Johns Hopkins Engineering

Principles of Database Systems

Module 8 / Lecture 4

ER and EER to Relational Mapping

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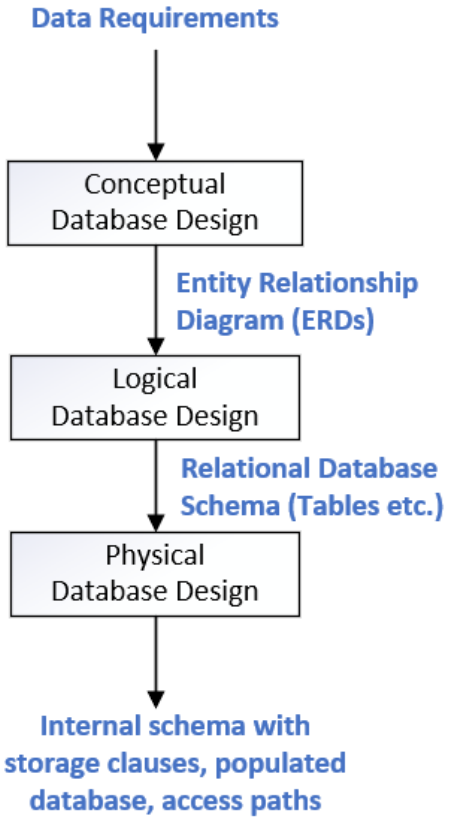
Database Design Process



Using a conceptual schema design (Entity Relationship Diagram) to create a relational database schema

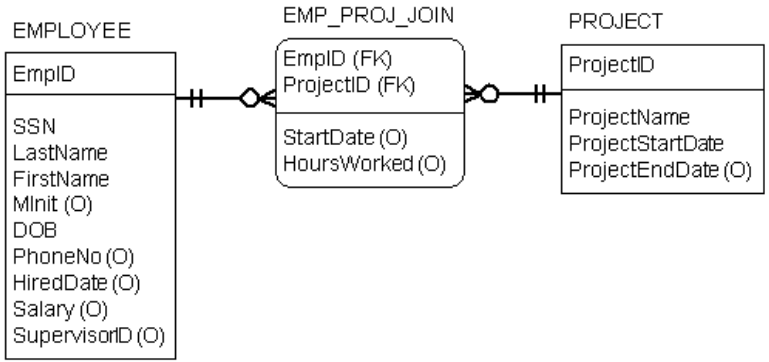
Converting ER Model to Relational Model

- Create relations for the conceptual data model to represent the entity types, relationships, and attributes that have been identified

- Implement the concepts of relational databases, primary keys, foreign keys, and data integrity

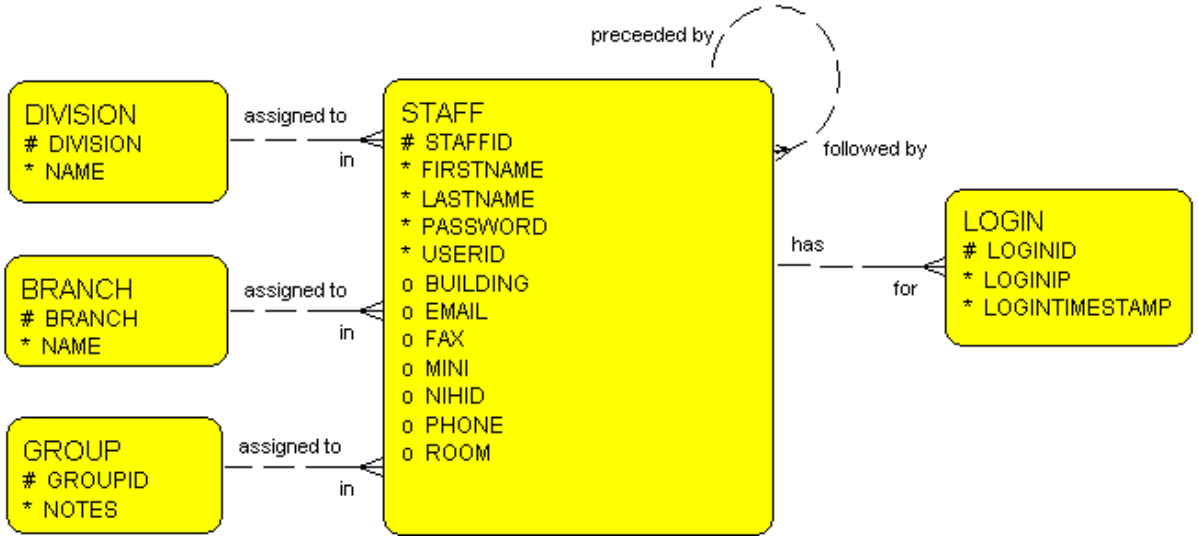
Converting ER Model to Relational Model (Cont.)

- Database design tools may have different graphical representations.
- ERwin and Visio show a foreign key attribute in a child relation:



Converting ER Model to Relational Model (Cont.)

- Oracle designer does not include a foreign key into a child relation. Why?



How to Map Entity Types and Relationships to Relations

ER Model	Mapping to Relation
Strong entity type	Create relation with all simple attributes
Weak entity type	Create relation with all simple attributes, and combine partial key of weak entity and a FK from the parent entity type as the PK
1:1 relationship type with mandatory participation on both sides	Combine entities into one relation or create two relations (see next) (e.g., EMPLOYEE vs. OFFICE or BADGE as 1-1 relationship)

How to Map Entity Types and Relationships to Relations (cont.)

ER Model	Mapping to Relation
1:1 relationship type with mandatory participation on one side	Post PK of entity on optional side to act as FK in relation representing entity on mandatory side (e.g., EMPLOYEE and CAR have 1-1 relationship)
1:M relationship type	Post PK of entity on **one** (parent) side to act as FK in relation representing entity on **many** (child) side

How to Map Entity Types and Relationships to Relations (cont.)

ER Model	Mapping to Relation
M:M relationship type	Create two 1:M relation types and follow above mapping and add additional attributes to the transitional relation (Be aware whether identifying or non-identifying relationships)
Multi-valued attribute	Create a new relation and post a copy of the PK of the parent entity into the new relation to act as a FK (e.g., DEPT_LOCATION)
N-ary relationship type	Create a new relation and post all PKs of the parent entities into the new relation to act as a PK and FKs (e.g., SUP_PRJ_PART_JOIN)

How to Map Entity Types and Relationships to Relations (cont.)

Table 9.1 Correspondence between ER and Relational Models

ER MODEL	RELATIONAL MODEL
Entity type	*Entity* relation
1:1 or 1:N relationship type	Foreign key (or *relationship* relation)
M:N relationship type	*Relationship* relation and *two* foreign keys
n-ary relationship type	*Relationship* relation and *n* foreign keys
Simple attribute	Attribute
Composite attribute	Set of simple component attributes
Multivalued attribute	Relation and foreign key
Value set	Domain
Key attribute	Primary (or secondary) key

Mapping COMPANY ER Schema Into A Relational Database Schema

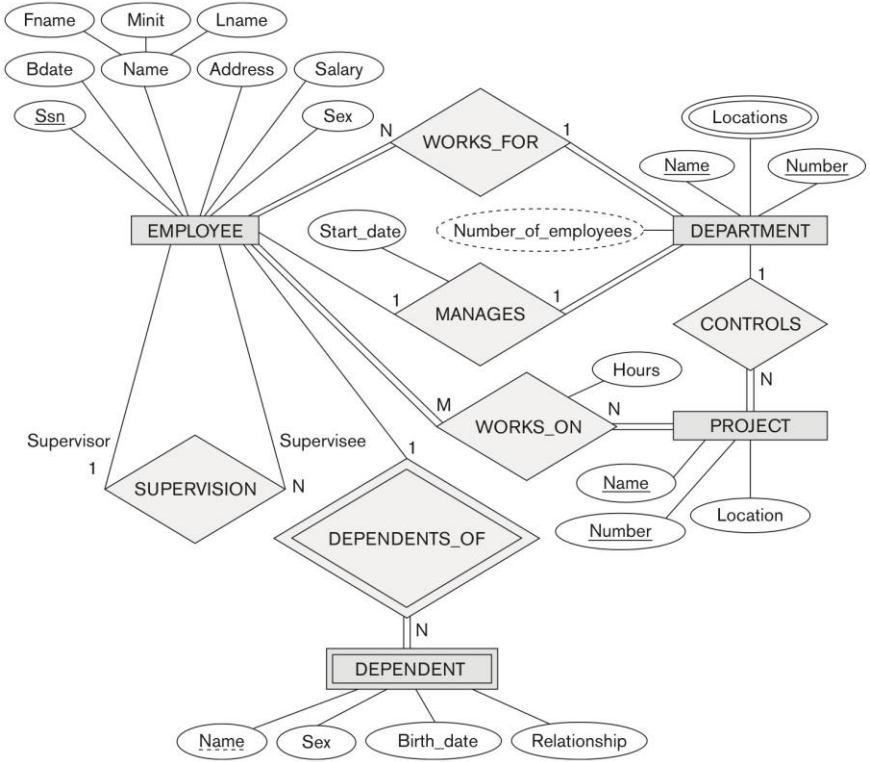


Figure 9.1 The ER conceptual schema diagram for the COMPANY database.

Mapping COMPANY ER Schema Into A Relational Database Schema (cont.)

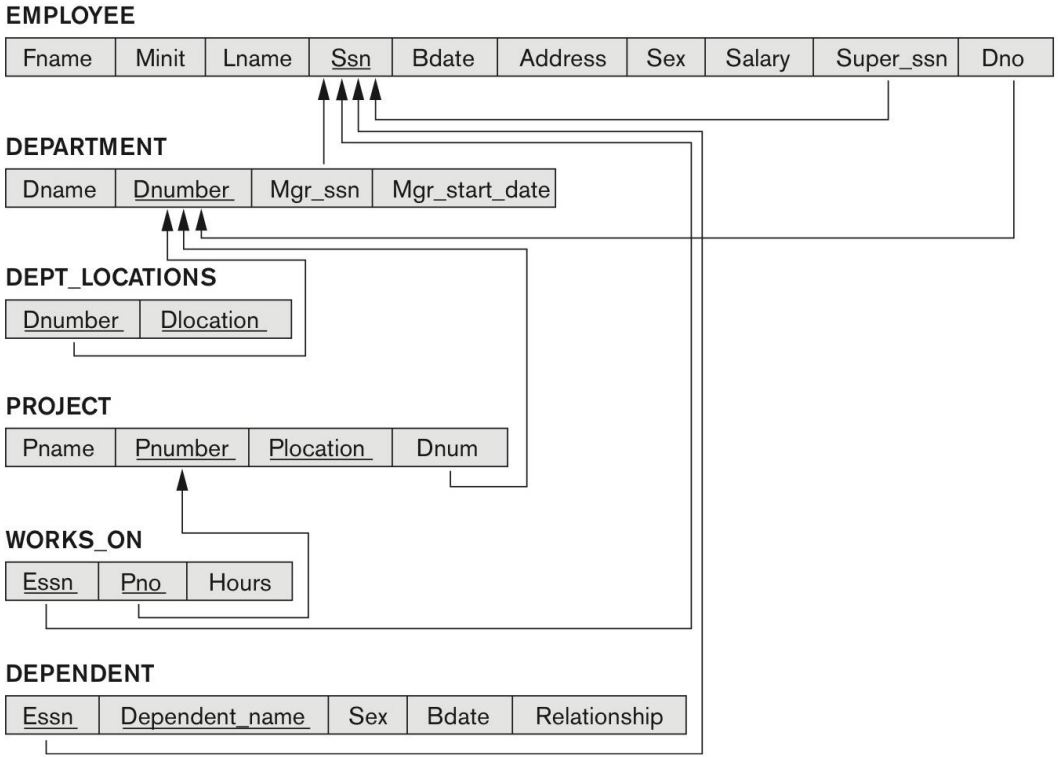
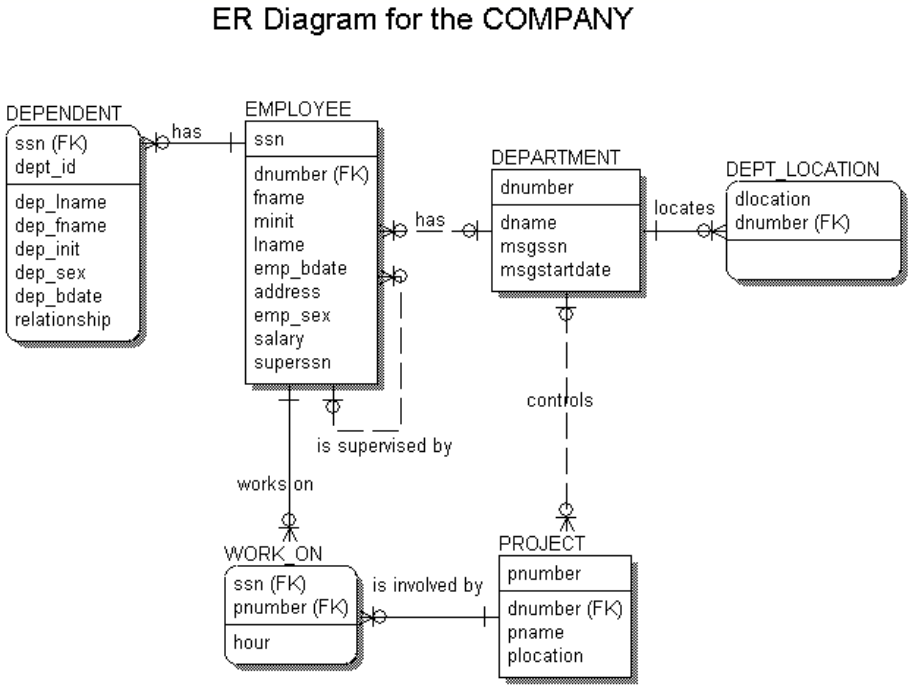


Figure 9.2 Result of mapping the COMPANY ER schema into a relational database schema.

Mapping COMPANY ER Schema Into A Relational Database Schema (cont.)

- IE notation is supported by DB design tools.



Mapping A Ternary Relationship Schema

Figure 3.17 Ternary relationship types. (a) The SUPPLY relationship.

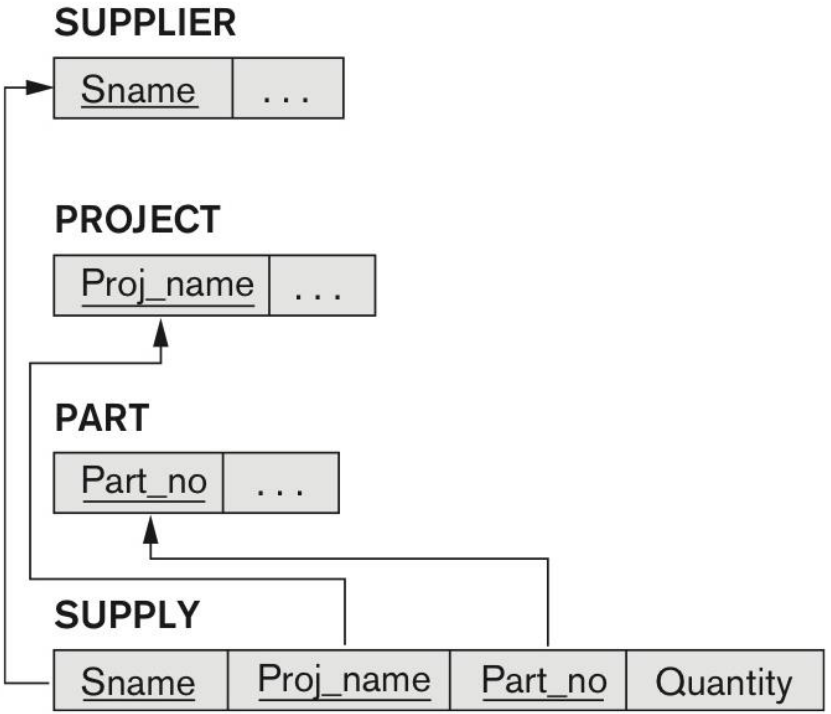


Figure 9.4 Mapping the n-ary relationship type SUPPLY from Figure 3.17(a).

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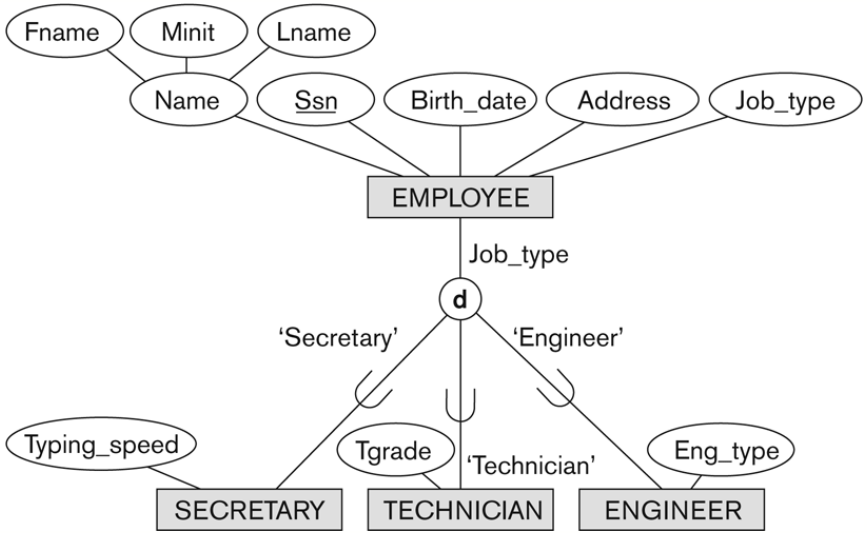
Mapping EER Model Concepts to Relations

- Convert Superclass and Subclass Relationships
  - Option 8A: Create the superclass relation and all subclass relations first, then migrate the PK from the superclass relation into each subclass relation as 1:1 relationships.
  - Multiple-relation option – superclass and subclasses

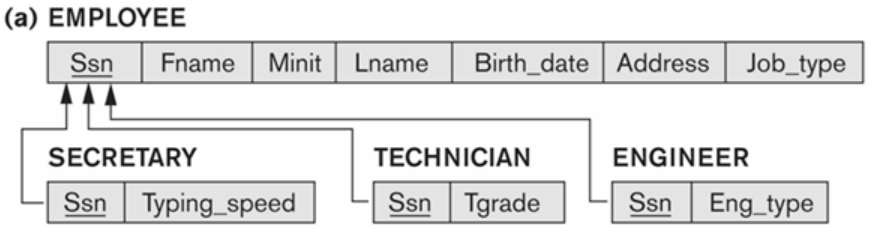
  Example EER schema in Figure 4.4

Mapping EER Model Concepts to Relations (cont.)

Figure 4.4
EER diagram notation for an attribute-defined specialization on Job_type.



Option 8A



Mapping EER Model Concepts to Relations (cont.)

- Convert Superclass and Subclass Relationships
  - Option 8B: Do not create a superclass relation, and create all subclass relations with all attributes from the superclass relation.
  - Multiple-relation option –subclass relations only

    Example:

    Mapping the EER schema in Figure 4.4 (b)

    EMPLOYEE → SECRETARY, TECHNICIAN, ENGINEER

    Mapping the EER schema in Figure 4.3 (b)

Mapping EER Model Concepts to Relations (cont.)

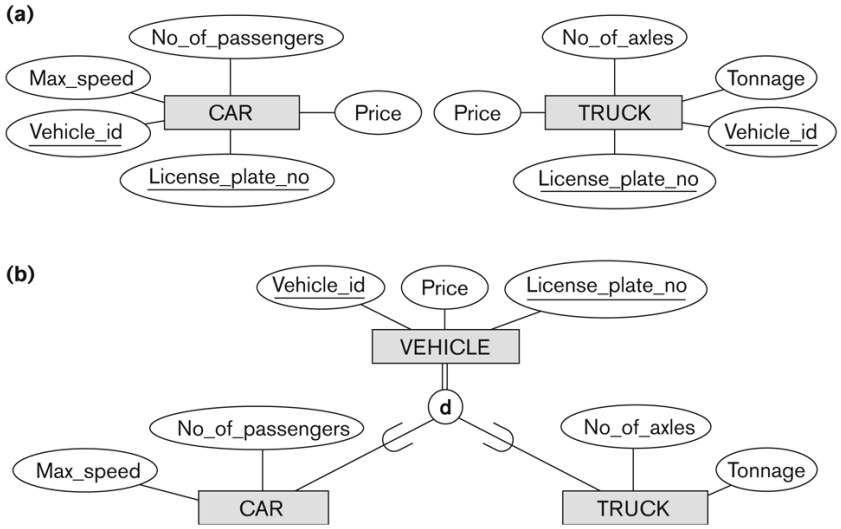


Figure 4.3
Generalization. (a) Two entity types, CAR and TRUCK.
(b) Generalizing CAR and TRUCK into the superclass VEHICLE.

Option 8B

(b) CAR

Vehicle_id	License_plate_no	Price	Max_speed	No_of_passengers

TRUCK

Vehicle_id	License_plate_no	Price	No_of_axles	Tonnage

Mapping EER Model Concepts to Relations (cont.)

- Convert Superclass and Subclass Relationships
  - Option 8C: Create a single relation that combines (union) all attributes from all subclass relations with one type attribute (t). This approach is for a specialization whose subclasses are *disjoint*, and *t* is a type attribute to indicate what the tuple belongs to. Many null values will be created.
  - Single-relation option with one type attribute
    Example: Figure 4.4

Mapping EER Model Concepts to Relations (cont.)

- Convert Superclass and Subclass Relationships
  - Option 8D: Create a single relation that combines (union) all attributes from the superclass and all subclass relations with a set (array) of type Boolean flags to indicate whether the tuple includes/belongs to the types. This approach is for a specialization whose subclasses are *overlapping*.
  - Single-relation option with multiple type attributes Example: Mapping Figure 4.5 using option 8D with Boolean type fields Mflag and Pflag.

Mapping EER Model Concepts to Relations (cont.)

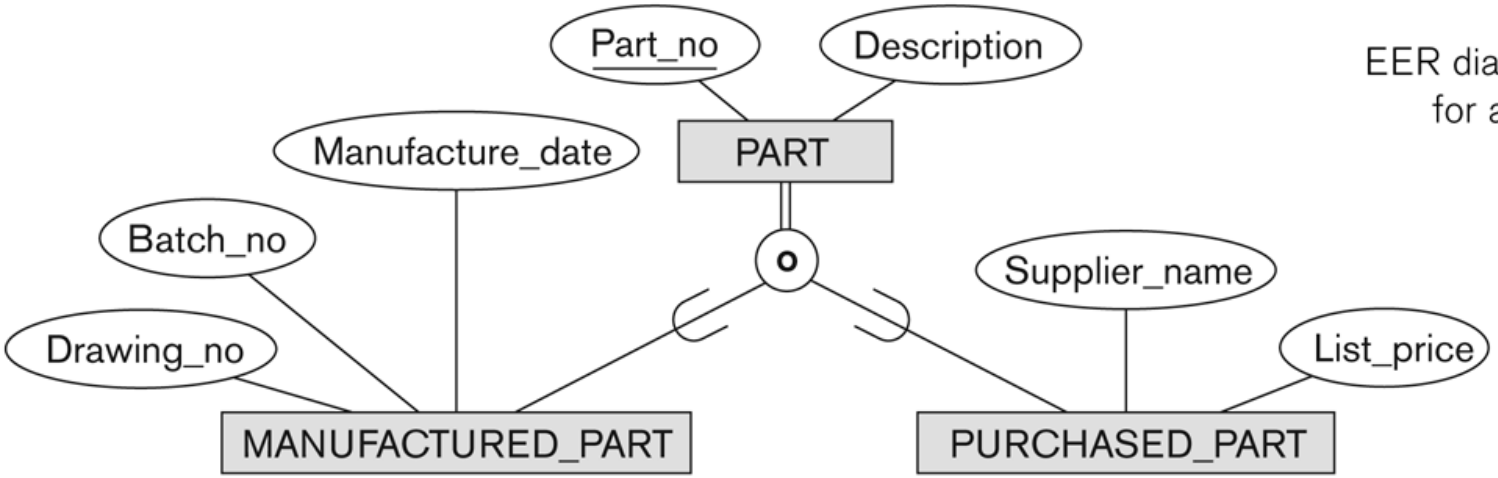


Figure 4.5
EER diagram notation for an overlapping (nondisjoint) specialization.

(d) PART

Part_no	Description	Mflag	Drawing_no	Manufacture_date	Batch_no	Pflag	Supplier_name	List_price

Option 8D

Boolean flags

Mapping Shared Subclasses

- A shared class is a subclass of several superclasses indicating multiple inheritance (specialization lattice)
- The classes must all have the same key attribute
- Mapping Figure 4.6

Mapping Shared Subclasses (cont.)

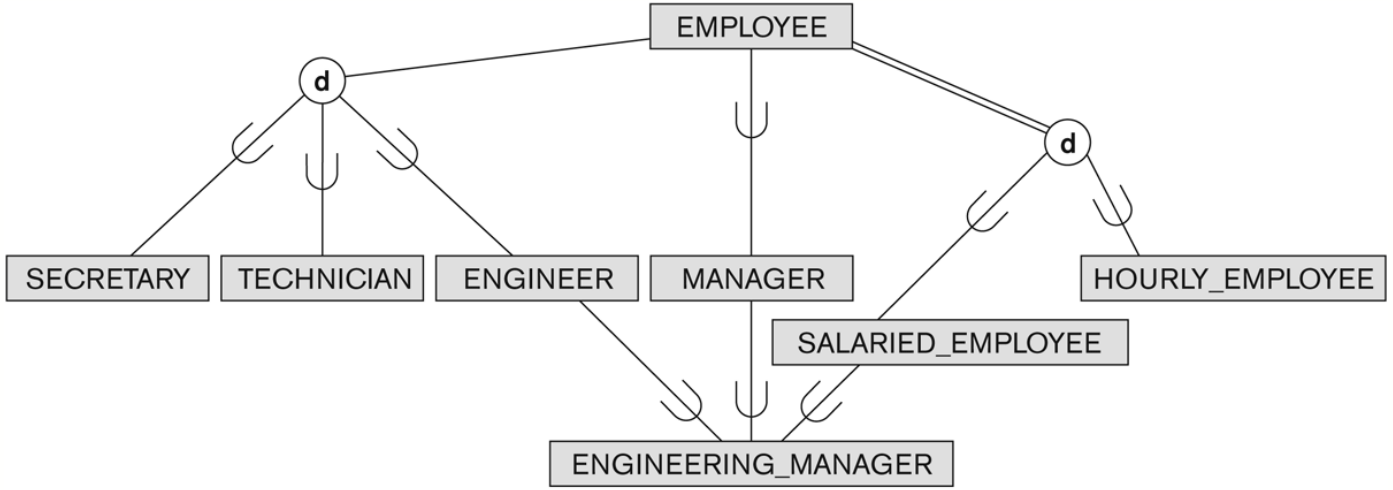


Figure 4.6
A specialization lattice with shared subclass ENGINEERING_MANAGER.

How do you map the EER specialization lattice?

Multiple-relation options (8A or 8B) in slides 15, 17

Single-relation options (8C or 8D) in slides 18, 20

Which one is a better choice and why? Open for Discussions

Mapping of Categories

- Is a subclass of the union of two or more superclasses that can have different entity types

- Can use a surrogate key

  Example: Mapping the EER categories (union types) in Figure 4.8 to relations.

Mapping of Categories (cont.)

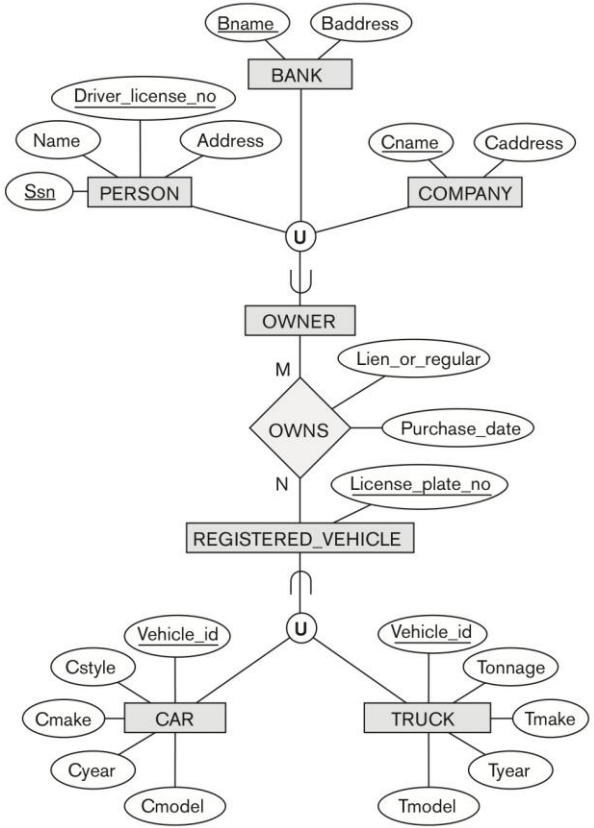


Figure 4.8 Two categories (union types): OWNER and REGISTERED_VEHICLE.

Mapping of Categories (cont.)

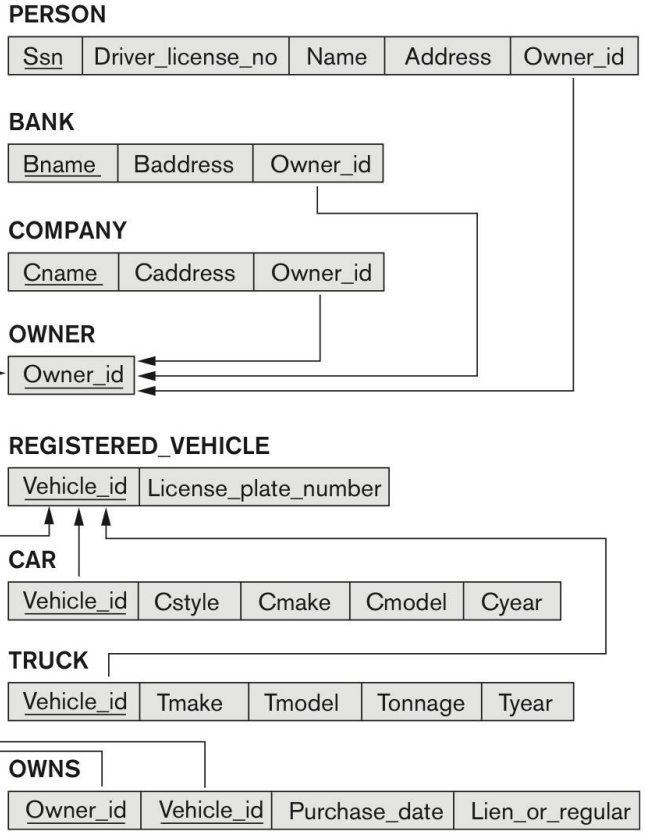


Figure 9.7 Mapping the EER categories (union types) in Figure 4.8 to relations.

Challenges on EER-to-Relation Mapping

- Can have multiple options available for specialization and generalization
  - Create more relations (tables) with multiple-relation options
  - Create fewer relations (tables) with single-relation options

- Consider implementation complications and performance when considering EER-to-Relation mapping

EER-to-Relation Mapping using ERwin

- Use supertype and subtype instead of superclass and subclass
- Create an identifying relationship between a supertype entity and its subtype entities
- Apply a transform to create an identifying relationship between a supertype entity and its subtype entities
  - Create a simple model
  - Improve query performance
  - Simplify application development and maintenance

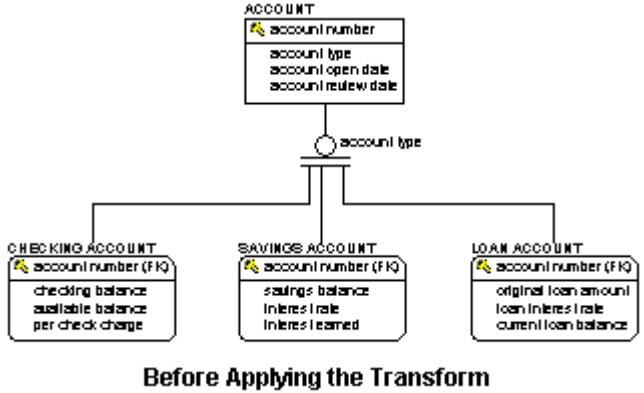
EER-to-Relation Mapping using ERwin (cont.)

Example:

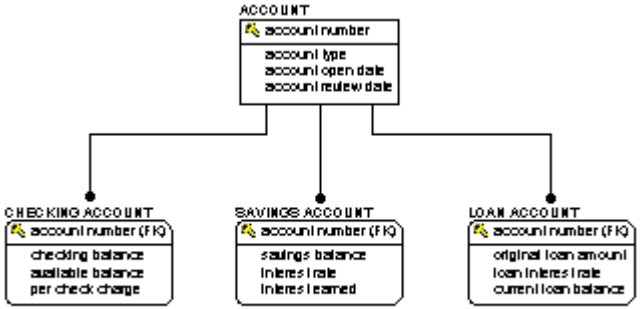
Bank ERD with various account types:
Checking, Saving and Loan

Mapping multiple relations with supertype and subtypes

Comments on this design



Before Applying the Transform



After Applying the Transform

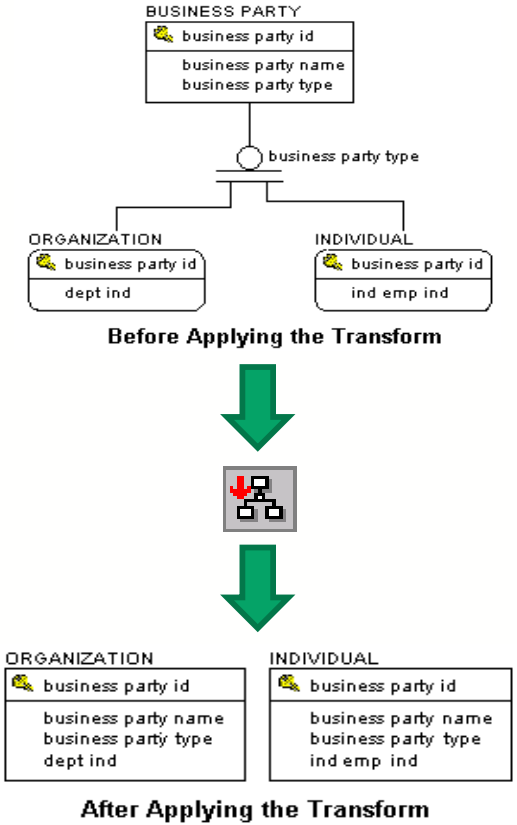
EER-to-Relation Mapping using ERwin (cont.)

Example:

Business Party ERD with Organization and individual types

Mapping to multiple relations with a result of “Rolling Down” two subtype relations

Comments on this design



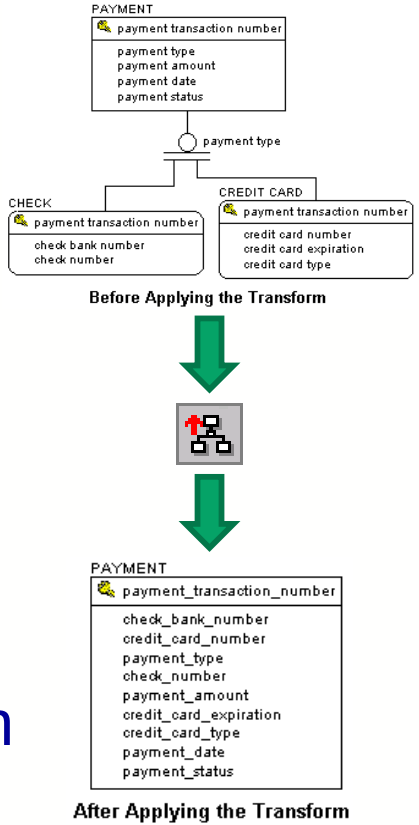
EER-to-Relation Mapping using ERwin (cont.)

Example:

Payment ERD with Check and Credit Card types

Mapping to multiple relations with a result of “Rolling up” a supertype relation

Comments on this design



Relational Mapping Considerations

- Normalized and Compact Design