need to be simulated
- Test doubles give repeatability and speed
 - Cheaper if have to pay for service

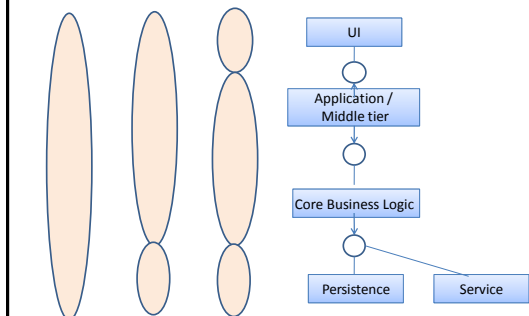


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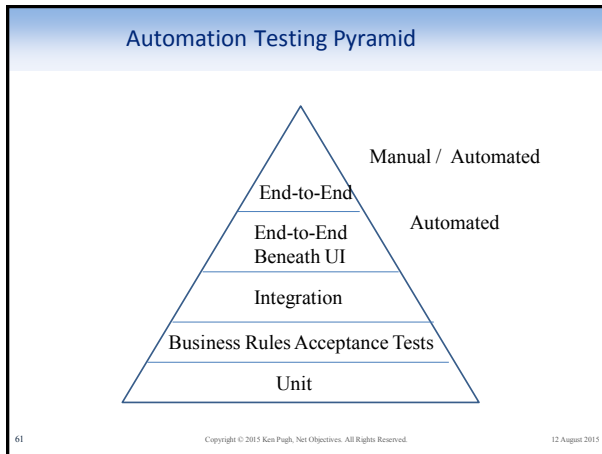
Tests to Cover Entire Flow



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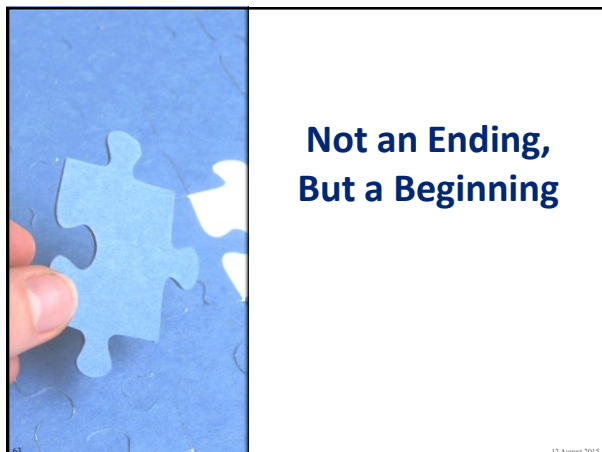
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Avoid Copy and Paste

In requirements, tests, code, documentation

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- Recap
- Primary goals
 - Discover ambiguous requirements and gaps in requirements early on
 - Create a record of business/development understanding
 - Secondary goals
 - Use acceptance tests as an executable regression test
 - Measure the complexity of requirements
 - Use the tests as a basis for user documentation
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