OCR Computer Science AS Level

2.2.2 Software Development

Advanced Notes

Specification:

a) Programming methodologies

- Waterfall lifecycle
- Agile methodologies
- Extreme programming
- Spiral model
- Rapid application development

b) Merits, drawbacks and uses of programming methodologies

c) Writing and following algorithms

d) Test strategies

- Black box testing
- Alpha testing
- Beta testing

e) Test programs that solve problems using suitable test data and end user feedback

- Justify test strategy for given situation

Programming Methodologies

Software can be developed using a variety of approaches. The approach used depends on the type of software being developed but most software development life cycles (SDLCs) have some stages in common, including:

- Analysis

  Stakeholders state what they require from the finished product. This information is used to clearly define the problem and the system requirements. Requirements may be defined by:
  - Analysing strengths and weaknesses with current way this problem is being solved
  - Considering types of data involved including inputs, outputs, stored data and amount of data

- Design

  The different aspects of the new system are designed, such as:
  - Inputs: *volume, methods, frequency*
  - Outputs: *volume, methods, frequency*
  - Security features: *level required, access levels*
  - Hardware set-up: *compatibility*
  - User interface: *menus, accessibility, navigation*

  A test plan may also be designed at this stage.

- Development

  The design from the previous stage is used to split the project into individual, self-contained modules, which are allocated to teams for programming.

- Testing

  The program is tested against the test plan formed in the Design stage. There are various types of testing that can be carried out:

  - Alpha testing

    Alpha testing is carried out in-house by the software development teams within the company. Bugs are pinpointed and fixed.
  - Beta testing

    Beta testing is carried out by end-users after alpha testing has been completed. Feedback from users is used to inform the next stage of development.
  - White box testing

    This is a form of testing carried out by software development teams in which the test plan is based on the internal structure of the program. All of the possible routes through the program are tested. This is also called structural testing.
  - Black box testing

    This is a form of testing where the software is tested without the testers being aware of the internal structure of the software and can be carried out both within the company and by end-users. The test plan traces through inputs and outputs within the software. This is also known as functional testing.

- Implementation

  Once the testing stage has been used to make the appropriate changes to the software, it is installed onto the users' systems.

- Evaluation

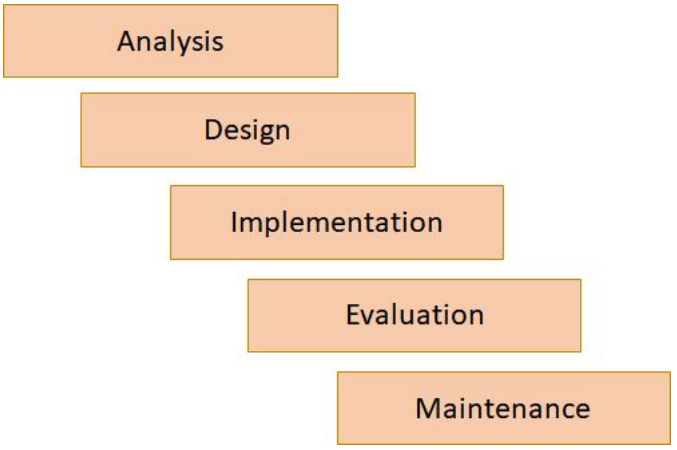
  After the implementation stage, the effectiveness of the software is evaluated against the system requirements defined at the analysis stage to evaluate its suitability in solving the problem. Different criteria are considered, including robustness, reliability, portability and maintainability.

- Maintenance

  Any errors or improvements that could be made to the software are flagged up by the end-users. Programmers will regularly send out software updates to fix any bugs, security issues or make any needed improvements.

Waterfall lifecycle

The traditional waterfall model of software development is well-known and well-defined but is now being replaced with more agile models. The waterfall model is based on a series of stages which are completed in sequence, from start to finish.



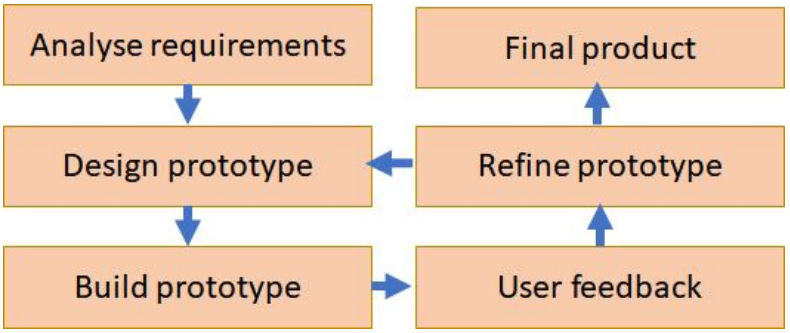
The analysis stage includes a feasibility study in which designers evaluate the feasibility of the project using '*TELOS*':

- Technical: *is the project possible considering the technology available and accessible*
- Economic: *can the project be financed in the short-term and the long-term?*
- Legal: *can the project be solved within the law?*
- Operational: *can the project be successfully implemented and maintained?*
- Scheduling: *can the project be completed given the time available?*

If a change needs to be made within a project being developed using the waterfall model, programmers must revisit all levels between the current stage and the stage at which a change needs to be made. This makes the model inflexible and so unsuitable to projects with changing requirements. This also means that users have little input as they are only involved at the very beginning and end of the waterfall lifecycle, during the analysis and evaluation stage.

Agile methodologies

This refers to a collection of methodologies which aim to improve the flexibility of software development and adapt to changes in user requirements faster. It is also easier to make improvements or changes to the software.



The problem is broken down into sections which are developed in parallel. The design and analysis phase often occur together. Different sections of software can be at different stages of development. A working prototype is delivered early on and prototypes are built upon and improved in an iterative manner so that new prototypes are delivered regularly throughout the course of the development cycle.

In agile development methodologies, there is less of a focus on documentation and more priority is given to user satisfaction.

Extreme programming

This is an agile model in which the development team consists of a pair of programmers alongside a representative end-user. The model is built on 'user stories': system requirements are specified by the end-user and used when designing the program. The aim of paired programming is to produce high-quality code, as the code is written by one person and critiqued by the other so is improved as it is written. Programmers work no longer than forty hours a week with the aim that quality is not compromised. Each iteration through the cycle generates what is called a 'working version' of the program which means it could function as the final product.

The iterative nature of development means that it is hard to produce high quality documentation, which is less of a priority. In order for XP to be effective, programmers must communicate effectively.

Spiral model

The spiral model is built on four key stages with the focus of effectively managing risk-heavy projects:

- Analysing system requirements
- Pinpointing and mitigating risks
- Development, testing and implementation
- Evaluating to inform the next iteration

If the project is found to be too risky at any point, the project is terminated. However hiring risk assessors to analyse the risks involved can be expensive, which makes this methodology suited to only very large-scale projects.

Rapid application development

RAD is an iterative methodology which uses partially functioning prototypes which are continually built-upon. User requirements are initially gathered using focus groups and used to develop an 'incomplete' version of the solution which is given to the user to trial. User feedback is then used to generate the next, improved prototype and this continues until the prototype matches the requirements of the end-users at which point it becomes the final product.

This is commonly used where user requirements are incomplete or unclear at the start. However, as requirements change over the course of the project, additions and changes made to the code may be inefficient.

Writing and following algorithms

An algorithm is a set of instructions used to solve a problem. They are core to computer science and can be used to tackle a wide range of problems. Regardless of the problem, all good algorithms have certain key qualities which are highlighted below:

- Inputs must be clearly defined - what is valid and what is invalid?
- Must *always* produce a valid output for any defined input
- Must be able to deal with invalid inputs
- Must always reach a stopping condition
- Must be well-documented for reference
- Must be well-commented so modifications can easily be made

Merits, drawbacks and uses of programming methodologies

	Merits	Drawbacks	Uses
Waterfall	- Straightforward to manage - Clearly documented	- Lack of flexibility - No risk analysis - Limited user involvement	Static, low-risk projects which need little user input, such as a piece of general-purpose software
Agile	- Produces high quality code - Flexible to changing requirements - Regular user input	- Poor documentation - Requires consistent interaction between user and programmer	Small to medium projects with unclear initial requirements.

Extreme Programming	- Produces high quality code - Constant user involvement means high usability	- High cost of two people working on one project - Teamwork is essential - End-user may not be able to be present	Small to medium projects with unclear initial requirements requiring excellent usability.
Spiral	- Thorough risk-analysis and mitigation - Caters to changing user needs - Produces prototypes throughout	- Expensive to hire risk assessors - Lack of focus on code efficiency - High costs due to constant prototyping	Large, risk-intensive projects with a high budget.
Rapid Application Development	- Caters to changing user requirements - Highly usable finished product - Focus on core features, reducing development time	- Poorer quality documentation - Fast pace may reduce code quality	Small to medium, low-budget projects with short time-frames.

Test Strategies

The testing stage of software development is designed to pinpoint any flaws in the software. Depending on the type of program, programmers must select the appropriate test strategy. The test strategy chosen will depend on the needs of the company, client and the project requirements. Software should produce the correct output for any given input and should produce a designated error if the data entered is invalid.

Therefore, in order to check that a program is fully functioning, the data selected for testing should include a wide range of valid and invalid values. When testing, programmers should record the purpose of the test, type of test, the expected result and the actual result of the test. There are three special types of data that programmers consider when testing:

- Normal
  Data within the range of the data type considered as valid.
- Boundary
  Data that falls at either of the ends of the valid data range.
- Erroneous
  Data that falls outside of the valid data range

Another test strategy is performing a dry-run of a program, which is when programmers manually work through the code. A trace table is used to note down the logical flow through the program alongside when and which variables are updated. If an unexpected result is produced, the cause of this can be traced and fixed. The downside to dry-runs is that they cannot pick up on run-time/execution errors.