PACE UNIVERSITY
Seidenberg School of Computer Science and Information Systems

CS631G Software Verification

SOFTWARE TESTING AS PROFESSIONAL FIELD (W1)

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Outline

- Definition of Terms
- Fundamental Software Engineering Activities
- Systems Development Lifecycle (SDLC)
- Evolution of Software Testing
- Role of Software Testing
- Software Testing as a Career
- Required Skills and Qualities of Professional Testers
- Appendix: Examples of Testing Job Descriptions

Class Objectives

The objective of this class is to introduce software testing as a distinct profession in the IT industry.

At the end of this class you will:

- Understand what software testing is and why it is important;
- Get familiar with the evolution of the software testing field;
- Understand software testing as a career in the IT industry and why demand for skilled testers is growing over time;
- Understand skills and qualities needed for a successful testing career.

IEEE Std.610 – Definition of Terms

Software

Computer programs, procedures, and **associated documentation** and data pertaining to the operation of a computer system.
a.k.a. Software Product
Contrast with: hardware.

Requirement

1. A condition or capability needed by a user to solve a problem or achieve an objective.
2. A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed documents.
3. A documented representation of a condition or capability as in (1) or (2).

IEEE Std.610 – Definition of Terms

Testing

1. The process of operating a system or component under specified conditions, observing or recording the results, and making an evaluation of some aspect of the **system** or component.
2. The process of analyzing a software item to detect the differences between existing and required conditions (that is, bugs) and to evaluate the **features** of the software item.

Software Feature

A distinguishing characteristic of a software item (e.g., performance, portability, or functionality).

Test Plan

A document describing the scope, approach, resources, and schedule of intended testing activities. It identifies test items, the features to be tested, the testing tasks, who owns each task, and any risks requiring contingency planning.

Test Design Specification

A document specifying the details of the test approach for a software feature or combination of software features and identifying the associated tests.

IEEE Std.610 – Definition of Terms

Test Case
A set of test inputs, execution conditions, and expected results developed for a particular objective, such as to exercise a particular program path or to verify compliance with a specific requirement.

Test Case Specification
A document specifying inputs, predicted (expected) results, and a set of execution conditions for a test item.

Test Incident Report (e.g., Defect Report)
A document reporting on any event that occurs during the testing process which requires investigation.

Test Execution Log
A chronological record of relevant details about the execution of tests.

Test Summary Report (a.k.a. Test Completion Report)
A document summarizing testing activities and results. It also contains an evaluation of the corresponding test items and test exit criteria.

Importance of Software Engineering

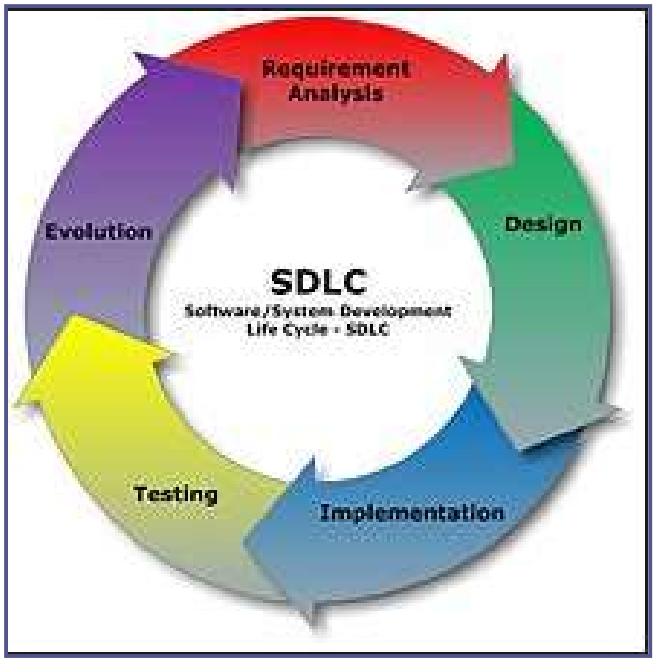
- The importance of software engineering lies in the fact that a specific piece of Software is required in almost every industry, every business, and any aspect of our lives.
- The Software Engineering discipline is important because it formalizes the development process for large technology projects providing common terminology, principles, etc.
- When developing software systems, it is usually cheaper to apply conventional Software Engineering methods and techniques rather than to just write the programs ad hoc, as if it was a personal programming project.
- Individuals and society increasingly rely on advanced software systems, hence, the importance of Software Engineering only grows over time.

Fundamental Software Engineering Activities

- A software process is a set of related activities that deliver a software product.
- There are many types of software systems, but there is no universally applicable software process.
- Project teams select a software process based on the context of their project that includes the type of software being developed, requirements of end-users, regulatory requirements, project timelines, etc.
- However, at a high level all processes must include the four fundamental activities:
  - Software Specification, defining the functionality of a system.
  - Software Development, delivering a working system.
  - Software Validation (a.k.a. testing), providing visibility into the degree to which the system conforms to its requirements.
  - Software Evolution, dealing with the changing needs of end-users and aligning the system functionality with the customer needs.
- On real-life projects, each of these activities is usually defined as a process area that includes multiple practices that we will discuss in the class.

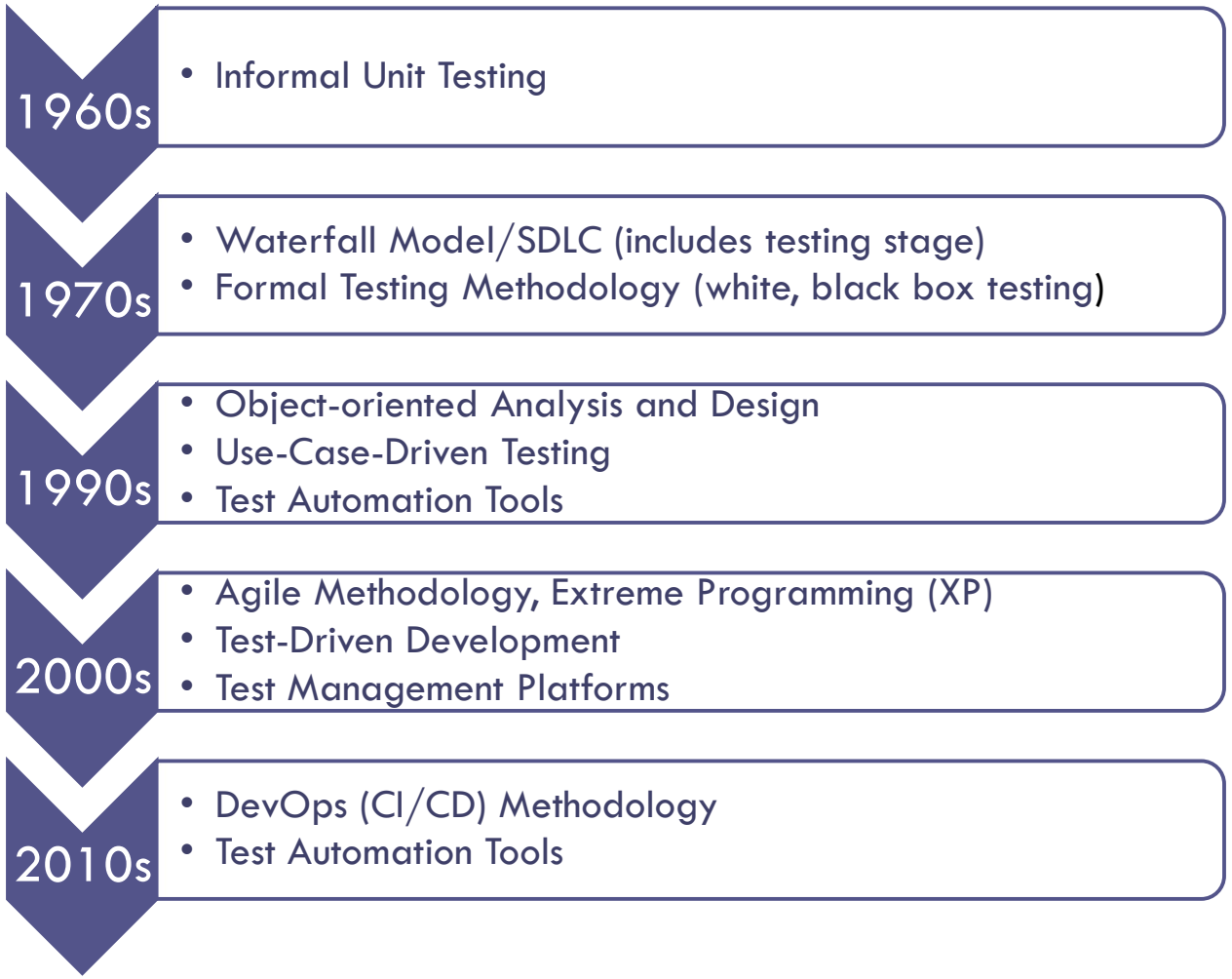
Process: Systems Development Lifecycle (SDLC)

- The systems development lifecycle (SDLC) is a conceptual model (framework) used in project management that describes the stages involved in an information system development project, from an initial feasibility study through maintenance of the completed application.
- **SDLC** is composed of a number of clearly defined and distinct process phases, which are aligned with **fundamental activities** and used by systems engineers and systems developers to plan for, design, build, test, and deliver software systems.



Software Testing emerged as a formal discipline in the1970s and is a critical phase of the SDLC.

The Evolution of Software Testing



Examples of Software Failures

Incident Name	Failure Description
Ariane 5 Flight 501 (1996)	The European Space Agency's Ariane 5 rocket's maiden flight ended in disaster 40 seconds after liftoff. The rocket's inertial reference system software failed to convert a 64-bit floating-point number to a 16-bit signed integer, causing a catastrophic failure.
Therac-25 Radiation Therapy Machine (1980s-1990s)	The Therac-25 was a medical radiation therapy machine designed to treat cancer patients. Due to software and hardware issues, it delivered lethal radiation doses to six patients and serious overdoses to others.
Healthcare.gov Launch (2013)	The rollout of the U.S. government's healthcare website, Healthcare.gov, faced numerous issues upon launch, including crashes, slow response times, and registration difficulties. These problems were attributed to insufficient load testing and system integration issues.
Equifax Data Breach (2017)	Equifax, one of the major credit reporting companies, suffered a massive data breach that exposed sensitive financial information of millions of consumers. The breach was attributed to a vulnerability in open-source software used by Equifax. The incident underscored the critical role of security testing and patch management.

Role of Software Testing in Ensuring Reliability

- The role of software testing in ensuring reliability and security is critical in the software development process.
- The mission of software testing is to systematically verify that a software system operates reliably, complies with quality standards, and is secure against potential threats and vulnerabilities.
- Testing helps identify defects, vulnerabilities, and weaknesses in software, allowing for their correction before deployment.
- By detecting and addressing issues early in the development process, testing significantly reduces the risks associated with software failures, data breaches, and security lapses in production.

Software Testing as a Career: Demand for Software Testing Professionals

The growing need for skilled testers in the software industry is driven by the following factors and needs:

- Rapid Growth in the Software Industry
- Complexity of Modern Software
- Regulatory Compliance
- Globalization and Outsourcing
- Identifying and Correcting Defects
- Validation of Functionality
- Preventing Security Vulnerabilities by Identifying Security Weaknesses
- Ensuring Data Privacy

Software Testing as a Career: Software Testing Roles in IT Industry

Job Title	Common Responsibilities
Test Architect	• Defining a test strategy for a large program; • Establishing commitments with impacted business and IT stakeholders; • Overseeing the test strategy implementation.
QA Manager	• Defining a test plan for a project; • Identifying and managing testing resources; • Overseeing test design and test execution; • Managing test repository; • Reporting test progress to project stakeholders.
QA Analyst	• Planning testing; • Performing test design; • Maintaining test data; • Executing testing; • Reporting test metrics.
Manual Tester	• Designing test case specifications; • Executing manual testing, reporting defects.
Test Automation Specialist	• Defining an approach to developing and executing automated testing; • Building and maintaining test automation infrastructure; • Coding automated scripts; • Executing automated testing; reporting defects; • Reporting test automation metrics.

Skills and Qualities Needed for a Successful Testing Career

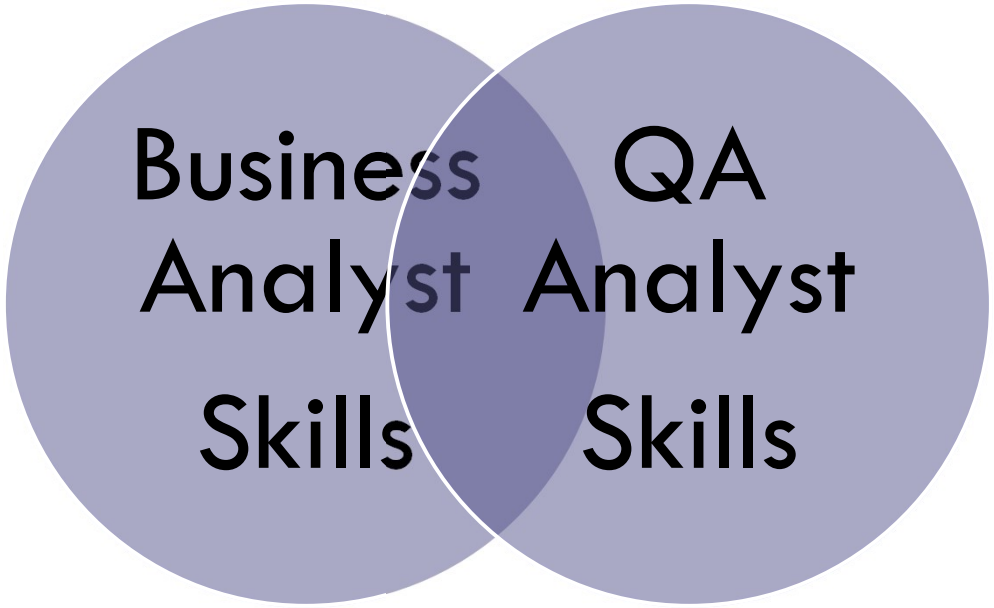
Technical Skills

- **Understanding of Software Development:** Testers should have a solid understanding of software development processes, methodologies, and life cycles. This knowledge allows them to effectively collaborate with developers and other team members.
- **Test Planning and Design:** Testers need to be skilled in creating comprehensive test plans, designing test cases, and developing test scripts. This involves understanding requirements, test data, and test coverage.
- **Test Execution and Automation:** Testers should be capable of executing test cases manually and be proficient in test automation using relevant tools and frameworks. Automation skills are particularly crucial in Agile and DevOps environments.
- **Defect Identification and Reporting:** The ability to identify, document, and report defects clearly and effectively is essential. Testers should provide detailed information to developers, aiding in the resolution of issues.
- **Performance Testing:** Understanding performance testing concepts and tools is important for ensuring software applications can handle expected workloads without performance bottlenecks.
- **Security Testing:** Knowledge of security testing techniques and tools is crucial in identifying vulnerabilities and ensuring the protection of sensitive data.
- **Test Management Tools:** Familiarity with test management and bug tracking tools, such as Jira, TestRail, qTest, or HP ALM, is valuable for organizing and tracking testing efforts.

QA Analyst vs. Business Analyst Skills

Skills of professional testers overlap with the skills of business analysts.
Requirements-based formal testing requires that testers:

- have a good understanding of software processes;
- have a good understanding of project requirements;
- have skills to identify and fill the gaps with missing requirements.



Skills and Qualities Needed for a Successful Testing Career (cont'd)

Soft Skills

- **Critical Thinking:** Testers must think critically to identify potential defects and vulnerabilities. They need to assess risk and prioritize test cases.
- **Attention to Detail:** Being meticulous in identifying and documenting defects and ensuring comprehensive test coverage is crucial.
- **Communication:** Effective communication is vital for conveying test results and collaborating with developers and other stakeholders. Testers need to explain defects clearly and provide valuable feedback.
- **Analytical Skills:** Testers analyze requirements, test results, and defect patterns to make informed decisions and improvements in the testing process.
- **Time Management:** Prioritizing tests and managing time efficiently, especially in fast-paced development environments, is a key skill.
- **Adaptability:** Testers should be adaptable and open to change, as software testing methods and tools are constantly evolving.

Skills and Qualities Needed for a Successful Testing Career (cont'd)

Personal Qualities

- **Curiosity:** A desire to explore and uncover defects, as well as a natural curiosity about how software works, can be motivating in this field.
- **Patience:** Software testing often involves repetitive tasks and thorough examination. Patience is required to ensure quality.
- **Persistence:** Testers may face challenges in defect reproduction or resistance to bug fixes. Persistence is essential for resolving issues.
- **Integrity:** Testers should have a strong sense of integrity, ensuring that test results are accurate and impartial.
- **Team Player:** Collaboration is vital in the software development process. Testers need to work effectively with developers, product owners, and other team members.
- **Continuous Learning:** A commitment to ongoing learning and keeping up with industry trends is critical in a field that evolves rapidly.

Emerging Trends and Technologies

Artificial Intelligence

- Artificial Intelligence (AI) in software testing refers to the application of artificial intelligence and machine learning techniques to enhance and automate various aspects of the software testing process.
- AI has the potential to revolutionize testing by improving efficiency, accuracy, and test coverage.

Examples of AI Benefits

- **Test Automation:** AI can be used to automate test case generation, execution, and result analysis. Test automation with AI can identify areas in the application that are most prone to defects and prioritize test cases accordingly. It can also adapt to changes in the application, reducing the need for manual script maintenance.
- **Test Data Generation:** AI can generate realistic and diverse test data for use in testing. It can analyze historical data, understand data patterns, and create test data that covers a wide range of scenarios, helping to uncover potential defects and vulnerabilities.
- **Defect Prediction:** AI models can predict potential defects and issues by analyzing historical data and identifying patterns in software development and testing. This helps teams focus their testing efforts on high-risk areas.

Appendix:
Testing Job Description Examples

Example: QA Test Strategist Job Description

Description/Job Summary:

The QA Test Strategist is a senior testing professional whose primary function is to design solutions to testing problems for various business and technology application platforms.

These solutions are solved through the application of contextually relevant process and practice, the use of tools and technology, and by applying soft skills such as effective communication and mentoring of both team and IT/Business partners.

The incumbent is responsible for understanding architectural and functional design of the application platforms and implementing test strategies and associated testing standards, and for working with solution architects, vendors, developers, and QA staff to ensure that applications are tested in a manner that is aligned with Cenlar's technology initiatives are executed within the existing or planned framework.

This position implements test automation strategies and builds test harnesses suitable for the application using state-of-the-art test tools.

Example: Test Automation Architect Job

Description/Job Summary:
Hands-on Java development.
BDD framework development and Cucumber
API automation
SOAP and REST webservices.
Java, Selenium WebDriver and JBehave/Cucumber.
BDD knowledge and Gherkin

Responsibilities:
Develop and evolve test plans for complex applications
Develop and evolve test plans for complex applications
Deconstruct business requirements into tests that optimize for coverage and risk (>95% target test coverage)
Create trusted test automation with high reliability and relevancy (>95% target test automation)
Build and extend test automation frameworks to incorporate new functionality
Assess and advise on testability of user stories, including acceptance criteria, non-functional requirements, and the definition of done
Work closely with engineering teams and demonstrate strong debugging skills
Share what you learn with your team and other members of the organization, such as recommending new tools/processes needed to enhance productivity and quality

Example: QA Manager Job Description

Description/Job Summary:

The Quality Assurance Manager will be responsible for ensuring that QA activities across IT are managed, planned, resourced & executed. In general the individual will be responsible for recognizing and understanding the QA needs of the Organization and managing resources to satisfactorily meet that demand. The individual will ensure that a coordinated and organized process for assuring the quality of IT projects / products / initiatives is adhered to. The QA Manager will be responsible for managing the engagement with an external QA service and it's consultants. Where required the QA Manager will be expected to take responsibility for testing activates across some initiatives. The individual will work with IT and other stakeholders (Internal and External) to build out Tests Plan and associated test items, defining the success criteria for each test suite, allocating QA resources to execute those tests and for reporting on that success to dedicated points of contact within the business and IT.

Responsibilities/Duties:

Analyze, develop and refine QA testing standards, processes and tools across IT

Manage external QA consultants to ensure they are allocated to, and meeting the demand of, ongoing initiatives

Develop Testing Strategies

Develop Test Plans for IT Initiatives (3rd party or custom developed)

Manage multiple concurrent initiatives in parallel

Work closely with other IT teams including infrastructure, product and development teams to support demand, execution and releases

Work closely with external solution vendors to ensure that testing activities are prioritized, planned and executed

Log, monitor, track and report on issues and defects

Define and report on success metrics

Example: QA Analyst Job Description

Role Responsibilities:
Assess software quality through manual and automated testing
Find and report bugs and issues
Develop and execute exploratory and automated tests to ensure product quality
Responsible for designing and conducting tests before product launches to ensure software runs smoothly and meets client needs
Work closely and iteratively with development and business teams to assure issues are found and corrected
Review and analyze system specifications prior to releases

Experience / Competences Essential:
Experience in with QA methodologies
Experience in writing clear, concise and comprehensive test plans and test cases
Ability to document and troubleshoot errors
Excellent written and verbal communication skills
Communicates effectively and efficiently to internal and external stakeholders
Attention to detail

Example: Manual Tester Job Description

Description:
This job is responsible for creation of all test materials, including test cases, test scripts, test data, defect management, issue resolution and production implementation. 1.) UAT Planning - Involvement in approach reviews for all impacting changes. - Partner with IT to offer technical expertise on overall system functionality in the current state as well as direction on future enhancements - Partner with cross function leads involved in UAT ? providing them with test schedules, test data, direction and detailed test scripts in accordance with the Enterprise Release Schedule - Writing and executing test plans and scripts, documentation of test procedures and issues - Utilization of Jira and Qtest for Test Case storage, allocation and defect logging and management 2.) UAT Execution and Implementation - Responsible for testing a range of projects from enhancements to strategic initiatives - Facilitate status calls and web demos to stakeholders to review projects and functionality prior to testing - Flexibility to work evenings and weekends to support testing efforts and meet deadlines - Partnership with IT leads in working through issues/defects and resolution - Responsible for overall testing completion and metrics analysis, as well as status readouts to upper management - Ensure testing is completed within established time and that objectives conform to the user requirements and needs of the business - Responsible for overall product delivery and approval/sign off - Responsible for Release Production Testing, Implementation and Launch support as well as Warranty issue tracking 3.) Project Management - Manage escalations to management on status of projects - Maintain communication with management, testers, IT and Stakeholders on project status - Provide input to and shape UAT management processes in alignment with industry best practices - Responsible for providing analysis and metrics for projects and overall release on an ongoing basis.

Example: Test Automation Specialist Job

Job Description:

As a Test Automation Specialist, you will ensure our software solution is verified and validated against the criteria set out in the functional and non-functional specifications by defining automation test scripts and ensuring their execution using existing frameworks.

Responsibilities:

Create and execute high-level test scenarios, record and analyze actions and maintain a defect register.
Review test results and modify tests if necessary.
Develop and maintain documentation and may need to produce some test plans and project documentation.
Reports on progress to stakeholders.
Ensure that knowledge is kept up-to-date with all relevant updates/releases to products.
Use appropriate tools for change control, risks and issues.
Provide focused, accurate and exact data analysis.
Demonstrate effective communication processes meeting demands of both Test & Assurance Office of Technology Management (OTM) and program / project requirements.