CSC 5524 : Software quality, metrics, tests, processes

#### J <u>Paul</u> Gibson, D311

paul.gibson@telecom-sudparis.eu

http://www-public.telecom-sudparis.eu/~gibson/Teaching/CSC5524/

# **Software Quality - Tips Techniques & Tools**

http://www-public.telecom-sudparis.eu/~gibson/Teaching/CSC5524/ TipsTechniquesTools.pdf

# These are the following TTTs that all quality software engineers know about, and use as a matter of habit:

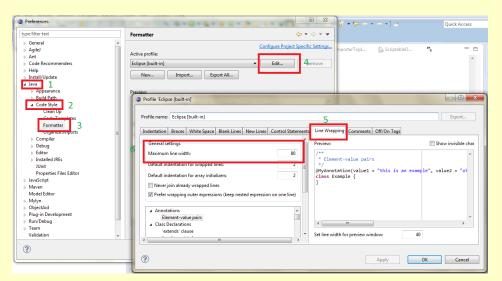
- Code style formatting
- Literate Programming
- Code Documentation Generators
- Code defect detection (bug finding)
- Design defect detection (bad smells), based on OO metrics
- Automated unit testing
- Code Coverage
- Version control
- Automated build: make, ant
- Continuous integration/delivery/testing
- Personal Software Process
- Software Process Improvement (SPI) & Capability Maturity Model (CMM)

#### **Code style formatting: indenting, whitespace**

All modern IDEs include tools for automatically formatting code to a predefined template/style/configuration

Many permit the definition of a library of these templates

TODO: Can you find and use this functionality in Eclipse (for Java)?



**READING** : *The elements of programming style*, Kernighan, Brian W., and Phillip James Plauger, 1979

2018: J Paul Gibson

#### **Literate Programming**

**READING:** Donald Knuth. "Literate Programming" (1984)

"Let us change our traditional attitude to the construction of programs: Instead of imagining that our main task is to instruct a computer what to do, let us concentrate rather on explaining to human beings what we want a computer to do."

Useful Link: http://vasc.ri.cmu.edu/old\_help/Programming/Literate/ literate.html

#### **Code Documentation Generators**

All modern IDEs include tools support for automating documentation generation

Language dependent, e.g. JavaDoc

http://www.oracle.com/technetwork/java/javase/ documentation/index-137483.html

http://doclet.com

Language independent, e.g. doxygen

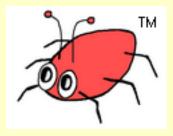
http://www.stack.nl/~dimitri/doxygen/index.html

### **Code defect detection (bug finding)**

Static analysis of code

Example, findbugs

http://findbugs.sourceforge.net



#### Design defect detection (bad smells), based on OO metrics

Example: JDeodorant is an Eclipse plugin that identifies bad designs and proposes fixes (refactorings)



http://users.encs.concordia.ca/~nikolaos/jdeodorant/

#### Automated unit testing

Nearly all modern programming languages have library/tool support for automated unit testing

For Java - JUnit



http://junit.org/junit4/

For C - CUnit

http://cunit.sourceforge.net

### **Code coverage**

When running tests, you need to know what percentage of code executed during the test runs.

Most modern IDEs provide coverage tools/plugins

For Eclipse, with Java, a good example is EclEmma

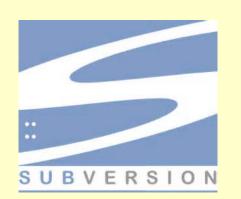
http://eclemma.org

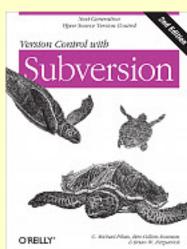
| Name 22 3 4 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1   | ≝∎G•]≜•§••∳•••]⊠.  | ar 1 🥭 🖼   |   | ti 😻 🏷   |  |
|---|--|--|---|--|--|
| Trained after 34,090 seconds  | 2 9 public boolean addAll int in   |  | (   |  |  |
|   | if [c.isEmpty]]] (   | nder, collect  | ion cl (  | -  |  |
| Runsi 13009/13009 DEmors: D Defailures: 0   | return false:  |  |   |  |  |
|   | <pre>} else if   size == index</pre>   | . II. aire an  | 01. (   |  |  |
|   | return add&11[c];  | 11 D100  | 01.0  |  |  |
| Pakzes Catherardry  | ) else (   |  |   |  |  |
| - In junit framework. Test Sube   | Listable succ = getl   | Listableätlin  | dex La  |  |  |
| junit.framework.TestSuite   | Listable pred = [mal   |  |   | mere i La  |  |
| TestBagLtils  | Iterator it = c.iter   |  |   |  |  |
| B - in org. apache.commons.collections.TestClos   | while [it.basNext]]  |  |   |  |  |
|   | Image: A second se  |  |   |  |  |
| ⊞ TestBufferUtils   |  |  |   |  |  |
| ∃ TestEnumerationUtils  | return true;   |  |   |  |  |
| B up apache commons collections. Testfact   |  |  |   |  |  |
| Testi.kti.kti     TestiMapi.tik   |  |  |   |  |  |
| Image of the second secon |  |  |   |  |  |
| TestSetLitik  |  |  | _   | •  |  |
|   | Problems Javadoc Dedaration Console Deverage   | 11   |   |  |  |
|   |  |  |   |  |  |
| org. apache.commons.collections.TestTrar     TestArrayStack   |  |  |   |  |  |
| H orp. apache .commons .collections. TestTrar     H orp. apache .commons .collections. TestTrar     H orp. TestBranNap  | TestAlPackages (31.10.2006 15:04:14)   | 0 <sub>6</sub>   36 %  | a 🗈 🗟 - 🔯   |  |  |
| ⊞ ≣ TestArrayStadk<br>⊞ ≣ TestBeanMap   | TestAlPackages (31.10.2006 15:D4:14)<br>Element  | Q 26 3<br>Coverage   | CoveredLines  | TotalLines   |  |
| ⊞- I TestArrayStack   | TestAlPachages (31,10,2006 15:04:14)<br>Element<br>  | Coverage<br>70,5 %   | Covered Lines   | Total Lines<br>13738   |  |
| TestArrayStack     TestBeanNap     Grg.apache.commons.collections.TestBina-   | TestAlPackages (31.10.2006 15:04:14)<br>Element<br>G S java - commons-collections<br>E) B org. spache science scientions   | 0, 36 3<br>Coverage<br>79,5 %<br>74,1 %  | Covered Lines<br>10927<br>3842  | TotalLines<br>13738<br>5183  |  |
| In TestArrayStad:     InstArrayStad:     InstBanMap     InstBanMap     InstBanMap     InstBandedTivBuffer   | TestAlPackages (31.10.2006 15:04:14)<br>Element<br>  | 0, 36 %<br>Coverage<br>79,5 %<br>74,1 %<br>80,5 %  | Covered Lines<br>10927<br>3842<br>32  | TotalLines<br>13738<br>5183<br>37  |  |
| Trestmarking     T | TestAlPackages (31.10.2005 15:04:14) Benet:  | 0, 10 %<br>Coverage<br>79,5 %<br>74,1 %<br>86,5 %<br>86,7 %  | Covered Lines<br>10927<br>3842<br>32<br>13  | TotalLines<br>13738<br>5183<br>37<br>15  |  |
| Fig. Technics Stack     Fig. Technics Stack     Fig. Technics Stack     Fig. Technics Collections Technics     Fig. Technics Collections     Fig. Technics And Provide Technics     Fig. TechCustor adds Index Air      Fig. TechCustor adds Index Air      Fig. TechCustor Collected Nap   | TestAllhackages (31.10.2005 (5:04:14)<br>Beneat<br>() (2) yon- commons-collectors<br>() (2) ArroyStackyene<br>() (2) ArroyStackyene<br>() (2) Bagtific jewa<br>() (2) Bagtific jewa<br>() (2) Bagtific jewa  | Op         M         Op           Coverage         79,5 %         74,1 %           86,5 %         86,7 %         86,7 %           72,4 %         72,4 %         72,4 % | Covered Lines<br>10927<br>3842<br>32<br>13<br>155                                   | TotalLines<br>13738<br>5183<br>37<br>15<br>214   |  |
| H = Trektras Stads     H = Trektras     H = Trektras Stads     H = Trektras     H = Trektras  | TestAlPackages (21.10.2005 35:04:14)<br>Benefit<br>■ ■ ■ aparties connects collectors<br>■ ■ Transition (pro-<br>0.1) Transition (pro-<br>0.1) Dearting (pro-<br>0.1) D  | Op         M         M           Coverage         79,5 %           79,5 %         74,1 %           86,5 %         85,7 %           72,4 %         87,6 %               | Covered Lines<br>10927<br>3842<br>32<br>13<br>155<br>127                            | TotalLines<br>13736<br>5183<br>37<br>15<br>214<br>145                                  |  |
| B T Technolitak     Techn | TestAll'schages (31.10.2005 15:04:14)<br>Brevet  | 0, 10 0<br>Coverage<br>79,5 %<br>74,1 %<br>80,5 %<br>80,7 %<br>72,4 %<br>87,6 %<br>93,2 %  | Covered Lines<br>10927<br>3842<br>32<br>13<br>155<br>127<br>82                      | TotalLines<br>13736<br>5183<br>37<br>15<br>214<br>145<br>88                            |  |
| B T Technologian     Technologian   | TestRifflexRages (21.10.2005 15:04:14)<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet<br>Bienet | 0, 36 3<br>Coverage<br>79,5 %<br>70,1 %<br>80,5 %<br>72,4 %<br>87,6 %<br>93,2 %<br>93,2 %<br>93,2 %  | CoveredLines<br>10927<br>3842<br>32<br>13<br>158<br>127<br>82<br>82<br>5            | TotalLines<br>13738<br>5183<br>37<br>15<br>214<br>145<br>58<br>9                       |  |
| Comparison of the second  | TestABlackages (31:10:2005 15:04:14)           Brenet           ● ● Prove common-collectors  | 0, 36 9<br>Coverage<br>79,5 %<br>74,1 %<br>86,5 %<br>86,5 %<br>72,4 %<br>87,6 %<br>93,2 %<br>93,2 %<br>83,9 %  | Covered Lines<br>10927<br>3842<br>32<br>13<br>155<br>127<br>82<br>5<br>8            | TotalLines<br>13738<br>5183<br>37<br>15<br>214<br>145<br>88<br>9<br>9                  |  |
| B      B      TestArmoltak     Signal TestArmoltak     Signal Second a     Signal Second a     Signal Second and a Second and American Second | TestRifflexRages (21.10.2005 15:04:14)<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext  | 05 38 3<br>Coverage<br>79,5 %<br>79,5 %<br>79,5 %<br>70,5 %<br>80,5 %<br>80,7 %<br>72,4 %<br>93,2 %<br>93,2 %<br>93,2 %<br>93,9 %<br>93,9 %                            | Covered Lines<br>10927<br>3842<br>32<br>13<br>155<br>127<br>82<br>5<br>5<br>6<br>4  | TotalLines<br>13738<br>5183<br>37<br>15<br>214<br>145<br>88<br>9<br>9<br>9<br>9        |  |
| Comparison of the second  | TentHirachappe (31.0.2000 35:04:14)<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet<br>Bannet    | 0, 28 %<br>Coverage<br>79,5 %<br>74,1 %<br>86,5 %<br>86,7 %<br>72,4 %<br>87,4 %<br>93,2 %<br>83,9 %<br>83,9 %<br>93,6 %<br>93,2 %                                      | Covered Lines<br>10907<br>3842<br>32<br>13<br>155<br>127<br>82<br>5<br>8<br>4<br>31 | TotalLines<br>13736<br>5183<br>37<br>15<br>214<br>145<br>88<br>9<br>9<br>9<br>13<br>33 |  |
| B      B      TestArmoltak     Signal TestArmoltak     Signal Second a     Signal Second a     Signal Second and a Second and American Second | TestRifflexRages (21.10.2005 15:04:14)<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext<br>Bienext  | 05 38 3<br>Coverage<br>79,5 %<br>79,5 %<br>79,5 %<br>70,5 %<br>80,5 %<br>80,7 %<br>72,4 %<br>93,2 %<br>93,2 %<br>93,2 %<br>93,9 %<br>93,9 %                            | Covered Lines<br>10927<br>3842<br>32<br>13<br>155<br>127<br>82<br>5<br>5<br>6<br>4  | TotalLines<br>133738<br>5183<br>37<br>15<br>214<br>145<br>88<br>9<br>9<br>9<br>9<br>13 |  |

# **Version control**

You should know the basics of

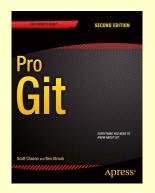
Subversion -svn https://subversion.apache.org



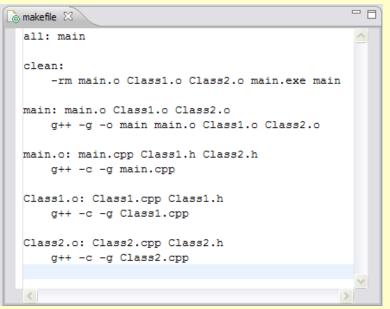


Git https://git-scm.com/





### Automated build: make, ant



http://www.gnu.org/software/make/manual/make.html



### **Continuous integration/delivery/testing**

- Maven https://maven.apache.org
  - http://www.sonarqube.org
- Jenkins https://jenkins.io

Sonar

Hudson http://hudson-ci.org

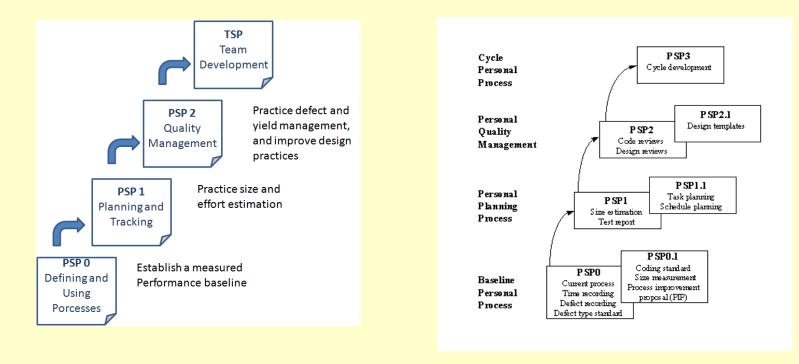






Make build easy Make build a uniform process Provide quality information feedback Support/enforce best practice for test/delivery Wrap up all this on an intreated service/server

# **Personal Software Process**

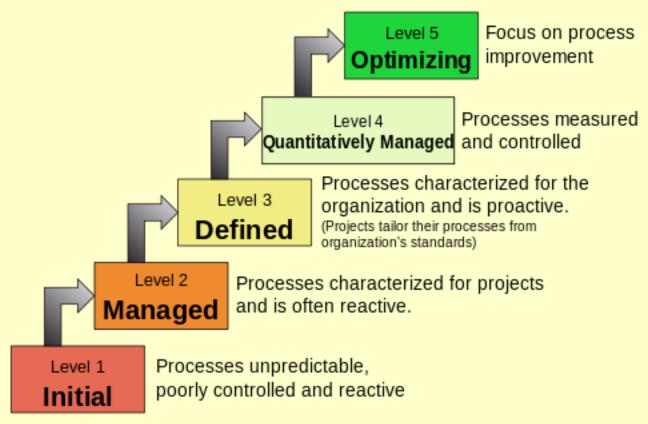


Using a defined and measured Personal Software Process, Watts S. Humphrey, 1996

The Personal Software Process: A Cautionary Case Study, Philip M. Johnson, Anne M. Disney, 1998

#### Software Process Improvement (SPI) & Capability Maturity Model (CMM)

#### **Characteristics of the Maturity levels**



#### http://www.sei.cmu.edu/cmmi/