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Project design

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Outline

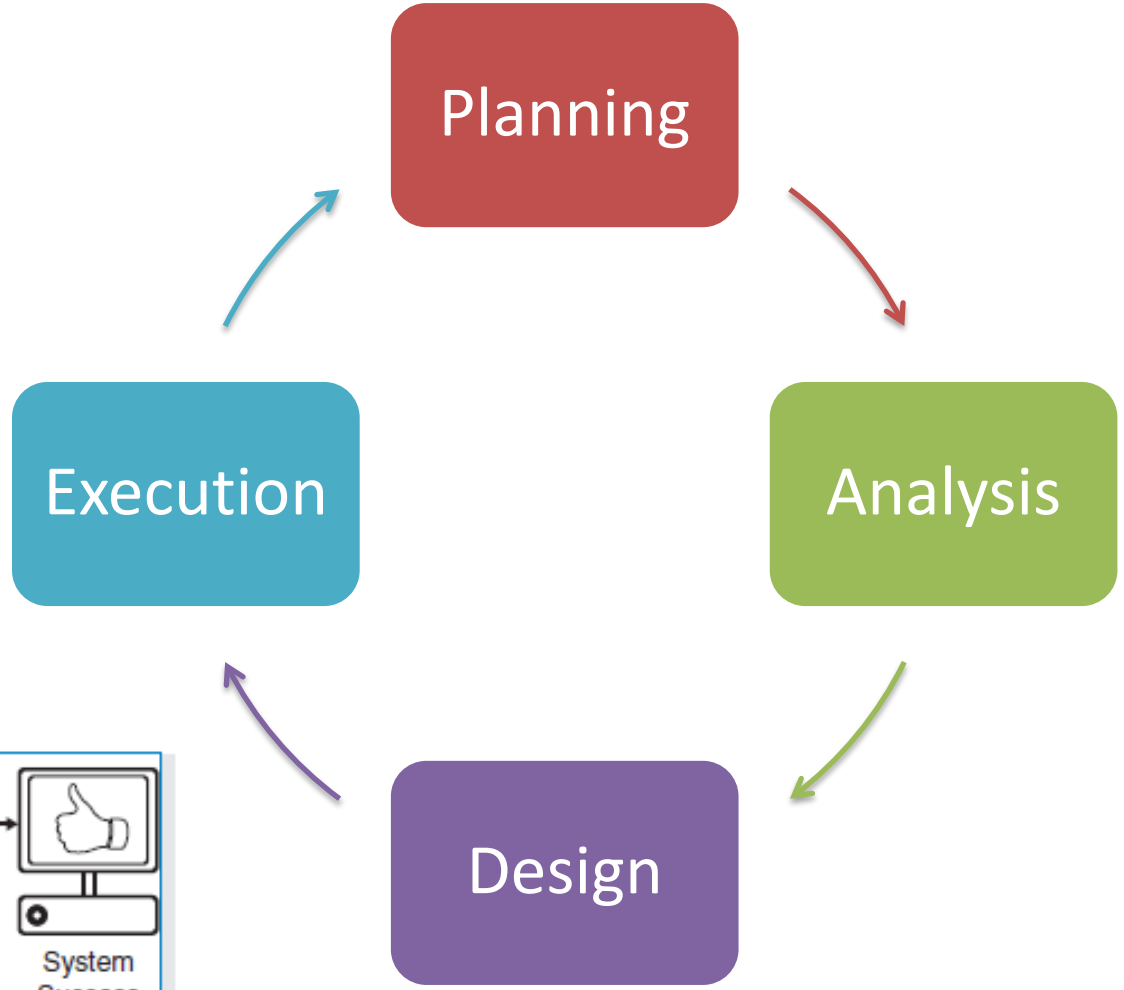
- Project and System Development Life Cycle (SDLC)
- The different phases of SDLC
- An use case example

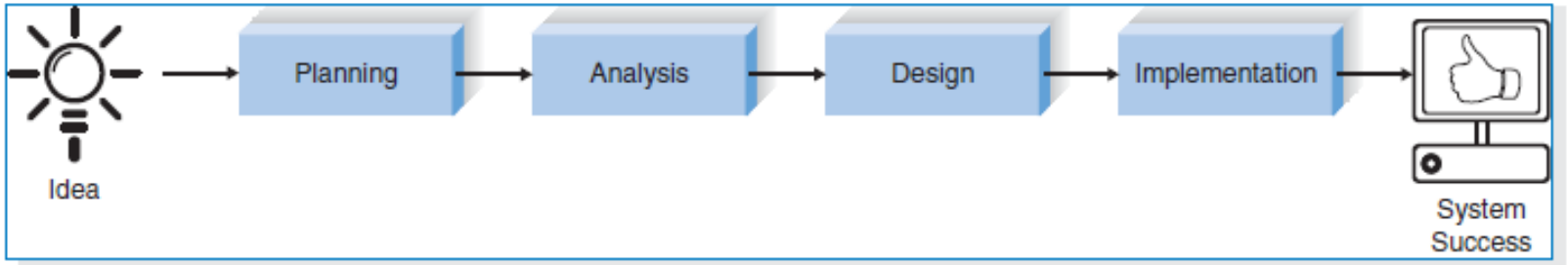
Terminology

- Project
  - An organized programme of pre determined group of activities that must be completed using the available resources within the given time limit
- System Development Life Cycle (SDLC)
  - It is a conceptual model used in project management to describe the overall process of developing information system through a multiphase process

SDLC

- Each phase is itself composed of a series of steps, which rely on techniques that produces deliverables





SDLC

- The SDLC helps in establishing a system project plan, because it gives the overall list of processes and sub-processes required for developing a system
- Each phase includes a set of steps that lead to specific outputs, called deliverables
- The system evolves through gradual refinement

SDLC

Phase	Focus	Primary output
Planning	*Why build this system?*	*System Request with feasibility study*
	How to structure the project?	*Project plan*
Analysis	*Who, what, where and when for this system?*	*System proposal*
Design	*How will this system work?*	*System specification*
Implementation	*Delivery and support of completed system*	*Installed system*

Planning phase

- The planning phase consists of the fundamental process of understanding **why** the system should be built
- In case a **team** is involved in the project, this phase will also determine how the different roles will be assigned to the different members of the project team
- The primary outputs of this phase are
  - The system request with **feasibility study**
  - The **project plan** along with a time schedule
    - Since it is almost impossible to develop an exact assessment of the project's schedule right from the start, it is recommended to set a 10% margin of error between the expected completion time and the declared completion time

Planning phase

- It is composed of two steps
  1. The project initiation: it provides as output the **system request** with **feasibility analysis**, which examines key aspects of the proposed project
     - The technical feasibility (can we build it?)
     - The economic feasibility (will it provide business value?)
     - The organization feasibility (if we build it, will it be used?)
  2. The project management: it provides as output the project plan, which is created by the project manager who
     - Creates the **work plan**
     - Assigns staff to the project
     - Puts techniques in place to help the project team *control* and *direct* the project through the entire SDLC

Analysis phase

- The *analysis phase* answers the questions:
  - *who* will use the system
  - *what* the system will do
  - *where* the system will be used
  - *when* the system will be used

Definition of the reference scenario

- During this phase, the project team investigates any current system(s), identifies improvement opportunities, and develops a concept for the new system.

Analysis phase

- The analysis phase consists of three steps:
  1. The *analysis strategy*, which is developed to guide the project team's efforts. It usually includes
     - A study of the current systems (called the *as-is systems*) and their problems (if available)
     - Definition of the requirements for the new system (called the *to-be system*).
  2. The *requirements gathering*, which are obtained through interviews, group workshops, or questionnaires
  3. The *system proposal*, which is presented to the project sponsor and other key decision makers (e.g., members of the approval committee) who will decide whether the project should continue to move forward
     - It is the initial deliverable that describes what business requirements the new system should meet
     - It is both an analysis and a high-level initial design for the new system

Analysis Phase
Reference scenario

- Who should use the system? How many users? What are they characteristics?
- Which is the domain of the proposed application?
- What are the most problematic issues to solve?
- Who is going to manage the system?
- Should the system be used indoors or outdoors?
- Under which conditions will the system be used?
- Is there any connectivity available?
- What are the possible stress causes for the system?

Try to understand if there are possible solutions that have not been investigated by the customer

Analysis Phase
State of the art

- Are there other similar systems?
- What are they advantages/disavantages?
- Are there any macro-categories?
- Which are they differences?

Analysis Phase
System Requirements

- What is a requirement?
  - It can be a statement of what the **system must do** or **describe a function/capability of the system** (functional requirement)
  - It can be a statement of the **characteristics that the system must have** or **the quality of a function** (non-functional requirement)

- Make a list of all the functionalities that are required (those related to a functional requirement)
- Example: Coffee machine
- The functional requirements of a coffee machine describe what the coffee machine can do:
  - The coffee machine is able to make coffee
  - The coffee machine is able to keep coffee warm
- The formulation of a functional requirement is similar to the formulation of a sentence:

  The **{name of the solution}** is able to **{verb form} {something}**
- It can be applied to functions from the user perspective: The **user** is able to **{verb form} {something}**
  - The user is able to plan the availability of coffee
  - The user is able to clean the coffee machine
- For each functional requirement, you should also define data required as input and returned as output

Non-functional Requirement

- Non-functional requirements can be applied to functionalities:
  - Frequency of execution, data rate, accuracy, reliability and robustness, latency, jitter, priority, security and privacy, degree of mobility
- Example
- **Functional requirement**
- The user is able to clean the coffee machine
- **Non-functional requirement**
  - It is possible to clean the coffee machine <quickly>
    - <quickly> = within 5 minutes
- Other non-functional requirement
  - The coffee machine is <modern>
    - The coffee machine is made of die-cast alloy
    - The coffee machine has an angular shape
- The formulation of a non-functional requirement is of the type:

It is possible to **{verb form} {something} {adjective/adverb}**

The **{something}** is **{adjective/adverb}**

Complete example

Requirements	Type
The coffee machine is able to make coffee	function
Coffee making stops, if the water is gone	rule
It is possible to make <a lot of coffee> in one go	quality
<a lot of coffee> = a minimum of 12 cups	
It is possible to make <different types of coffee>	quality
<different types of coffee> = espresso	quality
<different types of coffee> = cappuccino	quality
<different types of coffee> = fresh brew	quality
The coffee machine is <modern>	quality
The coffee machine is made of die-cast alloy	quality
The coffee machine an angular shape	quality
The user is able to clean the coffee machine	function
It is possible to clean the coffee machine <quickly>	quality
<quickly> = within 5 minutes	
It is possible to clean the coffee machine <easily>	quality
<Few parts> can get dirty	quality
<Few parts> = a maximum of 5 parts	
The parts are dishwasher proof	quality
The coffee machine is able keep coffee warm	function
The warming of the coffee stops, if the <warming period> is reached	rule
<warming period> = 30 minutes	
The user is able to plan the availability of coffee	Function
Coffee making starts, if the set time is reached	rule

Design phase

- The design phase decides *how* the system will operate in terms of
  - The hardware, software e network infrastructure that will be in place
  - The user interface, forms and reports that will be used
  - The specific programs, databases and files that will be needed
- The primary output of this phase is the *system specification*
  - It is the collection of the results of all the steps that are included in this phase

Design phase

- The design phase includes four steps
  1. The *design strategy*: it clarifies whether the system will be
     - Developed by the company's own programmers
     - Its development will be outsourced to another firm (usually a consultant firm)
     - An existing software package will be bought
  2. The *architecture* and *interface design*: it describes the hardware, software and network infrastructure that will be used. In most cases, the system will add or change the infrastructure that already exist

Design phase

3. The *database and file specifications*: it defines exactly what data will be stored and where they will be stored
4. The *program design*: it defines the programs that need to be written and exactly what each program will do

- At the end of the design phase, the feasibility analysis and project plan are reexamined and revised, and another decision is made by the project sponsor and approval committee about whether to terminate the project or continue.

Implementation phase

- The *implementation phase* is the longest and most expensive part of the development process
- During this phase, the system is either developed or purchased
- The primary output of this phase is the installed system
- The implementation phase includes three steps
  1. The *system construction*: it is the process of building and testing the system to ensure that it performs as designed
     - Testing is one of the most crucial steps, as fixing bugs can be highly expensive

Implementation phase

2. The *installation*: it is the process by which the old system is turned off and the new one is turned on
   - One of the most important aspects is the training plan, used to teach users how to use the new system and help manage the changes caused by the new system
3. The *support plan*: it is the collection of formal or informal post-implementation reviews
   - It includes the system maintenance

Project document

- It is a document comprises both analysis and design phase
- For the analysis part:
  - Definition of the scenario
    - Define all your assumptions
  - Analysis of the possible competitors and study of their pros and cons (OPTIONAL)
  - Analysis of functional and non-functional requirements
  - For each functional requirement:
    - Analysis and choice of available HW (development board, sensors, actuators, and so on)
    - Analysis and choice of the application protocol and communication technology (mostly WiFi)
    - Analysis of suitable user interfaces
- NOTE: some choices could be global (i.e. the same for the all requirements, such as development board, user interface)

Project document

- For the design part:
  - Architecture definition
  - Design of the algorithms (such as flowchart) – there could be as many algorithms as the FRs
  - Any approach used for sending data
  - Design of HW wirings
  - Discussion on the association real objects – Digital Twins
  - Mock-up of any user interface

Common Errors

- **Always** review documents
  - You lose points !!

- Analysis:
  - Lack of identification of functional and non-functional requirements
  - Lack of reference scenario

- Design
  - Lack of a complete vision of architecture
  - Lack of flowcharts
  - Lack of a mock-up
  - Remember to define data exchange format, database design and management algorithm (s)

References

- Dennis, Alan, Barbara Haley Wixom, and Roberta M. Roth. *Systems analysis and design, 7th edition*. John Wiley & Sons, 2018