Chapter 16
Conceptual Database Design for the Relational Model

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Objectives

- The purpose of a design methodology.

- The 3 main phases of database design: conceptual, logical, and physical design.

- How to document the process of conceptual database design

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Database Design

- In Chapter 10 we described the main stages of the database system development lifecycle, one of which is database design.
- Database design is made up of 3 phases:
    - Step 1: Conceptual
    - Step 2: Logical
    - Step 3: Physical database design
- Conceptual database design is to build the conceptual representation of the database, which includes identification of the important entities, relationships, and attributes.

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What is a Design Methodology?

- Design methodology is a structured approach that uses procedures, techniques, tools, and documentation aids to support and facilitate the process of design.

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Conceptual Database Design Methodology

- Step 1: Build Conceptual Data Model
- The objective is to build a conceptual data model of the data requirements of the enterprise.
- The conceptual data model is supported by documentation, including ER diagram and a data dictionary.

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Step 1: Build Conceptual Data Model

Activities involved:
- Step 1.1 Identify entity types
- Step 1.2 Identify relationship types
- Step 1.3 Identify and associate attributes with entity or relationship types
- Step 1.4 Determine attribute domains
- Step 1.5 Determine candidate, primary, and alternate key attributes
- Step 1.6 Draw ER diagram. Consider the use of enhanced modeling concepts (optional).

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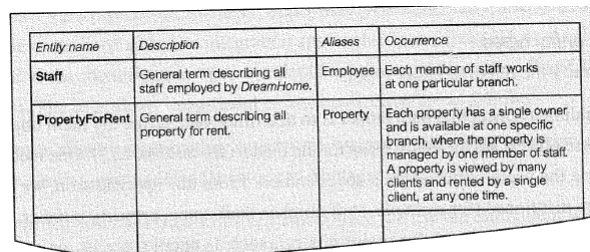## Step 1: Build Conceptual Data Model (cont'd)

Activities involved:

- Step 1.7 Check model for redundancy and remove any that exists
- Step 1.8 Validate conceptual data model against user transactions
- Step 1.9 Review conceptual data model with user

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Step 1.1 Identify entity types

- One method of identifying entities is to examine the users' requirements specification.
- As entity types are identified, assign them meaningful names.
- Record the names and descriptions of entities in a data dictionary.

Entity name	Description	Aliases	Occurrence
Staff	General term describing all staff employed by DreamHome.	Employee	Each member of staff works at one particular branch.
PropertyForRent	General term describing all property for rent.	Property	Each property has a single owner and is available at one specific branch, where the property is managed by one member of staff. A property is viewed by many clients and rented by a single client, at any one time.

Figure 16.1 Extract from the data dictionary for the StaffClient user views of DreamHome showing a description of entities.

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Step 1.2 Identify relationship types

- Determine the multiplicity constraints of relationship types.
- Document relationship types and the multiplicity constraints in the data dictionary.

Entity name	Multiplicity	Relationship	Multiplicity	Entity name
Staff	0..1 0..1	Manages Supervises	0..100 0..10	PropertyForRent Staff
PropertyForRent	1..1	AssociatedWith	0..*	Lease

Figure 16.3 Extract from the data dictionary for the StaffClient user views of *DreamHome*, showing a description of relationships.

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Step 1.3 Identify and associate attributes with entity or relationship types

- Identify simple/composite attributes
- Identify single/multi-valued attributes
- Identify derived attributes
- Document attributes in the data dictionary

Primary key? Candidate key? Foreign key? Derived attribute?, etc…..

Entity name	Attributes	Description	Data Type & Length	Nulls	Multi-valued	…
Staff	staffNo	Uniquely identifies a member of staff	5 variable characters	No	No	
	name fName lName position sex DOB	First name of staff Last name of staff Job title of member of staff Gender of member of staff Date of birth of member of staff	15 variable characters 15 variable characters 10 variable characters 1 character (M or F) Date	No No No Yes Yes	No No No No No	
PropertyForRent	propertyNo	Uniquely identifies a property for rent	5 variable characters	No	No	

Figure 16.4 Extract from the data dictionary for the StaffClient user views of *DreamHome* showing a description of attributes.

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Step 1.4 Determine attribute domains

- Document attributes domains in the data dictionary.
- Update the data dictionary entries for attributes to record their domain in place of the data type and length information.

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Step 1.5 Determine candidate, primary, and alternate key attributes

- In the process of identifying primary keys, note whether an entity is strong or weak.
- If we are able to assign a primary key to an entity, it is referred to as being strong.
- Otherwise, the entity is referred to as being weak.
- The primary key of a weak entity can be identified only when we map the weak entity and its relationship with its owner entity to a relation through the placement of a foreign key in that relation (to be described in Step 2.1 of Chapter 17)
- Document primary and alternate keys in the data dictionary.

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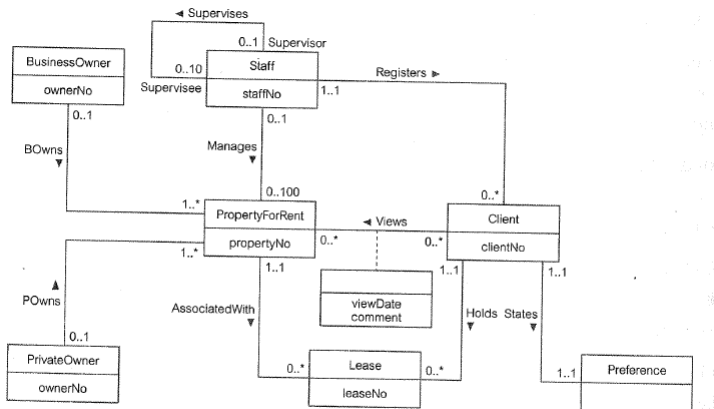# Step 1.5 Determine candidate, primary, and alternate key attributes (cont'd)

Figure 16.5 ER deagram for the StaffClient user views of DreamHome with primary keys added.

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Step 1.6 Draw ER diagram

- In this step, we have the option to continue the development of the ER model using the enhanced modeling concepts, namely specialization / generalization.

- There are no strict guidelines on when to develop the ER model using enhanced modeling concepts, as the choice is often subjective and dependent on the particular characteristics of the situation being modeled.

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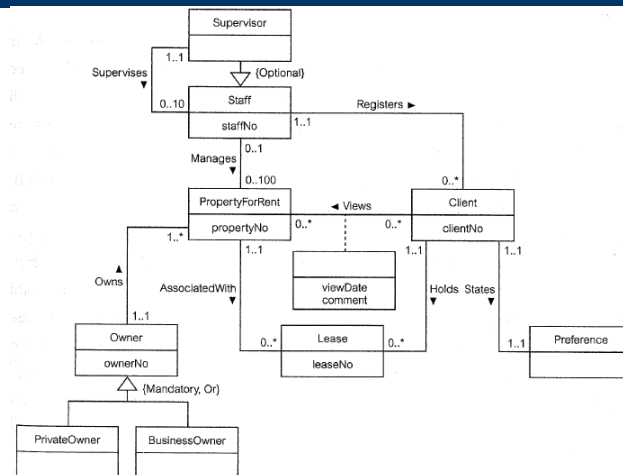## Step 1.6 Consider use of enhanced modeling concepts (cont'd)

Figure 16.6 Revised ER diagram for the StaffClient user views of DreamHome with specialization/generalization added.

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A Wrap-up for the database design process for relation model

- **Database Design Objective:** A well-designed database shall
  - **Reduce Data Redundancy**: the same piece of data shall not be stored in more than one place. This is because duplicate data not only waste storage spaces but also easily lead to inconsistencies.
  - However, do not be hard on avoiding redundancy, if performance is the key.
  - Ensure Data Integrity and Accuracy
    - Entity Integrity Rule
    - Referential Integrity Rule

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A Wrap-up for the database design process for relation model (cont'd)

- **Relational Database Design Process**
  - Step 1: Define the Purpose of the Database (Requirement Analysis)
  - Step 2: Gather Data, Organize in tables and Specify the Primary Keys
  - Step 3: Create Relationships among Tables
  - Step 4: Refine & Normalize the Design

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