

Index

Note: Page numbers followed by “b”, “f” and “t” indicate boxes, figures and tables respectively.

A

ABS. *See* Anti-braking system
Abstract Factory pattern, 36, 37f
AbstractButton class, 188, 189f
Abstraction, 21
 enabling techniques for, 22f, 24t
 human smiley face, 21f
 principle, 22
 smells resulting due to violation, 23f
 unused, 49–53
AbstractOwnableSynchronizer class, 142
 refactoring, 147, 148f
 unfactored methods in subtypes, 143f
AbstractQueuedLongSynchronizer class, 13–14,
 142, 143b
AbstractQueuedSynchronizer class, 13–14, 142
Acyclic Dependencies Principle (ADP), 108
Advanced Encryption Standard (AES), 80
Anti-braking system (ABS), 61
Antipattern, 13
Application Programming Interface (API), 171,
 12, 26
Architectural critique tools, 204
Auto-generated code, 101, 107

B

“Big-bang” refactoring, 211
Bloated implementation, 103
Bloated interface and implementation, 103–105
Booch’s object model, 16
Bounded Context, 60
Broken Hierarchy, 173
 aliases, 180
 causes, 173
 examples, 174–178
 practical considerations, 180–181
 quality attributes, 179–180
 rationale, 173
 refactoring, 178–179
Broken Modularization, 96, 199–200
 aliases, 101
 causes, 96
 classes in device management application, 97f
 examples, 97–99
 impacted quality attributes, 100–101
 practical considerations, 101–102
 rationale, 96
 refactoring, 99–100

Bug patterns. *See* Code analysis tools
ButtonModel interface, 38f
Buy-in for refactoring, 207–208

C

C-like procedural languages, 127
Calendar class, 13
Call-back functionality, 109–110
CallSite holder, 164b
 refactoring for, 166f–167f
Chained if-else statements, 127
Changeability, 28, 32, 39, 43, 59
ChangeableCallSite, 168
“Class Adapter” pattern, 180–181, 181f
Class with unparameterized methods, 71
Cloud ecosystem, 110
CoC. *See* Cost of Change
Code analysis tools, 204
Code clones, 54b
 detectors, 204–205
Code debt, 2
Collapse hierarchy, 155
Collapsed type hierarchy, 133
ColorModel class, 89, 88
Command pattern, 34
ComponentColorModel class, 87
Composite pattern, 172f, 172b
Comprehension tools, 204
“Compromised” Properties, 175b
ConcurrentLinkedQueue class, 183
ConstantCallSite class, 164
Cooccurring smells, 198–199. *See also* Precursors
 smells
Copy-paste programming, 55
Cost of Change (CoC), 4
Critique tools, 204–205
CustomListBox class, 75
Cyclic Hierarchy, 187, 197
 AbstractButton class, 189f
 aliases, 191–192
 causes, 188
 examples, 188
 practical considerations, 192
 quality attributes, 191
 rationale, 188
 refactoring, 189–190
 state design pattern, 190f
 strategy design pattern, 190f

Cyclically-dependent Modularization, 200, 108,
201f, 201b
aliases, 117–118
causes, 109–110
breaking, 113f–114f
between classes A and B, 113f
cycles in java.util package, 109f
examples, 110–112
between image and encryption classes, 111f
impacted quality attributes, 116–117
between matcher and pattern, 118f
between order and OrderImpl classes, 112f
between order and TaxCalculator classes, 111f
practical considerations, 118
rationale, 108–109
refactoring, 112–116
understanding cycles, 108b–109b

D

“Data buffer”, 136b–137b
Data clumps, 26, 28
Data Encryption Standard (DES), 80
Data Transfer Object (DTO), 102
DataBuffer class, 87
DatagramChannel hierarchy, 159f, 160–161
Deep Hierarchy, 157–159, 198
aliases, 163
causes, 158
examples, 158–159
practical considerations, 163
quality attributes, 161–163
rationale, 157–158
refactoring, 159–161
Deficient Encapsulation, 63, 199–200
aliases, 71
causes, 64
examples, 64–69
global variable “current” in Linux kernel, 68f
impacted quality attributes, 70
practical considerations, 71–72
public data members in java.awt.Point class, 64f
rationale, 63
refactoring, 69–70
smell effect
Definition Editor, 194–196, 195f
“Degenerate inheritance”, 187
Dependency diagram, 108b–109b
DES. *See* Data Encryption Standard
DESEncryption class, 110
Design debt, 2
Design fragment, 10–11
Design patterns, 13
Design principle violation, 13

Design smells, 1, 9
address, 15
care about, 10–12
catalog, 9
causes, 12, 12f
design principles violation, 13
inappropriate use of patterns, 13
language limitations, 13–14
nonadherence to practices and processes, 14
procedural thinking in OO, 14
viscosity, 14
classification, 15–16, 17f
design principles based classification, 16
high-level principles, 16t
naming scheme for, 16–18
template for documenting smells, 18–19,
18t–19t
quality attributes, 10t
DeviceData class, 97
Diamond hierarchy, multipath hierarchy vs., 182b
Distorted hierarchy, 163
Documentation debt, 2
Don’t Repeat Yourself (DRY), 55, 127
principle, 141
DTO. *See* Data Transfer Object
“Dump-all” utility classes, 119
Duplicate Abstraction, 54, 178. *See also*
Abstraction
aliases, 59
causes, 55
examples, 56–57
impacted quality attributes, 59
practical considerations, 59–60
rationale, 55
refactoring, 57–58
Duplicate abstraction smell, 194

E

E-commerce application, 47
Encapsulation, 61
application of principle, 61
deficient, 63–72
design smells, 63t
enabling techniques for, 62f
leaky, 72–78
missing, 78–86
smells, 62f
unexploited, 86–91
violated encapsulation enabling techniques, 63t
Environment viscosity, 14
EventObject hierarchy, 153f
Extensibility, 28, 32, 39, 43, 59
“Extract hierarchy” refactoring, 130

F

Factory Disposal Method pattern, 38
Fan-out, 95
 Feature-rich e-mail application, 73–75
 First-In-First-Out (FIFO), 50
 Font class hierarchy, 135f
 “Functional decomposition” approach, 33b
 Functionally similar clones, 54b
 Future-proofing, 155

G

Generalization, 125

H

“Half-hearted operations”, 39
 Hard-to-visualize indirect dependencies, 110, 188
 HashSet methods, 174–175
 Hideable public attributes/methods, 71
 Hierarchy
 broken, 173–181
 cyclic, 187–192
 deep, 157–163
 enabling techniques for principle, 124f
 human species classification, 123f
 missing, 127–134
 modern software, 124
 multipath, 182–187
 principle, 124
 rebellious, 163–173
 speculative, 154–157
 type, 124
 unfactored, 140–149
 unnecessary, 134–140
 wide, 150–154
 HTMLEditorKit class, 170
 HTMLReport hierarchy, 156f
 Hub-like Modularization, 118
 aliases, 122
 causes, 119
 examples, 119
 impacted quality attributes, 122
 practical considerations, 122
 rationale, 118–119
 refactoring, 119–121
 Human species, 123f

I

IDE. *See* Integrated Development Environment
 IMPACT refactoring process model, 208, 209f.
 See also Buy-in for refactoring
 action on planned refactoring tasks, 210
 behavior preservation ensuring test, 210

refactoring activities planning, 209–210
 refactoring candidates identification, 209

Imperative Abstraction, 29

aliases, 34
 classes
 image processing application, 31f
 report generation functionality, 30f
 examples, 30–31
 impacted quality attributes, 32–34
 practical considerations, 34
 procedural thinking, 29
 rationale, 29
 refactoring, 31–32, 31f–32f
 smell, 29

Inadequate design analysis, 25

Incomplete Abstraction, 34

aliases, 39
 ButtonModel interface, 38f
 causes, 35
 examples, 35–37
 impacted quality attributes, 39
 practical considerations, 39–40
 rationale, 34–35
 refactoring, 37–38
 symmetric method pairs, 37t

Inheritance hierarchy, 136

“Inline class” refactoring, 47

Insufficient Modularization, 102

aliases, 107
 causes, 103
 examples, 103–105
 impacted quality attributes, 106–107
 Multifaceted Abstraction vs., 102b
 practical considerations, 107
 rationale, 102–103
 refactoring, 105–106

Integrated Development Environment (IDE), 205

International Standard Book Numbers (ISBNs), 25

Interplay of smells, 196

in isolation, 196
 amplifying other smells, 198
 cooccurring smells, 198–199
 problems, 200–201
 smells as precursors, 199–200
 in java.util library, 197f

Inverted hierarchy, 178f–179f, 179

IS-A relationship, 173, 176b

ISBNs. *See* International Standard Book Numbers

J

java.awt.Component class, 103, 105f
 java.awt.Font class, 119, 120f
 java.awt.Point class, 64–65

- java.awt.Rectangle class, 144, 145f
- java.awt.Toolkit superclass, 164–165
- java.io.Console class, 69–70
- java.io.ObjectStreamClass, 133, 133b
- java.io.ObjectStreamConstants class, 46–47
- java.lang.invoke.CallSite class, 164, 165f
- java.lang.Math classes, 49
- java.lang.StrictMath classes, 49
- java.lang.System class, 66–69
- java.net.SocketPermission, 103
- java.nio.Buffer, 137f
- java.sql package, 176–177
- java.swing.JLabel class, 171
- java.swing.JTable class, 105f
- java.swing.plaf.windows.XPStyle.java example, 128, 128b
 - refactoring suggestion, 130–131
- java.text.NumberFormat, 141–142
- java.util library, 197f
- java.util.Calendar class, 13, 41
- java.util.Component class, 119
- java.util.Date class, 176, 177f
- java.util.EventObject class, 151, 152f
- java.util.Stack class, 13
- java.util.Timer class, 56
- javax.management.timer.Timer class, 56
- javax.sound.sampled.AudioFormat class, 128, 129b
 - refactoring suggestion, 131–132
- javax.swing.ColorChooserDialog hierarchy, 198, 199f
- javax.swing.text.rtf.RTFEditorKit, 170
- javax.swing.Timer class, 56
- javax.swing.WindowConstants interface, 46
- JDialog class, 46–47
- JFrame class, 46–47
- JInternalFrame class, 46–47
- JobStateReasons, 174b
 - partial inheritance hierarchy, 174f
- Joda class, 41

K

- Key classes, 107, 122

L

- L & F. *See* Look & Feel
- Leaky Encapsulation, 72
 - aliases, 78
 - case study, 77b
 - causes, 72–73
 - class leaking implementation details, 75f
 - examples, 73–75
 - impacted quality attributes, 77–78
 - practical considerations, 78

- rationale, 72
- refactoring, 75–77

- LineStyle hierarchy, 136f
 - refactoring for, 138–139, 139f

- Linux, 68b

- Liskov's Substitution Principle (LSP), 13, 125

- List-like inheritance hierarchies, 157

- Look & Feel (L & F), 159

- LSP. *See* Liskov's Substitution Principle

M

- Map domain entities, 29

- Mental blocks, 207

- Metric tools, 204–205

- Missing Abstraction, 24

- aliases, 28

- causes

- inadequate design analysis, 25

- lack of refactoring, 25

- misguided focus on minor performance gains, 25

- examples, 25–26

- impacted quality attributes, 28

- practical considerations, 28–29

- rationale, 24

- refactoring, 26–28

- Missing Encapsulation, 78

- aliases, 85

- causes, 79–80

- examples, 80–82

- impacted quality attributes, 85

- practical considerations, 86

- rationale, 78–79

- refactoring, 82–85

- Missing Hierarchy, 127

- aliases, 133

- causes, 127–128

- design smells and enabling techniques, 127t

- examples, 128–130

- interacting with external world, 133–134

- quality attributes, 132

- rationale, 127

- refactoring, 130–132

- “Missing inheritance”, 133

- “Mistaken aggregates”, 180

- Modern software, 124

- Modularization, 93

- broken, 96–102

- cyclically-dependent, 108–118

- design smells and violated enabling technique, 95t

- enabling techniques for, 94f, 95

- hub-like, 118–122

- insufficient, 102–107
- principle, 94
- smells resulting from violation, 95f
- Module, 94
- “Move method” refactoring, 166
- Multifaceted Abstraction, 40, 102b, 198–199
 - aliases, 44
 - causes, 40–41
 - examples, 41–42
 - impacted quality attributes, 43–44
 - practical considerations, 44
 - rationale, 40
 - refactoring, 42–43, 43f
- Multipath Hierarchy, 182
 - aliases, 187
 - causes, 183
 - diamond hierarchy vs., 182b
 - examples, 183–186
 - in Java, 183f
 - practical considerations, 187
 - quality attributes, 186–187
 - rationale, 182–183
 - refactoring, 186

N

- Naming scheme for smells, 16–18
- “Naughty children”, 170
- NO Operation (NOP), 163
- Novel naming scheme, 17–18
- NumberFormat class, 142f, 147f

O

- Object Adapter pattern, 181f
- “Object classes”, 140
- Object hierarchy, 124
- Object model, 16
- Object-oriented context (OO context), 14
 - decomposition, 33b
 - languages, 124
 - principles, 86
- Observation Editor, 194–196, 195f
- OCP. *See* Open Closed Principle
- OffsetCalculator classes, 30–31
- OO context. *See* Object-oriented context
- Open Closed Principle (OCP), 78–79
- Operating System (OS), 135–136
- Operation class, 34
- Order class, 97–99, 111–112
- OrderImpl class, 111–112
- OrderList class, 74b
- org.eclipse.jdt.internal.compiler.parser package, 56–57
- Orphan abstractions, 49–51

- OS. *See* Operating System
- Over-engineering, 155

P

- People role, 212
 - leading by example, 212
 - training, 212
- PHAME. *See* Principle of Hierarchy, Abstraction, Modularization, and Encapsulation
- PMD Copy Paste Detector, 146b
- Post-initialization, 183b–184b
- Pre-initialization, 183b–184b
- Precursors smells, 199–200
- Premature interface abstraction, 170
- Primitive obsession, 28
- Principle of Hierarchy, Abstraction, Modularization, and Encapsulation (PHAME), 16
- PrintEvent class, 151–152
- Procedural languages, 96
- Procedural thinking, 86
- Public classes, 65–66
- “Pull-up class” refactoring, 152f

R

- Rebellious hierarchy, 163
 - aliases, 169–170
 - causes, 164
 - composite pattern, 172b
 - examples, 164–165
 - practical considerations, 170–173
 - quality attributes, 169
 - rationale, 163–164
 - refactoring, 166–169
- Refactoring, 1, 9, 15, 203
 - for Broken Hierarchy, 178–179
 - buy-in for, 207–208
 - challenges in, 206–207
 - for Cyclic Hierarchy, 189–190
 - for Deep Hierarchy, 159–161
 - for Deficient Encapsulation, 69–70
 - IMPACT refactoring process model, 208–210, 209f
 - incompletely refactored design, 185f
 - intended, 185f
 - for Leaky Encapsulation, 75–77
 - for Missing Encapsulation, 82–85
 - for Missing Hierarchy, 130–132
 - for Multipath Hierarchy, 186
 - people, 212
 - leading by example, 212
 - training, 212
 - process, 206
 - for Rebellious Hierarchy, 166–169

Refactoring (*Continued*)

- repay technical debt, 203, 204f
- to repay technical debt, 211–212
- for Speculative Hierarchy, 155–156
- suggestion, 26–28
- tools, 203
 - categories, 205
 - code clone detectors, 204–205
 - comprehension tools, 204
 - critique tools, 204–205
 - metric tools, 204–205
 - in practice, 205–206
 - technical debt quantification, 205
 - visualization tools, 205
- for Unexploited Encapsulation, 88–89
- for Unfactored Hierarchy, 146–148
- for Unnecessary Hierarchy, 138–139
- for Wide Hierarchy, 151–153
- “Refused bequest”, 169
- “Refused parent bequest”, 170
- Reification, 34
- “Remove method” refactoring, 166
- Repaying technical debt, 203, 204f
- “Repeated inheritance”, 187
- Reusability, 28, 32–33, 39, 43–44, 48, 59
- Rich Text Format (RTF), 170
 - RTFEditorKit inheritance hierarchy, 170f
- RTF. *See* Rich Text Format

S

- SaveHandler classes, 30–31
- Scrum process, 53b
- SecureDocument class, 110
- Sibling types, 140
- Single Responsibility Principle (SRP), 11–12, 35, 102b
- Smell ecosystem, 193
 - interplay of smells, 196
 - in isolation, 196
 - amplifying other smells, 198
 - cooccurring smells, 198–199
 - problems, 200–201
 - smells as precursors, 199–200
 - in java.util library, 197f
 - role of context, 193
 - Definition Editor, 195f
 - design decision, 193–194
 - developers and designers, 196
 - Observation Editor, 195f
 - smells, 194
- Software design, 193
- Software viscosity, 14
- Speculative generalization, 158

- Speculative Hierarchy, 154
 - aliases, 157
 - causes, 155
 - examples, 155
 - practical considerations, 157
 - quality attributes, 157
 - rationale, 155
 - refactoring, 155–156
- SQL. *See* Structured Query Language
- SRP. *See* Single Responsibility Principle
- State pattern, 34
- Strategy pattern, 34
- StrictMath methods, 49
- Structured Query Language (SQL), 176–177
- sun.misc.Service class, 50
- Supertype process, 124, 140
- “Swiss-knife” types, 164
- Switch-based-on-type-code, 127, 134
- “Switch-case” statements, 133
- SynCheckBoxUI class hierarchy, 160f

T

- “Tag class”, 133
- “Tagged types”, 127
- TaxCalculator class, 112
- Taxonomy mania (Taxomania), 134, 140
- Technical bankruptcy, 2
- Technical debt, 1–2, 207
 - impact of, 4
 - causes, 6–7
 - dimensions of, 3f
 - management, 7
 - multiple sources of, 2
 - quantification, 205
- Test debt, 2
- Testability, 28, 33, 44
- TextGadget class, 184f
- Textually similar clones, 54b
- ToDoList class, 73
- Type hierarchy, 124

U

- Unencapsulated class, 71
- Unexploited Encapsulation, 86
 - aliases, 91
 - causes, 86–87
 - examples, 87–88
 - impacted quality attributes, 89–91
 - rationale, 86
 - refactoring, 88–89
- Unfactored Hierarchy, 140, 194–196
 - aliases, 149
 - causes, 141

- code clone detector tool, 146b
- examples, 141–146
- practical considerations, 149
- quality attributes, 148–149
- rationale, 140–141
- refactoring, 146–148
- Unfactored implementation, 140
- Unfactored interface, 140
- Unnecessary Abstraction, 44, 1965
 - aliases, 48
 - causes, 45
 - examples, 45–47
 - impacted quality attributes, 48
 - practical considerations, 48–49
 - rationale, 44–45
 - refactoring, 47–48
- Unnecessary Hierarchy, 134
 - aliases, 140
 - causes, 134
 - “data buffer”, 136b–137b
 - examples, 135–136
 - practical considerations, 140
 - quality attributes, 139
 - rationale, 134
 - refactoring, 138–139
- Unreferenced abstractions, 49–50
- Unutilized Abstraction, 49, 51f
 - aliases, 53
 - causes, 49–50

- examples, 50–52
- impacted quality attributes, 53
- practical considerations, 53
- rationale, 49
- refactoring, 52–53

V

- Variation Encapsulation Principle (VEP), 79
- Viscosity, 14
- Visualization tools, 205

W

- Weighted Methods per Class (WMC), 205
- Wide Hierarchy, 150
 - aliases, 154
 - causes, 151
 - examples, 151
 - practical considerations, 154
 - quality attributes, 153
 - rationale, 150–151
 - refactoring, 151–153
- WMC. *See* Weighted Methods per Class

Y

- Yet-to-be implemented functionality, 170–171
- You Aren’t Gonna Need It (YAGNI), 49, 155