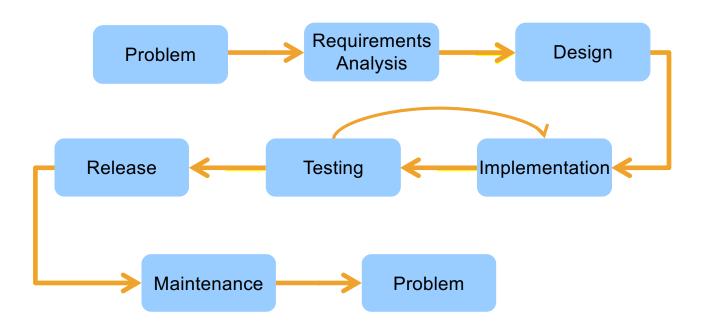
# CS 4320 / 7320 Software Engineering

Maintenance

# What is the SDLC? Where does Maintenance fit?



## Why Maintenance?

Why isn't *Release* the end?

- Defects are uncovered
- Operating environments change Hardware and software
- New user requirements surface

### Software Maintenance ...

...is the **totality** of activities required to provide **cost-effective support** to software.

#### ...occurs during:

#### Predelivery

Planning for operations, maintainability, transition

### **Postdelivery**

Software modification, training, interfacing with help desk

### Software Modification

Requests Logged and Tracked

Impact evaluated

Code & other artifacts modified

Testing performed

SW Change released

Training

Daily Support

## Software modification process: SLDC+

Requests Logged and Tracked

Impact evaluated

Code & other artifacts modified

Testing performed

SW Change released

Requests logged & tracked

Requirements Analysis

& impact analysis

& understanding code

& update req. docs

Design & update design docs

Implement

Testing & update tests

Release

# The Objective of Software Maintenance\* \*i.e., the software modification part of it

```
..is to modify existing software to fix defects, to adapt to changing the environment, and to add new features while preserving software integrity.
```

# Categories of Maintenance

|           | CORRECTION   | ENHANCEMENT |
|-----------|--------------|-------------|
| PROACTIVE | Preventative | Perfective  |
| REACTIVE  | Corrective   | Adaptive    |

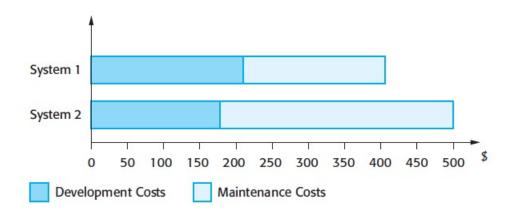
- Bug fixes: Corrective Maintenance
- Fix latent faults before they become operational: Preventative Maintenance
- New Features: Perfective Maintenance
- Adapt to changing environment: Adaptive Maintenance

### Maintenance Costs...

Typical: Development 1/3, Maintenance 2/3

Overall lifetime costs may decrease as more effort is expended during system development to produce a maintainable system.

For System 1, extra development costs of \$25,000 are invested in making the system more maintainable. This results in a savings of \$100,000 in maintenance costs.



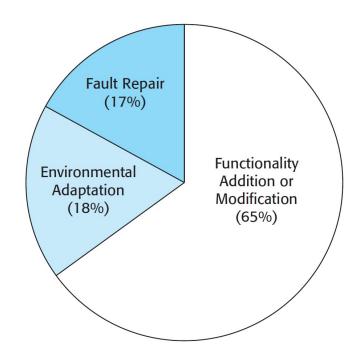
Sommerville, Software Engineering, 9th edition

### Software modification costs...

# Most cost is NOT in bug fixes

Most management reports don't distinguish

Sommerville, Software Engineering, 9th edition



## Software Evolution: Lehman's Laws





| Law                         | Description  |
|-----------------------------|--|
| Continuing change           | A program that is used in a real-world environment must necessarily change, or else become progressively less useful in that environment.  |
| Increasing complexity       | As an evolving program changes, its structure tends to become more complex. Extra resources must be devoted to preserving and simplifying the structure.                                     |
| Large program evolution     | Program evolution is a self-regulating process. System attributes such as size, time between releases, and the number of reported errors is approximately invariant for each system release. |
| Organizational stability    | Over a program's lifetime, its rate of development is approximately constant and independent of the resources devoted to system development.   |
| Conservation of familiarity | Over the lifetime of a system, the incremental change in each release is approximately constant.   |
| Continuing growth           | The functionality offered by systems has to continually increase to maintain user satisfaction.  |
| Declining quality           | The quality of systems will decline unless they are modified to reflect changes in their operational environment.  |
| Feedback system             | Evolution processes incorporate multiagent, multiloop feedback systems and you have to treat them as feedback systems to achieve significant product improvement.                            |







Sommerville, Software Engineering, 9<sup>th</sup> edition

## Key Issues in Software Maintenance

**Limited Understanding:** 1/2 total maintenance effort is understanding the software to be modified. Developers leave. Text (code) is hard to understand. Changes need to be documented or the documentation lies.

**Testing:** Takes time and money. Regression testing plan and automation help reduce time and cost.

Impact Analysis: Identify all systems affected by a change request. Estimate resources needed. Evaluate risk. Take severity of the problem into account. Plan course of action.

Maintainability: Software modifications need to be designed to maximize maintainability. Often neglected.

## Measures of maintainability

Analyzability: measure of effort to understand the issue

Changeability: measure of effort to implement a modification

Stability: measure of unexpected behavior, including during testing

Testability: Measure of effort to test the modified software

Size of the software

Complexity of the software

Understandability

## Refactoring is...

The restructuring of code to:
Increase reliability
Increase maintainability
Increase extensibility

Refactoring itself does NOT increase functionality It facilitates cleaner evolution

## Refactoring - how

Reverse engineer original design decisions

Re-design with understanding of:

New operational environment

New functionality requirements

The re-design is usually a high-level abstraction

# Refactoring – a few code "smells"

Duplicate code: replace with a single method or function.

Long methods, large classes: low coherence. Replace with smaller coherent methods.

Switch (case) statements: Often have duplication. In OOP can use polymorphism.

Data clumping: groups of data items reoccur. Encapsulate in an object.

Speculative generality: (YAGNI)

# Refactoring references

#### THE book on the subject:

M. Fowler and K. Beck, Refactoring: Improving the Design of Existing Code, Addison-Wesley Professional, 1999.

#### Recommended website:

Contains summary of all refactorings in the book.

https://refactoring.com/

# Readings

Reading: SWEBOK Chapter 5