Module Introduction & Software Development Life Cycle (SDLC)

CMP9134: Software Engineering

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University of Lincoln

6 February 2026

Today’s Agenda

1. Module Overview
2. What is Software Engineering?
3. Software Development Life Cycle
4. Project Management
5. SDLC Models

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Module Learning Outcomes

- **LO1:** Critically apply software engineering principles and techniques to software engineering problems, taking into account recent advances in the field.
- **LO2:** Analyse, develop and evaluate a software artefact from inception to deployment employing professional engineering approaches.
- **LO3:** Apply social, ethical and professional practices and critically analyse their applicability.

Main Topics Covered

- Project **management** principles and practices for software development.
- **Planning and specification** of software projects.
- **Software design** and architectural principles.
- **Software testing** and quality assurance.
- **Software maintenance** and evolution.

Module Delivery Team

Dr Francesco Del Duchetto

- Lecturer in Robotics and Autonomous Systems.
- Research: Human-robot interaction, AI & Robot learning, Robot vision and navigation.
- Office: INB3118. *Best if you contact me before showing up to my office!*
- Email: fdelduchetto@lincoln.ac.uk

Interactions

- **Lectures:** Fridays, 9:00 - 10:00 AM in MB3401.
- **Workshops:** Fridays, 1:30 - 3:30 PM in INB2102.
- **BlackBoard:**
  - Use the Discussion Board for questions regarding material or logistics.
  - Use the Continuous Module Feedback for providing feedback/suggestions/praise/requests.
- Don’t be shy to ask questions during lectures or workshops!

Module Syllabus (Weeks 1-5)

W	Date	Lecture Topic	Workshop
1	06/02/26	**Intro & Software Development Life Cycle**	**Versioning control (GitHub)**
2	13/02/26	**Agile Frameworks**	**Agile Setup**
3	20/02/26	**Software Requirements**	**Requirement Analysis**
4	27/02/26	**Software Modelling & OOP**	**System Architecture**
5	06/03/26	**Pattern & Reuse**	**Structural Design**
6	13/03/26	**HCI & Design Thinking**	**UI Prototyping**
7	20/03/26	**Containerisation**	**Docker & devcontainers**
8	27/03/26	**Software Testing**	**Unit Testing**
Break - No Lectures!			
12	24/04/26	**DevOps & CI/CD**	**Test Driven Development**
13	01/05/26	**Continuous Deployment**	**Automatic Deployment**
14	08/05/26	**Evolution & Legacy**	**Refactoring**
15	15/05/26	**Legal, Ethical, Professional & Social Issues**	**Project support**

Assessment

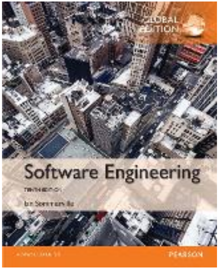
- **Assessment 1 (100%):** Design, develop, evaluate and document a comprehensive web application for remotely monitor and control an autonomous robot.
- **Deliverables:**
  1. Public GitHub repository (source code, documentation).
  2. Detailed project report (PDF).
  3. 5-minute video demonstration.
- **Some notes:**
  - This is an individual assessment.
  - Documentation will be provided on BlackBoard *soon*.
  - Workshops tasks will be grounded on the project, so you can have a headstart on the development from the beginning.

Module Pre-requisites

- Basic computer and IT skills (e.g., file management, using a web browser, installing software).
- Understanding of fundamental programming concepts (e.g., variables, control structures, functions).
- Proficiency in coding in any language (e.g., Python, Java, C++).
- Familiarity with basic software development tools (e.g., text editors, IDEs).
- Being proactive and independent in learning new languages and tools as needed.

Reference books

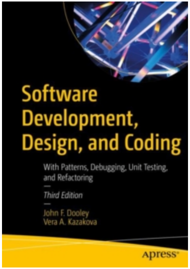
This is a *subset* of relevant books available at the University Library (physical or e-books):



Ian Sommerville

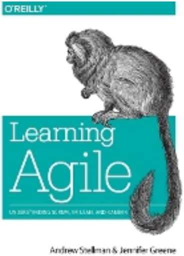
Software Engineering

10th Edition, 2016


Software Development, Design, and Coding
With Patterns, Debugging, Unit Testing, and Refactoring
Third Edition
John F. Dooley
Vera A. Kazakova
Apress

Dooley, John F.

Software Development, Design, and Coding, *3rd Ed., 2024*



Stellman & Greene

Learning Agile

1st Edition, 2014

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3 Software Development Life Cycle

4 Project Management

5 SDLC Models

Definition

- **Scientific method:** Discovery and organisation of knowledge by means of observation and experimentation.
- **Engineering:** The application of scientific methods to solving real-world problems.
- **Software Engineering:** Applies empirical and scientific approaches to solve practical problems in software.

"A Bad System Will Beat a Good Person Every Time" - W. Edwards Deming.

Attendance Code: 950258

Scope

Aim

Making our software systems more efficient, scalable, reproducible, economic, accessible, maintainable, reliable, secure, etc.

Software engineering is **concerned with all aspects of software production**, from the early stages of *system specification* through to *maintaining* the system after it has gone into use

Why is it Important?

- Society relies on advanced software systems.
- We need to produce reliable and trustworthy systems economically.
- It is cheaper in the long run to use SE methods than to write programs as personal projects.
- **Diversity:** There is no “Silver Bullet” (universal technique) for all systems (e.g., Stand-alone vs Embedded vs Data collection).

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The SDLC

The Software Development Life Cycle (SDLC) is the process of designing, building, and maintaining software applications.

1. Planning
2. Analysis
3. Design
4. Implementation
5. Testing & Integration
6. Maintenance

- Managing complexity in a structured way.
- Provides specific deliverables at each stage.
- Frameworks (like Agile) emerge from best practices.

Core Process Activities

All software processes involve these four activities:

1. **Software specification:** Defining the software to be produced and constraints.
2. **Software development:** Designing and programming the software.
3. **Software validation:** Checking that it is what the customer requires.
4. **Software evolution:** Modifying software to reflect changing requirements.

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Project Management in SDLC

Planning, organising, and controlling resources to achieve project goals.

- **Planning Phase:** Define goals, identify risks, estimate costs.
- **Analysis/Design:** Create Work Breakdown Structure (WBS) and schedules.
- **Implementation:** Monitor progress and manage stakeholders.
- **Maintenance:** Allocate resources for updates.

Planning: The Project Charter

A document outlining objectives, scope, stakeholders, and high-level requirements.

Components

- Project Background & Objectives
- Scope & Deliverables
- Stakeholders (Sponsors, Managers, Team)
- Assumptions, Constraints, and Risks

Planning: Risk Management

Identifying, assessing, and mitigating potential risks.

- **Monitoring:** Tracking progress vs planned performance.
- **Issue Tracking:** Using tools like Jira or GitHub Issues to track defects.
- **Burndown Charts:** Visualizing work completed vs work remaining.

Analysis/Design: Work Breakdown Structure (WBS)

A hierarchical decomposition of project deliverables into smaller, manageable components.

- Level 1: Product Vision
- Level 2: Major Deliverables/Phases
- Lower Levels: Tangible results requiring decomposition.

Analysis/Design: Scheduling and Estimation

- **Project Schedule:** Timeline identifying tasks, dependencies, and resources.
- **Tools:** Microsoft Project, GanttPRO, Trello (Kanban), Jira.
- **Software Metrics:**
  - Lines of Code (LOC)
  - Function Points (FP)
  - Story Points (Agile complexity metric)

Implementation/Testing: Monitoring Progress

- **Earned Value Analysis (EVA):** Combines scope, schedule, and cost to assess project performance.
- **Key Metrics:**
  - Planned Value (PV)
  - Earned Value (EV)
  - Actual Cost (AC)
- **Formulas:**
  - Schedule Variance (SV) = EV - PV
  - Cost Variance (CV) = EV - AC
  - Schedule Performance Index (SPI) = EV / PV
  - Cost Performance Index (CPI) = EV / AC

Implementation/Testing: Tracking Issues

- **Issue Tracking Tools:** Jira, GitHub Issues, Bugzilla.
- **Burndown Charts:** Visual representation of work completed vs work remaining.
- **Purpose:** Monitor progress, identify bottlenecks, and adjust plans.

Maintenance: Resource Allocation

There are 4 types of software maintenance: **corrective**, **adaptive**, **perfective**, and **preventive**.

- Allocate resources for bug fixes, updates, and enhancements.
- Use historical data to estimate maintenance effort.
- Plan for long-term support and scalability.

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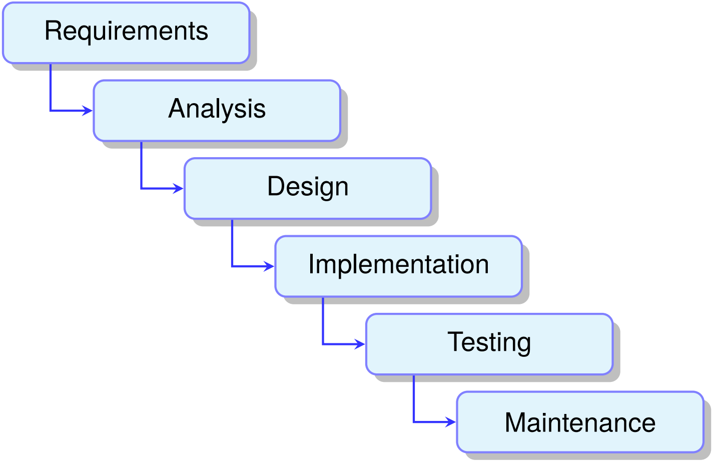
SDLC Models Overview

- Different projects require different approaches.
- Common models:
  - **Waterfall:** Linear, sequential.
  - **V-Model:** Emphasises verification and validation.
  - **Incremental:** Progressive development.
  - **Spiral:** Risk-driven.
  - **Agile:** Iterative, flexible (e.g., Scrum).

Waterfall Model



First formal Waterfall model is introduced in the 1970s. Emphasises a linear and sequential approach to software development.

Waterfall Model

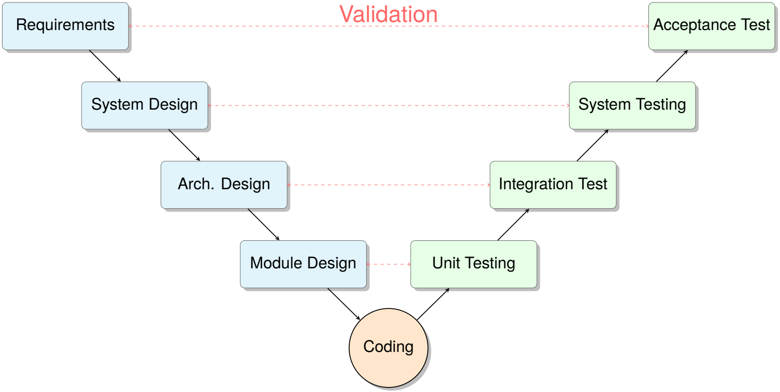
Qualities

- Sequential design process: easy to understand and manage.
- Each phase must be completed before the next begins: easy to organise and coordinate.
- Documentation-centric: suitable for projects with well-defined requirements.

Limitations

- Inflexible to changes: not ideal for projects with evolving requirements.
- Late testing phase: issues may be discovered late in the process.
- Not suitable for complex or long-term projects: lacks iterative feedback.

The V-Model



Introduced in the 1980s as an extension of the Waterfall model.

Emphasises verification and validation at each stage of development.

The V-Model

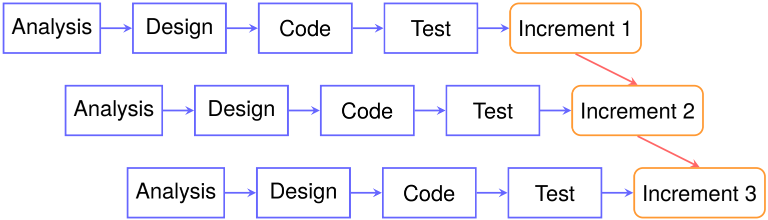
Qualities

- Focus on testing & quality: each development phase has a corresponding testing phase. *Solves waterfall's late testing issue.*
- Sequential and linear phases: easy to organise and coordinate.
- Well suited for projects with clearly defined requirements.

Limitations

- Inflexible to changes: not ideal for projects with evolving requirements.
- Assumes requirements are well understood upfront.
- Not suitable for complex or long-term projects: lacks iterative feedback.

Incremental Model



System is broken down into small, manageable portions. Functional software is produced early.

Incremental Model

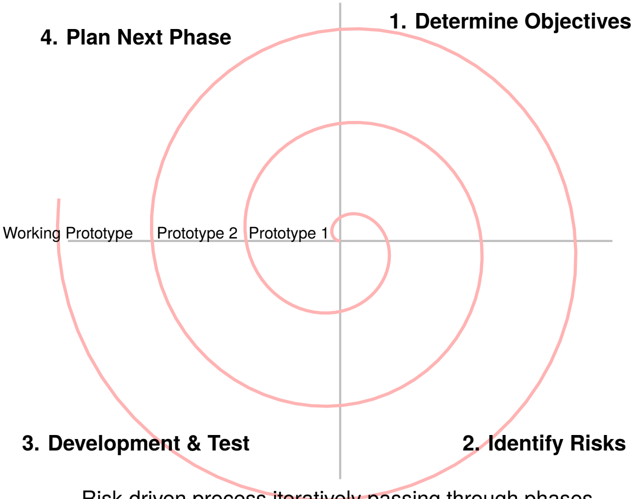
Qualities

- Each increment delivers a functional part of the system: allows for early delivery of useful software. *Solves waterfall's late delivery issue.*
- Allows for flexibility and adaptability as each increment can be adjusted based on feedback. *Solves waterfall's and v-model's inflexibility issue.*
- Easier to manage risks by breaking down the project into smaller parts.

Limitations

- Requires careful planning and design to ensure increments integrate well.
- May lead to higher overall costs due to repeated phases for each increment. Hence, not suitable for very small projects where overhead may outweigh benefits.

Spiral Model



Risk-driven process iteratively passing through phases.
Radius grows with cost/time.

Spiral Model

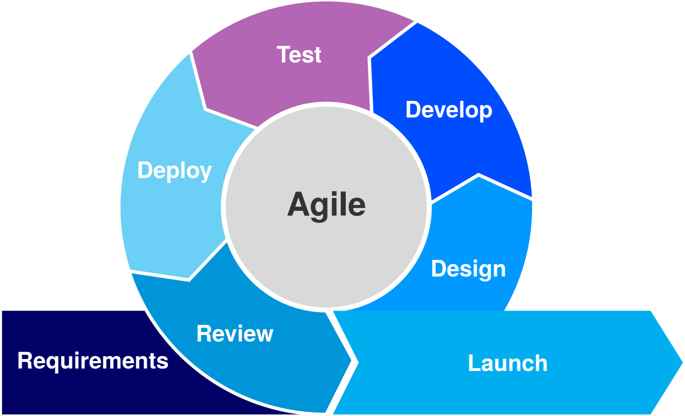
Qualities

- Focus on early risk identification and mitigation: suitable for high-risk projects.
- Allows for iterative development and refinement based on customer's feedback.
- Flexible and adaptable to changing requirements at various stage of development.

Limitations

- Requires careful planning and design to ensure increments integrate well.
- May lead to higher overall costs due to amount of risk assessments and iterations. Hence, not suitable for very small projects where overhead may outweigh benefits.
- Risk assessment and management require expertise and experience.

Agile Process



Commonly described as a set of principles or a phylosophy rather than a strict methodology. Introduced in the early 2000s as a response to the limitations of traditional SDLC models.

Agile Process

Qualities

- Focus on customer collaboration and responsiveness to change: suitable for projects with evolving requirements.
- Allows for iterative development and frequent delivery of working software.
- Emphasises teamwork, communication, and continuous improvement.

Limitations

- Requires active customer involvement throughout the project.
- May lead to scope creep if not properly managed.
- Less emphasis on documentation may lead to challenges in knowledge transfer and maintenance.

Next Steps

- **This Week's Workshop:** Learning Git (Version Control).
- **Next Week:** Agile Frameworks.

Q & A

Any Questions?

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