Lecture 6
Relational Database Design by ER to Relational Mapping

Agenda

- Mapping of **Regular Entity Types**
- Mapping of **Weak Entity Types**
- Mapping of **Binary 1:1 Relationship Types**
- Mapping of **Binary 1:N Relationship Types**
- Mapping of **Binary M:N Relationship Types**
- Mapping of **Multivalued attributes**
- Mapping of **N-ary Relationship Types**

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 Relationship 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**
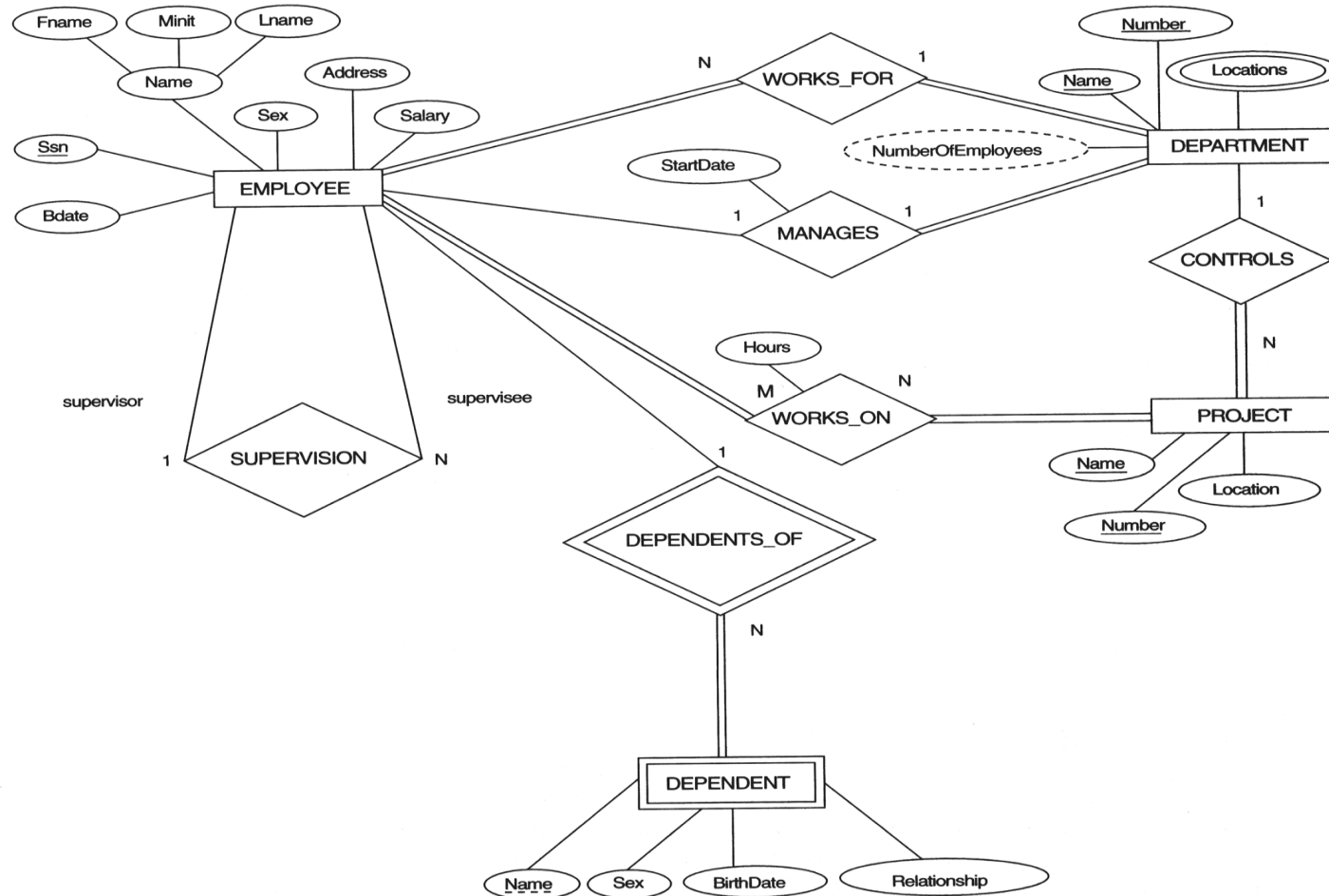
ER-to-Relational Mapping Algorithm

➢ **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.
- For composite attribute, put each attribute in its set as a single attribute.

➢ 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.

The ER conceptual schema diagram for the COMPANY database

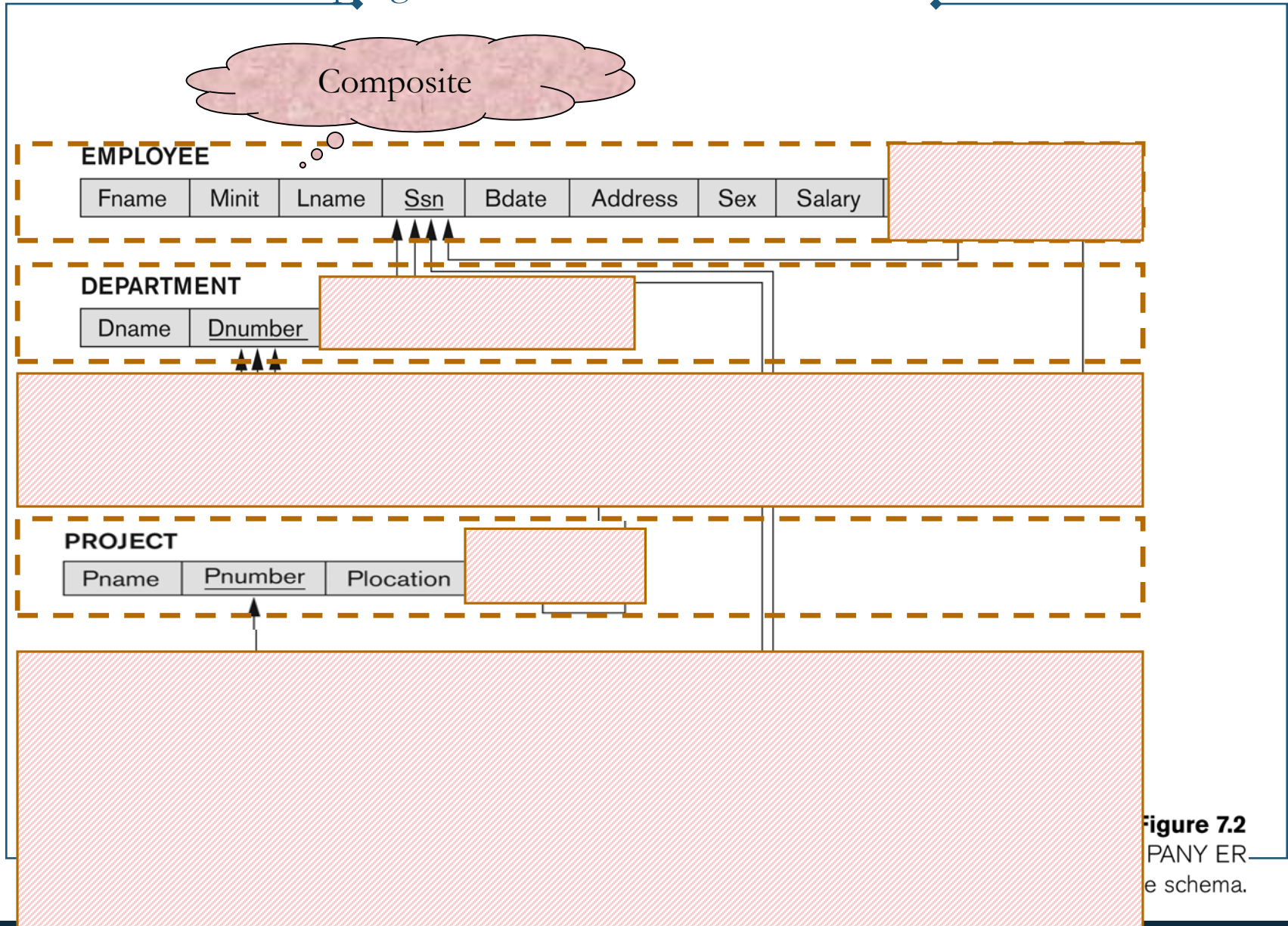# Result of mapping the COMPANY ER schema into a relational schema

Composite

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	

DEPARTMENT

Dname	Dnumber	

PROJECT

| Pname	Pnumber	Plocation	

Figure 7.2
PANY ER
e schema.

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ER-to-Relational Mapping Algorithm

➤ **Step 2: Mapping of Weak Entity Types**

- For each weak entity type W in the ER schema with owner entity type E, <u>Create a Relation R</u> & include all simple attributes (or simple components of composite attributes) of W as attributes of R.

- 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.

- 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).

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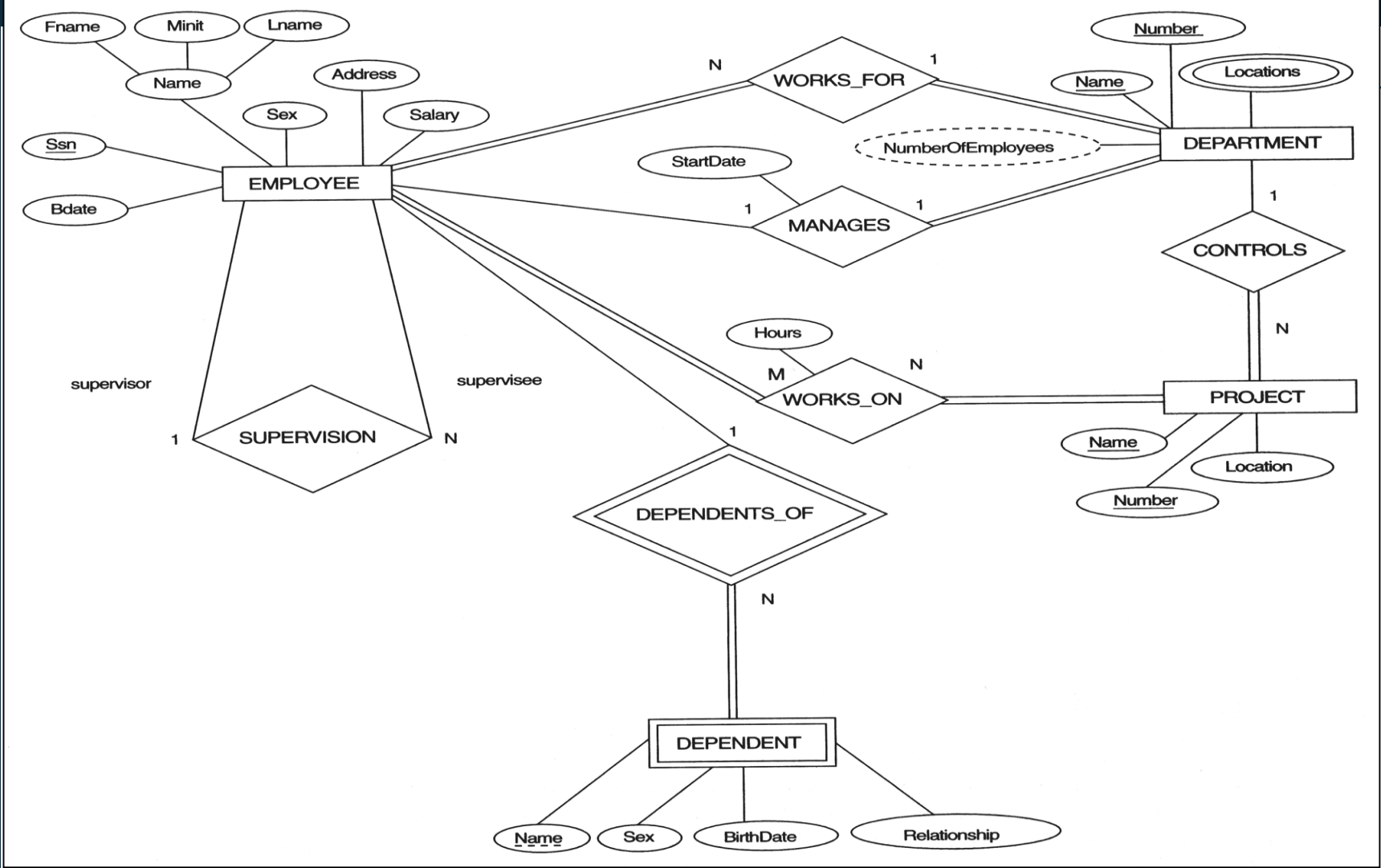
Figure 7.2
Result of mapping the COMPANY ER schema into a relational database schema.

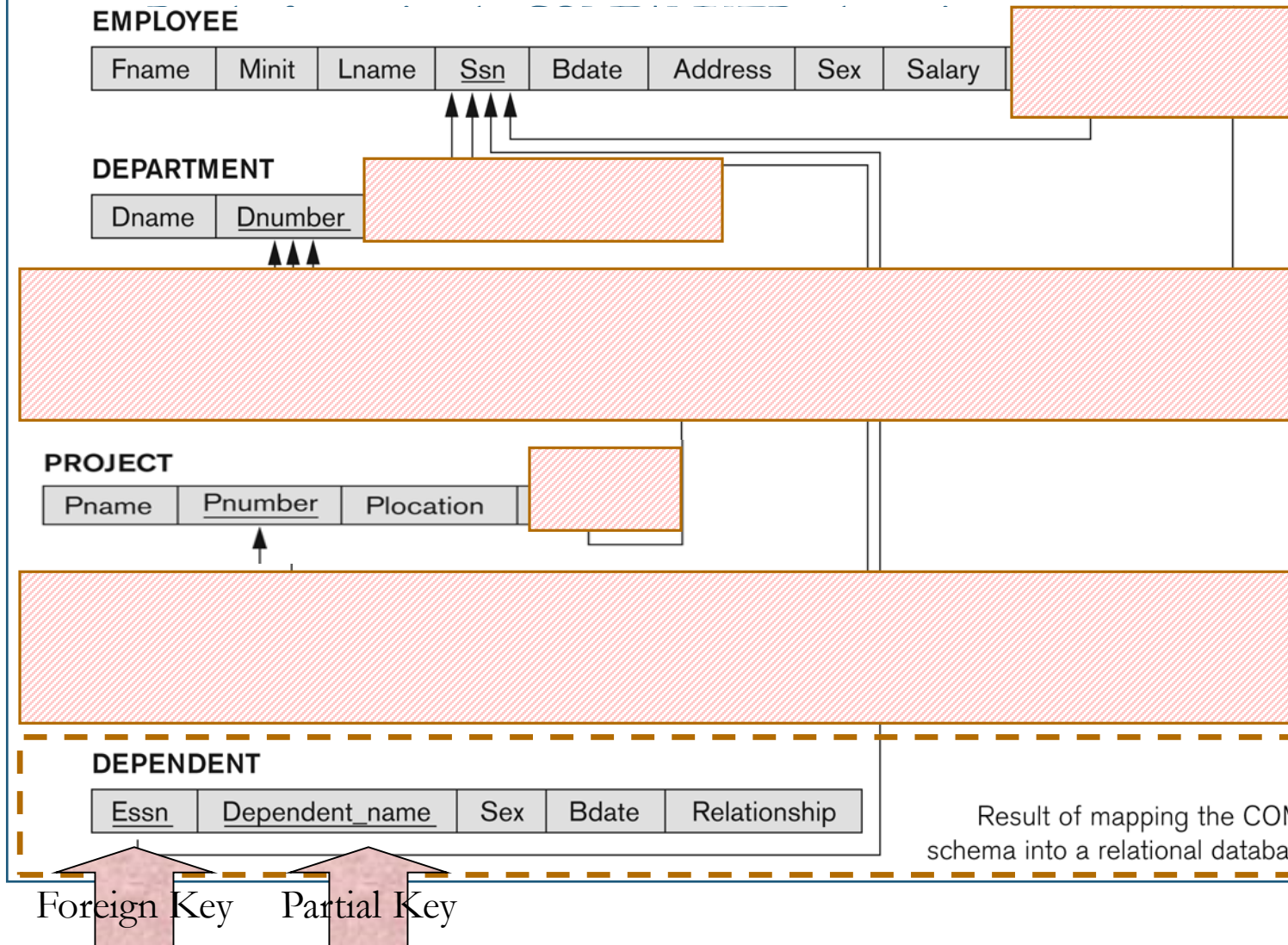# Result of mapping the COMPANY ER schema into a relational schema

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary		

DEPARTMENT

Dname	Dnumber		

PROJECT

Pname	Pnumber	Plocation	

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

Foreign Key   Partial Key

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ER-to-Relational Mapping Algorithm

➢ **Step 3: Mapping of Binary 1:1 Relationship 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 <u>both participations are total.</u>

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.

Result of mapping the COMPANY ER schema into a relational schema

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

PROJECT

Pname	Pnumber	Plocation	

DEPENDENT

Essn	Dependent_name	Sex	
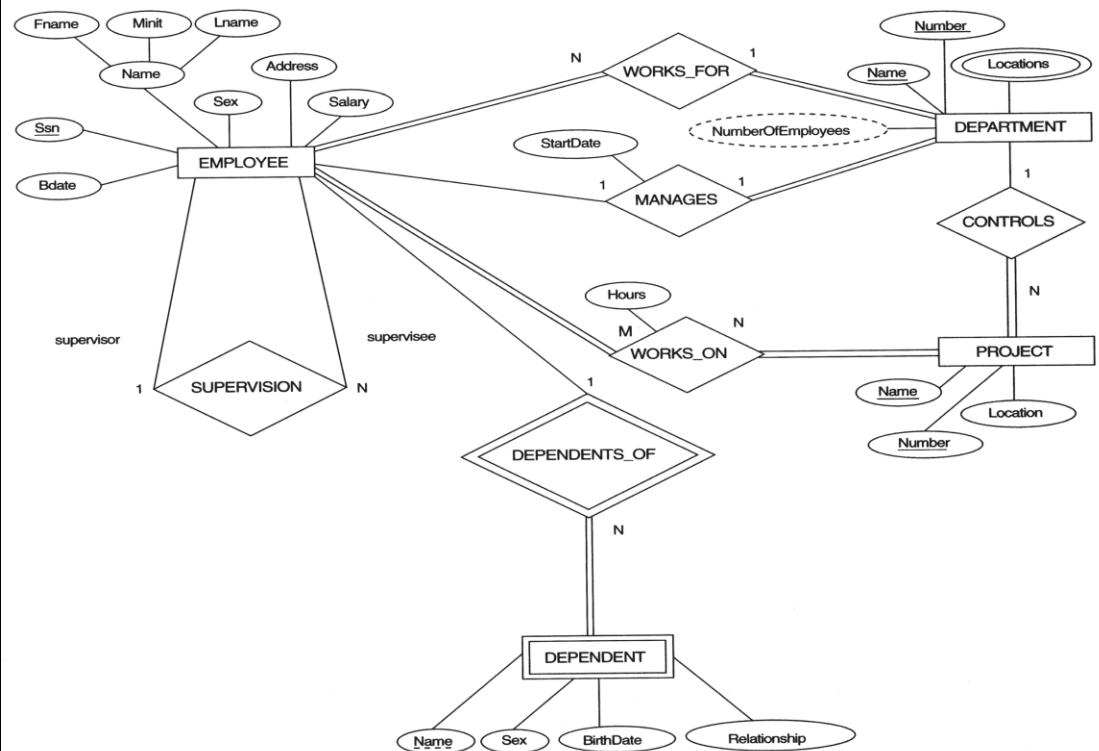
ER-to-Relational Mapping Algorithm

➤ **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 relationship 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.

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

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

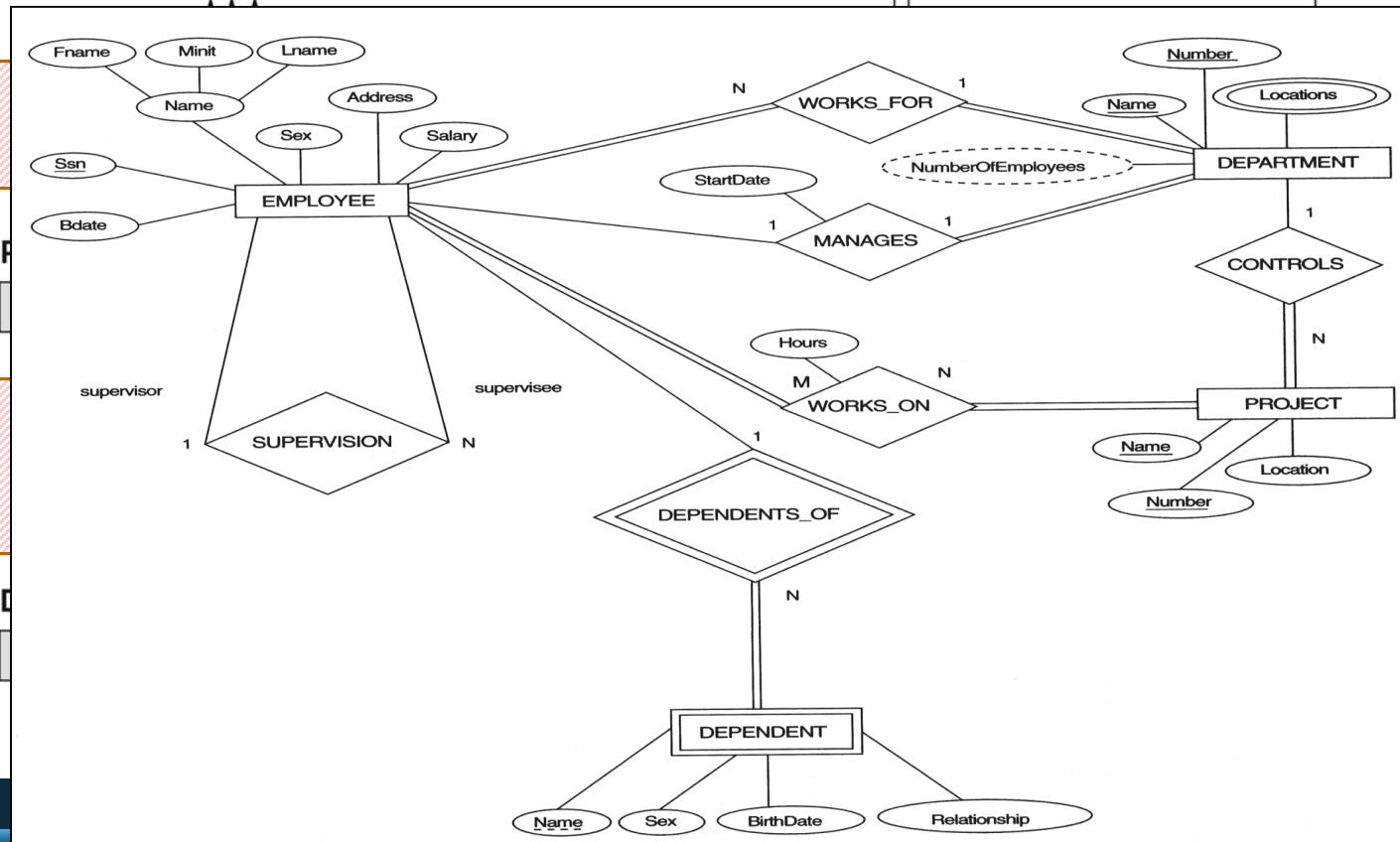| Dname	Dnumber	Mgr_ssn	Mgr_start_date

Figure 7.2
COMPANY ER
schema.

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ER-to-Relational Mapping Algorithm

➢ **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
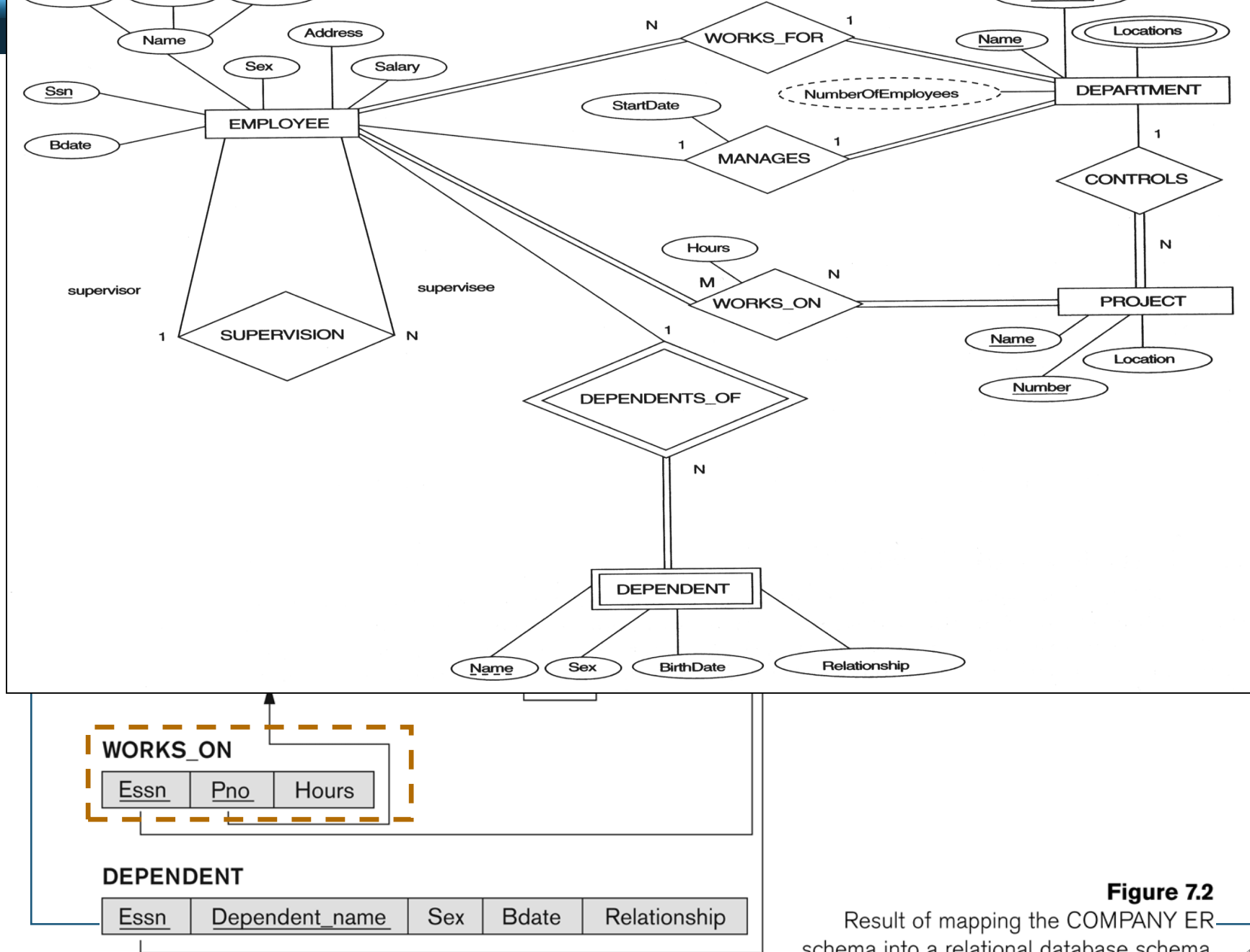Result of mapping the COMPANY ER schema into a relational database schema.

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

ER-to-Relational Mapping Algorithm

➢ **Step 6: Mapping of Multivalued attributes.**

- For each multivalued attribute A, <u>Create a Relation R</u>.

- 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}.
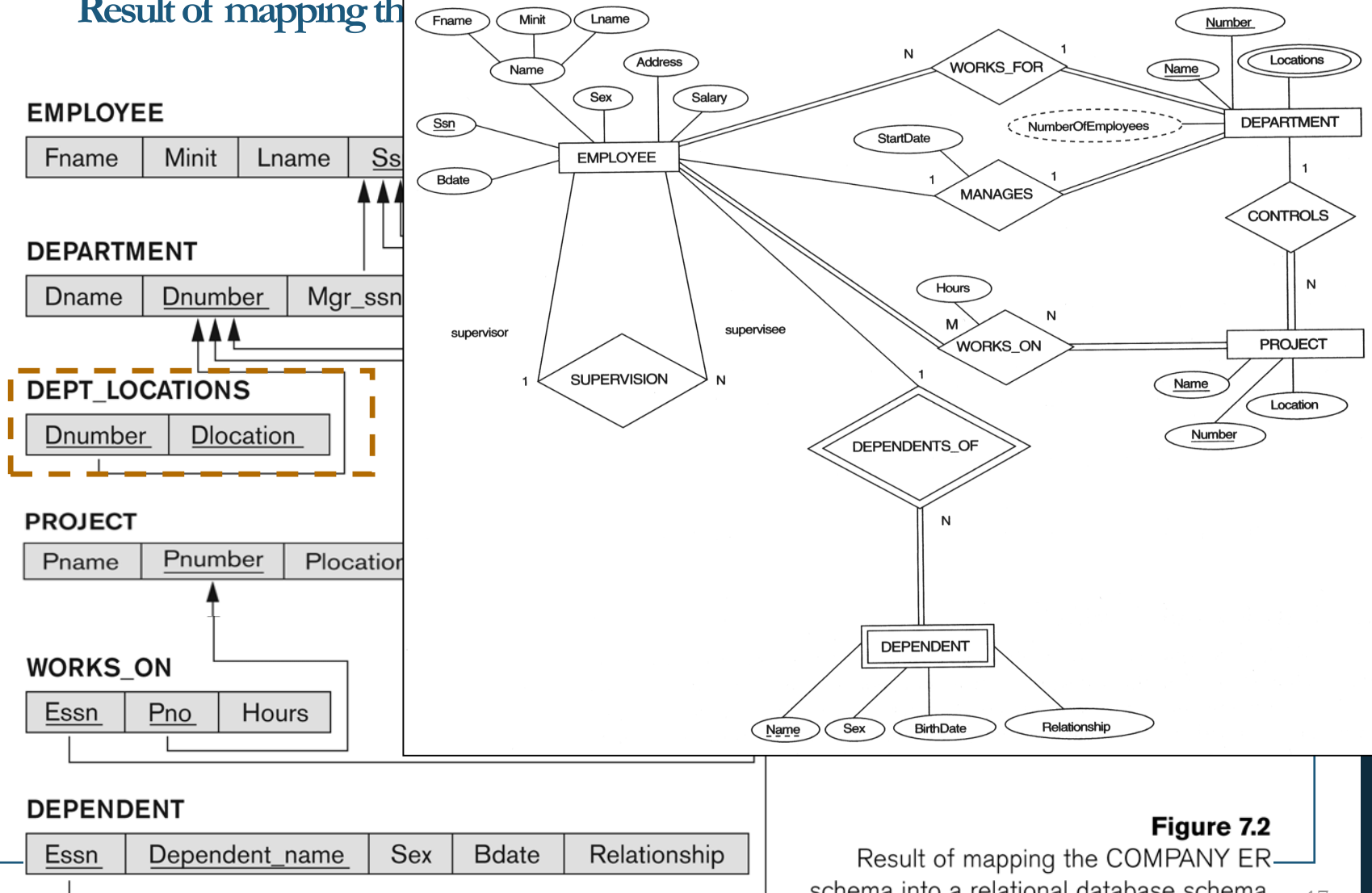
Result of mapping th

EMPLOYEE

Fname	Minit	Lname	Ss...

DEPARTMENT

Dname	Dnumber	Mgr_ssn...

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation...

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

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

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Result of mapping the COMPANY ER schema into a relational schema

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation	Dnum

WORKS_ON

Essn	Pno	Hours

DEPENDENT

| Essn	Dependent_name	Sex	Bdate	Relationship

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

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ER-to-Relational Mapping Algorithm

➢ **Step 7: Mapping of N-ary Relationship Types.**

- For each n-ary relationship type R, where n>2, <u>Create a Relation S</u> 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 SUPPLY 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}

Ternary relationship types. (a) The SUPPLY relationship
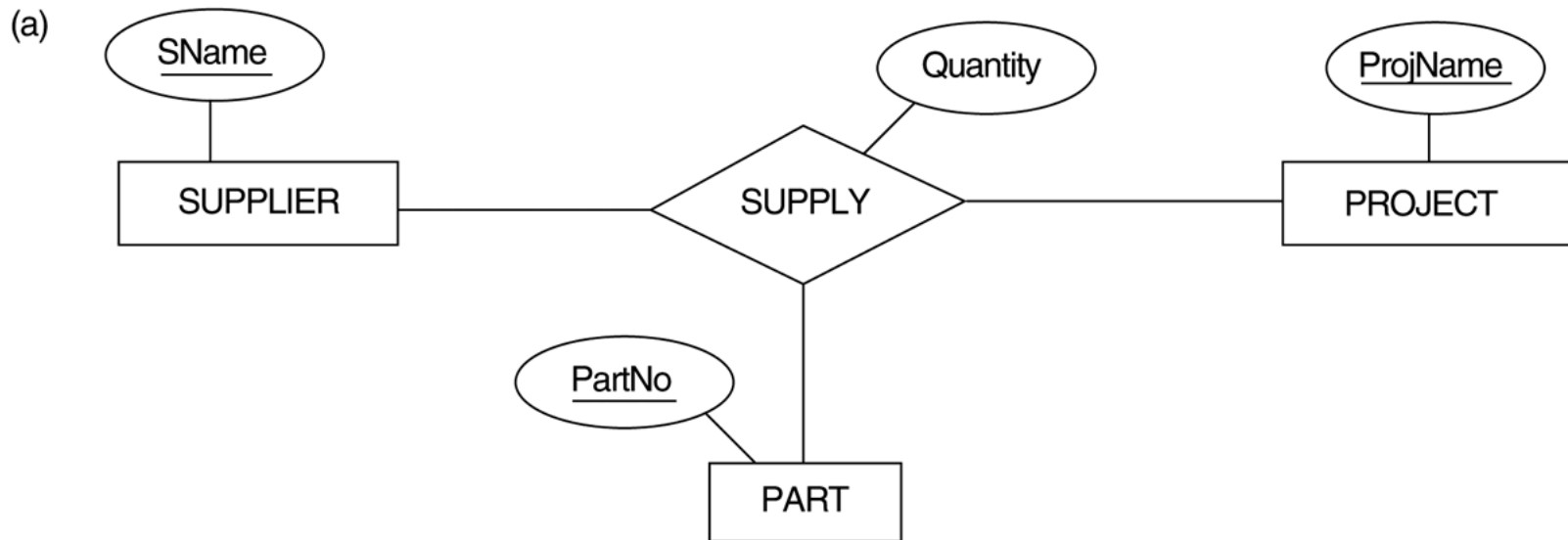
Mapping the *n*-ary relationship type SUPPLY

SUPPLIER

SNAME	. . .

PROJECT

PROJNAME	. . .

PART

PARTNO	. . .

SUPPLY

SNAME	PROJNAME	PARTNO	QUANTITY

Correspondence between ER and Relational Models

ER Model   → **Relational Model**

Entity type   → "Entity" relation
1:1 or 1:N relationship   → Foreign key (or "relationship" relation)
M:N relationship   → "Relationship" relation and two foreign keys
n-ary relationship   → "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

Thank You