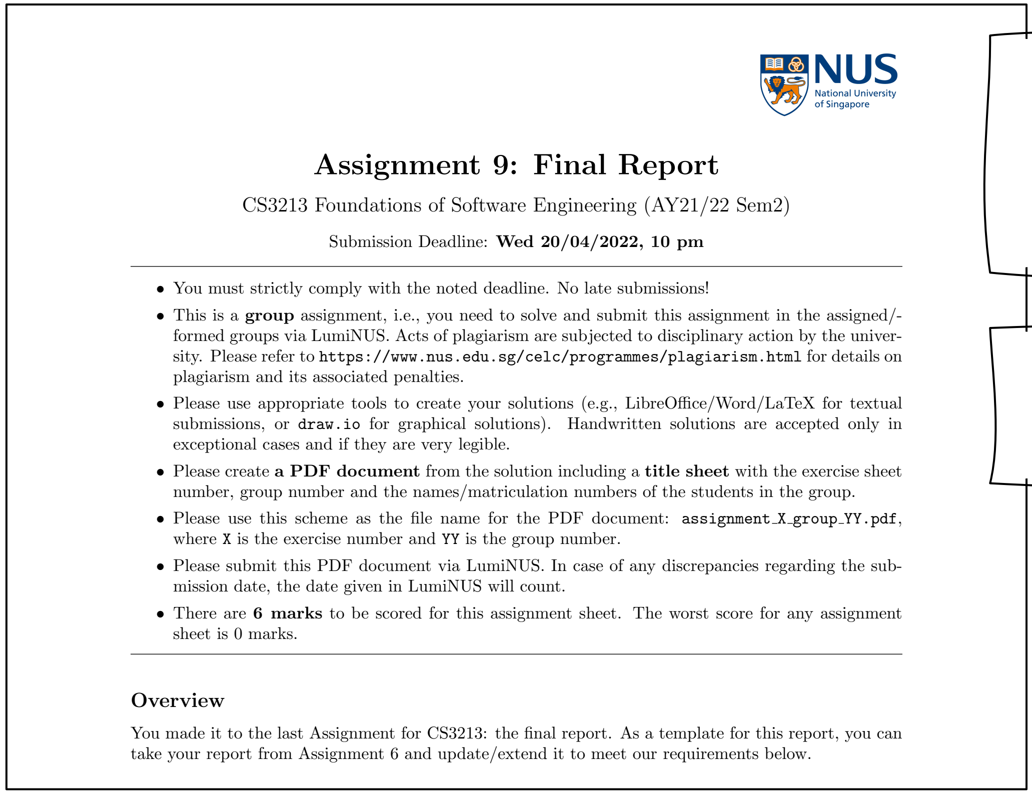
CS3213 Project – Week 10

Implementation | 23-03-2022

- ❑ Assignment 9 – Final Report
- ❑ Implementation (Clean Code)

Assignment 9: Final Report



Assignment 9: Final Report

CS3213 Foundations of Software Engineering (AY21/22 Sem2)

Submission Deadline: **Wed 20/04/2022, 10 pm**

- You must strictly comply with the noted deadline. No late submissions!
- This is a **group** assignment, i.e., you need to solve and submit this assignment in the assigned/-formed groups via LumiNUS. Acts of plagiarism are subjected to disciplinary action by the university. Please refer to `https://www.nus.edu.sg/celc/programmes/plagiarism.html` for details on plagiarism and its associated penalties.
- Please use appropriate tools to create your solutions (e.g., LibreOffice/Word/LaTeX for textual submissions, or `draw.io` for graphical solutions). Handwritten solutions are accepted only in exceptional cases and if they are very legible.
- Please create **a PDF document** from the solution including a **title sheet** with the exercise sheet number, group number and the names/matriculation numbers of the students in the group.
- Please use this scheme as the file name for the PDF document: `assignment_X_group_YY.pdf`, where `X` is the exercise number and `YY` is the group number.
- Please submit this PDF document via LumiNUS. In case of any discrepancies regarding the submission date, the date given in LumiNUS will count.
- There are **6 marks** to be scored for this assignment sheet. The worst score for any assignment sheet is 0 marks.

Overview

You made it to the last Assignment for CS3213: the final report. As a template for this report, you can take your report from Assignment 6 and update/extend it to meet our requirements below.

Due to: Wednesday, 20/04/2022 (**Reading Week**)

Available Marks: 6

Assignment 9 – Final Report (1/3)

- You need to submit a **textual report** showing your **project's final documentation** and wrap-up.
- Overall, your report **must not exceed 6 pages**.
- Your report should have the following structure:

1. **Overview** [1.5 marks]: Describe/Explain your project, the **idea**, the **foundational concepts**, and put it in the **broader picture**.

   Questions to answer could be: ***Which module is it implementing? What is its functionality? How does it contribute to the overall system?***

   We expect some textual description, a **component diagram** to show the embedding of your work, the description of the **interface** for your component, and the general solution idea with explanations of **relevant algorithms**.

Assignment 9 – Final Report (2/3)

2. **Project Planning** [1 mark]: Describe and illustrate your **updated project plan** (Gantt chart and Resource Allocation Plan). Explain if any tasks have not been finished. Include a **Milestone Trend Analysis** (MTA) diagram for the project planning ***retrospective***. Describe **any lessons learned** for project planning.

3. **Testing Reports** [1 mark]: Illustrate the results of running your **test cases**. Are there any remaining failing tests? If yes, **explain** why you did not fix them. Show the overall **line** and **branch coverage** achieved by your test cases and argue why the non-covered code parts do not need tests.

4. **Module Design & Maintainability** [1 mark]: Describe and illustrate your final module design in a **class diagram** and add **at least one behavioral diagram** to show your workflow. Describe and justify how you ensure the **maintainability** of your code. It can be done in list style (no long text is required). Provide references to your code where appropriate. We will **cross-check your code** for the described measures.

Assignment 9 – Final Report (3/3)

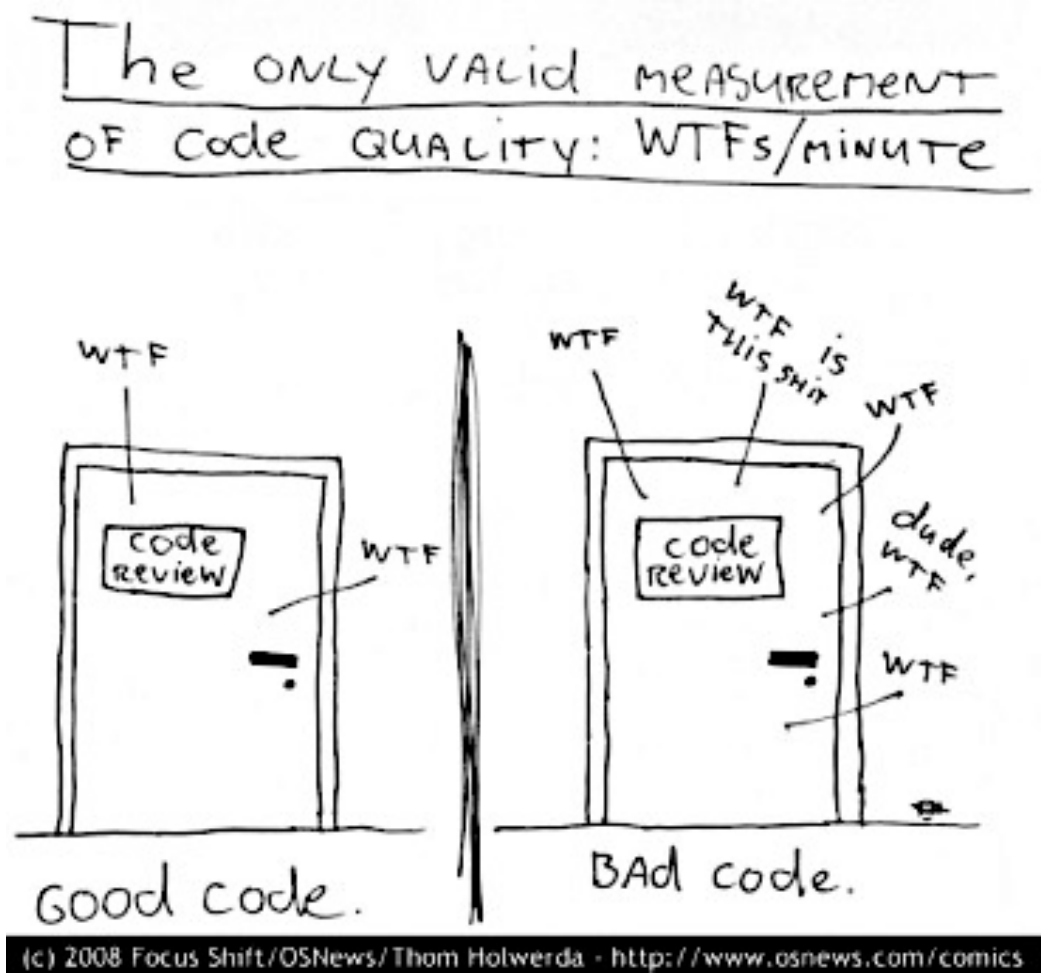
5. **Encountered Challenges & A6 Feedback** [1.5 marks]: Describe the challenges you encountered during software development (and in general during the team project) and how you **solved** them. Describe how you addressed the **feedback given for the intermediate submission** with Assignment 6.

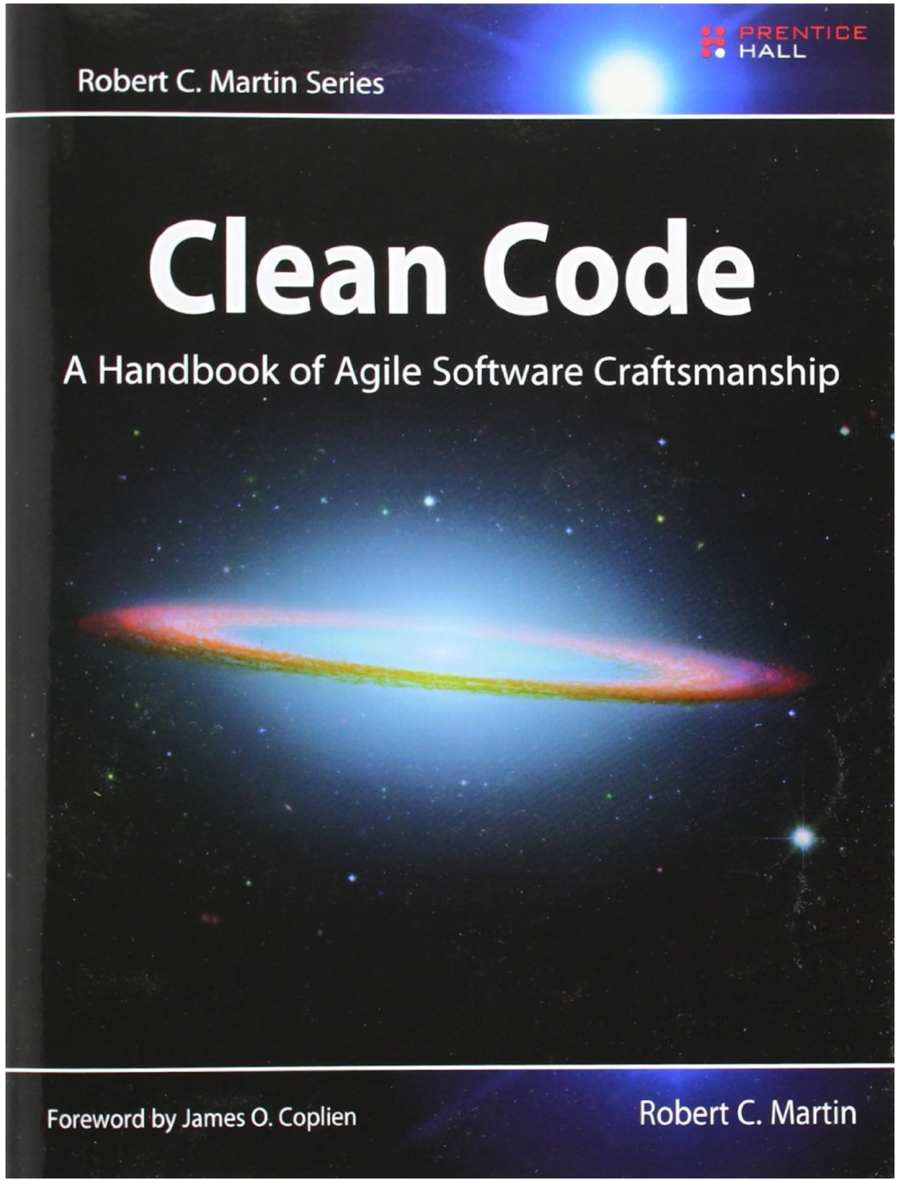
Grading Comment:
To receive the noted full amount of marks, it is necessary that your textual report follows the described **structure** and that **all aspects are sufficiently explained**. In particular, you need to show that you understand the **purpose** of your module for the overall system, **critically revisit the made choices** (retrospective), and show that you incorporated our **feedback given for Assignment 6**.

Any remaining question about Assignment 9?

“One bad programmer can easily create two new jobs a year.”

– David Parnas


The only valid measurement of code quality: WTFs/minute
WTF
code review
WTF
Good code.
WTF
WTF is this shit
WTF
code review
dude, WTF
WTF
BAd code.
(c) 2008 Focus Shift/OSNews/Thom Holwerda - http://www.osnews.com/comics


Robert C. Martin Series
PRENTICE HALL
Clean Code
A Handbook of Agile Software Craftsmanship
Foreword by James O. Coplien
Robert C. Martin

Robert C. “Uncle Bob” Martin:
Clean Code: A Handbook of Agile Software Craftsmanship

Prentice Hall, 2008

Contents of the Clean Code Book vs. Contents Covered Today

1. Meaningful Names
2. Functions
3. Comments
4. Formatting
5. Objects and Data Structures
6. Error Handling

   Boundaries

7. Unit Tests
8. Classes

   Systems

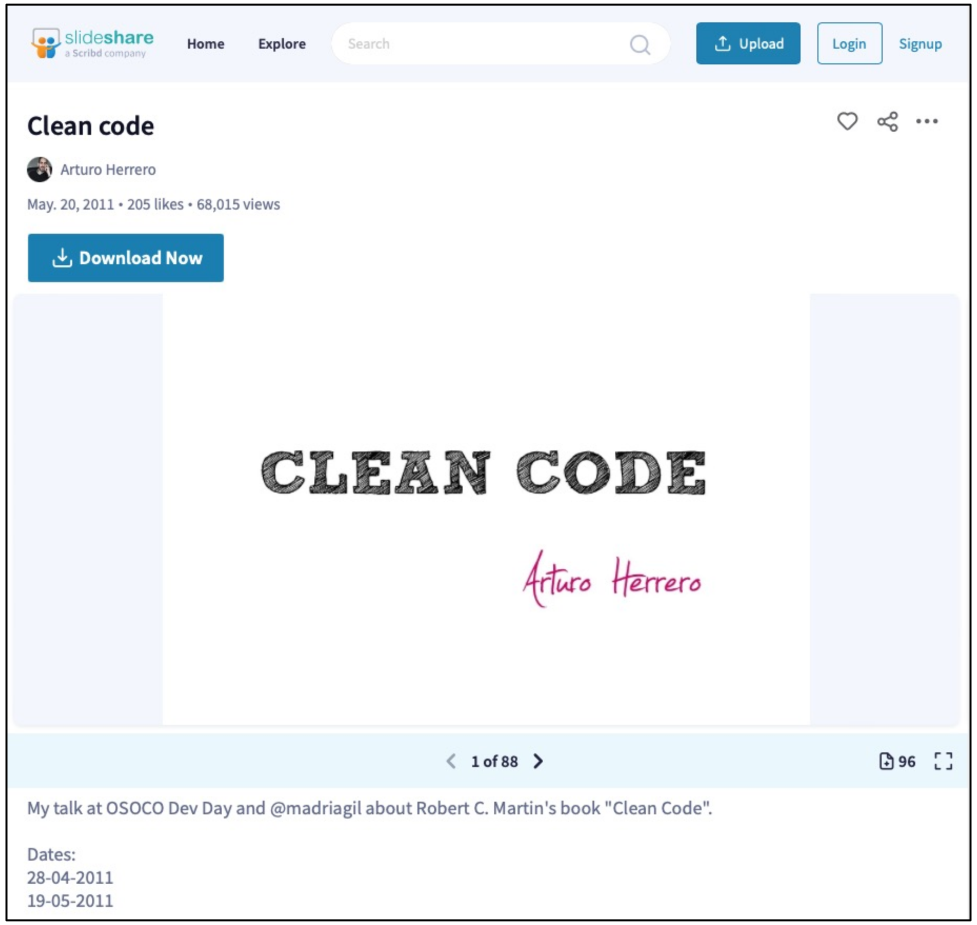
   Emergence

   Concurrency

Acknowledgment

The material for our slides is based on the slides by Arturo Herrero.

http://www.slideshare.net/arturoherrero/clean-code-8036914



Clean code

Arturo Herrero

May. 20, 2011 • 205 likes • 68,015 views

My talk at OSOCO Dev Day and @madriagil about Robert C. Martin's book "Clean Code".

Dates:
28-04-2011
19-05-2011

1. Meaningful Names

Use Intention-Revealing Names

```
int d; // elapsed time in days
```

```
int elapsedTimeInDays;
int daysSinceCreation;
int daysSinceModification;
int fileAgeInDays;
```

Use Intention-Revealing Names (cont'd)

```
public List<int[]> getThem() {
    List<int[]> list1 = new ArrayList<int[]>();
    for (int[] x : theList)
        if (x[0] == 4)
            list1.add(x);
    return list1;
}
```

Use Intention-Revealing Names

```
public List<Cell> getFlaggedCells() {
    List<Cell> flaggedCells = new ArrayList<Cell>();
    for (Cell cell : gameBoard)
        if (cell.isFlagged())
            flaggedCells.add(cell);
    return flaggedCells;
}
```

Disinformation and Distinction

Avoid Disinformation

```
int a = l;
if (O == l)
    a = O1;
else
    l = 01;
```

Make Meaningful Distinctions

```
public static void copyChars(char a1[], char a2[]) {
    for (int i = 0; i < a1.length; i++) {
        a2[i] = a1[i];
    }
}
```

Pronounceable Names

```
class DtaRcrd102 {
    private Date genymdhms;
    private Date modymdhms;
    private final String pszqint = "102";
    /* ... */
};
```

Use Pronounceable Names

```
class Customer {
    private Date generationTimestamp;
    private Date modificationTimestamp;;
    private final String recordId = "102";
    /* ... */
};
```

Searchable Names

```
for (int j = 0; j < 34; j++) {
    s += (t[j] * 4) / 5;
}
```

Use Searchable Names

```
int realDaysPerIdealDay = 4;
const int WORK_DAYS_PER_WEEK = 5;
int sum = 0;
for (int j = 0; j < NUMBER_OF_TASKS; j++) {
    int realTaskDays = taskEstimate[j] *
realDaysPerIdealDay;
    int realTaskWeeks = (realdays / WORK_DAYS_PER_WEEK);
    sum += realTaskWeeks;
}
```

Avoid Encodings

```
public class Part {
    private String m_dsc; // The textual description
    void setName(String name) {
        m_dsc = name;
    }
}
```

```
PhoneNumber phoneString;
// name not changed when type changed
```

Member Prefixes (Avoid encodings)

```
public class Part {
    String description;
    void setDescription(String description) {
        this.description = description;
    }
}
```

Hungarian Notation (Avoid encodings)

```
PhoneNumber phone;
```

Mental Mapping

```
for (a = 0; a < 10; a++)
    for (b = 0; b < 10; b++)
```

Avoid Mental Mapping

```
for (i = 0; i < 10; i++)
    for (j = 0; j < 10; j++)
```

Method Names

```
postPayment, deletePage, save
// methods should have verb or verb phrase names


string name = employee.getName();
customer.setName("mike");
if (paycheck.isPosted())...


Complex fulcrumPoint = Complex.fromRealNumber(23.0);
// is generally better than
Complex fulcrumPoint = new Complex(23.0);
```

One Word Per Concept; Don‘t Pun

Pick One Word per Concept

```
fetch, retrieve, get    // as equivalent methods

controller, manager, driver  // confusing
```

Don't Pun

```
// avoid using the same word for two purposes
```

Use Solution Domain Names and Context

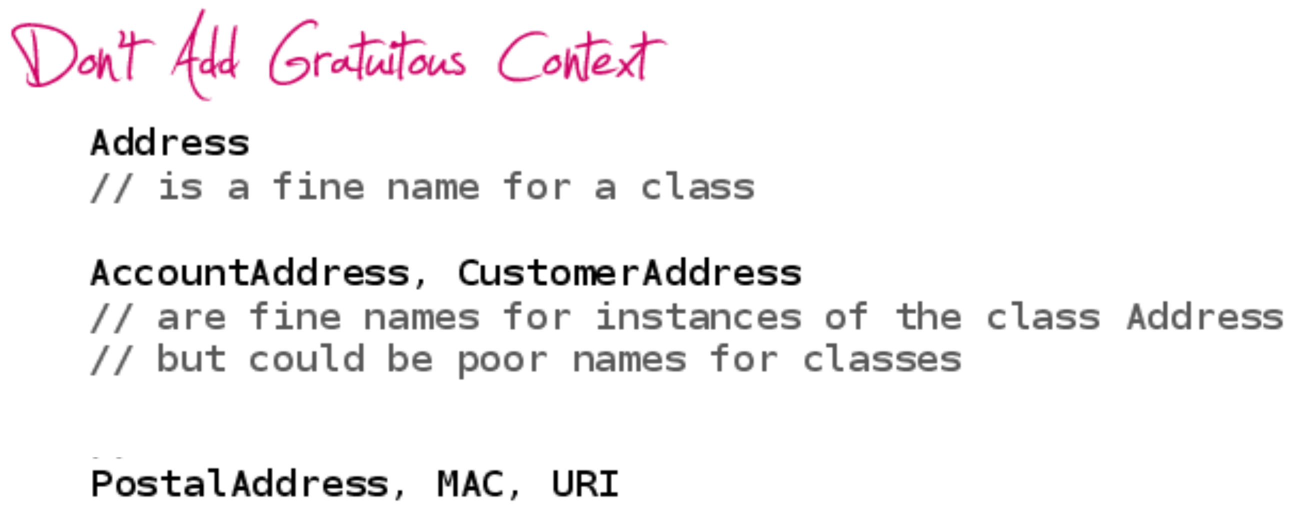
Use Solution Domain Names

```
AccountVisitor, JobQueue
// people who read your code will be programmers
```

Add Meaningful Context

```
firstName, lastName, street, city, state, zipcode
// a better solution
addrFirstName, addrLastName, addrState
// a better solution
Class Address
```

No Gratuitous Context



Don't Add Gratuitous Context

```
Address
// is a fine name for a class

AccountAddress, CustomerAddress
// are fine names for instances of the class Address
// but could be poor names for classes


PostalAddress, MAC, URI
```

2. Functions

Size and Scope

Small!

```
// rules of functions:
//     1. should be small
//     2. should be smaller than that

// < 150 characters per line
// < 20 lines
```

Do One Thing

```
// FUNCTIONS SHOULD DO ONE THING. THEY SHOULD DO IT WELL.
// THEY SHOULD DO IT ONLY.
```

Level of Abstraction and Reading Direction

One Level of Abstraction per Function

```
// high level of abstraction
   getHtml()

// intermediate level of abstraction
   String pagePathName = PathParser.render(pagePath);

// remarkably low level
   .append("\n")
```

Reading Code from Top to Bottom

```
// the Stepdown Rule
```

Switch/Case-Based Functions

```
class Employee...
    int payAmount() {
        switch (getType()) {
            case EmployeeType.ENGINEER:
               return _monthlySalary;
            case EmployeeType.SALESMAN:
               return _monthlySalary + _commission;
            case EmployeeType.MANAGER:
               return _monthlySalary + _bonus;
            default:
               throw new Exception("Incorrect Employee");
        }
    }
```

Switch Statements

```
class EmployeeType...
    abstract int payAmount(Employee emp);

class Salesman...
    int payAmount(Employee emp) {
        return emp.getMonthlySalary() + emp.getCommission();
    }

class Manager...
    int payAmount(Employee emp) {
        return emp.getMonthlySalary() + emp.getBonus();
    }
```

Names and Arguments

Use Descriptive Names

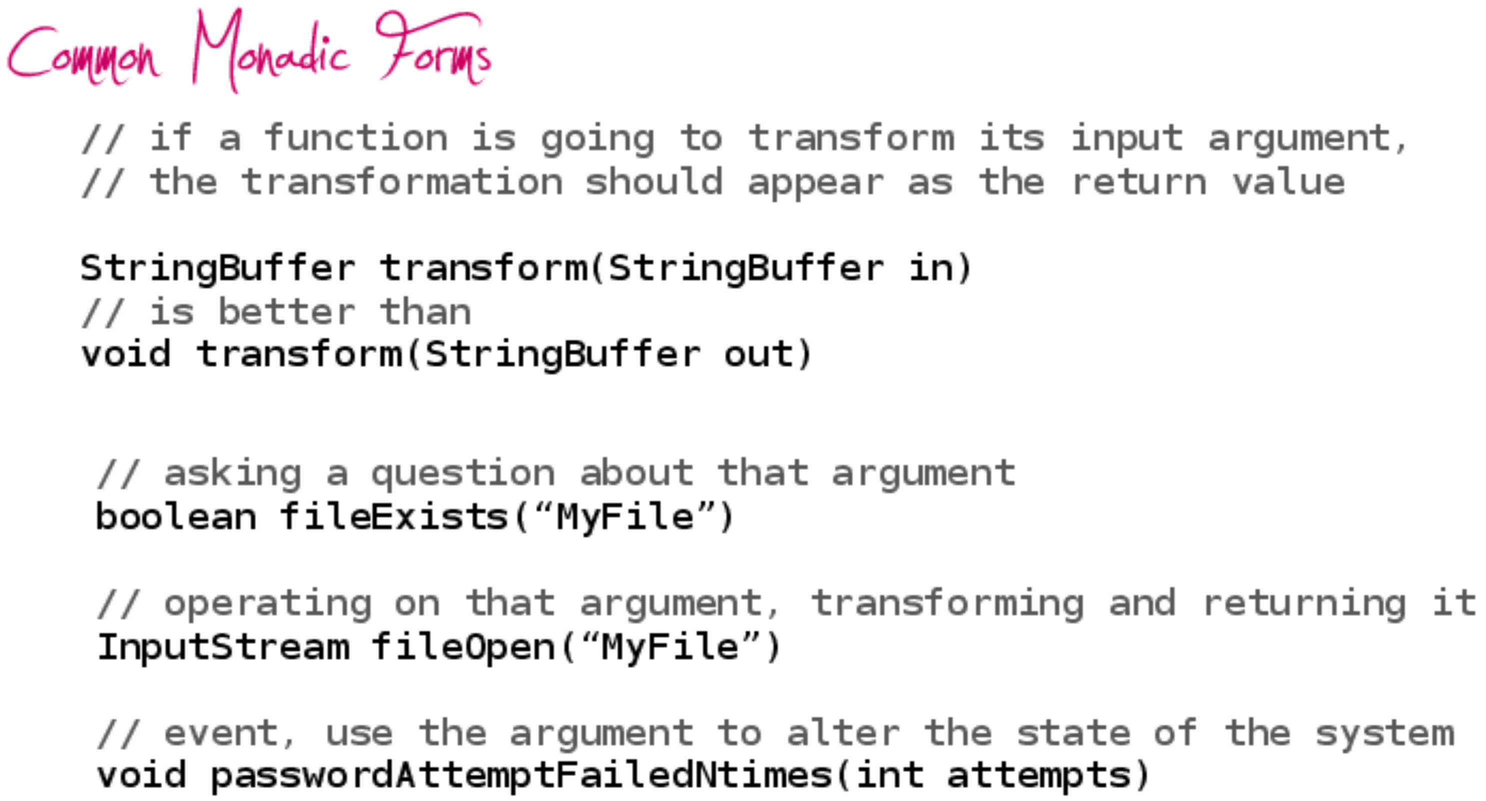
```
testableHtml  =>  includeSetupAndTeardownPages

includeSetupAndTeardownPages, includeSetupPages,
includeSuiteSetupPage, includeSetupPage
// what happened to
includeTeardownPages, includeSuiteTeardownPage,
includeTeardownPage
```

Function Arguments

```
// the ideal number of arguments for a function is zero
```

Monadic Forms



Common Monadic Forms

```
// if a function is going to transform its input argument,
// the transformation should appear as the return value

StringBuffer transform(StringBuffer in)
// is better than
void transform(StringBuffer out)


 // asking a question about that argument
 boolean fileExists(“MyFile”)

 // operating on that argument, transforming and returning it
 InputStream fileOpen(“MyFile”)

 // event, use the argument to alter the state of the system
 void passwordAttemptFailedNtimes(int attempts)
```

(Avoid) Flag Arguments

Flag Arguments

```
render(true)
```

```
renderForSuite()
renderForSingleTest()
```

Dyadic Functions and Triads

Dyadic Functions

```
writeField(name)
// is easier to understand than
writeField(outputStream, name)

// perfectly reasonable
Point p = new Point(0,0)

// problematic
assertEquals(expected, actual)
```

Triads

```
assertEquals(message, expected, actual)
```

🚫

Argument Objects, Verbs and Keywords

Argument Objects

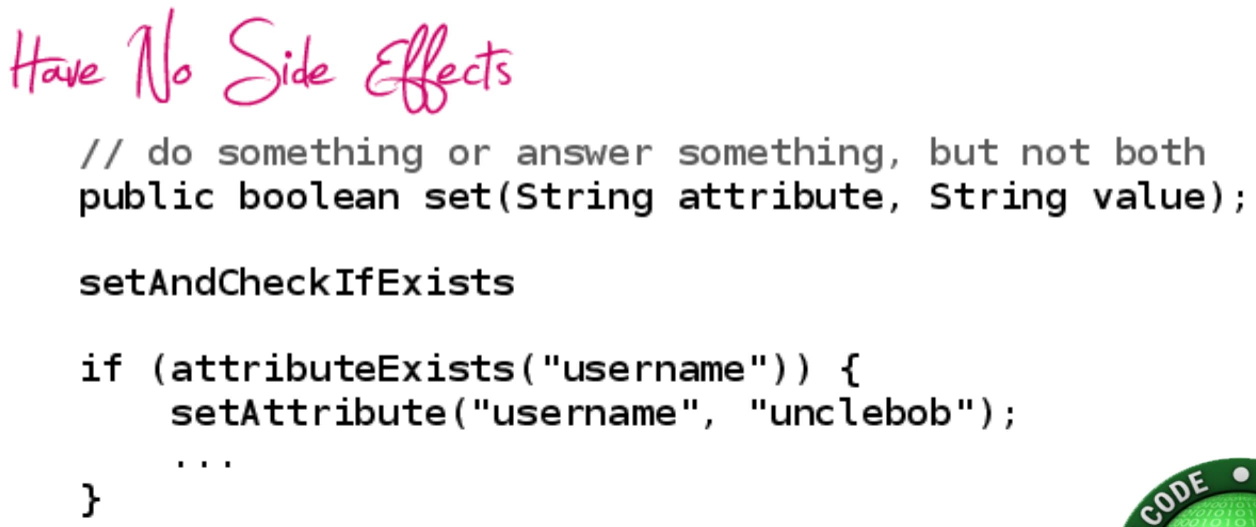
```
Circle makeCircle(double x, double y, double radius);
Circle makeCircle(Point center, double radius);
```

Verbs and Keywords

```
write(name)
writeField(name)

assertEquals(expected, actual)
assertExpectedEqualsActual(expected, actual)
```

No Side Effects



Have No Side Effects

```
// do something or answer something, but not both
public boolean set(String attribute, String value);

setAndCheckIfExists

if (attributeExists("username")) {
    setAttribute("username", "unclebob");
    ...
}
```

DRY and Structured Programming

Don't Repeat Yourself (DRY)

```
// duplication may be the root of all evil in software
```

Structured Programming

```
// Edsger Dijkstra’s rules
//   one entry
//   one exit

// functions small
// occasional multiple return, break, or continue statement
// can sometimes even be more expressive Dijkstra’s rules
```

3. Comments

Explain Yourself in Code

Comments Do Not Make Up for Bad Code

```
// don't comment bad code, rewrite it!
```

Explain Yourself in Code

```
// Check to see if the employee is eligible for full
benefits
if ((employee.flags & HOURLY_FLAG) &&
   (employee.age > 65))
```

```
if (employee.isEligibleForFullBenefits())
```

Legal and Informative Comments

Legal Comments

```
// Copyright (C) 2011 by Osoco. All rights reserved.
// Released under the terms of the GNU General Public
License // version 2 or later.
```

Informative Comments

```
// Returns an instance of the Responder being tested.
protected abstract Responder responderInstance();
// renaming the function: responderBeingTested

// format matched kk:mm:ss EEE, MMM dd, yyyy
Pattern timeMatcher = Pattern.compile(
"\\d*:\\d*:\\d* \\w*, \\w* \\d*, \\d*");
```

Explanation of Intent and Clarification (Good)

Explanation of Intent

```
//This is our best attempt to get a race condition
//by creating large number of threads.
for (int i = 0; i < 25000; i++) {
    WidgetBuilderThread widgetBuilderThread =
    new WidgetBuilderThread(widgetBuilder, text, failFlag);
    Thread thread = new Thread(widgetBuilderThread);
    thread.start();
}
```

Clarification

```
assertTrue(a.compareTo(b) == -1); // a < b
assertTrue(b.compareTo(a) == 1); // b > a
```

Warnings and TODOs

Warning of Consequences

```
public static SimpleDateFormat makeStandardHttpDateFormat() {
    //SimpleDateFormat is not thread safe,
    //so we need to create each instance independently.
    SimpleDateFormat df = new SimpleDateFormat("dd MM yyyy");
    df.setTimeZone(TimeZone.getTimeZone("GMT"));
    return df;
}
```

TODO Comments

```
//TODO-MdM these are not needed
// We expect this to go away when we do the checkout model
```

Amplification and JavaDoc in Public APIs

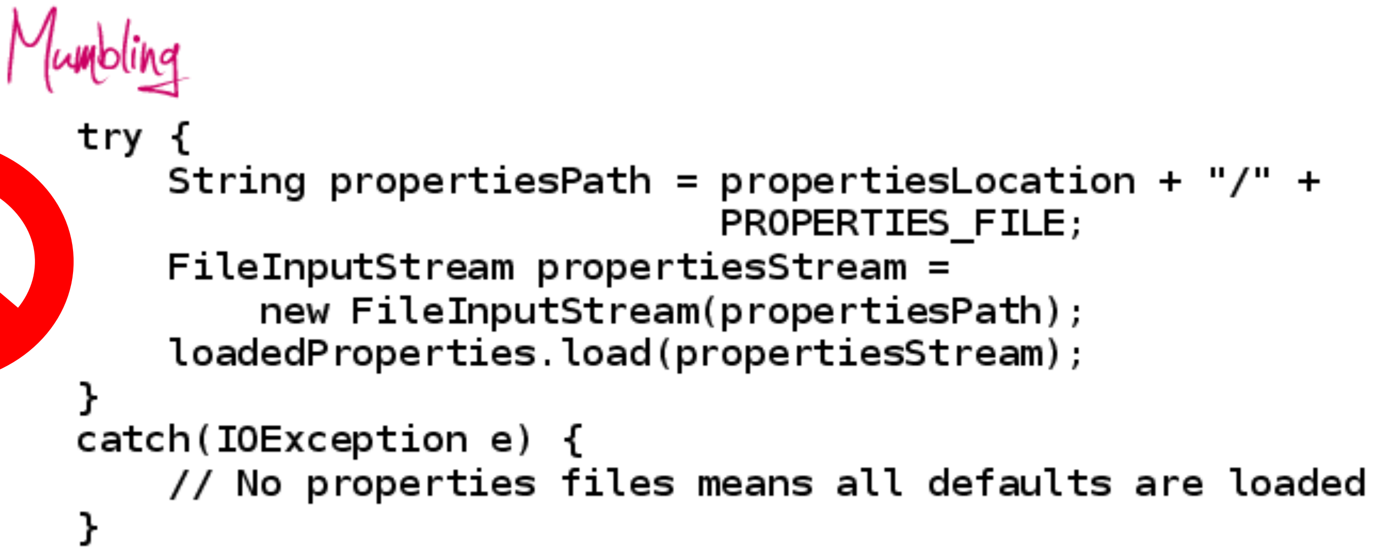
Amplification

```
String listItemContent = match.group(3).trim();
// the trim is real important. It removes the starting
// spaces that could cause the item to be recognized
// as another list.
new ListItemWidget(this, listItemContent, this.level + 1);
return buildList(text.substring(match.end()));
```

Javadocs in Public APIs

```
// there is nothing quite so helpful and satisfying
// as a well-described public API
```

Mumbling



Mumbling

```java
try {
    String propertiesPath = propertiesLocation + "/" +
                            PROPERTIES_FILE;
    FileInputStream propertiesStream =
        new FileInputStream(propertiesPath);
    loadedProperties.load(propertiesStream);
}
catch(IOException e) {
    // No properties files means all defaults are loaded
}
```

Redundant Comments

```
// Utility method that returns when this.closed is true.
// Throws an exception if the timeout is reached.
public synchronized void waitForClose
                (final long timeoutMillis) throws Exception
{
    if(!closed) {
        wait(timeoutMillis);
        if(!closed)
            throw new Exception("MockResponseSender
                                 could not be closed");
    }
}
```

Redundant Comments (cont‘d)

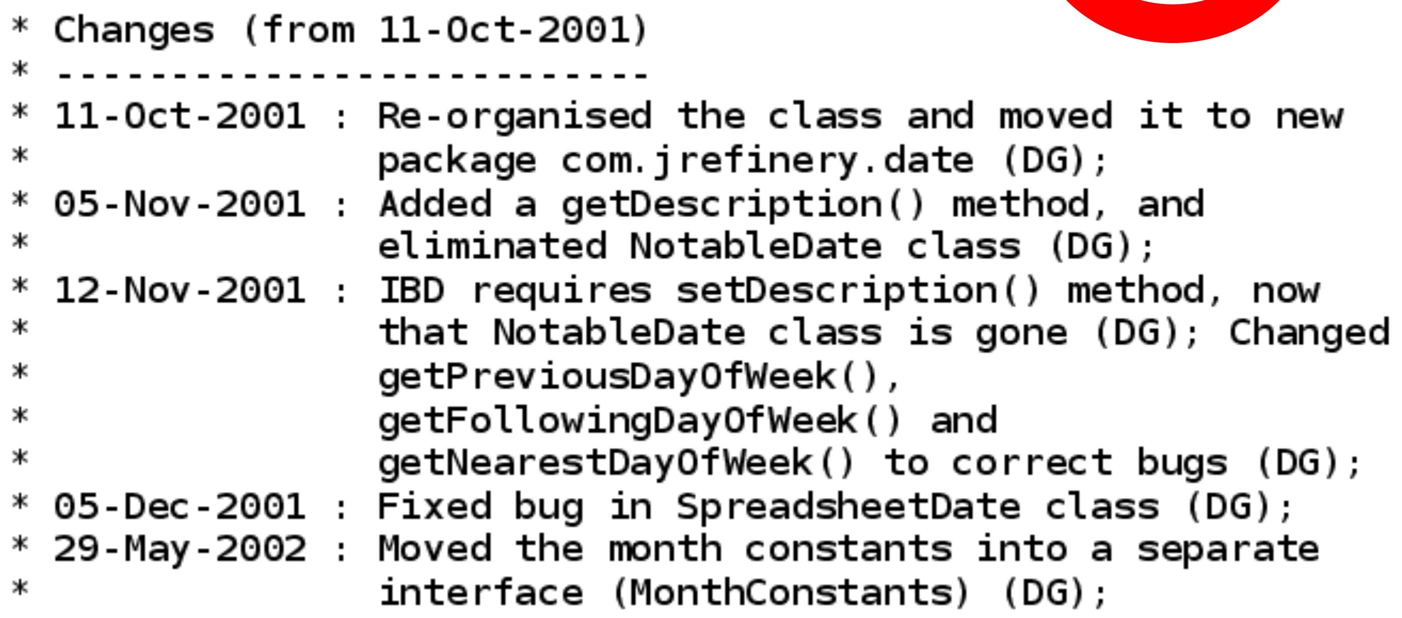
```
/**
 * The processor delay for this component.
 */
protected int backgroundProcessorDelay = -1;

/**
 * The lifecycle event support for this component.
 */
protected LifecycleSupport lifecycle =
                                  new LifecycleSupport(this);
/**
 * The container event listeners for this Container.
 */
protected ArrayList listeners = new ArrayList();
```

Mandated Comments

```
/**
 * @param title The title of the CD
 * @param author The author of the CD
 * @param tracks The number of tracks on the CD
 * @param durationInMinutes The duration of the CD in minutes
 */
public void addCD(String title, String author,
                  int tracks, int durationInMinutes) {
    CD cd = new CD();
    cd.title = title;
    cd.author = author;
    cd.tracks = tracks;
    cd.duration = durationInMinutes;
}
```

Journal Comments



```
* Changes (from 11-Oct-2001)
* --------------------------
* 11-Oct-2001 : Re-organised the class and moved it to new
*               package com.jrefinery.date (DG);
* 05-Nov-2001 : Added a getDescription() method, and
*               eliminated NotableDate class (DG);
* 12-Nov-2001 : IBD requires setDescription() method, now
*               that NotableDate class is gone (DG); Changed
*               getPreviousDayOfWeek(),
*               getFollowingDayOfWeek() and
*               getNearestDayOfWeek() to correct bugs (DG);
* 05-Dec-2001 : Fixed bug in SpreadsheetDate class (DG);
* 29-May-2002 : Moved the month constants into a separate
*               interface (MonthConstants) (DG);
```

Noise Comments

```
/**
 * Default constructor.
 */
protected AnnualDateRule() { }


/** The day of the month. */
private int dayOfMonth;


/**
 * Returns the day of the month.
 * @return the day of the month.
 */
public int getDayOfMonth() {
    return dayOfMonth;
}
```

Scary Noise

```
/** The name. */
private String name;

/** The version. */
private String version;

/** The licenceName. */
private String licenceName;

/** The version. */
private String info;
```

Function and/or Variable Over Comment

Don't Use a Comment When You Can Use a Function or a Variable

```
// does the module from the global list <mod> depend on the
// subsystem we are part of?
if (smodule.getDependSubsystems()
    .contains(subSysMod.getSubSystem()))
```

```
// this could be rephrased without the comment as
ArrayList moduleDependees = smodule.getDependSubsystems();
String ourSubSystem = subSysMod.getSubSystem();
if (moduleDependees.contains(ourSubSystem))
```

Position Markers and Closing Brace Comments

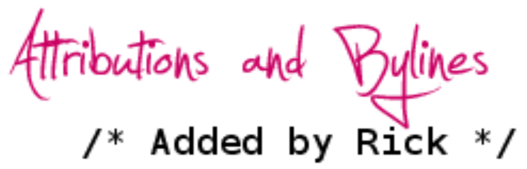
Position Markers

```
// Actions //////////////////////////////////
```

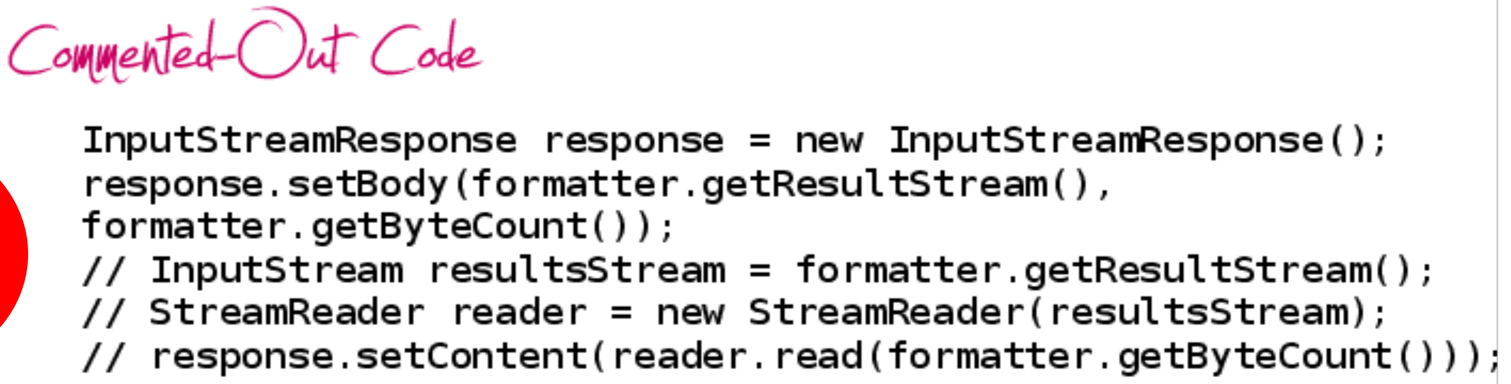
Closing Brace Comments

```
while ((line = in.readLine()) != null) {
    lineCount++;
    charCount += line.length();
    String words[] = line.split("\\W");
    wordCount += words.length;
} //while
```

Attributions, Bylines and Commented-Out Code

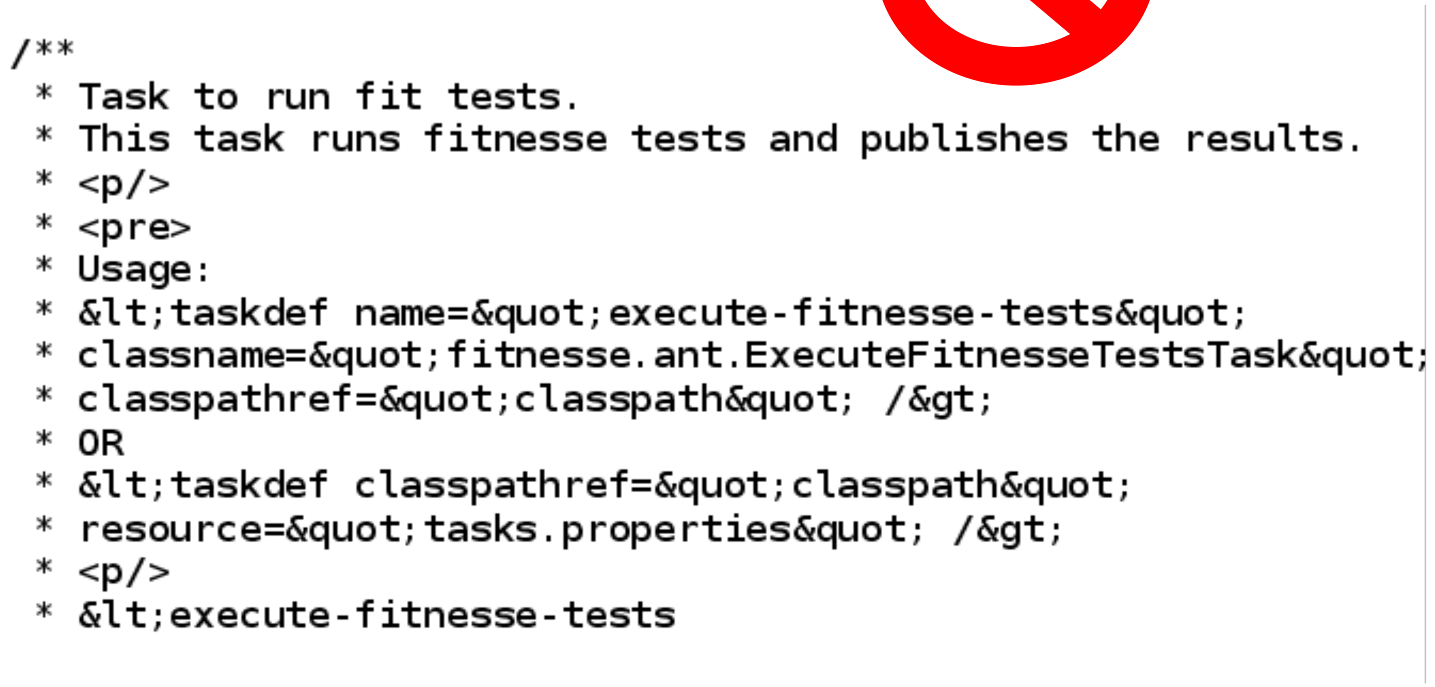

Attributions and Bylines

```
/* Added by Rick */
```


Commented-Out Code

```
InputStreamResponse response = new InputStreamResponse();
response.setBody(formatter.getResultStream(),
formatter.getByteCount());
// InputStream resultsStream = formatter.getResultStream();
// StreamReader reader = new StreamReader(resultsStream);
// response.setContent(reader.read(formatter.getByteCount()));
```

HTML Comments



```
/**
 * Task to run fit tests.
 * This task runs fitnesse tests and publishes the results.
 * <p/>
 * <pre>
 * Usage:
 * &lt;taskdef name=&quot;execute-fitnesse-tests&quot;
 * classname=&quot;fitnesse.ant.ExecuteFitnesseTestsTask&quot;
 * classpathref=&quot;classpath&quot; /&gt;
 * OR
 * &lt;taskdef classpathref=&quot;classpath&quot;
 * resource=&quot;tasks.properties&quot; /&gt;
 * <p/>
 * &lt;execute-fitnesse-tests
```

Too Much Information

```
/*
  RFC 2045 - Multipurpose Internet Mail Extensions (MIME)
  Part One: Format of Internet Message Bodies section 6.8.
  Base64 Content-Transfer-Encoding
  The encoding process represents 24-bit groups of input bits
  as output strings of 4 encoded characters. Proceeding from
  left to right, a 24-bit input group is formed by
  concatenating 3 8-bit input groups.
  These 24 bits are then treated as 4 concatenated 6-bit
  groups, each of which is translated into a single digit in
  the base64 alphabet.
  When encoding a bit stream via the base64 encoding, the bit
  stream must be presumed to be ordered with the most-
  significant-bit first.
 */
```

Inobvious Connection and Function Headers

Inobvious Connection

```
/*
 * start with an array that is big enough to hold all the
 * pixels (plus filter bytes), and an extra 200 bytes for
 * header info
 */
this.pngBytes = new byte[((this.width + 1) * this.height * 3)
                         + 200];
```

Function Headers

```
// short functions don't need much description
```

4. Formatting

Formatting

The Purpose of Formatting

```
// communication
```

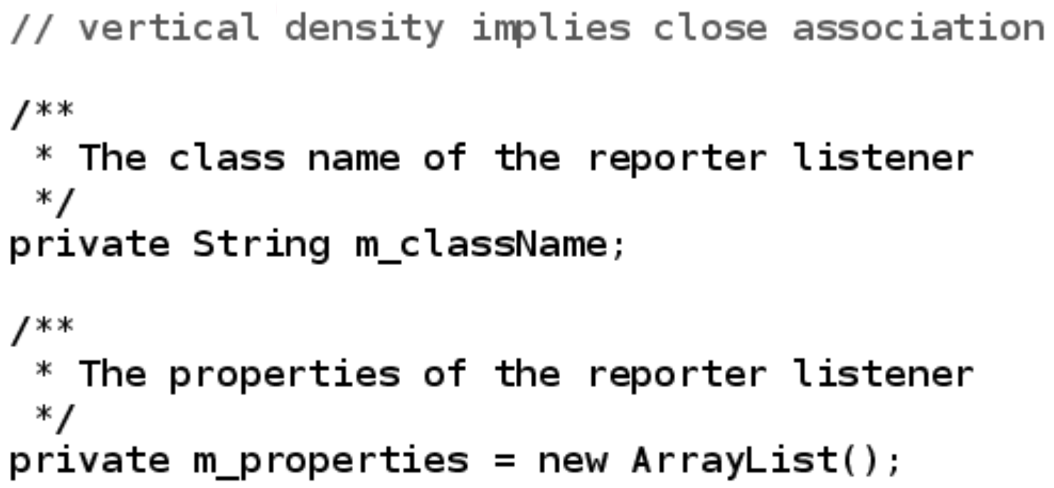
The Newspaper Metaphor

```
// high-level -> details
```

Vertical Openness Between Concepts

```
// each blank line is a visual cue
// that identifies a new and separate concept
```

Vertical Density

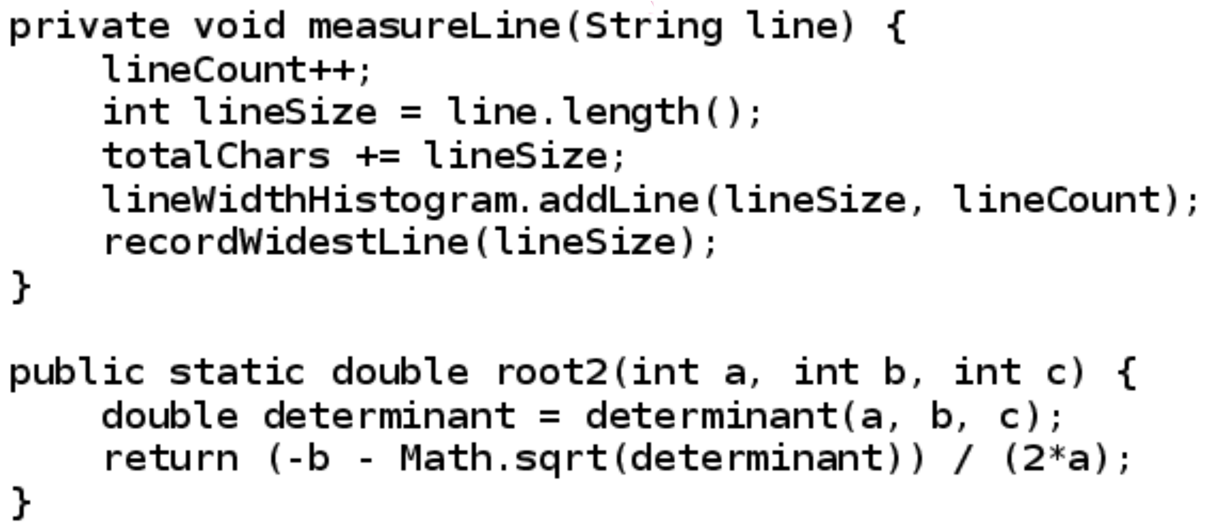


```
// vertical density implies close association

/**
 * The class name of the reporter listener
 */
private String m_className;

/**
 * The properties of the reporter listener
 */
private m_properties = new ArrayList();
```

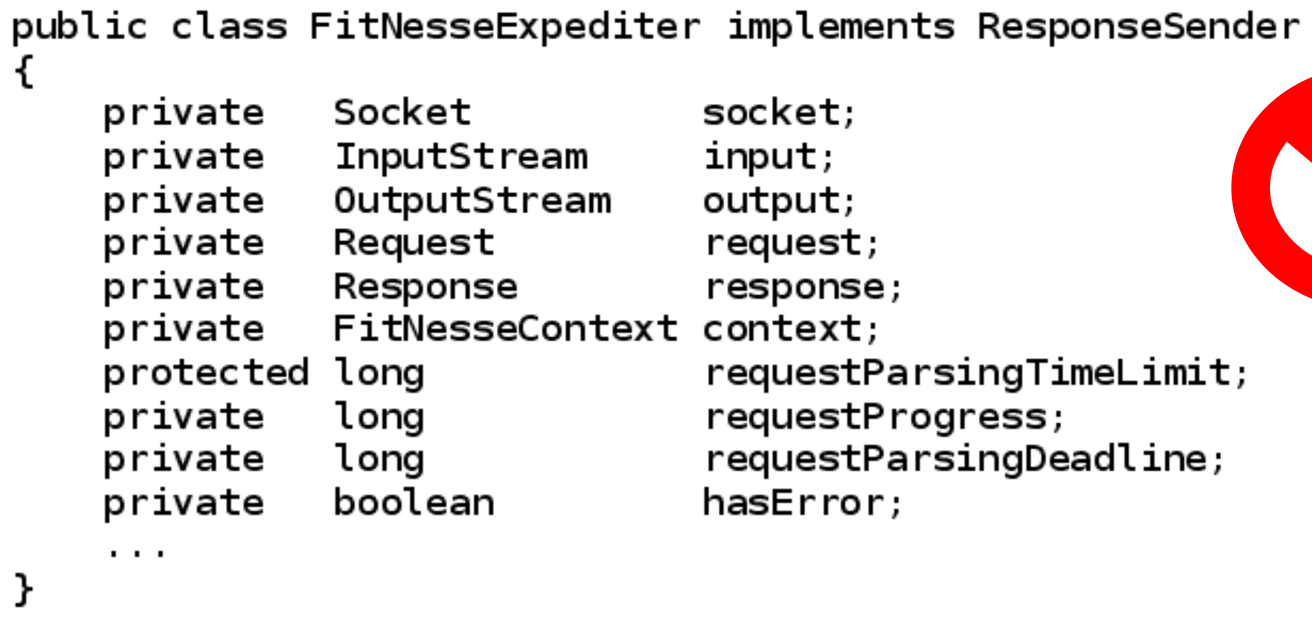
Horizontal Openness and Density



```
private void measureLine(String line) {
    lineCount++;
    int lineSize = line.length();
    totalChars += lineSize;
    lineWidthHistogram.addLine(lineSize, lineCount);
    recordWidestLine(lineSize);
}

public static double root2(int a, int b, int c) {
    double determinant = determinant(a, b, c);
    return (-b - Math.sqrt(determinant)) / (2*a);
}
```

Horizontal Alignment



```
public class FitNesseExpediter implements ResponseSender
{
    private   Socket          socket;
    private   InputStream     input;
    private   OutputStream    output;
    private   Request         request;
    private   Response        response;
    private   FitNesseContext context;
    protected long            requestParsingTimeLimit;
    private   long            requestProgress;
    private   long            requestParsingDeadline;
    private   boolean         hasError;
    ...
}
```

Horizontal Alignment (cont‘d)

```
public class FitNesseExpediter implements ResponseSender
{
    private Socket socket;
    private InputStream input;
    private OutputStream output;
    private Request request;
    private Response response;
    private FitNesseContext context;
    protected long requestParsingTimeLimit;
    private long requestProgress;
    private long requestParsingDeadline;
    private boolean hasError;
    ...
}
```

Breaking Indentation

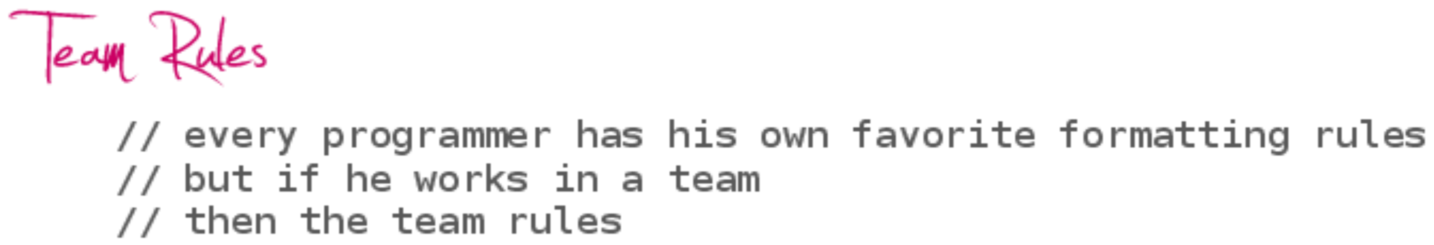
```
public class CommentWidget extends TextWidget {
    public static final String REGEXP =
           "^#[^\r\n]*(?:(?:\r\n)|\n|\r)?";
    public CommentWidget(String text) { super(text); }
    public String render() throws Exception { return ""; }
}
```

```
public class CommentWidget extends TextWidget {
    public static final String REGEXP =
           "^#[^\r\n]*(?:(?:\r\n)|\n|\r)?";

    public CommentWidget(String text) {
        super(text);
    }

    public String render() throws Exception {
        return "";
    }
}
```

Agree on Formatting Rules



Team Rules

```
// every programmer has his own favorite formatting rules
// but if he works in a team
// then the team rules
```

5. Objects and Data Structures

Data Abstraction

```java
public class Point {
    public double x;
    public double y;
}
```

```java
public interface Point {
    double getX();
    double getY();
    void setCartesian(double x, double y);
    double getR();
    double getTheta();
    void setPolar(double r, double theta);
}
```

Data Abstraction (cont‘d)

```
public interface Vehicle {
    double getFuelTankCapacityInGallons();
    double getGallonsOfGasoline();
}
```

```
public interface Vehicle {
    double getPercentFuelRemaining();
}
```

Train Wrecks

```
final String outputDir = ctxt.getOptions()
                             .getScratchDir()
                             .getAbsolutePath();

final String outputDir = ctxt.options.scratchDir.absolutePath;
```

```
Options opts = ctxt.getOptions();
File scratchDir = opts.getScratchDir();
final String outputDir = scratchDir.getAbsolutePath();
```

6. Error Handling

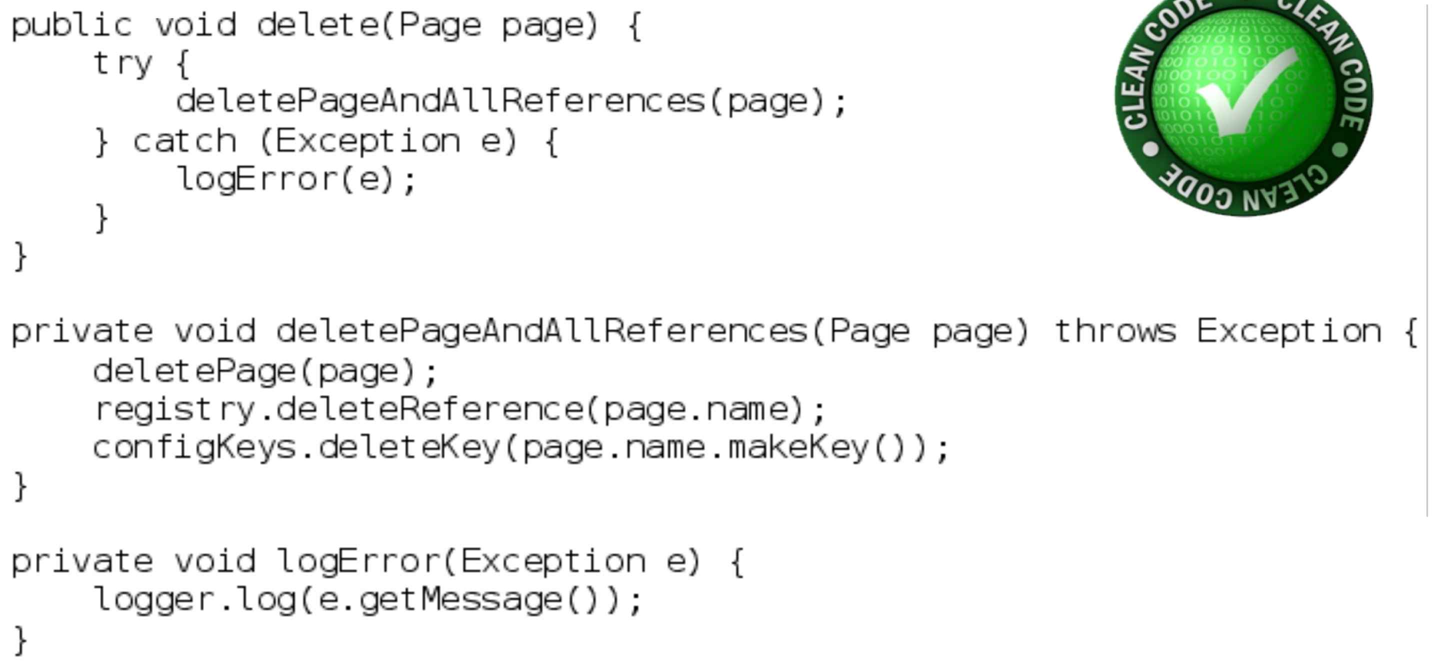
Exceptions Over Error Codes

```
if (deletePage(page) == E_OK) {
  if (registry.deleteReference(page.name) == E_OK) {
    if (configKeys.deleteKey(page.name.makeKey()) == E_OK){
      logger.log("page deleted");
    } else {
      logger.log("configKey not deleted");
    }
  } else {
    logger.log("deleteReference from registry failed");
  }
} else {
  logger.log("delete failed");
  return E_ERROR;
}
```

Prefer Exceptions to Returning Error Codes

```
try {
     deletePage(page);
     registry.deleteReference(page.name);
     configKeys.deleteKey(page.name.makeKey());
}
catch (Exception e) {
     logger.log(e.getMessage());
}
```

Extract Try/Catch Blocks



```java
public void delete(Page page) {
    try {
        deletePageAndAllReferences(page);
    } catch (Exception e) {
        logError(e);
    }
}

private void deletePageAndAllReferences(Page page) throws Exception {
    deletePage(page);
    registry.deleteReference(page.name);
    configKeys.deleteKey(page.name.makeKey());
}

private void logError(Exception e) {
    logger.log(e.getMessage());
}
```

Error Handling Is One Thing

```
// functions should do one thing
// error handing is one thing

// if the keyword try exists in a function
// it should be the very first word in the function and that
// there should be nothing after the catch/finally blocks
```

Define the Normal Flow

```
try {
    MealExpenses expenses = expenseReportDAO
                            .getMeals(employee.getID());
    m_total += expenses.getTotal();
} catch(MealExpensesNotFound e) {
    m_total += getMealPerDiem();
}
```

```
MealExpenses expenses = expenseReportDAO
                        .getMeals(employee.getID());
m_total += expenses.getTotal();
```

Don‘t Return Null

```
List<Employee> employees = getEmployees();
if (employees != null) {
    for(Employee e : employees) {
        totalPay += e.getPay();
    }
}
```

```
List<Employee> employees = getEmployees();
    for(Employee e : employees) {
        totalPay += e.getPay();
}
```

```
public List<Employee> getEmployees() {
    if( .. there are no employees .. )
        return Collections.emptyList();
}
```

Don‘t Pass Null

```
public double xProjection(Point p1, Point p2) {
    return (p2.x – p1.x) * 1.5;
}
```

```
public double xProjection(Point p1, Point p2) {
    if (p1 == null || p2 == null) {
        throw InvalidArgumentException ("Invalid argument
                                     for MetricsCalculator.xProjection");
    }
    return (p2.x – p1.x) * 1.5;
}
```

7. JUnit Tests

Three Laws of TDD (by Kent Beck)

Recap

Rule 1:
You may not write production code until you have written a failing unit test.

Rule 2:
You may not write more of a unit test than is sufficient to fail, and not compiling is failing.

Rule 3:
You may not write more production code than is sufficient to pass the currently failing test.

K. Beck. “Test Driven Development: By Example.” Addison-Wesley Longman, 2002.

Clean Tests

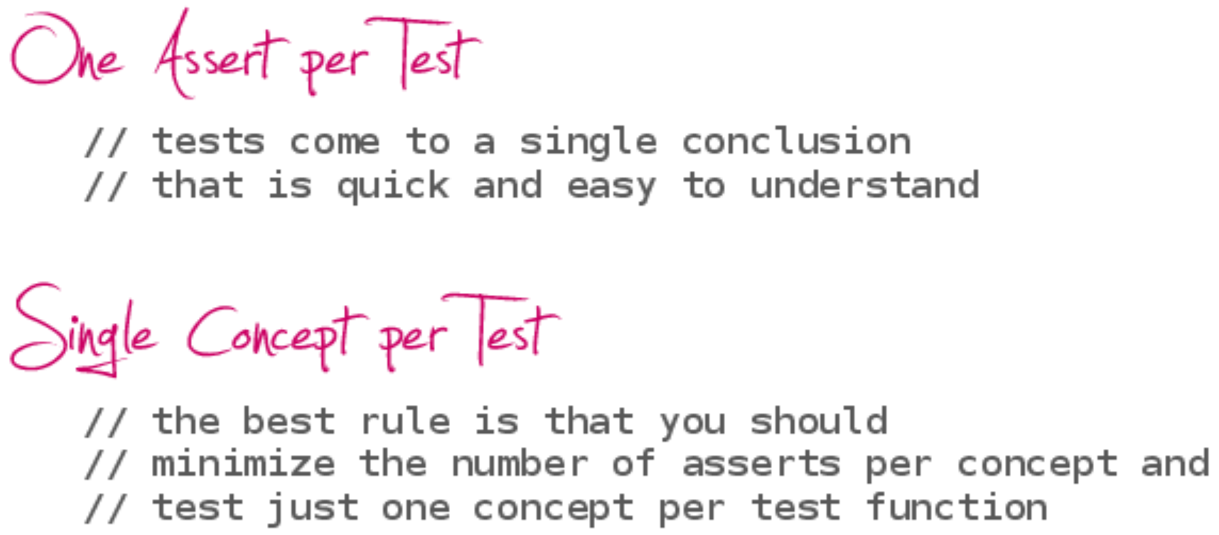
Keeping Tests Clean

```
// test code is just as important as production code
```

Clean Tests

```
// what makes a clean test? three things
// readability, readability, and readability
```

Single Assert and Single Concept Per Test



One Assert per Test

```
// tests come to a single conclusion
// that is quick and easy to understand
```

Single Concept per Test

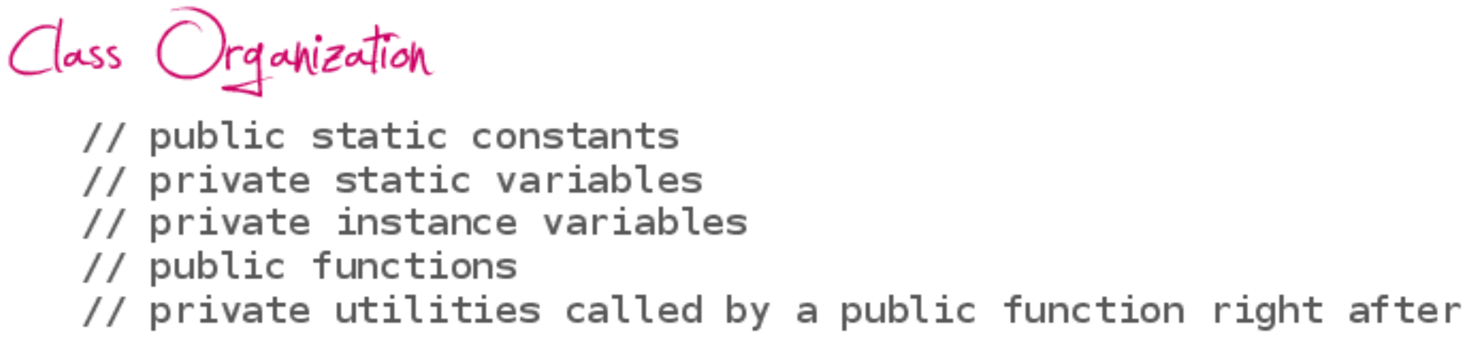
```
// the best rule is that you should
// minimize the number of asserts per concept and
// test just one concept per test function
```

F.I.R.S.T.

```
// Fast
// Independent
// Repeatable
// Self-validating
// Timely
```

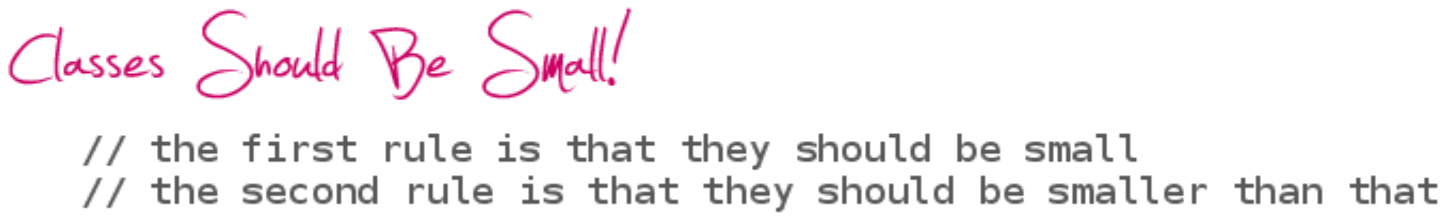
8. Classes

Class Organization and Size



Class Organization

```
// public static constants
// private static variables
// private instance variables
// public functions
// private utilities called by a public function right after
```



Classes Should Be Small!

```
// the first rule is that they should be small
// the second rule is that they should be smaller than that
```

Single Responsibility and Cohesion

The Single Responsibility Principle (SRP)

```
// a class or module should have one, and only one,
// reason to change

// SRP is one of the more important concept in OO design
```

Cohesion

```
// maintaining cohesion results in many small classes
```

Summary: Clean Code Strategies

Simple Design Rule 1: Runs All the Tests

Simple Design Rules 2: No Duplication

Simple Design Rules 3: Expressive

Simple Design Rules 4: Minimal Classes and Methods

More Readings

- ❑ ***„Clean Code: A Handbook of Agile Software Craftsmanship”*** by Robert C. “Uncle Bob” Martin, Prentice Hall, 2008
- ❑ ***„Effective Java“*** by Joshua Bloch, December 2017, Addison-Wesley Professional
- ❑ ***„Design Patterns. Elements of Reusable Object-Oriented Software.“*** by Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides, Addison-Wesley Publishing Company (1995)
- ❑ https://www.uml-diagrams.org
  Examples and descriptions of various concepts.

Any remaining question about Clean Code or Implementation Aspects?

Conclusion

- ❑ Clean Code is a constructive method for software engineering.
- ❑ Keep deadlines in mind: Final Code submission.

Next Week (Project-Part) – Week 11:
Integration Testing

- ➢ Integration Testing (Motivation, Approaches, Stubs and Drivers, Principles)
- ➢ Aspects of Version Control