3. Database Design Process

IT2306 - Database Systems

Level I - Semester 2

Database Design Process

- Database design and the creation of an entity relationship diagram (also known as an " ERD" or data model) is an important yet sometimes overlooked part of the application development lifecycle.

- An accurate and up to date data model can serve as an important reference tool for DBAs, developers, and other members of a JAD (joint application development) team.

- The process of creating a data model helps the team uncover additional questions to ask of end users Effective database design also allows the team to develop applications that perform well, from the beginning.

- By building quality into the project, the team reduces the overall time it takes to complete the project, which in turn reduces project development costs.

- The central theme behind database design is to "measure twice, cut once" .

Data Modeling

- A data model represents a business' data and act as a blueprint and foundation of a database. If the data model is flawed, the database and all programs that use the database will be flawed.

- This data model is a conceptual representation of Data objects, the associations between different data objects and the rules.

- The data model and subsequently the database should be designed, to be extensible and expandable.

- Therefore, understanding the business environment and the initial reason for the database is essential.

- Data modeling helps in the visual representation of data and enforces business rules, regulatory compliances, and government policies on the data.

Data Modeling

- Data model emphasizes on what data is needed and how it should be organized instead of what operations need to be performed on the data.
    - Ex: House Plan
- The two types of Data Models techniques are
    - Entity Relationship (E-R) Model
    - UML (Unified Modelling Language)
- Many CASE tools are available to assist in data modeling.

Goals of Data Modeling

- Ensures that all data objects required by the database are accurately represented.

- Helps design the database at the conceptual, physical and logical levels.

- Data Model structure helps to define the relational tables, primary and foreign keys and stored procedures.

- It provides a clear picture of the base data and can be used by database developers to create a physical database.

- Helpful to identify missing and redundant data.

- Initial creation of data model is labor and time consuming, in the long run, it makes the IT infrastructure upgrade and maintenance cheaper and faster.

- A poor database design can cripple an application, producing problems with redundancy, inaccuracy, consistency, and concurrency of your data.

- Normalization is a process that serves to reduce, if not eliminate, these problems with data.

Database Design Process

- Effective database designers will keep in mind the principles of normalization while they design a database. Normalization is a database design approach that seeks the following four objectives.

1. Minimization of data redundancy,

2. Minimization of data restructuring,

3. Minimization of I/O by reduction of transaction sizes, and

4. Enforcement of referential integrity.

Types of Data Models

- **Conceptual**
  - Defines **WHAT** the system contains.
  - This model is typically created by Business stakeholders and Data Architects. The purpose is to organize, scope and define business concepts and rules.

- **Logical**
  - Defines **HOW** the system should be implemented regardless of the DBMS.
  - This model is typically created by Data Architects and Business Analysts. The purpose is to developed technical map of rules and data structures.

- **Physical**
  - This Data Model describes **HOW** the system will be implemented using a specific DBMS system.
  - This model is typically created by DBA and developers. The purpose is actual implementation of the database.

Database Design

- The database design process can be broken down into four phases.

```
Phase 1   -Requirements Collection
              and analysis
Phase 2   -Conceptual Design
Phase 3   -Logical Design
Phase 4   -Physical Design
```

Database Design...

Database Design...

Mini-world
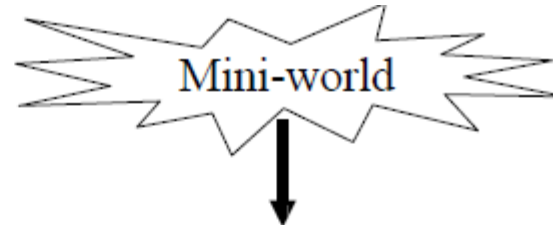
Phase 1 - Requirements Collection and Analysis phase

Functional Requirements

Database Requirements

Prospective database uses are interviewed to understand and document their data requirements.

From data view (e.g. ERD) rather than functional view (e.g. DFD)

Database Design...

↓

Phase 2 - Conceptual Design

↓

Conceptual Design

This is high level description of the structure of a database. E.g. E-R diagram

Concise description of the data requirements of the users and includes detailed descriptions of the data, relationships and constraints.
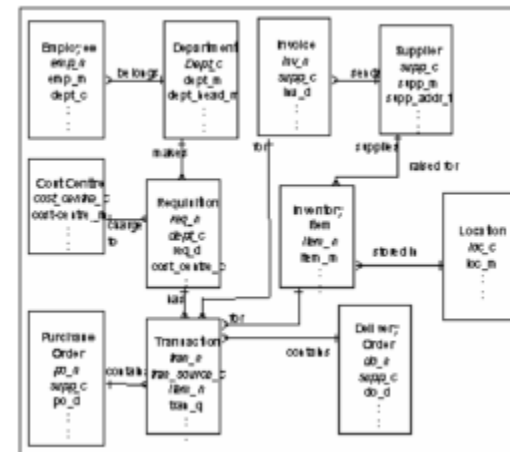
Database Design...

Database Design...

Conceptual Design

Phase 3 - Logical Design

This is the process of mapping the database structure developed in the previous phase to a particular database model. E.g. map E-R model to relational

Logical Design

Specific to a database model, but independent of a particular DBMS (product)

Database Design...

Database Design...

Phase 4 - Physical Design

This is the process of defining structure that enables the database to be queried in an efficient manner.

E.g. index and hash file design, data partition

Logical Design

↓

Physical Design
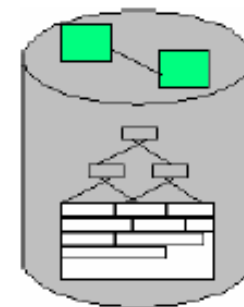
Phases of DB Design
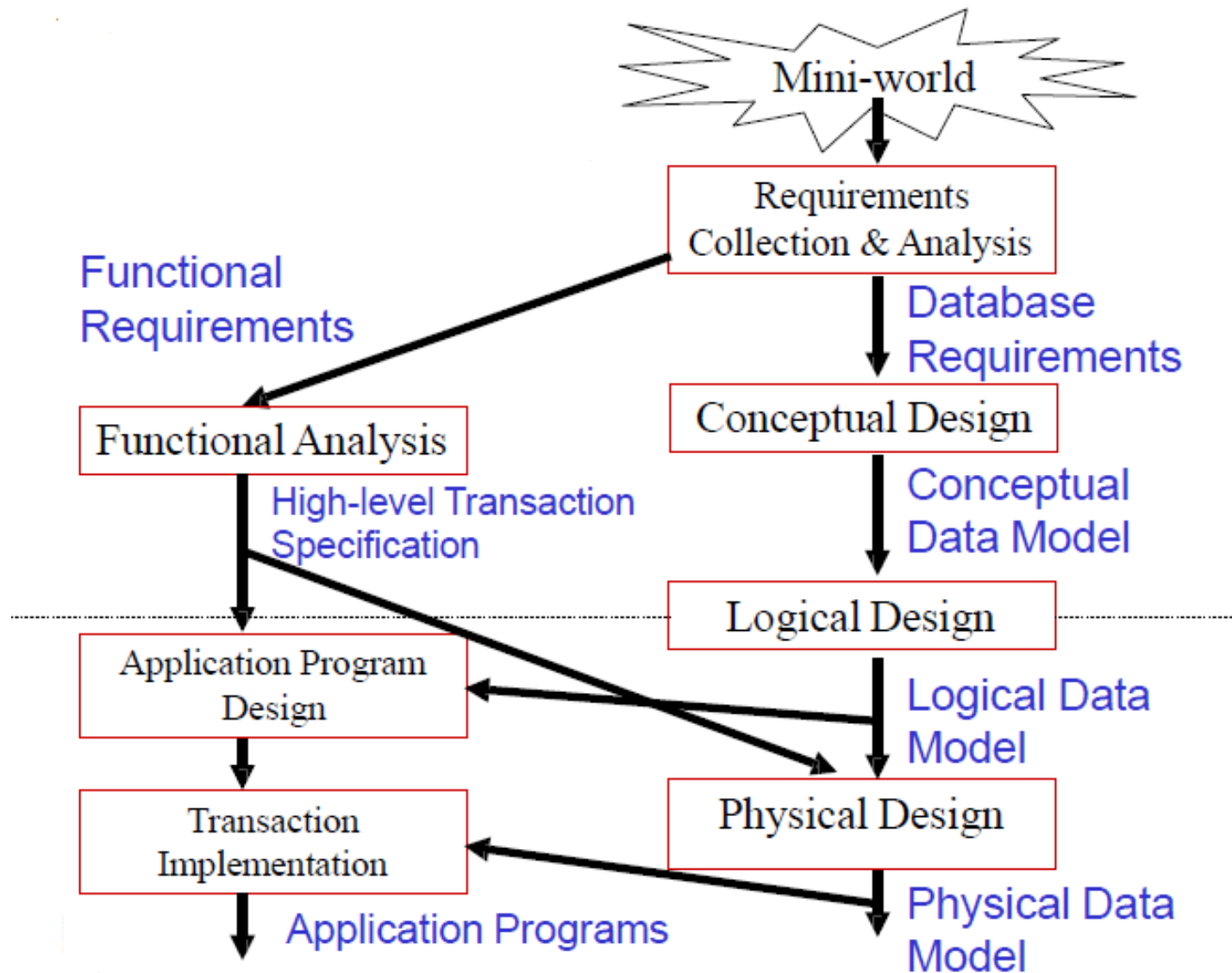
Types of Database Models
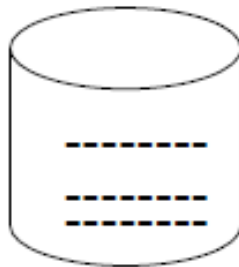
Traditional Files — 60s

Hierarchical Database Model — 70s
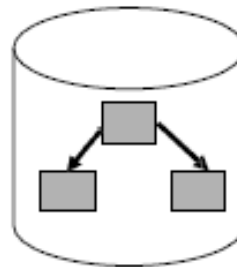
Network Database Model — 70s
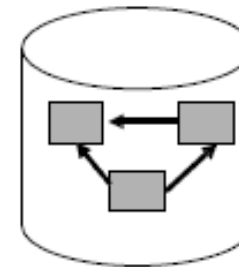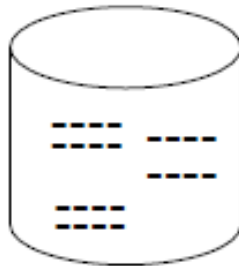
Relational Database Model — 80s

Object-oriented Database Model — 90s
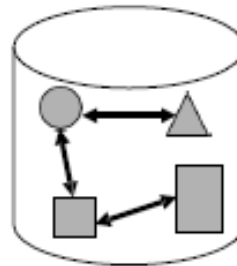
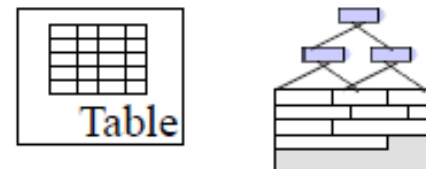Object-relational Database Model — 90s
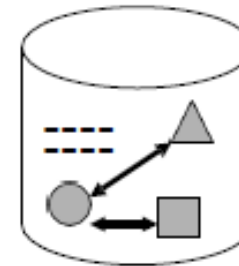
Types of Data Models

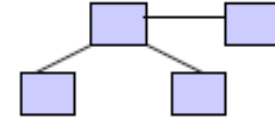- **Conceptual Data Model**
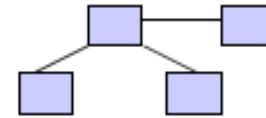
- **Logical Data Model**

- **Physical Data Model**

Conceptual Data Model

- A data model representing the objects and business rules that govern the operation of an organisation
  - *Done by a Business Analyst*
  - *Not constrained by access requirement and technology*

Logical Data Model

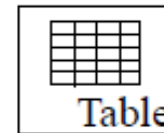| ATTR1	ATTR2 A	TTTR3 ATT	R4 ATTR	LLL 5

Table

employee(empno, …)

- A set of data structures assembled following rules that describe the processing requirements (access paths) of the data in terms of a logical database model
  - *Done by a Data Analyst*
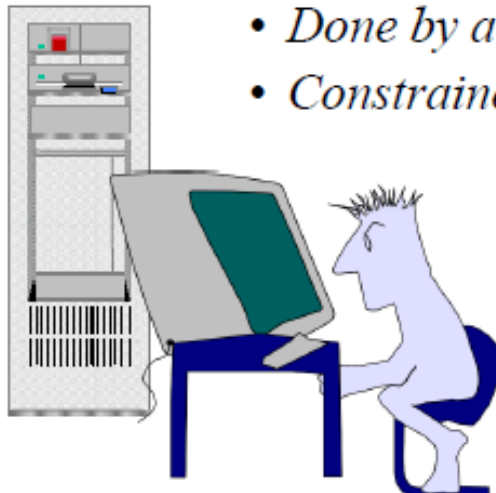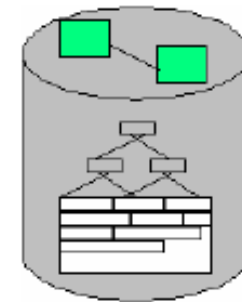 - *Not constrained by technology (?)*
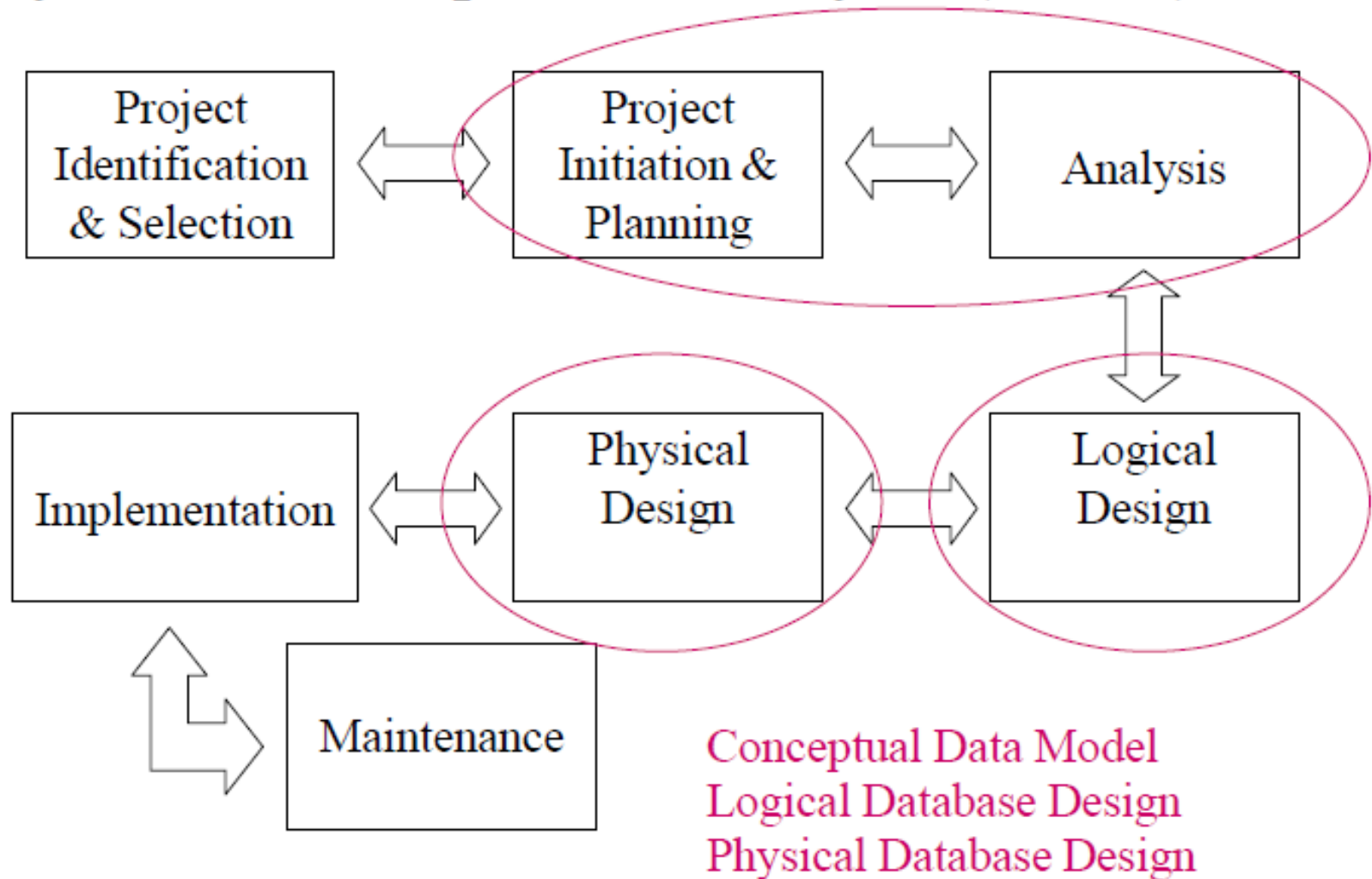
Physical Data Model

create table   Table

employee(empno …)

- A model prepared for the purpose of implementing a database that runs under the control of a particular DBMS (product)
  - *Done by a DBA*
  - *Constrained by Technology*

Systems Development Life Cycle (SDLC)

Database Development Activities

- Enterprise Modelling

- Conceptual Data Modelling

- Logical Database Design

- Physical Database Design and Creation

- Database Implementation

- Database Maintenance

Enterprise Modelling

- Analyze current data processing

- Analyze the general business functions and their database needs

- Justify need for new data and databases in support of business

Project Identification &Selection

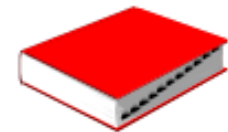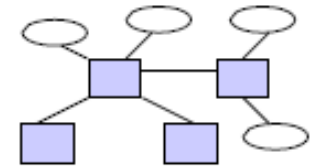# Conceptual Data Modelling

- Identify scope of database requirements for proposed information system

- Analyze overall data requirements for business function(s) supported by database

- Develop preliminary conceptual data model including entities and relationships

- Compare preliminary conceptual data model with enterprise data model
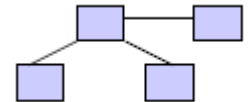
Analyze

Conceptual Data Modelling...

- Develop detailed conceptual data model, including all entities, relationships, attributes and business rules

- Make conceptual data model consistent with other models of information system

- Populate repository with all conceptual database specifications
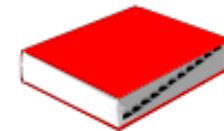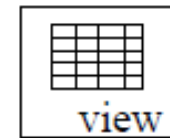
Analysis

Logical Database Design

- Analyse in detail the transactions, forms, displays and inquires (data views) required by the business functions supported by the database

- Integrate database views into conceptual data model

- Identify data integrity and security requirements, and populate repository

view

Logical Design

Physical Database Design

- Define database to DBMS (often generated from repository)

- Decide on physical organisation of data

- Design database processing programs
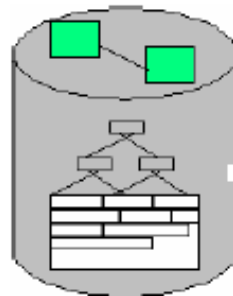
Physical Design

Database Implementation

- Code and test database processing programs
- Complete database documentation and training materials
- Install database and convert data from prior systems
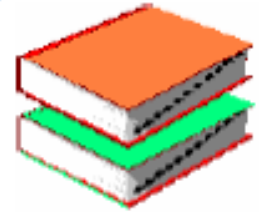
Implementation

Database Maintenance

- Analyze database and database applications to ensure that evolving information requirements are met

- Tune database for improved performance

- Fix errors in database and database applications and recover database when it is contaminated

Maintenance

Thank You