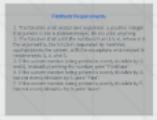
# CS1699 - Lecture 4 - Test Plans


## Developing a Test Plan

So you have requirements...

how do you test them?

**Think About What You're Testing**

1. Throw-away script?
2. Development tool?
3. Internal website?
4. Enterprise software?
5. Operating system?
6. Avionics software?

Your test plan should flow from the functional requirements through the non-functional requirements.

**Example**

*System shall fail gracefully.*

This will mean something very different for an MRI machine and a website.

**The Seven Testing Principles**

1. Testing shows presence of defects.
2. Exhaustive testing is impossible.
3. Test early.
4. Defect clustering.
5. The "pesticide paradox"
6. Testing is context dependent.
7. Absence of errors fallacy.

- ISO/IEC International Software Quality Testing Board Foundations Syllabus

**Testing Shows Presence of Defects**

You can never really "prove" * software is free of defects.

Absence of evidence IS NOT evidence of absence.

* Yes, there are "formally proven" programs out there. This is a whole other rabbit hole to go down, and this concept is going to come up for maybe 1% of testers.

**Testing Can Never Show All Defects or Possible Failure Cases**

1. What if an asteroid destroys the crust of our planet, bathing the entire surface with lava?
2. Will system work correctly under 100 Tests of imagnerism?
3. What happens when malloc() fails at instruction 1...2...3... etc?
4. Concurrency and parallelism?
5. What if the value of pi was slightly shifted in our Universe, would program work correctly?

**Exhaustive Testing is Impossible**

Could you prove a spellchecker could work with every possible input?

**Early Testing**

```
It is always, always, always
better to discover a problem
sooner rather than later.

Report early, report often.

Don't wait to test.
```

**Defect Clustering**

Defects tend to cluster in certain areas of code or functionality.

Usually due to technical difficulty of implementing, bad requirements, etc.

If you find many errors in one module, don't assume that others are "fine". (Gambler's Fallacy)

**Pesticide Paradox**

If you keep testing over and over with the same test plan, you'll only ever find bugs in that test plan.

You will need to test other aspects of the system and revise the test plan!

**Testing is Context-Dependent**

How you test
How much you test
What tools you use
What documentation you provide...

All very based on software context.

**Absence of Errors Fallacy**

Let's say we give our fully tested and vetted FizzBuzz implementation to a customer.

Customer says he actually wanted a frontLogic and files.

FINDING DEFECTS DOESN'T HELP IF IT'S NOT WHAT THE USER WANTS!

**Verification vs Validation**

Verification - "Are we building the software right?"

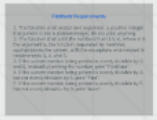
Validation - "Are we building the right software?"

## Test Cases / Runs / Plans / Suites



## Test Tracking

# CS1699 - Lecture 4 - Test Plans


## Developing a Test Plan

So you have requirements...

how do you test them?

**Think About What You're Testing**

1. Throw-away script?
2. Development tool?
3. Internal website?
4. Enterprise software?
5. Operating system?
6. Avionics software?

Your test plan should flow from the functional requirements through the non-functional requirements.

**Example**

*System shall fail gracefully.*

This will mean something very different for an MRI machine and a website.

**The Seven Testing Principles**

1. Testing shows presence of defects.
2. Exhaustive testing is impossible.
3. Test early.
4. Defect clustering.
5. The "pesticide paradox"
6. Testing is context dependent.
7. Absence of errors fallacy.

- ISO/IEC International Software Quality Testing Board Foundations Syllabus

**Testing Shows Presence of Defects**

You can never really "prove" * software is free of defects.

Absence of evidence IS NOT evidence of absence.

* Yes, there are "formally proven" programs out there. This is a whole other rabbit hole to go down, and this concept is going to come up for maybe 1% of testers.

**Testing Can Never Show All Defects or Possible Failure Cases**

1. What if an asteroid destroys the crust of our planet, bathing the entire surface with lava?
2. Will system work correctly under 100 Tests of imagnerism?
3. What happens when malloc() fails at instruction 1...2...3... etc?
4. Concurrency and parallelism?
5. What if the value of pi was slightly shifted in our Universe, would program work correctly?

**Exhaustive Testing is Impossible**

Could you prove a spellchecker could work with every possible input?

**Early Testing**

```
It is always, always, always
better to discover a problem
sooner rather than later.

Report early, report often.

Don't wait to test.
```

**Defect Clustering**

Defects tend to cluster in certain areas of code or functionality.

Usually due to technical difficulty of implementing, bad requirements, etc.

If you find many errors in one module, don't assume that others are "fine". (Gambler's Fallacy)

**Pesticide Paradox**

If you keep testing over and over with the same test plan, you'll only ever find bugs in that test plan.

You will need to test other aspects of the system and revise the test plan!

**Testing is Context-Dependent**

How you test
How much you test
What tools you use
What documentation you provide...

All very based on software context.

**Absence of Errors Fallacy**

Let's say we give our fully tested and vetted FizzBuzz implementation to a customer.

Customer says he actually wanted a frontLogic and files.

FINDING DEFECTS DOESN'T HELP IF IT'S NOT WHAT THE USER WANTS!

**Verification vs Validation**

Verification - "Are we building the software right?"

Validation - "Are we building the right software?"

## Test Cases / Runs / Plans / Suites



## Test Tracking

# FizzBuzz

# FizzBuzz Requirements

1. The function shall accept one argument, a positive integer. If argument is not a positive integer, do not print anything.
2. The function shall print the numbers from 1 to n, where n is the argument to the function, separated by newlines appropriate to the system, with the exceptions enumerated in requirements 3, 4, and 5.
3. If the current number being printed is evenly divisible by 3 and 5, instead of printing the number, print "FizzBuzz".
4. If the current number being printed is evenly divisible by 3, but not evenly divisible by 5, print "Fizz".
5. If the current number being printed is evenly divisible by 5, but not evenly divisible by 3, print "Buzz".

*Argument: 20*

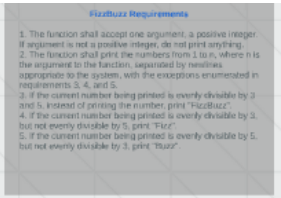
1
2
Fizz
4
Buzz
Fizz
7
8
Fizz
Buzz
11
Fizz
13
14
FizzBuzz
16

# Example Output

# Let's Come up with a Test Plan!

Equivalence Classes?
Boundary Values?
Base case?
Success vs Failure Cases?
Edge cases, Corner/Pathological cases?

## FizzBuzz


FizzBuzz Requirements

1. The function shall accept one argument, a positive integer. If argument is not a positive integer, do not print anything.
2. The function shall print the numbers from 1 to n, where n is the argument to the function, separated by newlines appropriate to the system, with the exceptions enumerated in requirements 3, 4, and 5.
3. If the current number being printed is evenly divisible by 3 and 5, instead of printing the number, print "FizzBuzz".
4. If the current number being printed is evenly divisible by 3, but not evenly divisible by 5, print "Fizz".
5. If the current number being printed is evenly divisible by 5, but not evenly divisible by 3, print "Buzz".


Example Output

1
2
Fizz
4
Buzz
Fizz
7
8
Fizz
Buzz
11
Fizz
13
14
FizzBuzz
16

# Developing a Test Plan

**So you have requirements...**

**how do you test them?**

### Think About What You're Testing

1. Throw-away script?
2. Development tool?
3. Internal website?
4. Enterprise software?
5. Operating system?
6. Avionics software?

**Your test plan should flow from the functional requirements through the non-functional requirements.**

### Example

*System shall fail gracefully.*

This will mean something very different for an MRI machine and a website.

### The Seven Testing Principles

1. Testing shows presence of defects.
2. Exhaustive testing is impossible.
3. Test early.
4. Defect clustering.
5. The "pesticide paradox"
6. Testing is context dependent.
7. Absence of errors fallacy.

*-ISQTB (International Software Quality Testing Board) Foundational Syllabus*

### Testing Shows Presence of Defects

You can never really "prove" * software is free of defects.

Absence of evidence IS NOT evidence of absence.

* Yes, there are "formally proven" programs out there. This is a whole other rabbit hole to go down, and this concept is going to come up for maybe 1% of testers.

### Testing Can Never Show All Defects or Possible Failure Cases

1. What if an asteroid destroys the crust of our planet, bathing the entire surface with lava?
2. Will system work correctly under 100 Tesla of magnetism?
3. What happens when malloc() fails at instruction 1.. 2... 3... etc?
4. Concurrency and parallelism?
5. What if the value of pi was slightly shifted in our Universe, would program work correctly?

### Exhaustive Testing is Impossible

Could you prove a spellchecker could work with every possible novel?

### Early Testing

**It is always, always, always better to discover a problem sooner rather than later.**

**Report early, report often.**

**Don't wait to test.**

### Defect Clustering

Defects tend to cluster in certain areas of code or functionality.

Usually due to technical difficulty of implementing, bad requirements, etc.

If you find many errors in one module, don't assume that others are "due". (Gambler's Fallacy)

### Pesticide Paradox

If you keep testing over and over with the same test plan, you'll only ever find bugs in that test plan.

You will need to test other aspects of the system and revise the test plan!

### Testing is Context-Dependent

How you test
How much you test
What tools you use
What documentation you provide...

All vary based on software context.

### Absence of Errors Fallacy

Let's say we gave our fully tested and vetted FizzBuzz implementation to a customer.

Customer says he actually wanted a hamburger and fries.

FINDING DEFECTS DOESN'T HELP IF IT'S NOT WHAT THE USER WANTS!

### Verification vs Validation

Verification - "Are we building the software right?"

Validation - "Are we building the right software?"

So you have requirements...

how do you test them?

# Think About What You're Testing

1. Throw-away script?
2. Development tool?
3. Internal website?
4. Enterprise software?
5. Operating system?
6. Avionics software?

**Your test plan should flow from the functional requirements through the non-functional requirements.**

# Example

*System shall fail gracefully.*

This will mean something very different for an MRI machine and a website.

# The Seven Testing Principles

1. Testing shows presence of defects.
2. Exhaustive testing is impossible.
3. Test early.
4. Defect clustering.
5. The "pesticide paradox"
6. Testing is context dependent.
7. Absence of errors fallacy.

*-ISQTB (International Software Quality Testing Board) Foundational Syllabus*

# Testing Shows Presence of Defects

You can never really "prove" * software is free of defects.

Absence of evidence IS NOT evidence of absence.

* Yes, there are "formally proven" programs out there.  This is a whole other rabbit hole to go down, and this concept is going to come up for maybe 1% of testers.

# Testing Can Never Show All Defects or Possible Failure Cases

1. What if an asteroid destroys the crust of our planet, bathing the entire surface with lava?
2. Will system work correctly under 100 Tesla of magnetism?
3. What happens when malloc() fails at instruction 1.. 2... 3... etc?
4. Concurrency and parallelism?
5. What if the value of pi was slightly shifted in our Universe, would program work correctly?

# Exhaustive Testing is Impossible

Could you prove a spellchecker could work with every possible novel?

# Early Testing

It is always, always, always better to discover a problem sooner rather than later.

Report early, report often.

Don't wait to test.

# Defect Clustering

Defects tend to cluster in certain areas of code or functionality.

Usually due to technical difficulty of implementing, bad requirements, etc.

If you find many errors in one module, don't assume that others are "due". (Gambler's Fallacy)

# Pesticide Paradox

If you keep testing over and over with the same test plan, you'll only ever find bugs in that test plan.

You will need to test other aspects of the system and revise the test plan!

# Testing is Context-Dependent

How you test
How much you test
What tools you use
What documentation you provide...

All vary based on software context.

# Absence of Errors Fallacy

Let's say we gave our fully tested and vetted FizzBuzz implementation to a customer.

Customer says he actually wanted a hamburger and fries.

FINDING DEFECTS DOESN'T HELP IF IT'S NOT WHAT THE USER WANTS!

# Verification vs Validation

Verification - "Are we building the software right?"

Validation - "Are we building the right software?"

# Test Cases / Runs / Plans / Suites

### Test Cases

A test case is the lowest level of a test plan.
It consists of:
1. Input values
2. Other preconditions
3. Execution steps (or Procedure)
4. Output values
5. Other postconditions

See IEEE 829, "Standard for Software Test Documentation", for more details

**Example**

Assuming an empty shopping cart, when I click "Buy Widget", the number of widgets in the shopping cart becomes one.

Preconditions: Empty shopping cart
Execution Steps: Click "Buy Widget"
Postconditions: Shopping cart displays one widget

**Example**

Assuming that the SORT_ASCENDING flag is set, calling the sort method with [9,3,4,2] will return a new array sorted from high to low, i.e., [2,3,4,9].

Precondition: SORT_ASCENDING flag is set
Input values: [9,3,4,2]
Execution steps: Call .sort method
Output values: [2,3,4,9]

**Test Plan**

A group of test cases makes up a test plan. These are usually associated functionally or in other ways.

Examples:
Database Connectivity Test Plan
Pop-up Warning Test Plan
Calculator Subsystem Test Plan
Pressure Safety Lock Test Plan
Regression Test Plan

**Pressure Safety Lock Test Plan**

LOW-PRESSURE-TEST
HIGH-PRESSURE-TEST
SAFETY-LIGHT-TEST
SAFETY-LIGHT-OFF-TEST-
RESET-SWITCH-TEST
RESET-SWITCH2-TEST
FAST-MOVEMENT-TEST
RAPID-CHANGE-TEST
GRADUAL-CHANGE-TEST
MEDIAN-PRESSURE-TEST
LIGHT-FAILURE-TEST
SENSOR-FAILURE-TEST
SENSOR-INVALID-TEST

**A Group of Test Plans is a Test Suite**

**Regression Test Suite**

Pressure Safety Regression Test Plan
Power Regulation Regression Test Plan
Water Flow Regression Test Plan
Control Flow Test Plan
Security Regression Test Plan
Secondary Safety Process Test Plan

### Test Run

The actual execution of a test plan or suite.

During this execution, the status of each test case is recorded. Possible statuses include:
PASSED
FAILED
PAUSED
RUNNING
BLOCKED
ERROR

PASSED - The test case met all postconditions and expected values. No other problems were observed (e.g., test met all postconditions, but screen turned fuchsia afterwards).

FAILED - The test case did not meet one or more postconditions or expected values, or an unexpected problem occurred.

PAUSED - The test started, but is not complete due to internal factors (e.g., the tester went to lunch).

RUNNING - The test is currently executing. This is useful for long-running background tests.

BLOCKED - The test cannot proceed due to external factors (e.g., waiting for a machine to be available).

ERROR - There is a problem with the test itself. For example, it says "Output should be sorted, returning [1,9,7,2,3]." The test could also not meet requirements. In this case, the tester should discuss with the relevant systems engineer, test writer, or requirements analyst.

If a test fails, a DEFECT should be filed.

Note that this need not be official; if you're doing preliminary testing, it may be sufficient to just talk to the developer.





## Test Tracking

# Test Cases

A test case is the lowest level of a test plan.
It consists of:

1. Input values
2. Other preconditions
3. Execution steps (or Procedure)
4. Output values
5. Other postconditions

See IEEE 829, "Standard for Software Test Documentation", for more details

# Example

Assuming an empty shopping cart, when I click "Buy Widget", the number of widgets in the shopping cart becomes one.

Preconditions: Empty shopping cart
Execution Steps: Click "Buy Widget"
Postconditions: Shopping cart displays one widget

# Example

Assuming that the SORT_ASCENDING flag is set, calling the sort method with [9,3,4,2] will return a new array sorted from high to low, i.e., [2,3,4,9].

Precondition: SORT_ASCENDING flag is set
Input values: [9,3,4,2]
Execution steps: Call .sort method
Output values: [2,3,4,9]

# Test Plan

A group of test cases makes up a test plan. These are usually associated functionally or in other ways.

Examples:
Database Connectivity Test Plan
Pop-up Warning Test Plan
Calculator Subsystem Test Plan
Pressure Safety Lock Test Plan
Regression Test Plan

# Pressure Safety Lock Test Plan

LOW-PRESSURE-TEST
HIGH-PRESSURE-TEST
SAFETY-LIGHT-TEST
SAFETY-LIGHT-OFF-TEST-
RESET-SWITCH-TEST
RESET-SWITCH2-TEST
FAST-MOVEMENT-TEST
RAPID-CHANGE-TEST
GRADUAL-CHANGE-TEST
MEDIAN-PRESSURE-TEST
LIGHT-FAILURE-TEST
SENSOR-FAILURE-TEST
SENSOR-INVALID-TEST

# A Group of Test Plans is a Test Suite

## Regression Test Suite

Pressure Safety Regression Test Plan
Power Regulation Regression Test Plan
Water Flow Regression Test Plan
Control Flow Test Plan
Security Regression Test Plan
Secondary Safety Process Test Plan

# Test Run

The actual execution of a test plan or suite.

During this execution, the status of each test case is recorded.  Possible statuses include:

PASSED
FAILED
PAUSED
RUNNING
BLOCKED
ERROR

PASSED - The test case met all postconditions and expected values.  No other problems were observed (e.g., test met all postconditions, but screen turned fuchsia afterwards).

FAILED - The test case did not meet one or more postconditions or expected values, or an unexpected problem occurred.

PAUSED - The test started, but is not complete due to internal factors (e.g., the tester went to lunch).

RUNNING - The test is currently executing.  This is useful for long-running background tests.

BLOCKED - The test cannot proceed due to external factors (e.g., waiting for a machine to be available).

ERROR - There is a problem with the test itself. For example, it says "Output should be sorted, returning [1,9,7,2,3]."  The test could also not meet requirements.  In this case, the tester should discuss with the relevant systems engineer, test writer, or requirements analyst.

If a test fails, a DEFECT should be filed.

Note that this need not be official; if you're doing preliminary testing, it may be sufficient to just talk to the developer.

# Test Tracking

### Record All Test Runs!

1. Keep track of date, version of software
2. Which test run produced a defect
3. Which test case produced a defect
4. Any other relevant information

### Example

Project: Calculator
Test Plan: Multiplication Functionality
Test Run Date: 14 JAN 2014
SW Version: 1.0 Build 141 (RC1)
Defects Found: 108 (Case 6), 110 (Case 7)
Executed on Machine #75

If you're using test tracking software, much of this will be automated.

**If I can leave you with one thing...**

**...more details are better when testing, almost always.**

**Best to mark down as you go. Don't wait.**
**File defects ASAP.**
**Report errors in tests ASAP.**
**Ask questions ASAP.**

**When executing a test, the worst thing to do is sit around staring and thinking. You will usually save time by asking someone.**

**This applies to most software development tasks.**

### Examples of Test Tracking Software

Mozilla Testopia
HP Quality Manager
IBM Rational Quality Manager
TestLink
Tosca Testsuite

# Record All Test Runs!

1. Keep track of date, version of software
2. Which test run produced a defect
3. Which test case produced a defect
4. Any other relevant information

# Example

Project: Calculator
Test Plan: Multiplication Functionality
Test Run Date: 14 JAN 2014
SW Version: 1.0 Build 141 (RC1)
Defects Found: 108 (Case 6), 110 (Case 7)
Executed on Machine #75

If you're using test tracking software, much of this will be automated.

**If I can leave you with one thing...**

**...more details are better when testing, almost always.**

Best to mark down as you go.  Don't wait.
File defects ASAP.
Report errors in tests ASAP.
Ask questions ASAP.

When executing a test, the worst thing to do is sit around staring and thinking.  You will usually save time by asking someone.

This applies to most software development tasks.

# Examples of Test Tracking Software

Mozilla Testopia
HP Quality Manager
IBM Rational Quality Manager
TestLink
Tosca Testsuite

# Tying Defects to Tests

**When a defect is found...**

1. That test should FAIL
2. If the defect already exists in the bug tracking system, note that it failed due to defect X
3. If a defect does not already exist, create a new defect

**We'll Talk More About Describing Defects Next Class...**

but for our purposes today, you want to track...

1. Software Version discovered
2. Date discovered
3. Test Run discovered
4. Test Case discovered

Note the pattern -

Everything is traceable and trackable.

Traceability and trackability lead to reproducibility.

Reproducibility leads to resolution.

# When a defect is found...

1. That test should FAIL
2. If the defect already exists in the bug tracking system, note that it failed due to defect X
3. If a defect does not already exist, create a new defect

# We'll Talk More About Describing Defects Next Class...

but for our purposes today, you want to track...

1. Software Version discovered
2. Date discovered
3. Test Run discovered
4. Test Case discovered

**Note the pattern -**

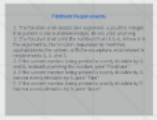
**Everything is traceable and trackable.**

**Traceability and trackability lead to reproducibility.**

**Reproducibility leads to resolution.**

# Deliverable 1

# CS1699 - Lecture 4 - Test Plans


## Developing a Test Plan

So you have requirements...

how do you test them?

**Think About What You're Testing**

1. Throw-away script?
2. Development tool?
3. Internal website?
4. Enterprise software?
5. Operating system?
6. Avionics software?

Your test plan should flow from the functional requirements through the non-functional requirements.

**Example**

*System shall fail gracefully.*

This will mean something very different for an MRI machine and a website.

**The Seven Testing Principles**

1. Testing shows presence of defects.
2. Exhaustive testing is impossible.
3. Test early.
4. Defect clustering.
5. The "pesticide paradox"
6. Testing is context dependent.
7. Absence of errors fallacy.

- ISO/IEC International Software Quality Testing Board Foundations Syllabus

**Testing Shows Presence of Defects**

You can never really "prove" * software is free of defects.

Absence of evidence IS NOT evidence of absence.

* Yes, there are "formally proven" programs out there. This is a whole other rabbit hole to go down, and this concept is going to come up for maybe 1% of testers.

**Testing Can Never Show All Defects or Possible Failure Cases**

1. What if an asteroid destroys the crust of our planet, bathing the entire surface with lava?
2. Will system work correctly under 100 Tests of imagnerism?
3. What happens when malloc() fails at instruction 1...2...3... etc?
4. Concurrency and parallelism?
5. What if the value of pi was slightly shifted in our Universe, would program work correctly?

**Exhaustive Testing is Impossible**

Could you prove a spellchecker could work with every possible input?

**Early Testing**

```
It is always, always, always
better to discover a problem
sooner rather than later.

Report early, report often.

Don't wait to test.
```

**Defect Clustering**

Defects tend to cluster in certain areas of code or functionality.

Usually due to technical difficulty of implementing, bad requirements, etc.

If you find many errors in one module, don't assume that others are "fine". (Gambler's Fallacy)

**Pesticide Paradox**

If you keep testing over and over with the same test plan, you'll only ever find bugs in that test plan.

You will need to test other aspects of the system and revise the test plan!

**Testing is Context-Dependent**

How you test
How much you test
What tools you use
What documentation you provide...

All very based on software context.

**Absence of Errors Fallacy**

Let's say we give our fully tested and vetted FizzBuzz implementation to a customer.

Customer says he actually wanted a frontLogic and files.

FINDING DEFECTS DOESN'T HELP IF IT'S NOT WHAT THE USER WANTS!

**Verification vs Validation**

Verification - "Are we building the software right?"

Validation - "Are we building the right software?"

## Test Cases / Runs / Plans / Suites



## Test Tracking