

Software Design Principles

01 Introduction



Dr. Mostafa Elgendy

Mostafa.Elgendy@fci.bu.edu.eg

Course Syllabus

No.	Module Name
1	Introduction to SW Design
2	Design Principles
3	OOP Concepts
4	UML
5	Solid Principles 1
6	Solid Principles 2
7	Design Patterns1
8	Design Patterns 2
9	Design Patterns 3
10	Design Patterns 4
11	UI & UX 1
12	UI & UX 2



Grade Distribution

Graded Item	Marks
Attendance	5%
Participation	5%
Midterm Exam	30%
Lab	20%
Final Exam	40%



Agenda

- Importance of Design and Architecture in industrial process.
- SW Development as an Industry.
- Defining SW Architecture and SW Design.
- Modeling and Documenting SW Architecture and SW Design.





Main Activities of many Industries

Main Activities of many Industries

- European Union (EU) Parliament defines industry as:
 - The automated production of material goods.
- In order to understand if software (SW) development is an **industry, or not**, and how does it work, we need to understand the six main activities of any given industry.
- The main question is that is software Development is a real industry?



Main Activities of many Industries

- Each, and every industry worldwide has six main activities that that should be accomplished.
 - Planning.
 - Requirements Analysis.
 - Architecture and Design.
 - Build.
 - Test.
 - Deliver/Deploy.



Main Activities of many Industries

- Example: Let us take the planes production industry as an example.
 - If Boeing will produce a plane for Egypt Air, first of all, they have to understand how Egypt Air thinks in the potential plane. This needs to reach answers for lots of questions including:
 - What is the model of that plane?
 - How many seats should be in that plane?
 - Which engine Egypt needs the plane to come with?
 - What is the dedicated budget in Egypt Air for that plane?



Main Activities of many Industries

- The previous questions helps in **defining the scope** of that project. Answers helps in having a clear consensus about if this production project could be conducted or not.
- If there some financial, technical, legal, expertise-related, political, or other could arise, and couldn't be mitigated, then the production project is not feasible.
- If the dedicated budget was not reasonable at all then, Boeing will notify Egypt Air that this plane couldn't be produced and delivered to Egypt.



Main Activities of many Industries

- In contrary, if the project shows feasibility, then, the rest of information will help in defining the scope of the project.
- Scope sets the boundaries of the project from every prospective that shouldn't be exceeded, including but not limited to; timing, budgetary, resources.
- The scope in our context could be the type of the plane (e,g 777, 737,747,..etc). If they have chosen a 777 plane. The subtype of the plane must be defined as well (777-200, 777-300, 777-300ER, 777-400 or 777-400ER)?



Main Activities of many Industries

- Without such kind of information, the scope couldn't be defined clearly. Moreover, it may lead to complete failure of the project due to failure in achieving all what has been agreed on during scope definition.
- These tasks are being accomplished as part of what is called **Planning Activity**.



Main Activities of many Industries

- After contract agreement between Boeing and Egypt Air, the second activity should begin. During this activity, Boeing should **gather the requirements, or wish list** of Egypt Air in this plane.



Main Activities of many Industries

- This wish list include answers for:
 - What will be the material of furnishing the seats (e.g. recycled leather, genuine leather, textiles, etc...)?
 - How many first-class, business-class, and economy class seats should be placed?
 - What will be spacing distance between each class's seats?
 - How will each seat be equipped (e.g. LCD screen, Sky Phone, First Class bed-like seat, etc...)?
- This activity is called **Requirements Analysis**.



Main Activities of many Industries

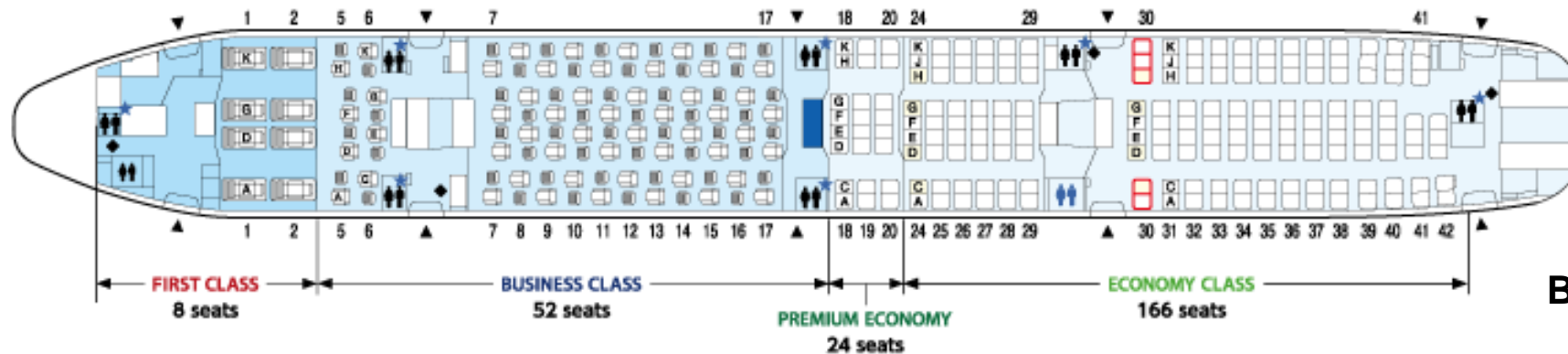
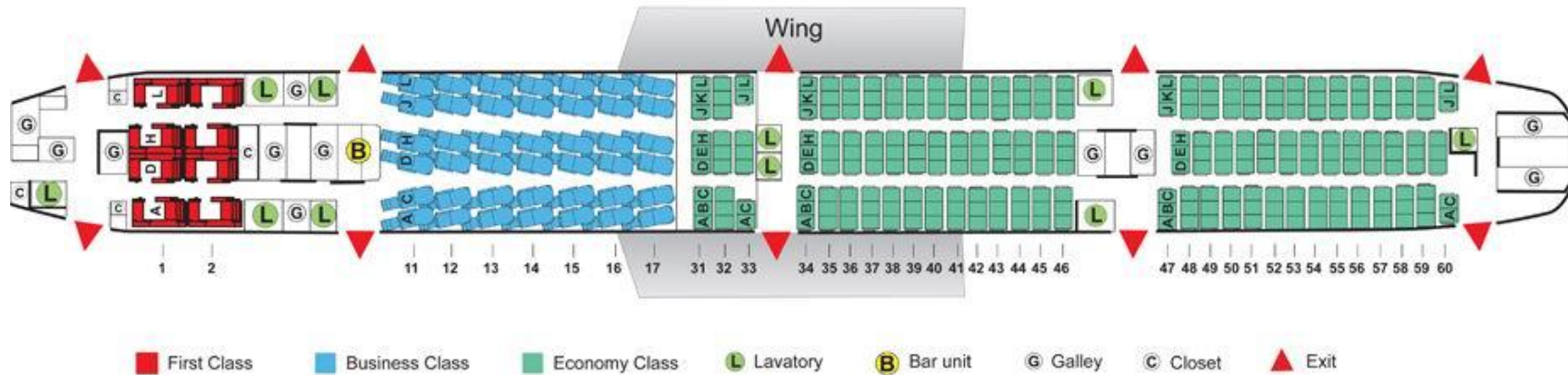
- When both parties finally agree on all requirements, Boeing should pass the agreed specifications to the manufacturing team.
- This team is concerning with producing the product (the Plane in our example). In order to produce the plane, a blueprint should be there for the people who will build it.
- The blueprint has lots of details that should be elaborated in order to let the producers able to build the plane.
- Usually, the blueprint includes two important parts; the product **Architecture & Design**.



Main Activities of many Industries

Boeing B777-300ER (313 seats)

First Class: Rows 1 - 2; 8 seats Business Class: Rows 11 - 17; 42 seats Economy Class: Rows 31 - 60; 263 seats



BOEING 777-300ER (Seats 250)

Main Activities of many Industries

- The same plane type that comes with same subtype can have multiple designs with similar predefined architecture.
- Previous Figures showed the architecture and internal design of the Boeing 777-300ER that are being built for the favor of three different Airline customers.
- The first design is for Air China, 313 seats, The second design is for ANA (a Japanese carrier), 250 seats.



Main Activities of many Industries

- The blueprint includes most of the Architecture and Design specifications that are needed to enable plane developers to develop the plane.
- The development or build activity itself that ends with built plane is called **product Development** activity (the fourth main activity in the production process). This activity ends with producing the plane.



Main Activities of many Industries

- This plane couldn't be delivered to the customer without being tested aggressively. Its engines should be tested under the expected load of range, and weight. This activity is called **Testing**.



Main Activities of many Industries

- At the end, the plane should be prepared to be deployed at the customer's predefined airport.
- To do this, the plane should be painted with the theme, and logo of the customer Airline.
- Finally, a crew flies by the plane to be deployed into the customer's airport. This activity is called product **deployment**.
- Each SW development project includes those main six activities.





SW Development as an Industry

SW Development as an Industry

- According to a study that has been conducted by Stanford University; **SW is considered as an industry** by US, and Japan.
- This mapping is important to grown the belief that architecture and design are core activities in any product development process.



Defining SW design and architecture

- Understanding the customer's **requirements** is **a key factor** for having any **good design**.
- Design always needs to start by identifying the users of application, and understanding the goals and tasks these users wish to accomplish when using the application.



Defining SW design and architecture

- Design vs. Architecture.
- Types of Designer roles
- Types of Designer roles.
- Order of architecture & design within the SW development lifecycle.



Defining SW design and architecture

- **Design vs. Architecture (1/5)**

- Most of Technical people mix between architecture and design.
- The design of any given SW encompasses two kinds of technical decisions; components **design decisions** and **architectural decisions**. Both of those decisions are key pillar in finishing the SW final blueprint/design.



Design



Architecture

Defining SW design and architecture

- **Design vs. Architecture (2/5)**
 - Design Decisions are mostly concerned with fulfilling the **Functional requirements**. This includes but not limited to; identifying the applications domain object model, business objects, and data entities that will be physically implemented through code writing.
 - Architecture Decisions are mostly related to fulfilling **Non-Functional Requirement**. This includes but not limited to; *scalability, reliability, availability, extensibility, maintainability*.



Defining SW design and architecture

- **Design vs. Architecture (3/5)**
 - SW Architecture is:
 - Highest level concept of a system in its environment. The architecture of a software system (at a given point in time) is its organization or structure of significant components interacting through interfaces, those components being composed of successively smaller components and interfaces.
 - SW Design is:
 - The Details of Components and Interfaces are defined through SW Design!



Defining SW design and architecture

- Design vs. Architecture (4/5)

Architecture	Design
Performed by architect.	Performed by designer.
Concerned mainly with application quality attributes, and nonfunctional requirements.	Concerned mainly with fulfilling customer's functional requirements.



Defining SW design and architecture

■ Design vs. Architecture (5/5)

Architecture	Design
<u>Some example decisions:</u> <ul style="list-style-type: none">-Platform, operating system to be used.-Programming language to be used.-User experience technology (e.g. HTML5, CCS3, Silverlight, AJAX, etc...)-Component messaging (e.g. SOAP).	<u>Some example decisions:</u> <ul style="list-style-type: none">-Entity Relationship Diagram design.-Class diagram design (in case of object-Oriented programming)-Classes data and behavior.
<u>Two main types of architect roles</u> <ul style="list-style-type: none">- Application architect.- Infrastructure architect.	<u>Three main types of designer roles</u> <ul style="list-style-type: none">-User Interface (UI) designer.-Application component designer.-Data designer.

Defining SW design and architecture

- **Types of Architect Roles (1/6)**
 - **Application architect.**
 - **Infrastructure/technical architect**



Defining SW design and architecture

- **Types of Architect Roles (2/6)**

- **Application architect.**

- Applications architect is the ones who define how the application will be structured coding-wise.
- By other words, he is the one who is concerned with defining the way that will be used for coupling, and cohering the application's components, and layers.
- Application architect has to take major decisions that affect the rest of the development team, and the SW production cycles.



Defining SW design and architecture

- **Types of Architect Roles (3/6)**
 - **Application architect.**
 - Some decisions that are taken by AA, aligned with the gathered requirements and agreed scope and affect the development team OS, DBMS, UI types, Component Messaging:
 - Platform to be utilized (on premise, cloud, hybrid),
 - Language of code the will be written (Java, C#,...)
 - User interface technologies (HTML5 & CSS3, AJAX, ...)
 - The type of client devices (desktop PCs, tablets, mobile, etc...)



Defining SW design and architecture

- Types of Architect Roles (4/6)
 - Application architect styles

Architecture Style	Description
Client/Server	Divide the application into two parts, where the client sends requests to the server. Usually, the server is a database with application logic represented as stored procedures.
Component-Based Architecture	Decomposes application design into reusable functional or logical components that expose well-defined communication interfaces.
Layered Architecture	Segregates the concerns of the application into stacked sets (layers).



Defining SW design and architecture

- Types of Architect Roles (5/6)

- Application architect styles

Architecture Style	Description
Message Bus	In this style, the application can receive and send messages using one or more communication channels autonomously, so that applications can interact without the need to know specific details about each other.
N-Tiers	Divide functionality into loosely couple segments in a way that is close to the layered style, however in this style, each segment is being a tier that is usually deployed on a physically separate machine.
Service Oriented Architecture (SOA)	Refers to applications that expose and consume functionality as a service using contracts and messages.



Defining SW design and architecture

- **Types of Architect Roles (6/6)**
 - **Infrastructure architect.**
 - Infrastructure architect is the one who defines how these components and layers should be physically deployed on the hardware, and network infrastructure



Defining SW design and architecture

- **Types of Designer Roles (1/4)**
 - User Interface (UI) designer
 - Application domain designer
 - Data designer



Defining SW design and architecture

- **Types of Designer Roles (2/4)**
 - **User Interface (UI) designer**
 - UI design is out of the scope. You can refer to Human-Computer-Interaction (HCI) Course for more extra details related this topic.



Defining SW design and architecture

- **Types of Designer Roles (3/4)**
 - **Application domain designer**
 - Domain designer is a major key player in the process of architecting and designing an application.
 - He is responsible of understanding the detailed business rules, and the main domain objects that are generated from this set of customer's business rule requirements.
 - He designs the application components that have enough algorithms to maintain these requirements processed and implemented accurately.



Defining SW design and architecture

- **Types of Designer Roles (4/4)**
 - **Data designer.**
 - Those are a kind of database (DB) professionals who are concerned with designing the applications DB, and defining its chosen schema; conceptually, logically and physically.
 - This kind of design is out of the scope of this course.



Defining SW design and architecture

- **Order of architecture & design within the SW development lifecycle (1/2)**
 - Most of the required information by Architect and Designer are Requirements that come from Analysis, and scoping constraints that come from Planning.
 - In waterfall process model, Architecture, and design comes after Analysis.



Defining SW design and architecture

- **Order of architecture & design within the SW development lifecycle (2/2)**
 - In agile iterative based processes, some architectural and design questions may lead to getting back to analysis thus, changing the final requirements upon received answers.
 - Ensure that all design decisions are being documented up to the last version of design and architecture.



Modeling and Documenting

- Without documenting the decisions of architecture and design we will be risking lots of aspect including but not limited to:
 - The implementation.
 - The maintainability.
- For OO, development, UML is the documentation standard



Summary

- The Importance of Design and Architecture in the industrial process.
- SW Development as an Industry.
- Defining SW Architecture and SW Design.
- Modeling and Documenting SW Architecture and SW Design.
- Summary



Questions

