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Code Smells & Anti-Patterns

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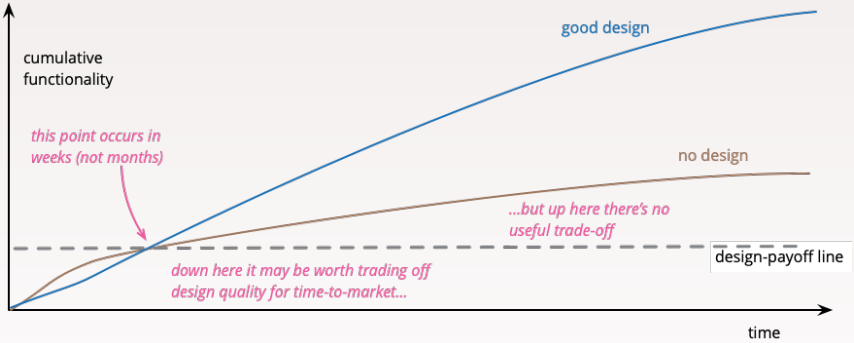
Design Stamina Hypothesis [1]



You can save short-term time by neglecting design, but this accumulates **technical debt** *which will slow your productivity later. — Martin Fowler [1]*

Definition (Technical Debt)

The implied cost of additional work in the future resulting from choosing an expedient solution over a more robust one.

> *The danger occurs when the debt is not repaid. Every minute spent on not-quite-right code counts as interest on that debt. — Ward Cunningham [2]*

Definition (Code Smell [3])

Suboptimal design decisions applied by developers that can negatively affect the overall maintainability of a software system.

Code smells are one of the symptoms of the technical debt.

Code Smells

Common code smells discussed by Martin Fowler [4]:

- Duplicated Code
- Long Methods
- Large Classes
- Long Parameter Lists
- Divergent Change
- Shotgun Surgery
- Feature Envy
- Data Clumps
- Primitive Obsession
- Switch Statements
- Parallel Inheritance Hierarchies
- Lazy Class
- Speculative Generality
- Temporary Field
- Message Chains
- Middle Man
- Insider Trading
- Alternative Classes with Different Interfaces
- Incomplete Library Class
- Data Class
- Refused Bequest
- Comments

Code Smells

Code smells proposed by Wake [5]:

- Type Embedded in Name
- Uncommunicative Names
- Inconsistent Names
- Dead Code
- Null Check
- Complicated Boolean Expression
- Special Case
- Magic Numbers

Code Smells

Code smells proposed by Kerievsky [6]:

- Conditional Complexity
- Indecent Exposure
- Solution Sprawl
- Combinatorial Explosion
- Oddball Solution

Anti-Patterns

Development anti-patterns by Brown et al. [7]:

- The Blob
- Continuous Obsolescence
- Lava Flow
- Ambiguous Viewpoint
- Functional Decomposition
- Poltergeists
- Boat Anchor
- Golden Hammer
- Dead End
- Spaghetti Code
- Input Kludge
- Walking through a Minefield
- Cut-and-Paste Programming
- Mushroom Management

Anti-Patterns

Architectural anti-patterns by Brown et al. [7]:

- Autogenerated Stovepipe
- Stovepipe Enterprise
- Jumble
- Stovepipe System
- Cover Your Assets
- Vendor Lock-In
- Wolf Ticket
- Architecture by Implication
- Warm Bodies
- Design by Committee
- Swiss Army Knife
- Reinvent the Wheel
- The Grand Old Duke of York

Definition

The same code structure repeats in more than one place.

```
int sumA = 0;
for (int i = 0; i < 3; i++)
   sumA += arrayA[i];
int avgA = sumA / 3;

int sumB = 0;
for (int i = 0; i < 4; i++)
   sumB += arrayB[i];
int avgB = sumB / 4;
```

Eliminating duplicate code via refactoring:

```
int calcAvg(int[] a, int n) {
    int sum = 0;
    for (int i = 0; i < n; i++)
        sum += a[i];
    return sum / n;
}
int avgA = calcAvg(arrayA, 3);
int avgB = calcAvg(arrayB, 4);
```

Long Methods/Large Classes

Definition

Methods or classes, whose excessive length make them hard to understand.

Such methods/classes often violate **separation of concerns**. Need to be decomposed into smaller classes via refactoring.

Long Parameter Lists

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Definition

Long parameter lists that are hard to understand, because they become inconsistent and difficult to use, and that are frequently changing as you need more data.

```
drawLine(int xBegin, int yBegin, int xEnd, int yEnd,
         int red, int green, int blue, int alpha);
```

Long Parameter Lists

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Addressing long parameter list via refactoring:

```
Point begin = new Point(xBegin, yBegin);
Point end = new Point(xEnd, yEnd);
Color color = new Color(red, green, blue, alpha);
drawLine(begin, end, color);
```

Definition

Divergent change occurs when one class is commonly changed in different ways for different reasons (violation of **single responsibility principle**).

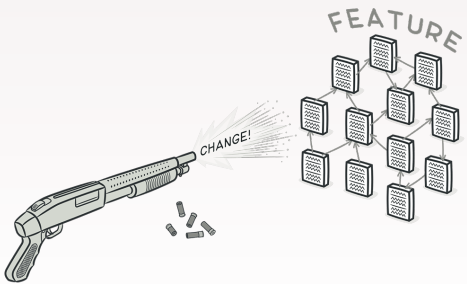
For example, the following holds inside the same class:

- "I will have to change these three methods every time I get a new database";
- "I have to change these four methods every time there is a new financial instrument".

You likely have a situation in which two objects are better than one.

Definition

When every time you make a kind of change, you have to make a lot of little changes to a lot of different classes.



Definition

A method that seems more interested in a class other than the one it actually is in.

```python
class ShoppingItem:
    name: str
    price: float
    tax: float

class Order:
    ...
    def get_bill_total(self, items: list[ShoppingItem]) -> float:
        return sum([item.price * item.tax for item in items])

    def get_receipt_string(self, items: list[ShoppingItem]) -> list[str]:
        return [f"{item.name}: {item.price * item.tax}$" for item in items]

    def create_receipt(self, items: list[ShoppingItem]) -> float:
        bill = self.get_bill_total(items)
        receipt = self.get_receipt_string(items).join('\n')
        return f"{receipt}\nBill {bill}"
```

Feature Envy (Solution)

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```python
class ShoppingItem:
    name: str
    price: float
    tax: float

    @property
    def taxed_price(self) -> float:
        return self.price * self.tax

    def get_receipt_string(self) -> str:
        return f"{self.name}: {self.price * self.tax}$"

class Order:
    ...
    def get_bill_total(items: list[ShoppingItem]) -> float:
        return sum([item.taxed_price for item in items])

    def get_receipt_string(items: list[ShoppingItem]) -> list[str]:
        return [item.get_receipt_string() for item in items]

    def create_receipt(items: list[ShoppingItem]) -> float:
        bill = self.get_bill_total(items)
        receipt = self.get_receipt_string(items).join('\n')
        return f"{receipt}\nBill: {bill}$"
```

Definition

Data items that tend to be used in groups together.

```
def colorize(red: int, green: int, blue: int):
    ...
```

Addressed by introducing a data structure:

```
class RGB:
    red: int
    green: int
    blue: int


def colorize(rgb: RGB):
    ...
```

Definition

Whenever a variable that is just a simple string, or an int simulates being a more abstract concept, which could be an object.

```
birthday_date: str = "1998-03-04"
name_day_date: str = "2021-03-20"
```

Addressed by introducing appropriate data structures:

```
class Date:
    year: int
    month: int
    day: int

    def __str__(self):
      return f"{self.year}-{self.month}-{self.day}"

birthday: Date = Date(1998, 03, 04)
name_day: Date = Date(2021, 03, 20)
```

Definition

Use of explicit switch statements instead of dynamic dispatch in object-oriented languages.

```
def calculate_area(shape):
    if shape['type'] == 'circle':
        return math.pi * (shape['radius'] ** 2)
    elif shape['type'] == 'rectangle':
        return shape['width'] * shape['height']
    else:
        raise ValueError("Unknown shape type")

circle = {'type': 'circle', 'radius': 5}
rectangle = {'type': 'rectangle', 'width': 4, 'height': 6}
```

Addressed by applying dynamic dispatch:

```
class Circle(Shape):
    def __init__(self, radius):
        self.radius = radius
    def area(self):
        return math.pi * (self.radius ** 2)

class Rectangle(Shape):
    def __init__(self, width, height):
        self.width = width
        self.height = height
    def area(self):
        return self.width * self.height

class Triangle(Shape):
    def __init__(self, base, height):
        self.base = base
        self.height = height
    def area(self):
        return 0.5 * self.base * self.height
```

Definition

Every time you make a subclass of one class, you also have to make a subclass of another (a special case of shotgun surgery).

```
class User(ABC):
    ...
    functions: Functions

class Functions(ABC):
    ...

class BasicUser(User):
    ...

class BasicFunctions(Functions):
    ...

class PremiumUser(User):
    ...

class PremiumFunctions(Functions):
    ...
```

Definition

Each class you create costs money to maintain and understand. A class that isn't doing enough to pay for itself should be eliminated.

```
class Strength:
    value: int

class Person:
    health: int
    intelligence: int
    strength: Strength
```

Definition

Features added in preparation for the future, guessing they will be useful, but that time never came.

```
class Animal:
    health: int

class Human(Animal):
    name: str
    attack: int
    defense: int

class Swordsman(Human):
    ...

class Archer(Human):
    ...

class Pikeman(Human):
    ...
```

Definition

Temporary field is a variable created where it is not needed.

```python
@dataclass
class MyDateTime:
    def __init__(self, year, month, day):
        self.year = year
        self.month = month
        self.day = day
        self.full_date = f"{year}, {month}, {day}"

    def foo(self):
        ...

    def goo(self):
        ...

    def hoo(self):
        ...

    def __str__(self):
        return self.full_date
```

Definition

Long sequences of methods calls indicate hidden dependencies by being intermediaries.

```
class Minion:
    _location: Location

    def action(self):
        ...
        if self._location.field.is_frontline():
            ...

class Location:
    field: Field

class Field:
    def is_frontline(self)
        ...
```

Definition

The class that only performs delegation work to other classes.

```
class Minion:
    _location: Location

    def action(self):
        ...
        if self.is_frontline():
            ...

    def is_frontline(self)
        return self._location.is_frontline()

class Location:
    _field: Field

    def is_frontline(self)
        return self._field.is_frontline()

class Field:
    def is_frontline(self)
        ...
```

Definition

"Classes spend too much time delving in each other's private parts."

```python
@dataclass
class Commit:
    name: str

    def push(self, repo: Repo):
        repo.push(self.name)

    def commit(self, url: str):
        ...

@dataclass
class Repo:
    url: str

    def push(self, name: str):
        ...

    def commit(self, commit: Commit):
        commit.commit(self.url)
```

Definition

If two classes have the same functionality but different implementations.

```
class Snowman(Humanoid):
    def hug_snowman():
        ...

class Zombie(Humanoid):
    def hug_zombie():
        ...
```

Incomplete Library Class

Definition

A library API arbitrarily omits some useful capabilities.

Null Check

Definition

Use of NULL causes a multitude of undefined or null checks everywhere: in guard checks, in condition blocks, and verifications clauses.

Definition

Use of hard-to-understand boolean expressions.

```
def cook(ready: bool, bag: list):
  if (ready):
    if (['raspberry', 'apple', 'tomato'] in bag and
        ['carrot', 'spinach', 'garlic'] not in bag):
          ...
```

Complicated Boolean Expression

Addressed via refactoring:

```
# "ready" extracted out of the function scope
def cook(bag: list):
    def hasFruit(container: list) -> bool:
        return ['raspberry', 'apple', 'tomato'] in container
    def hasVeggie(container: list) -> bool:
        return ['carrot', 'spinach', 'garlic'] in container

    if not hasFruit(bag):
        return
    if hasVeggie(bag):
        return
    ...
```

Magic Numbers

Definition

Using numbers that do not convey clear meaning.

```
def calculateDamage(...) -> int:
    total_damage = ...
    return math.max(100, damage)
```

Better:

```
def calculateDamage(...) -> int:
    total_damage = ...

    MAX_DAMAGE_CAP: int = 100
    return math.max(MAX_DAMAGE_CAP, total_damage)
```

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