Unit Testing and Test Driven Design

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Unit Testing and Test Driven Design

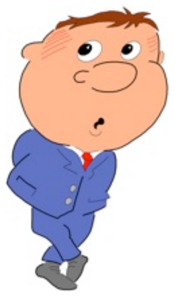
- **Target audience**
  - *Developers, Designers, Architects, Project Managers and Project Sponsors interested in lean and mean ways to achieve good-enough quality without paying an excessive price*
- **Objectives**
  - *Provide an overview of Unit Testing, and how Designing with Testability in mind changes your way of thinking*
- **Non-Objectives**
  - *To say anything about Functional Testing, Performance Testing, GUI Testing, …*

Agenda

- ☐ About Tests and Testing
- ☐ What is a Unit Test?
- ☐ Inside a Unit Test
- ☐ Test-First Design: How does Testability affect your way of thinking?

About Tests …

- ☐ Everybody knows they should, but few actually do
- ☐ "Why isn't this tested before"?
  - ▫ *Because it has been too expensive, difficult, cumbersome to test*
  - ▫ *Because we have been too busy*
  - ▫ *Because things have changed*



Absence of tests … Greetings from Hell!

The Diabolical Challenge of Modern Software Development

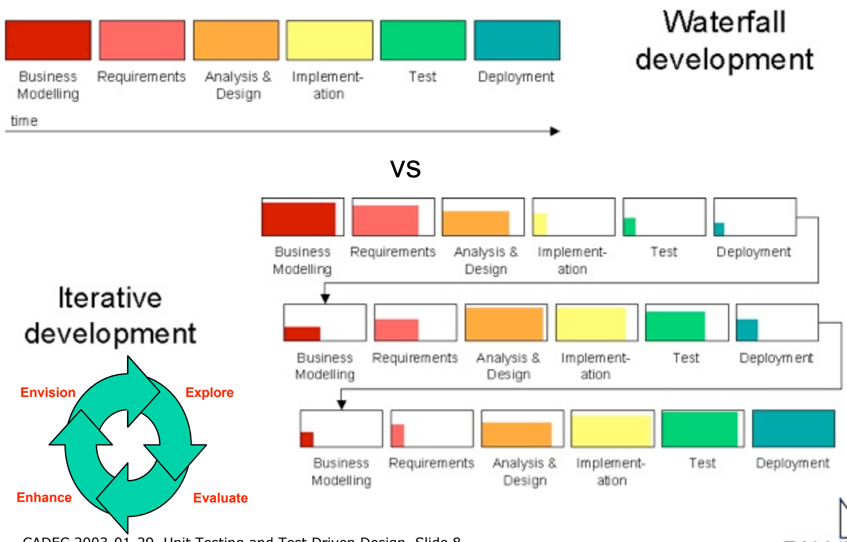
To rapidly complete large projects that are both research-like and mission-critical in a turbulent business and technology environment.

- *Exciting Features*
- *Rapid delivery*
- *High quality*
- *High change*
- *Low cost*

OMG's Six 'Best Practices' for Software Engineering

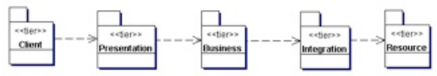
1. ***Develop software iteratively***
2. Manage requirements
3. ***Use component-based architectures***
4. Model software visually
5. ***Verify software quality continuously***
6. Control changes

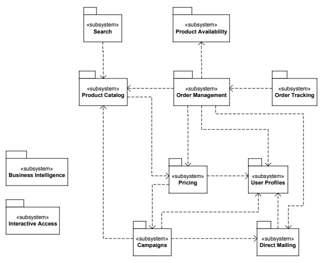
1. Develop software iteratively



3. Use component-based architectures

- ☐ Using well-defined interfaces makes a system much more resilient to change
- ☐ A component-based architecture enables projects to run more efficiently and with lesser risk

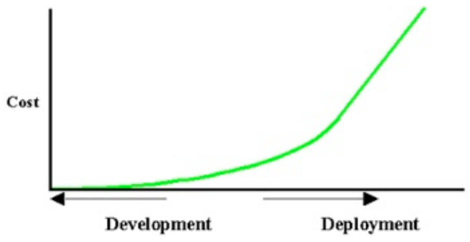




«subsystem» Search
«subsystem» Product Availability
«subsystem» Product Catalog
«subsystem» Order Management
«subsystem» Order Tracking
«subsystem» Business Intelligence
«subsystem» Interactive Access
«subsystem» Pricing
«subsystem» User Profiles
«subsystem» Campaigns
«subsystem» Direct Mailing

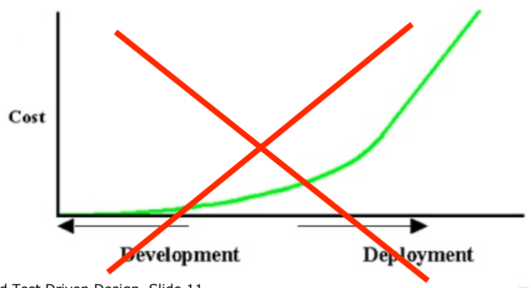
5. Verify software quality continuously

- ☐ Quality: The characteristic identified by the following:
  - ▫ *satisfies or exceeds an agreed upon set of requirements, and*
  - ▫ *assessed using agreed upon measures and criteria, and*
  - ▫ *produced using an agreed upon process*
- ☐ Test every iteration – automate test!



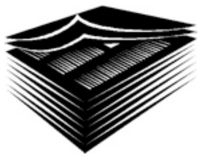
Refactoring challenges the Software Quality Entropy!

- The device `Do it right the first time´ sends the wrong message to an iterative project – make sure you do it right the last time!
- Refactoring is a systematic approach to improve the design and quality of an existing system, without changing its external behaviour.



Full Lifecycle Object Oriented Testing

- Requirements Testing
  - *Use-case scenario testing*
  - *Prototype walkthroughs*
  - *User Requirements reviews*
- Analysis & Design Testing
  - *Model walkthroughs*
  - *Prototype walkthroughs*
  - *Peer reviews*
- Code Testing
  - *Black-box testing*
  - *White-box testing*
  - *Boundary-value testing*
  - *Class-integration testing*
  - *Class testing*
  - *Code reviews*
  - *Coverage testing*
  - *Regression testing*
- System Testing
  - *Function testing*
  - *Installation testing*
  - *Stress testing*
  - *Operations testing*
  - *Support testing*
- User Testing
  - *Alpha testing*
  - *Beta testing*
  - *Pilot testing*
  - *User acceptance testing*



Gee, that sounds both difficult, boring and expensive!

- Yes, all testing comes with a price.
- 0% defect rate is impossible, and perhaps not even desirable?

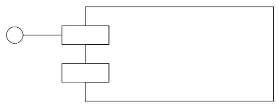
but …

- If it can be built, it can also be tested!
- If it’s not worth testing, maybe it’s not even worth building?

Lesson: **Test cheap, test early, test often!**

Unit Tests

- Black-box or White-box test of a *logical unit*, which verifies that the logical unit behaves correctly – *honors its contract*.

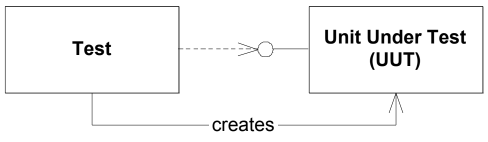


Smoke Tests

- A set of Unit Tests (which tests a set of logical units) executed as a whole provides a way to perform a *Smoke Test*: Turn it on, and make sure that it doesn't come smoke out of it!
- A relatively cheap way to see that the units "seems to be working and fit together", even though there are no guarantees for its overall function (which requires functional testing)

What exactly is a Unit Test?

- A self-contained software module (typically a Class) containing one or more test scenarios which tests a Unit Under Test *in isolation*.
- Each test scenario is autonomous, and tests a separate aspect of the Unit Under Test.



Unit Test Example

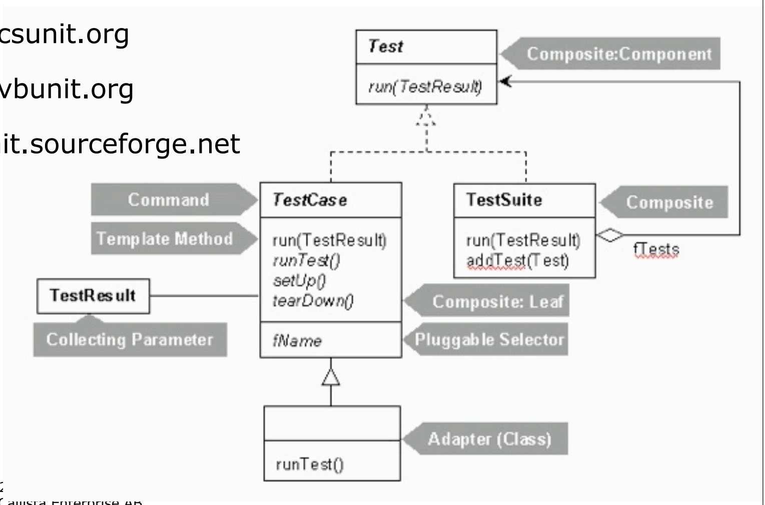
```
public interface Account {
    public void withdraw(double amount);
    public void deposit(double amount);
    public double balance();
    …
}
public class AccountTest extends TestCase {
    public void testWithdraw() {
        AccountImpl account = new AccountImpl("1234-9999", 2000);
        account.withdraw(300);
        assertEquals(account.balance(), 1700);
    }
    public void testWithdrawTooMuch() { … }
    …
}
```

Desiderata for Unit Tests

- Easy to write a test class
- Easy to find test classes
- Easy to test different aspects of a contract
- Easy to maintain tests
- Easy to run tests

XUnit: A Framework for Unit Tests

- www.junit.org
- www.csunit.org
- www.vbunit.org
- cppunit.sourceforge.net



Test-Driven Design

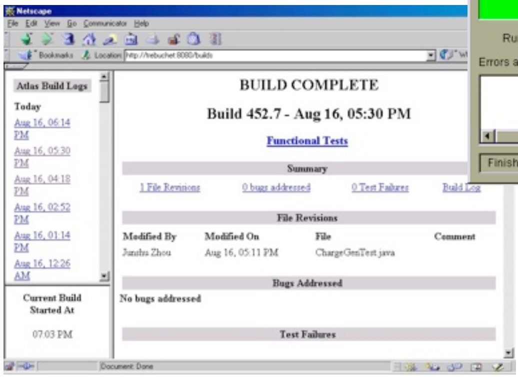
Unit Tests may be written very early. In fact, they may even be written *before any production code exists*:

1. Write a test that specifies a tiny bit of functionality
2. Ensure the test fails (you haven't built the functionality yet!)
3. Write the code necessary to make the test pass

There is a certain rhythm to it: Design a little – test a little – code a little – design a little – test a little – code a little – ...

Obvious Effects of Test-Driven Design

- Already automated tests, immediately useful for
  - *Integration tests*
  - *Regression tests*



Netscape

File Edit View Go Communicator Help

Bookmarks Location: http://trebuchet:8080/builds

Atlas Build Logs

Today

Aug 16, 06:14 PM

Aug 16, 05:30 PM

Aug 16, 04:18 PM

Aug 16, 02:52 PM

Aug 16, 01:14 PM

Aug 16, 12:26 AM

Current Build Started At

07:03 PM

BUILD COMPLETE

Build 452.7 - Aug 16, 05:30 PM

Functional Tests

Summary

1 File Revisions   0 bugs addressed   0 Test Failures   Build Log

File Revisions

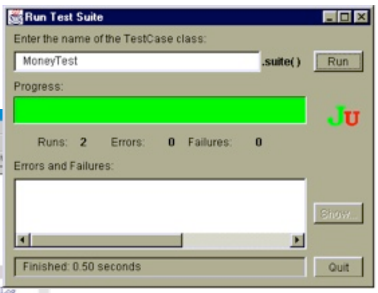
Modified By	Modified On	File	Comment
Junshu Zhou	Aug 16, 05:11 PM	ChargeGenTest.java	

Bugs Addressed

No bugs addressed

Test Failures

Document: Done



Run Test Suite

Enter the name of the TestCase class:

MoneyTest .suite() Run

Progress:

Runs: 2 Errors: 0 Failures: 0

Errors and Failures:

Finished: 0.50 seconds

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Not-so-obvious Effects of Test-Driven Design

- Intentional Design of Interfaces
  - *Since the code in question is not written yet, we are free to choose the interface that is most usable.*
- Non-speculative Interfaces
  - *Interfaces provide the functionality which is just enough for right now*
- Documented requirements and intended usage
  - *The tests themselves provide immediately useful documentation of the Interfaces*
- Good OO Design: High Cohesion and Low Coupling
  - *If you have to write tests first, you'll devise ways of minimizing dependencies in your system in order to write your tests.*

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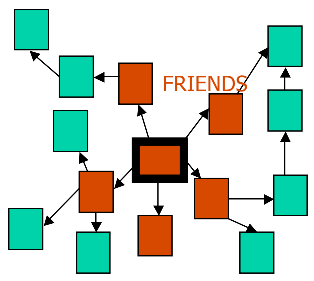
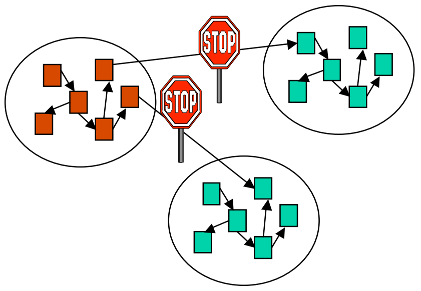
Designing for Testability: *Low Coupling*

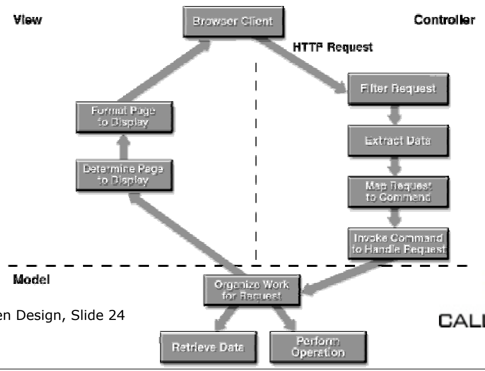
- Minimize dependencies between classes
- Only allow "closely related" classes to interact directly





Designing for Testability: *Model-View-Control*

- User Interfaces are notoriously difficult to test
- Splitting a complex application into separate, cohesive parts which separates presentation from application logic allows testing the application logic in isolation



So what exactly is a Unit?

- ☐ Class?
- ☐ Interface?
- ☐ Component?
- ☐ Sub-system?
- ☐ Whole system?

Pragmatics!

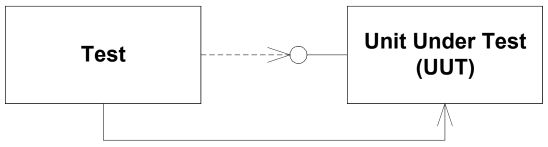
Design properties and Design goals

For Units:

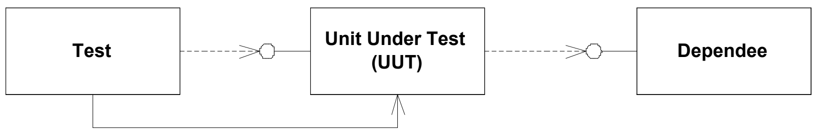
- ☐ Modularity
- ☐ High cohesion
- ☐ Low coupling

For Tests:

- ☐ Modularity
- ☐ Locality



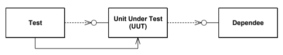
But what about units that depend on other units (with potential side effects)?



- Different strategies possible:
  - *Create a real context*
  - *Run in it's natural context (In Container in the case of J2EE or .NET)*
  - *Create a synthetic context*

Create a real context

- Ok



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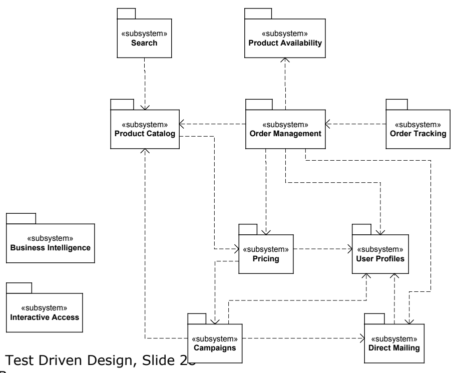
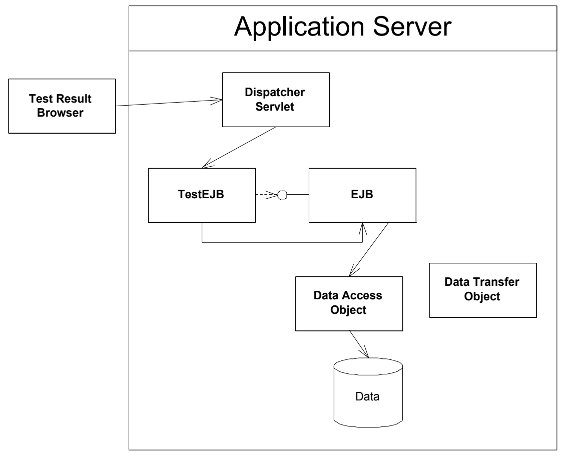

«subsystem» Search
«subsystem» Product Availability
«subsystem» Product Catalog
«subsystem» Order Management
«subsystem» Order Tracking
«subsystem» Business Intelligence
«subsystem» Pricing
«subsystem» User Profiles
«subsystem» Interactive Access
«subsystem» Campaigns
«subsystem» Direct Mailing

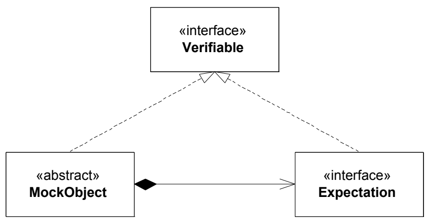
Run in context - Cactus

- jakarta.apache.org/cactus/



Synthetic context – MockObjects

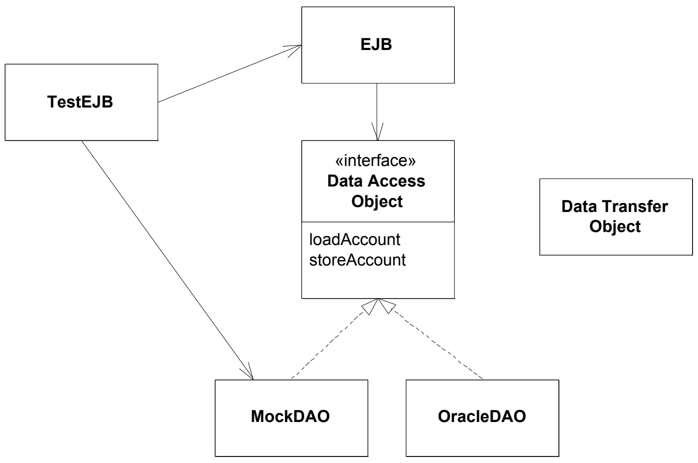
- Implements the same interface as the resource that it represents
- Enables configuration of its behavior from outside (i.e. from the test class, in order to achieve locality)
- Enables registering and verifying *expectations* on how the resource is used



Typical usage scenario for Mock Objects in a TestCase

1. Instantiate mockobjects
2. Set up state in mockobjects, which govern their behavior
3. Set up expectations on mock objects
4. Execute the method(s) on the Unit Under Test, using the mockobjects as resources
5. Verify the results
6. Verify the expectations

Example: A Mock database resource

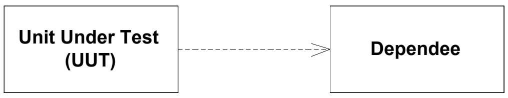


Example (contd.)

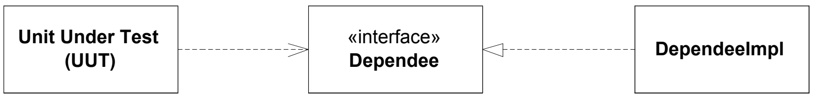
```
public void testWithdraw() {
        EJB ejb = new EJB();
        MockDAO mockDAO = new MockDAO();
        mockDAO.setupLoadAccount(new ValueObject(…));
        mockDAO.setExpectedStoreAccount(new ValueObject(…));
        mockDAO.setExpectedLoadAccountCalls(1);
        mockDAO.setExpectedStoreAccountCalls(1);
        ejb.setDAO(mockDAO);
        int result = ejb.withdraw(…);
        assertEquals(result, expectedResult);
        mockDAO.verify();
}
```

Designing for Testability : *Don't Talk To Strangers*

- ☐ If there are no strong reasons why two classes should talk to each other directly, *they shouldn't!*



becomes



Designing for Testability : *Law of Demeter*

Any method should have limited knowledge about an object structure.

```
public EJBBean() {
     …
     DAO dao = new DAO();
     …
}
```

becomes

```
public void setDAO(DAO dao) {
      this.dao = dao;
}
```

Bottom Line: Unit Testing and Test-First Design is Infectious!

It’s always a bit painful to change your habits, but once you’ve been there, you’re stuck!

- ☐ Enables truly iterative projects
- ☐ Improves your design
- ☐ Doesn’t cost your project a fortune
- ☐ Is even fun!

Enables you to test cheap, to test early, and to test often!

Questions?

CADEC 2003-01-29, Unit Testing and Test Driven Design, Slide 37