Fundamentals of

Database Systems

5th Edition

Elmasri / Navathe

Summary of notation for ER diagrams

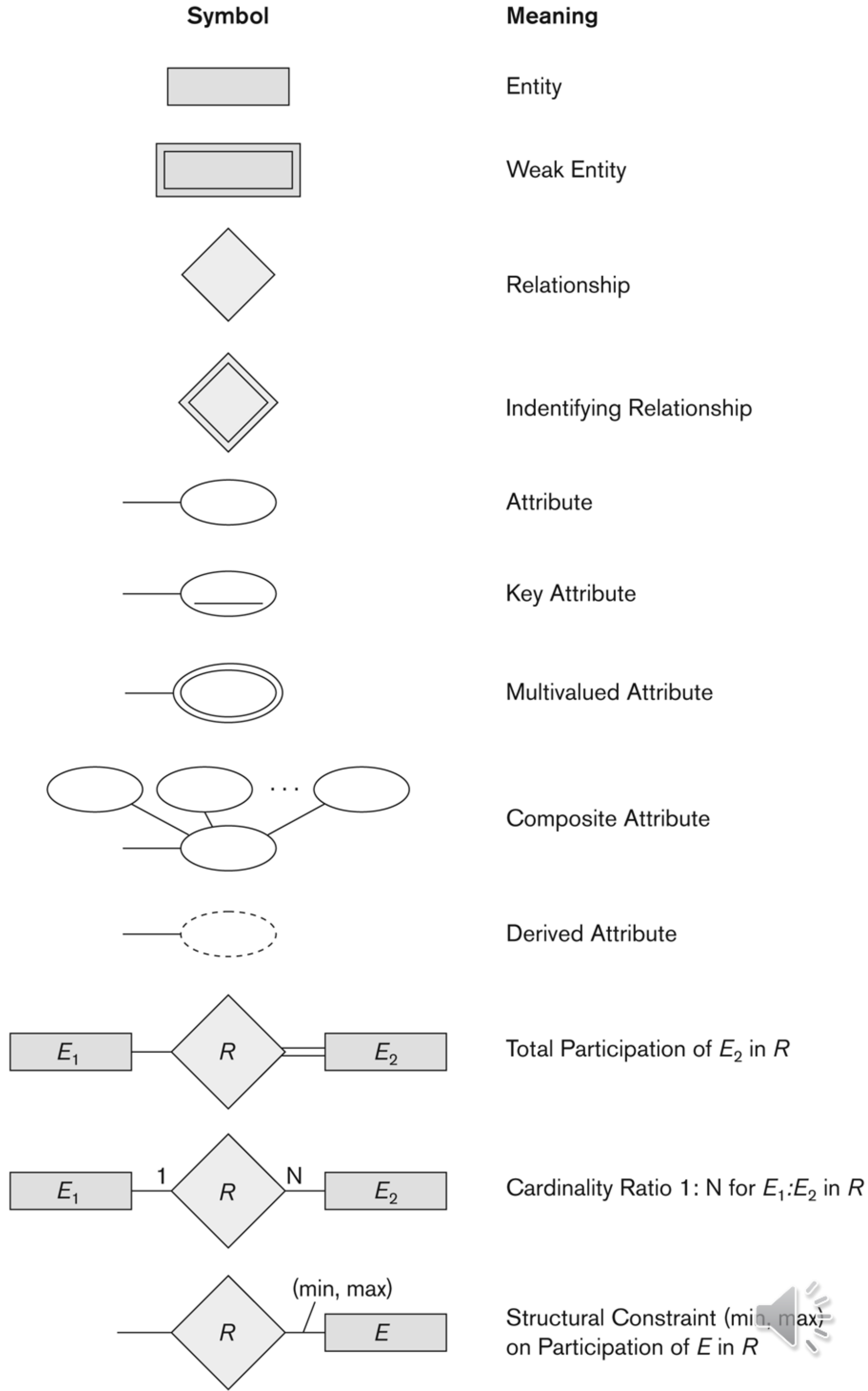


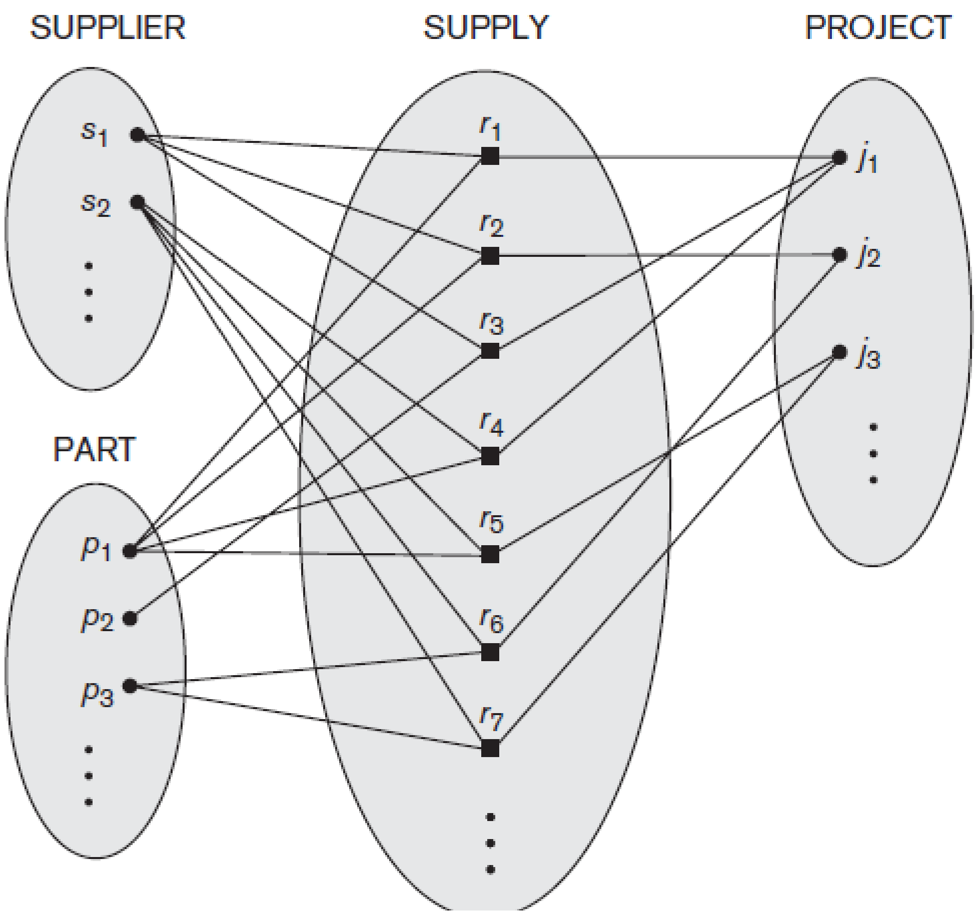
Figure 3.14
Summary of the notation for ER diagrams.

Relationships of Higher Degree

- Relationship types of degree 2 are called **binary**
- Relationship types of degree 3 are called **ternary** and of degree n are called n-ary
- In general, an n-ary relationship is not equivalent to n binary relationships
- Constraints are harder to specify for higher-degree relationships (n > 2) than for binary relationships

Discussion of n-ary relationships (n > 2)

- In general, **3 binary relationships can represent different information than a single ternary relationship** (see Figure 3.17a and b on next slide)
- If needed, the binary and n-ary relationships can all be included in the schema design (see Figure 3.17a and b, where all relationships convey different meanings)
- In some cases, **a ternary relationship can be represented as a weak entity if the data model allows a weak entity type to have multiple identifying relationships** (and hence multiple owner entity types) (see Figure 3.17c)
    - **Some database design tools** are based on variations of the ER model that **permit only binary relationships**


SUPPLIER
SUPPLY
PROJECT
PART
s1
s2
r1
r2
r3
r4
r5
r6
r7
j1
j2
j3
p1
p2
p3

Example of a ternary relationship

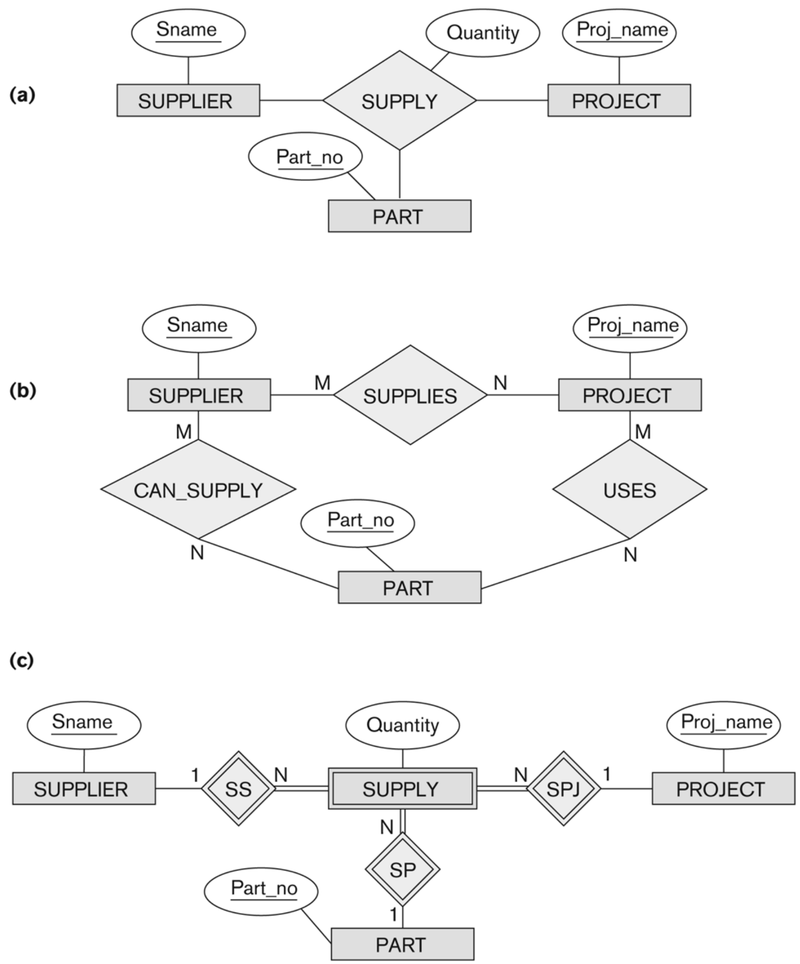


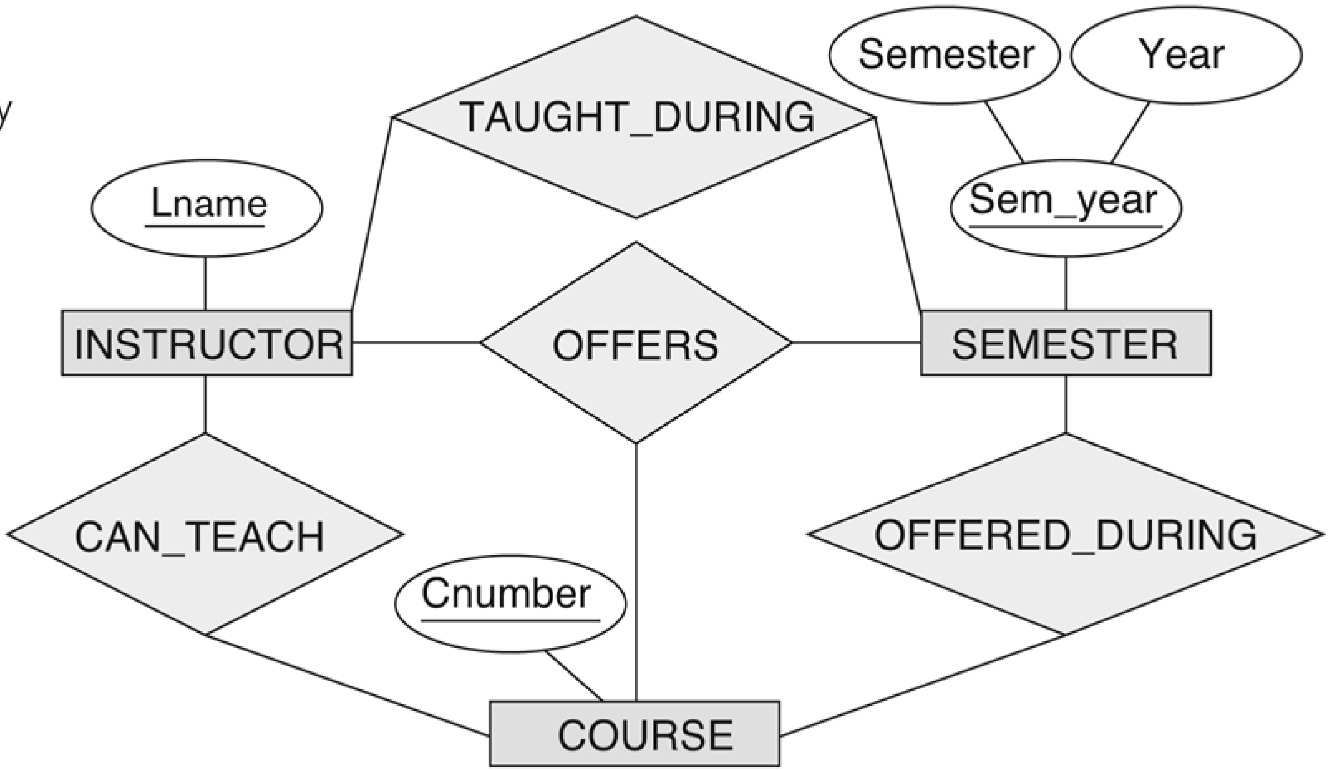
Figure 3.17
Ternary relationship types. (a) The SUPPLY relationship. (b) Three binary relationships not equivalent to SUPPLY. (c) SUPPLY represented as a weak entity type.

Discussion of n-ary relationships (n > 2)

- If a particular binary relationship can be derived from a higher-degree relationship at all times, then it is redundant
- For example, the TAUGHT_DURING binary relationship in Figure 3.18 (see next slide) can be derived from the ternary relationship OFFERS (based on the meaning of the relationships)
- Although in general three binary relationships *cannot replace a ternary relationship,* they may do so under certain *additional constraints. In our example, if the* CAN_TEACH relationship is 1:1 (an instructor can teach one course, and a course can be taught by only one instructor), then the ternary relationship OFFERS can be left out because it can be inferred from the three binary relationships CAN_TEACH, TAUGHT_DURING, and OFFERED_DURING.
- The schema designer must analyze the meaning of each specific situation to decide which of the binary and ternary relationship types are needed.

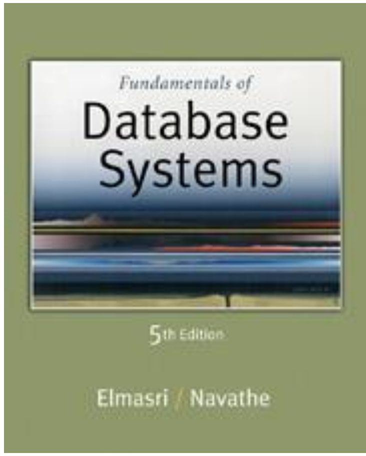
Another example of a ternary relationship

Figure 3.18
Another example of ternary versus binary relationship types.



Chapter 7

Relational Database Design by ER- -to-Relational Mapping



Chapter Outline

- **ER-to-Relational Mapping Algorithm**
  - Step 1: Mapping of Regular Entity Types
  - Step 2: Mapping of Weak Entity Types
  - Step 3: Mapping of Binary 1:1 Relation Types
  - Step 4: Mapping of Binary 1:N Relationship Types.
  - Step 5: Mapping of Binary M:N Relationship Types.
  - Step 6: Mapping of Multivalued attributes.
  - Step 7: Mapping of N-ary Relationship Types.

FIGURE 7.1
The ER conceptual schema diagram for the COMPANY database.

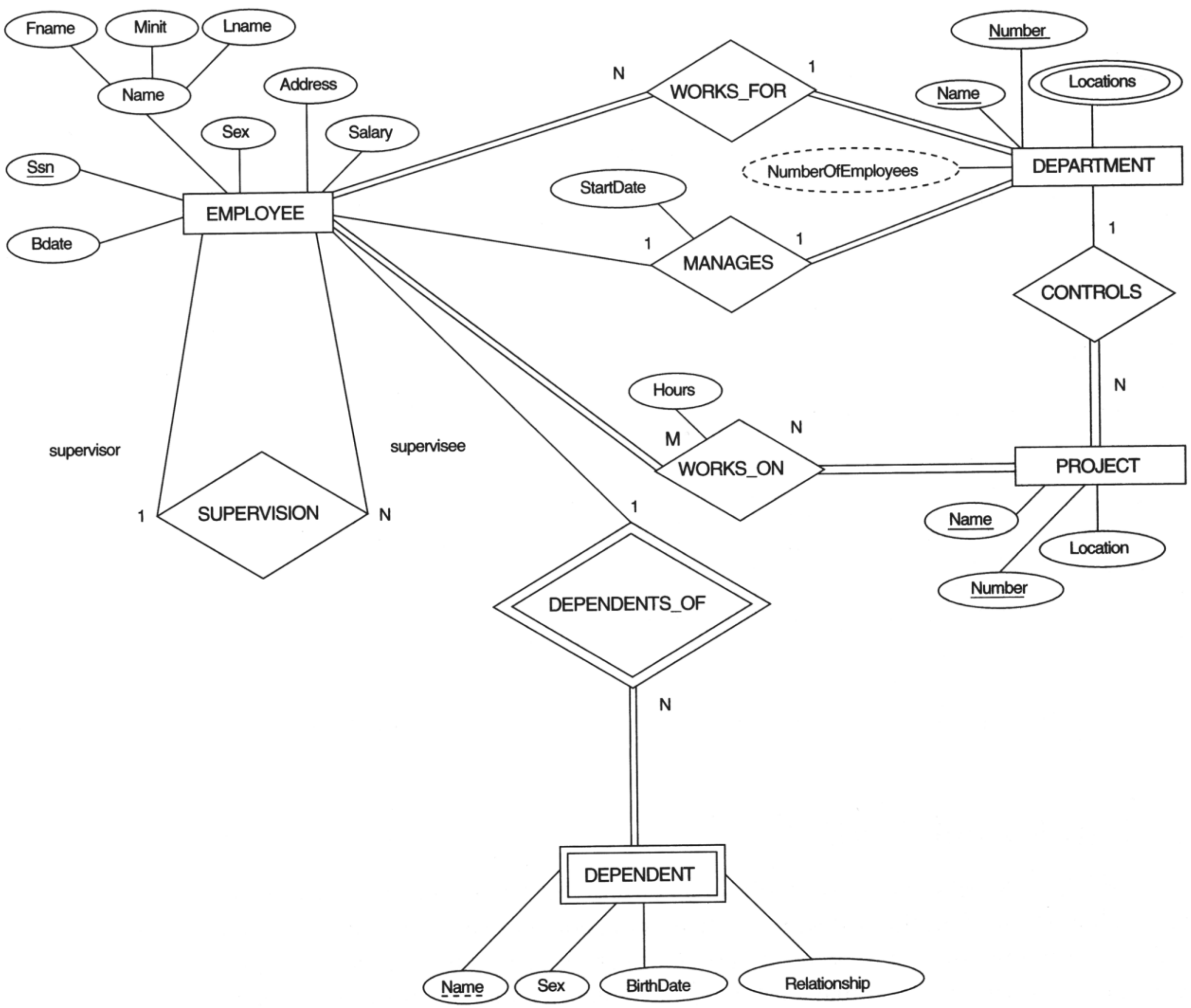


FIGURE 7.2
Result of mapping the COMPANY ER schema into a relational schema.

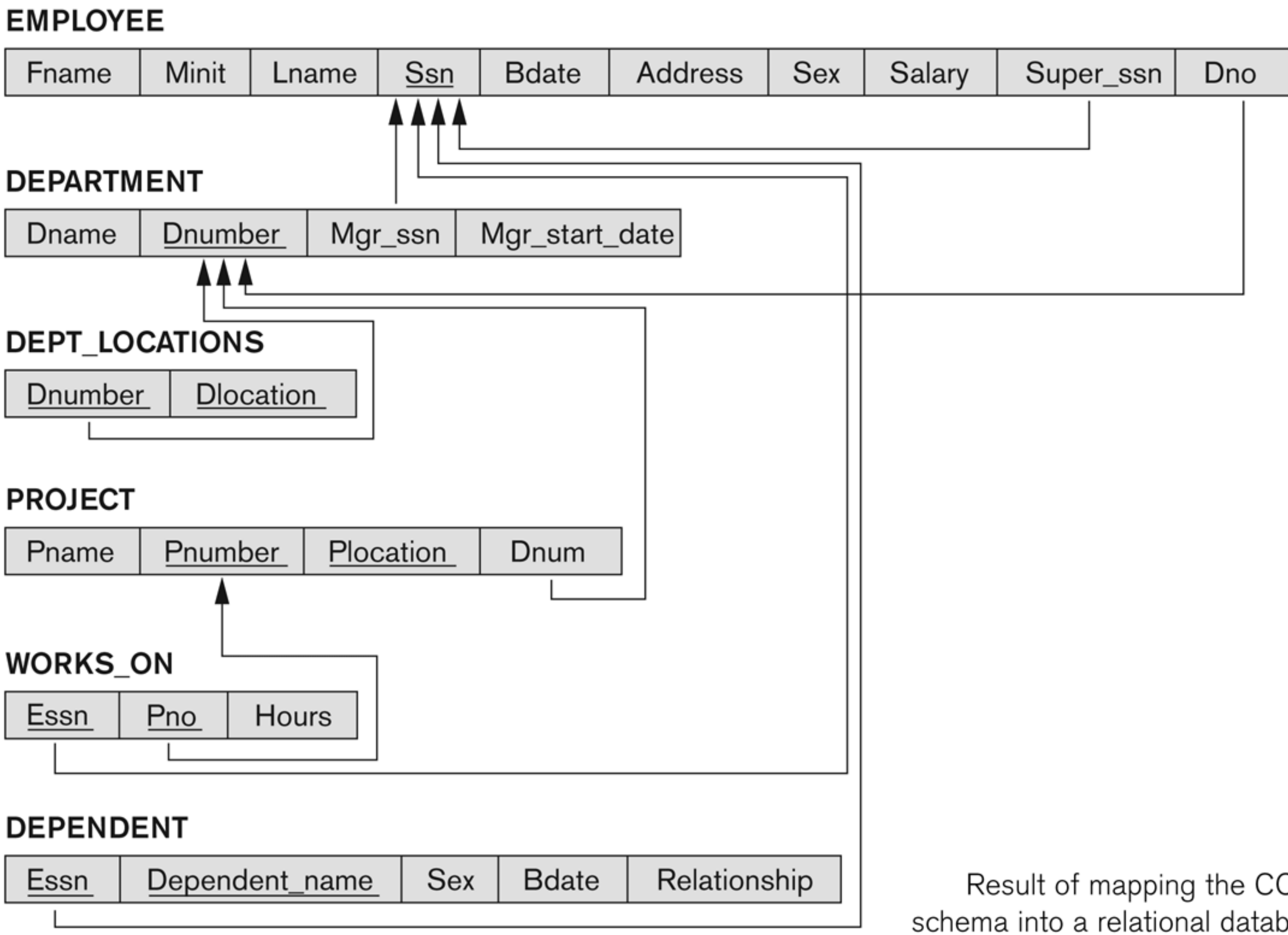
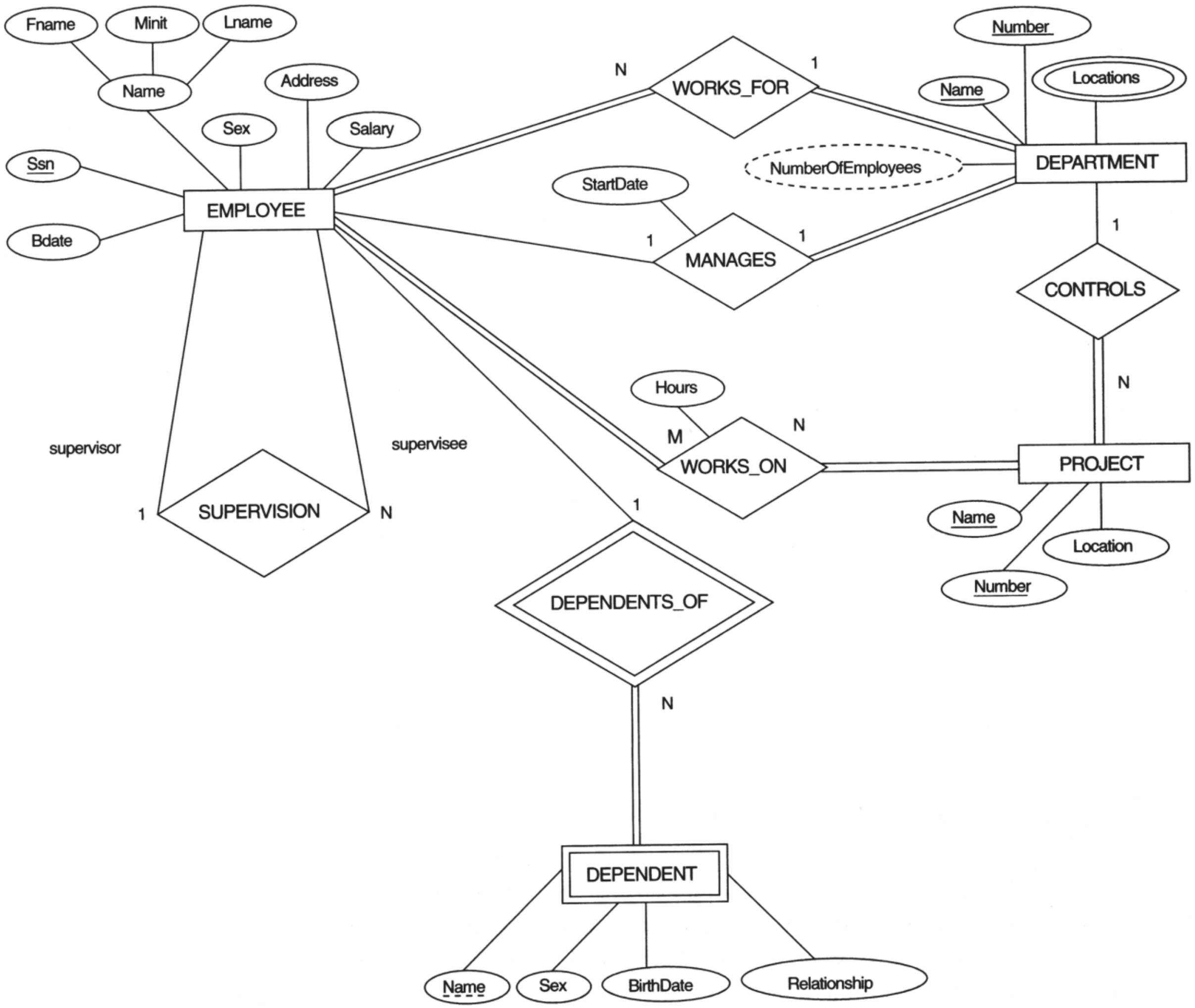


Figure 7.2
Result of mapping the COMPANY ER schema into a relational database schema.

ER-to-Relational Mapping Algorithm

- Step 1: Mapping of Regular Entity Types.
  - For each regular (strong) entity type E in the ER schema, **create a relation** R that includes **all the simple attributes** of E.
  - **Choose one of the key attributes** of E as the primary key for R.
  - If the chosen key of E is **composite**, the set of simple attributes that form it will together form the primary key of R.
- Example: We create the relations EMPLOYEE, DEPARTMENT, and PROJECT in the relational schema corresponding to the regular entities in the ER diagram.
  - SSN, DNUMBER, and PNUMBER are the primary keys for the relations EMPLOYEE, DEPARTMENT, and PROJECT as shown.

FIGURE 7.1
The ER conceptual schema diagram for the COMPANY database.



(a) **EMPLOYEE**

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary

DEPARTMENT

Dname	Dnumber

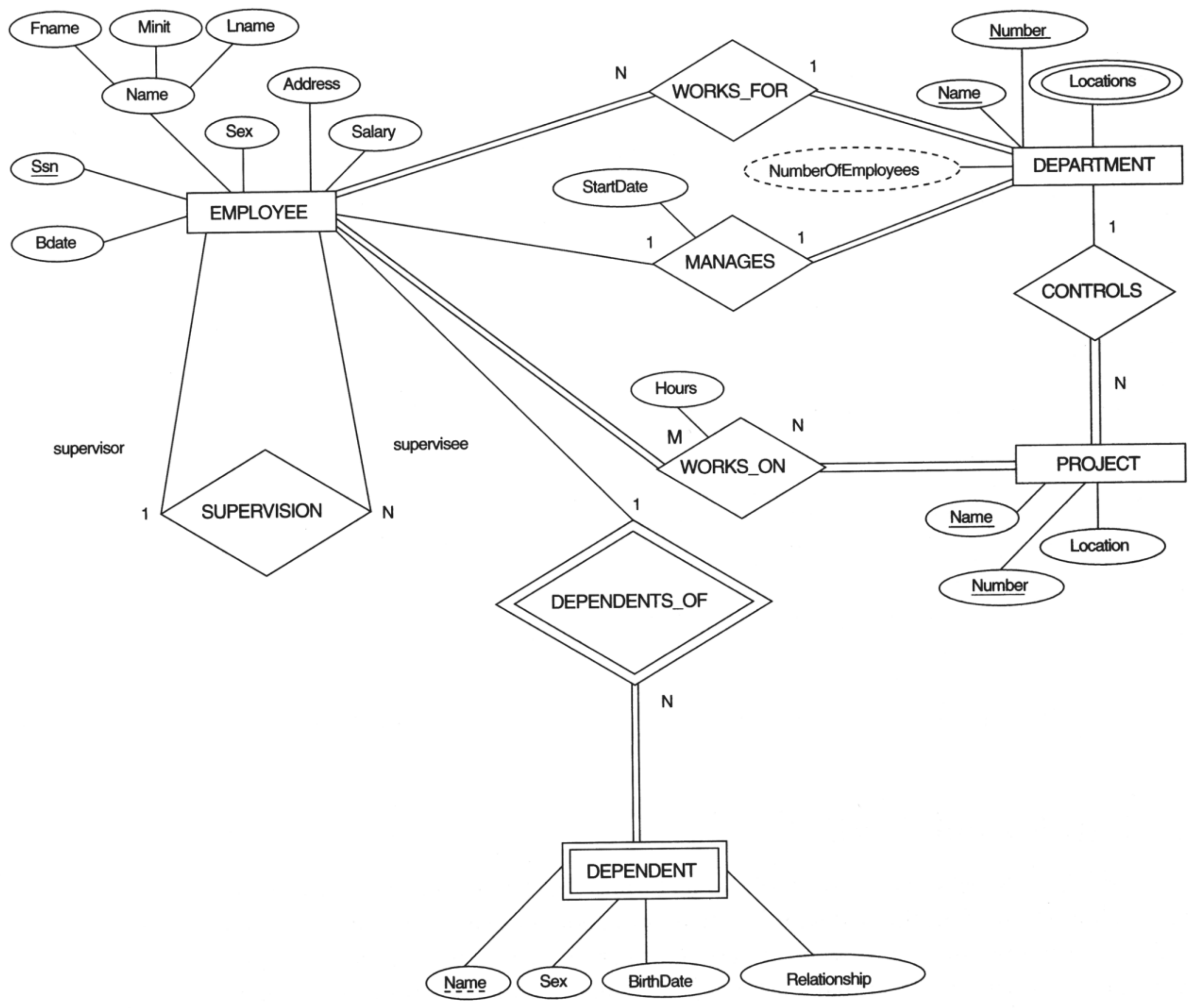
PROJECT

Pname	Pnumber	Plocation

ER-to-Relational Mapping Algorithm (contd.)

- **Step 2: Mapping of Weak Entity Types**
  - For each weak entity type W in the ER schema with owner entity type E, **create a relation R** & include all simple attributes (or simple components of composite attributes) of W as attributes of R.
  - Also, **include as foreign key attributes** of R the primary key attribute(s) of the relation(s) that correspond to the owner entity type(s).
  - **The primary key of R is the *combination of* the primary key(s) of the owner(s) and the partial key of the weak entity type** W, if any.
- **Example:** Create the relation DEPENDENT in this step to correspond to the weak entity type DEPENDENT.
  - Include the primary key SSN of the EMPLOYEE relation as a foreign key attribute of DEPENDENT (renamed to ESSN).
  - The primary key of the DEPENDENT relation is the combination {ESSN, DEPENDENT_NAME} because DEPENDENT_NAME is the partial key of DEPENDENT.

FIGURE 7.1
The ER conceptual schema diagram for the COMPANY database.



(b) **DEPENDENT**

Essn	Dependent_name	Sex	Bdate	Relationship

ER-to-Relational Mapping Algorithm (contd.)

- **Step 3: Mapping of Binary 1:1 Relation Types**
  - For each binary 1:1 relationship type R in the ER schema, identify the relations S and T that correspond to the entity types participating in R.
- There are three possible approaches:

1. **Foreign Key approach:** Choose one of the relations-say S-and include a foreign key in S the primary key of T. **It is better to choose an entity type with total participation** in R in the role of S.
   - Example: 1:1 relation MANAGES is mapped by choosing the participating entity type DEPARTMENT to serve in the role of S, because its participation in the MANAGES relationship type is total.
2. **Merged relation option:** An alternate mapping of a 1:1 relationship type is possible by merging the two entity types and the relationship into a single relation. This may be appropriate **when both participations are total.**
3. **Cross-reference or relationship relation option:** The third alternative is to set up a **third relation R** for the purpose of cross-referencing the primary keys of the two relations S and T representing the entity types.

Option 1: **It is better to choose an entity type with total participation**

- EMP

<u>SSN</u>	…..	DNO	StartDate
1234		5	1-1-2000
2345		Null	Null
…	…	Null	Null
9898	….	1	1-1-2005
…	…	Null	Null

DEPT

<u>DNO</u>	Dname
1	HR
5	Sales

- OR

<u>SSN</u>	…..
1234	
2345	
…	…
9898	

<u>DNO</u>	Dname	MSSN	StartDate
1	HR	9898	1-1-2005
5	Sales	1234	1-1-2000

Option 2: When both participations are total

- Accounts STUD

<u>Username</u>	**Passwrod**

<u>ID</u>	**Name**

<u>ID</u>	**Name**	**Username**	**Passwrod**

Cross-reference or relationship relation option

- EMP

SSN	…..
1234	
2345	
…	…
9898	….
…	…

DEPT

DNO	Dname
1	HR
5	Sales

- DEPTMANAGER

SSN	DNO	StartDate
1234	1	1-1-2000
9898	5	1-1-2005

FIGURE 7.1

The ER conceptual schema diagram for the COMPANY database.

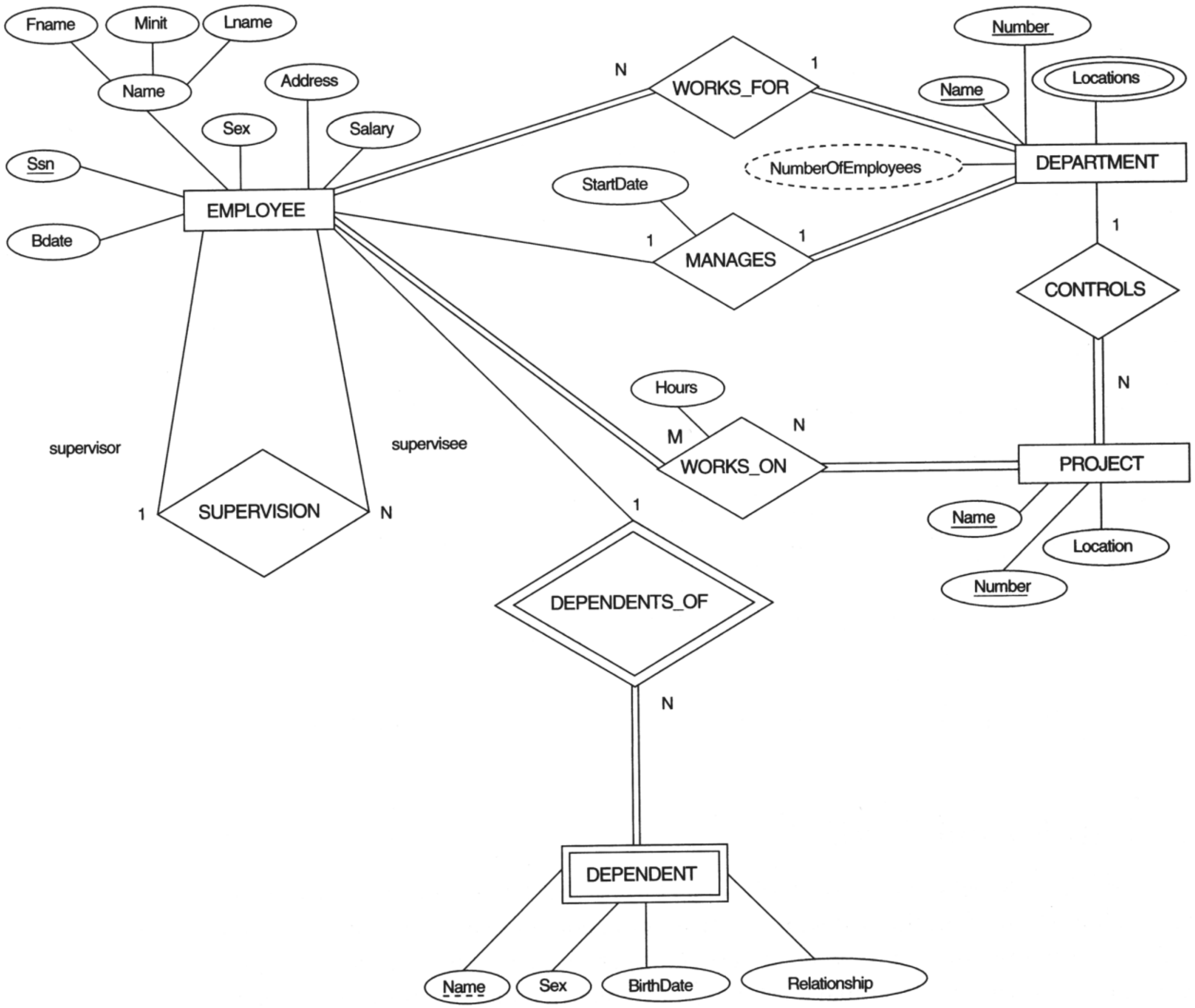


FIGURE 7.2
Result of mapping the COMPANY ER schema into a relational schema.

DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date

ER-to-Relational Mapping Algorithm (contd.)

- Step 4: Mapping of Binary 1:N Relationship Types.
  - For each regular binary 1:N relationship type R, identify the relation S that represent the participating entity type at the N-side of the relationship type.
  - Include as **foreign key** in S the primary key of the relation T that represents the other entity type participating in R.
  - **Include any simple attributes** of the 1:N relation type as attributes of S.
- Example: 1:N relationship types WORKS_FOR, CONTROLS, and SUPERVISION in the figure.
  - For WORKS_FOR we include the primary key DNUMBER of the DEPARTMENT relation as foreign key in the EMPLOYEE relation and call it DNO.

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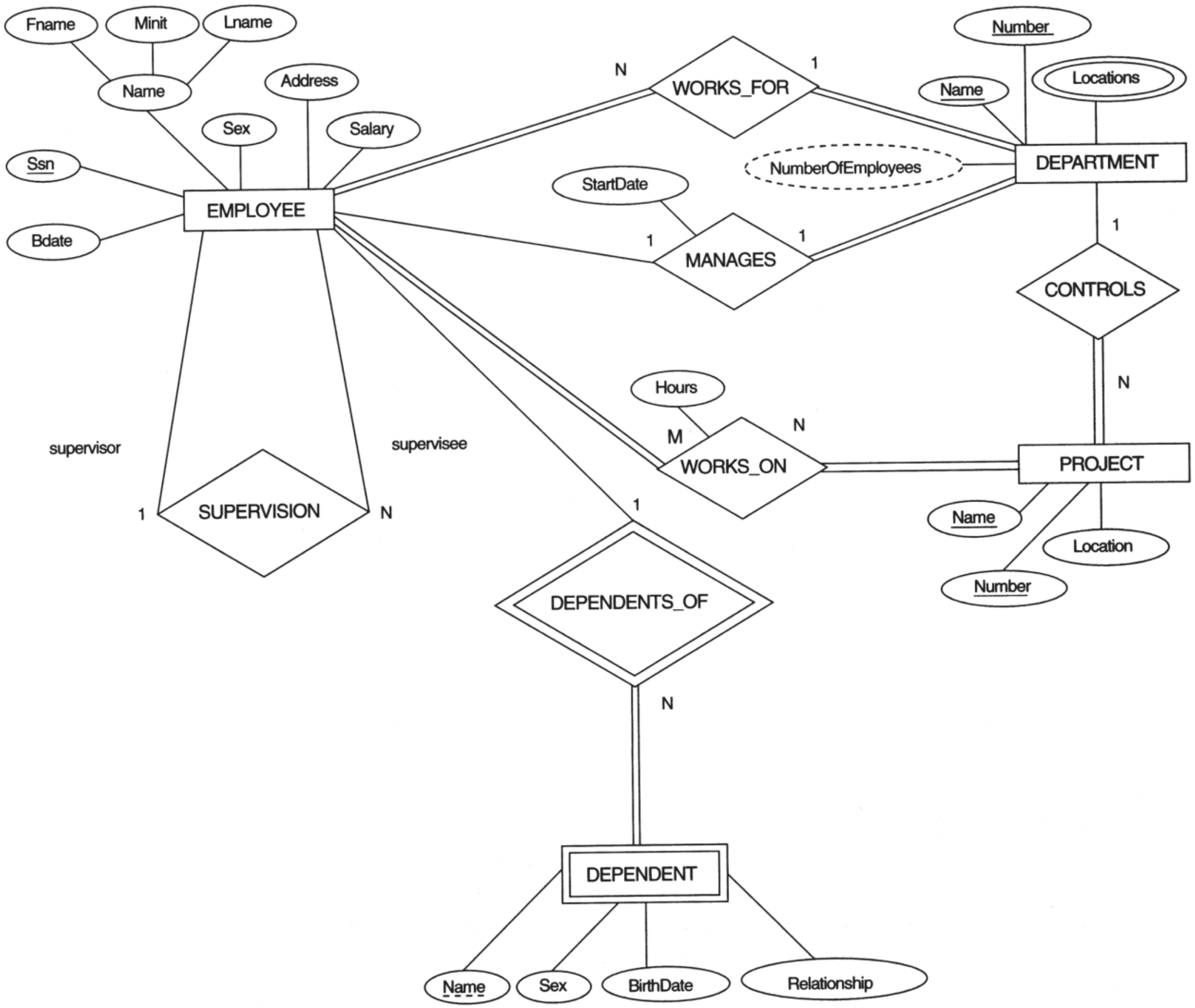

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Result of mapping the COMPANY ER schema into a relational schema.

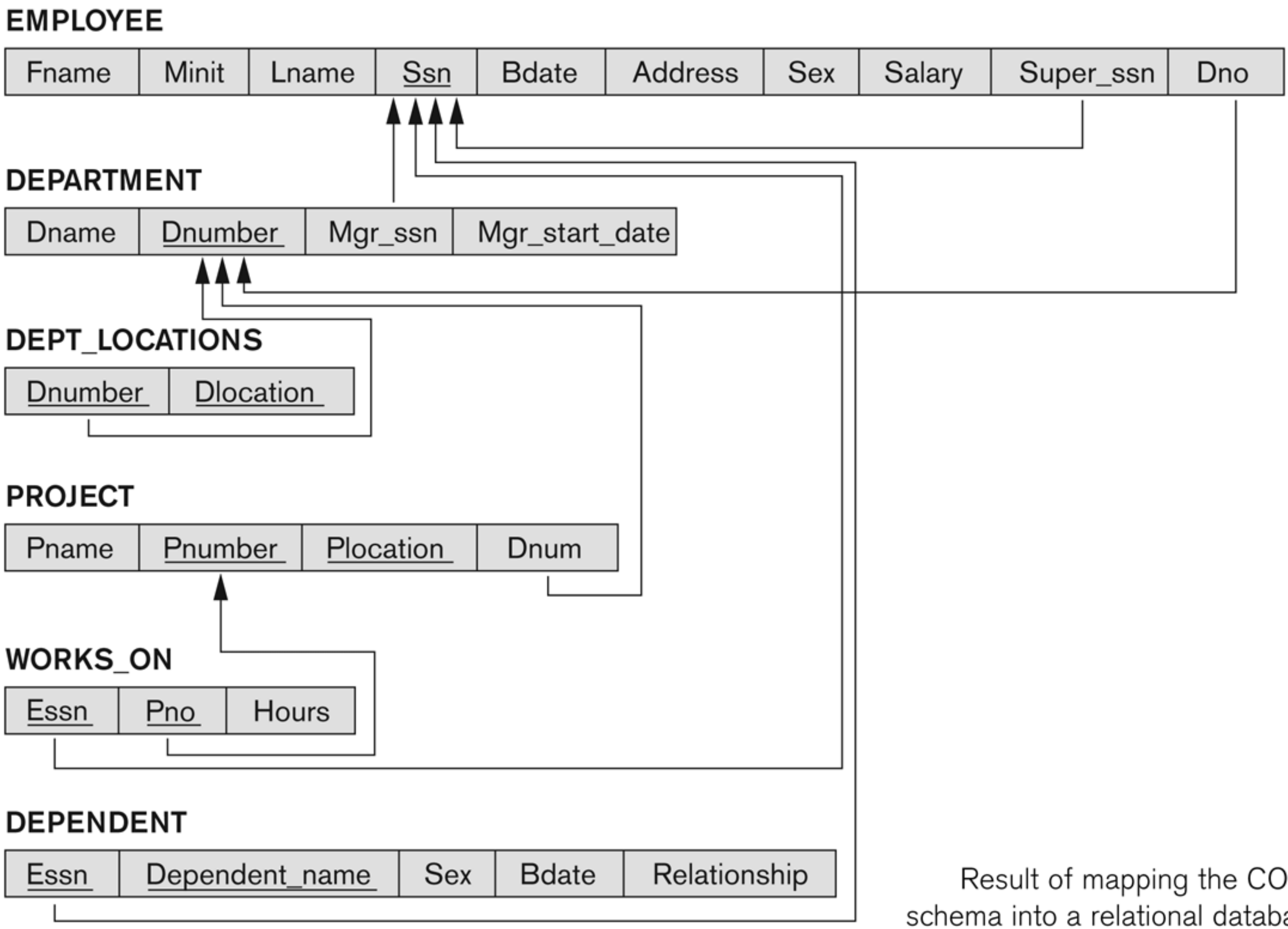

Figure 7.2
Result of mapping the COMPANY ER schema into a relational database schema.

ER-to-Relational Mapping Algorithm (contd.)

- **Step 5: Mapping of Binary M:N Relationship Types.**
  - For each regular binary M:N relationship type R, *create a **new relation*** S to represent R.
  - Include as **foreign key attributes** in S the primary keys of the relations that represent the participating entity types; *their **combination will form the primary key*** of S.
  - Also include any **simple attributes** of the M:N relationship type (or simple components of composite attributes) as attributes of S.
- Example: The M:N relationship type WORKS_ON from the ER diagram is mapped by creating a relation WORKS_ON in the relational database schema.
  - The primary keys of the PROJECT and EMPLOYEE relations are included as foreign keys in WORKS_ON and renamed PNO and ESSN, respectively.
  - Attribute HOURS in WORKS_ON represents the HOURS attribute of the relation type. The primary key of the WORKS_ON relation is the combination of the foreign key attributes {ESSN, PNO}.

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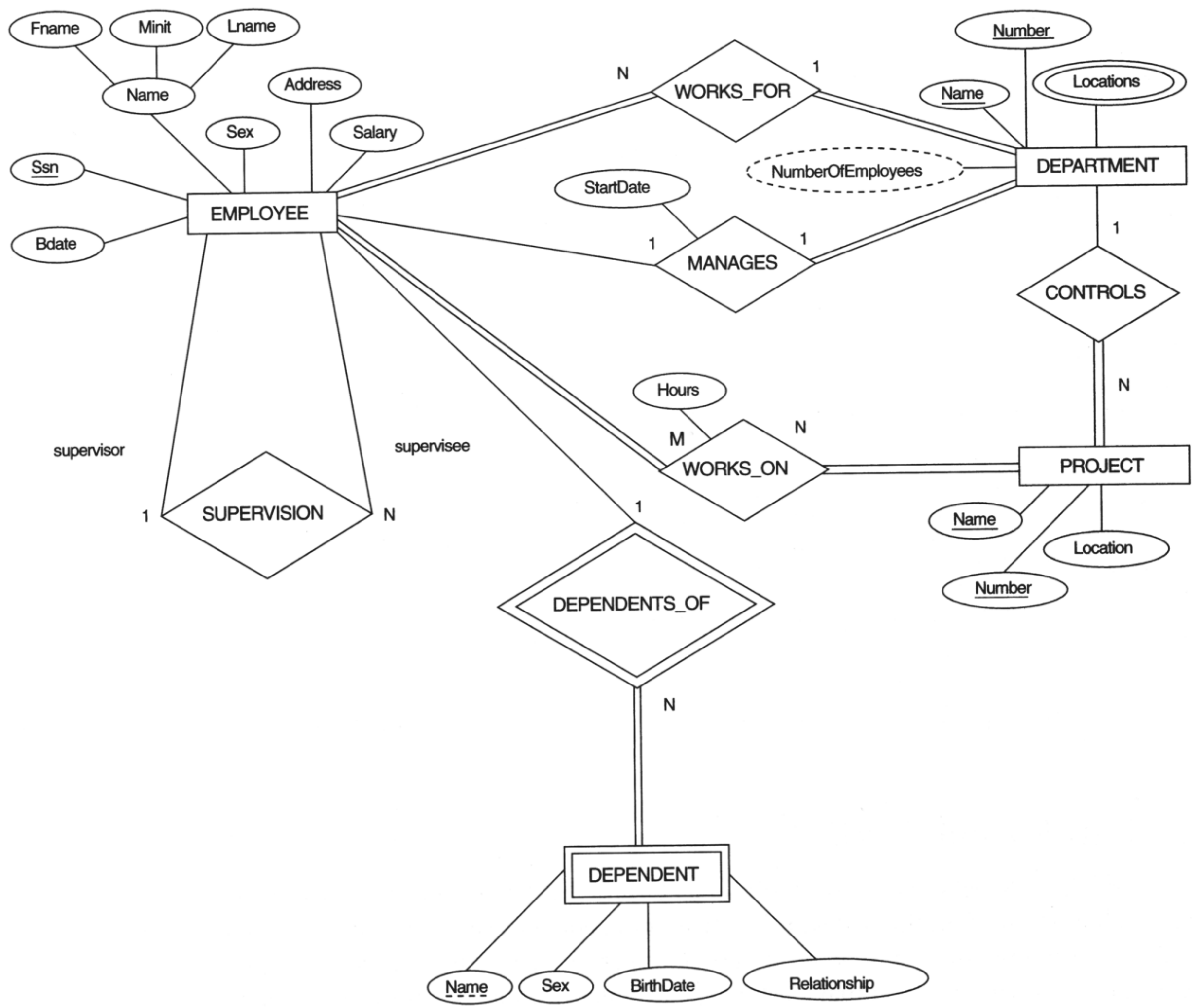


FIGURE 7.2

Result of mapping the COMPANY ER schema into a relational schema.

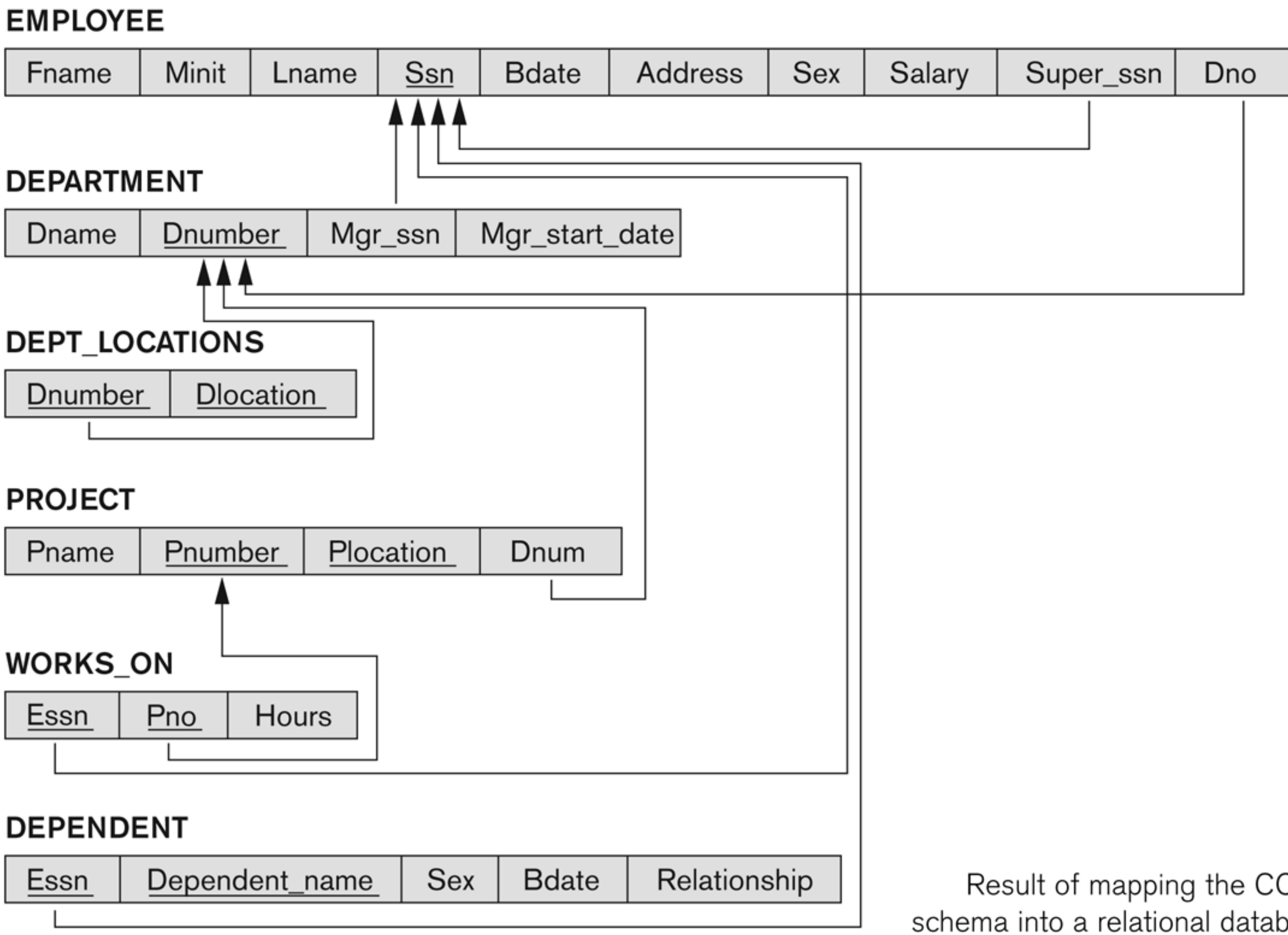
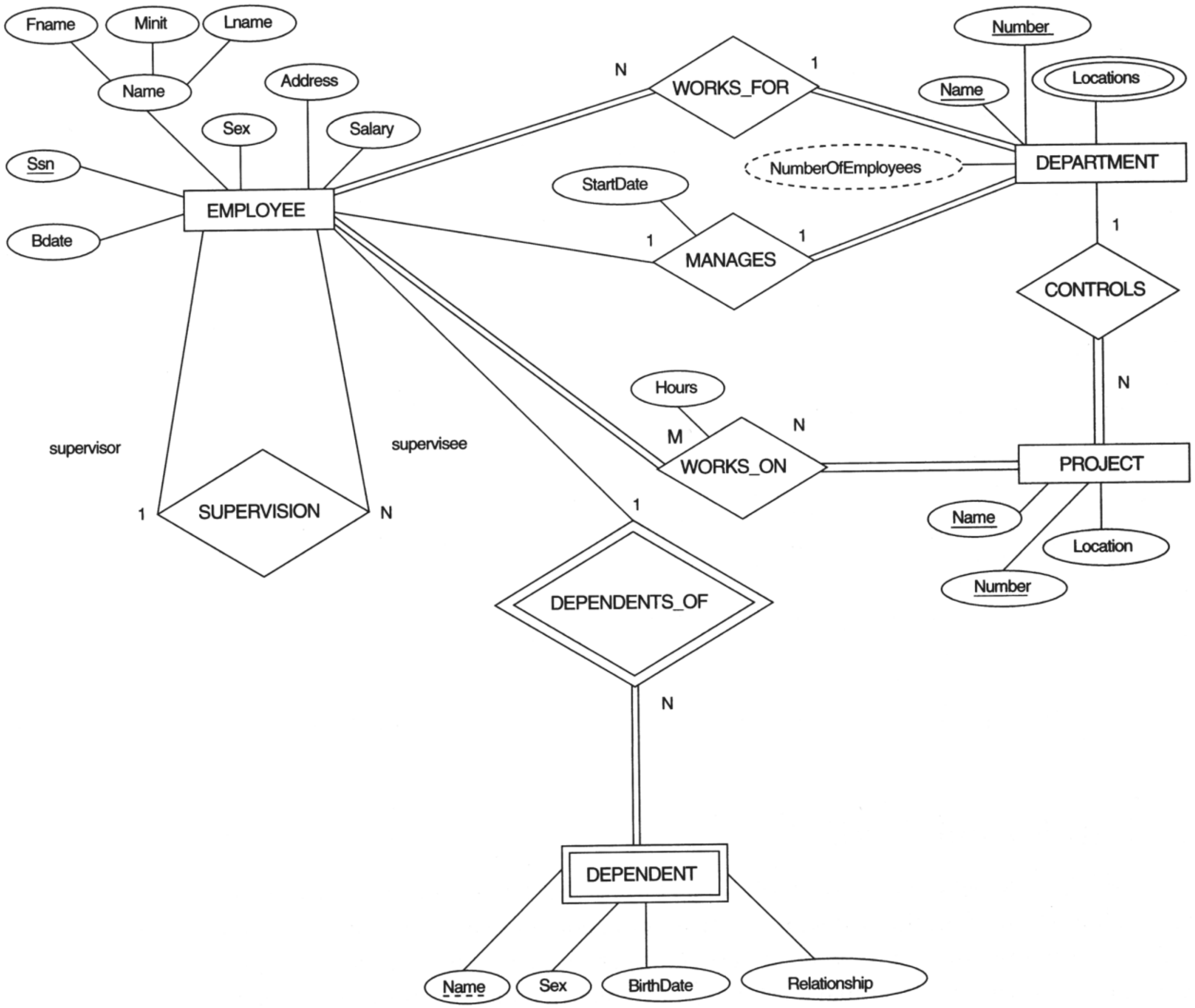


Figure 7.2
Result of mapping the COMPANY ER schema into a relational database schema.

ER-to-Relational Mapping Algorithm (contd.)

- **Step 6: Mapping of Multivalued attributes.**
  - **For each multivalued attribute A, create a new relation R**.
  - This relation R will include an attribute corresponding to A, plus the **primary key** attribute K-as a foreign key in R-of the relation that represents the entity type of relationship type that has A as an attribute.
  - The **primary key** of R is the **combination of A and K**. If the multivalued attribute is composite, we include its simple components.
- **Example:** The relation DEPT_LOCATIONS is created.
  - The attribute DLOCATION represents the multivalued attribute LOCATIONS of DEPARTMENT, while DNUMBER-as foreign key-represents the primary key of the DEPARTMENT relation.
  - The primary key of R is the combination of {DNUMBER, DLOCATION}.

FIGURE 7.1
The ER conceptual schema diagram for the COMPANY database.



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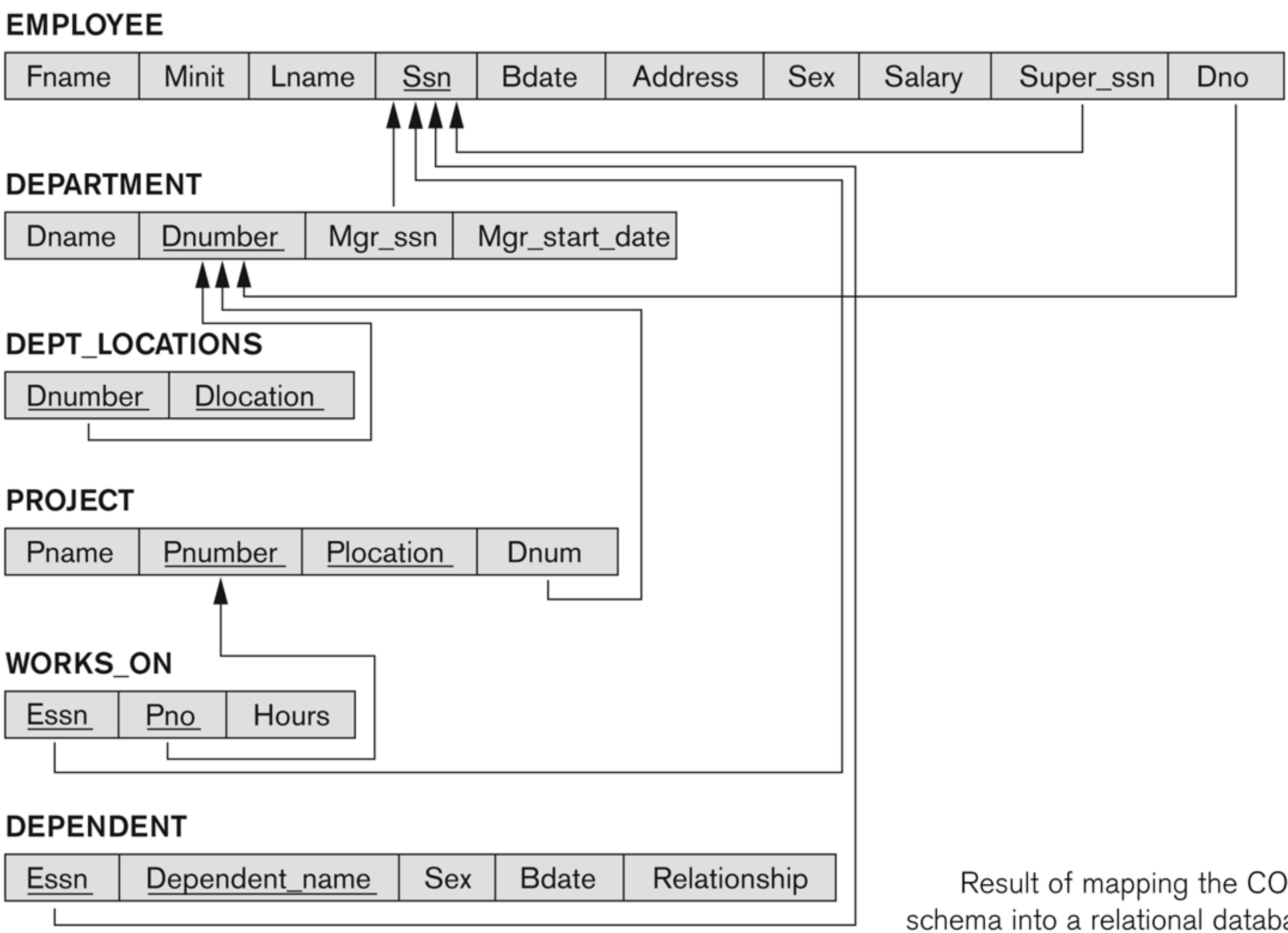


Figure 7.2
Result of mapping the COMPANY ER schema into a relational database schema.

ER-to-Relational Mapping Algorithm (contd.)

- **Step 7: Mapping of N-ary Relationship Types.**
  - For each n-ary relationship type R, where n>2, **create a new relationship** S to represent R.
  - Include as **foreign key attributes** in S the primary keys of the relations that represent the participating entity types.
  - Also include any **simple attributes** of the n-ary relationship type (or simple components of composite attributes) as attributes of S.
- **Example:** The relationship type SUPPY in the ER on the next slide.
  - This can be mapped to the relation SUPPLY shown in the relational schema, whose primary key is the combination of the three foreign keys {SNAME, PARTNO, PROJNAME}

FIGURE 4.11

Ternary relationship types. (a) The SUPPLY relationship.

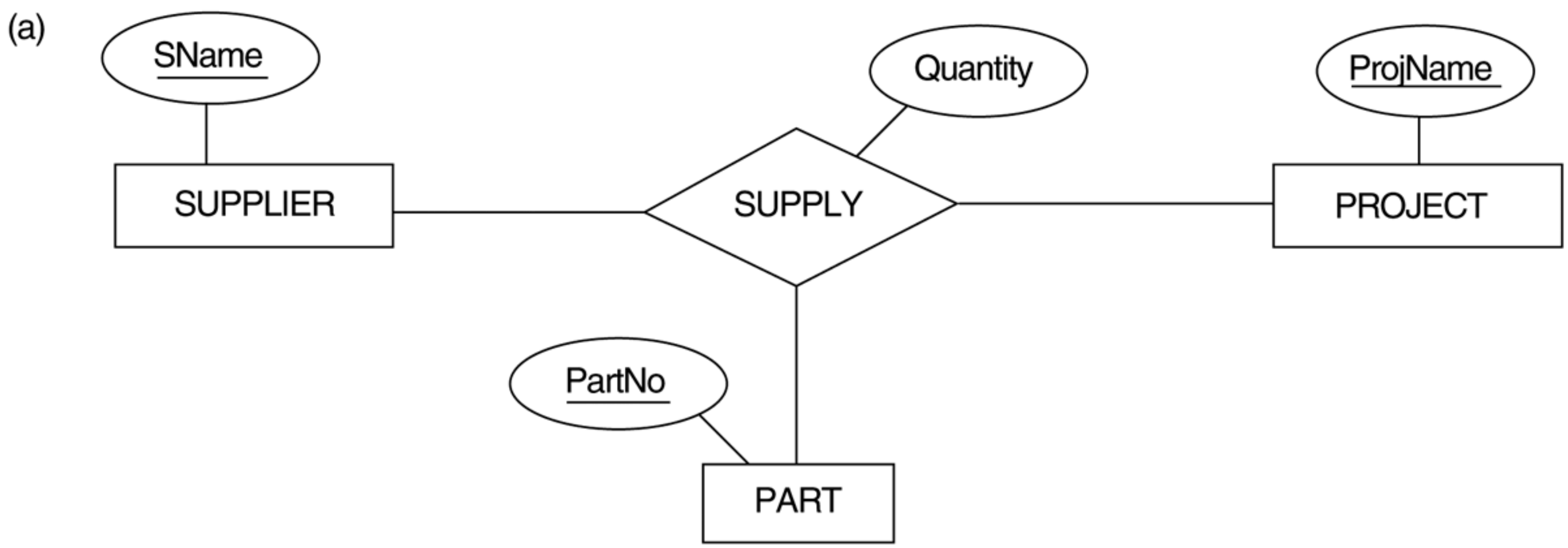
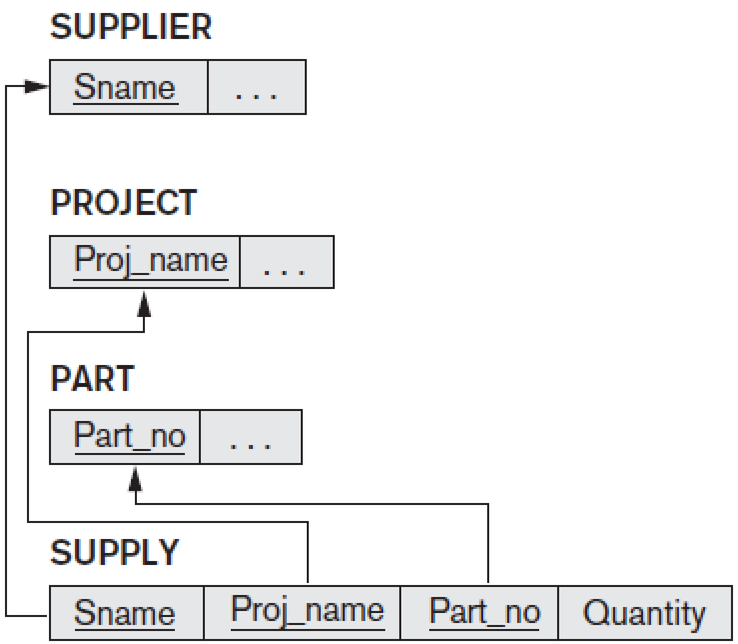


FIGURE 7.3
Mapping the *n*-ary relationship type SUPPLY from Figure 4.11a.



Summary of Mapping constructs and constraints

Table 7.1 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

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  - Step 4: Mapping of Binary 1:N Relationship Types.
  - Step 5: Mapping of Binary M:N Relationship Types.
  - Step 6: Mapping of Multivalued attributes.
  - Step 7: Mapping of N-ary Relationship Types.