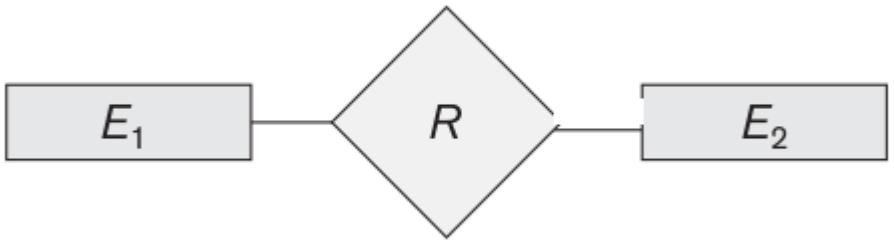
Chapter Outline

- **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.

Relationships

- A **relationship** relates two or more distinct entities with a specific meaning.
- The degree of a relationship type is the number of participating entity types.
  - For example,

EMPLOYEE John Smith *works on* the ProductX PROJECT, or
EMPLOYEE Franklin Wong *manages* the Research DEPARTMENT.



Constraints on Relationships

- Constraints on Relationship Types
  - Cardinality Ratio (specifies *maximum* participation)
    - One-to-one (1:1)
    - One-to-many (1:N) or Many-to-one (N:1)
    - Many-to-many (M:N)
  - Existence Dependency Constraint (specifies *minimum* participation) (also called participation constraint)
    - Partial/zero (optional participation, not existence-dependent)
    - Total/one or more (mandatory participation, existence-dependent)

1. Total Participation-

- It specifies that each entity in the entity set must compulsorily participate in at least one relationship instance in that relationship set.
- That is why, it is also called as **mandatory participation.**
- Total participation is represented using a double line between the entity set and relationship set.

Total Participation

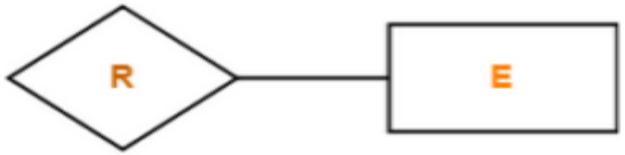
Example-

Here,

- Double line between the entity set "Student" and relationship set "Enrolled in" signifies total participation.
- It specifies that each student must be enrolled in at least one course.

2. Partial Participation-

- It specifies that each entity in the entity set may or may not participate in the relationship instance in that relationship set.
- That is why, it is also called as **optional participation.**
- Partial participation is represented using a single line between the entity set and relationship set.



Partial Participation

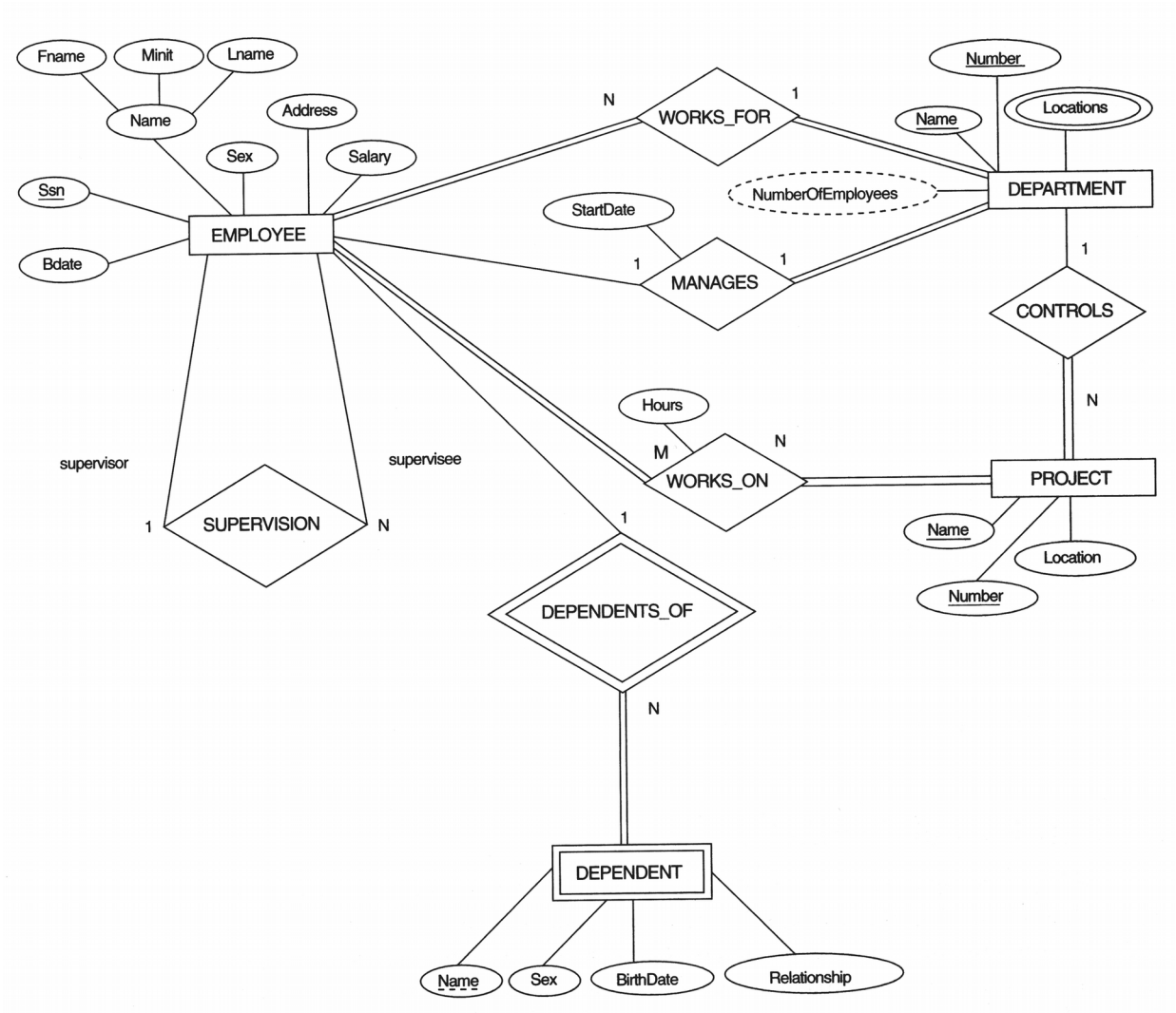
Example-

Here,

- Single line between the entity set "Course" and relationship set "Enrolled in" signifies partial participation.
- It specifies that there might exist some courses for which no enrollments are made.

FIGURE

The ER conceptual schema diagram for the COMPANY database.



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.

ER-to-Relational Mapping Algorithm

- Step 1: Mapping of Regular Entity Types.

- 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.

Step 1 Result

EMPLOYEE

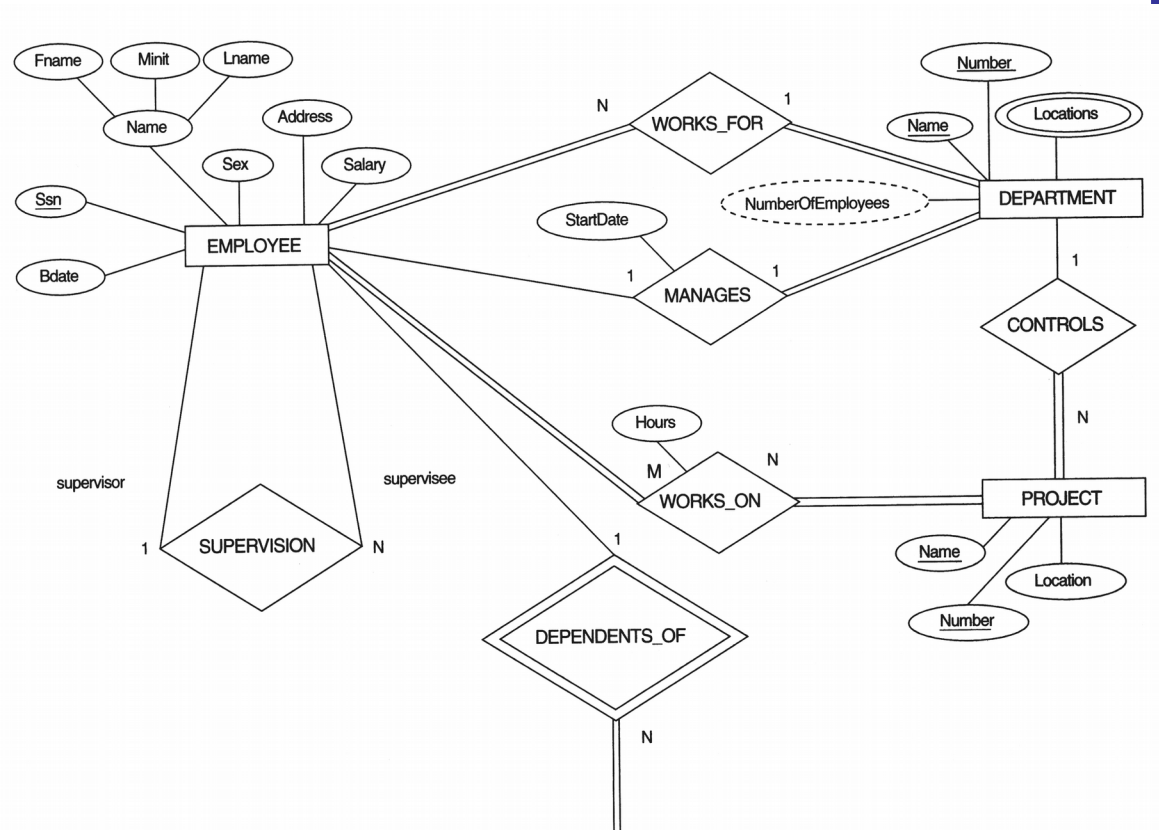
Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary

DEPARTMENT

Dname	Dnumber

PROJECT

Pname	Pnumber	Plocation



ER-to-Relational Mapping Algorithm (contd.)

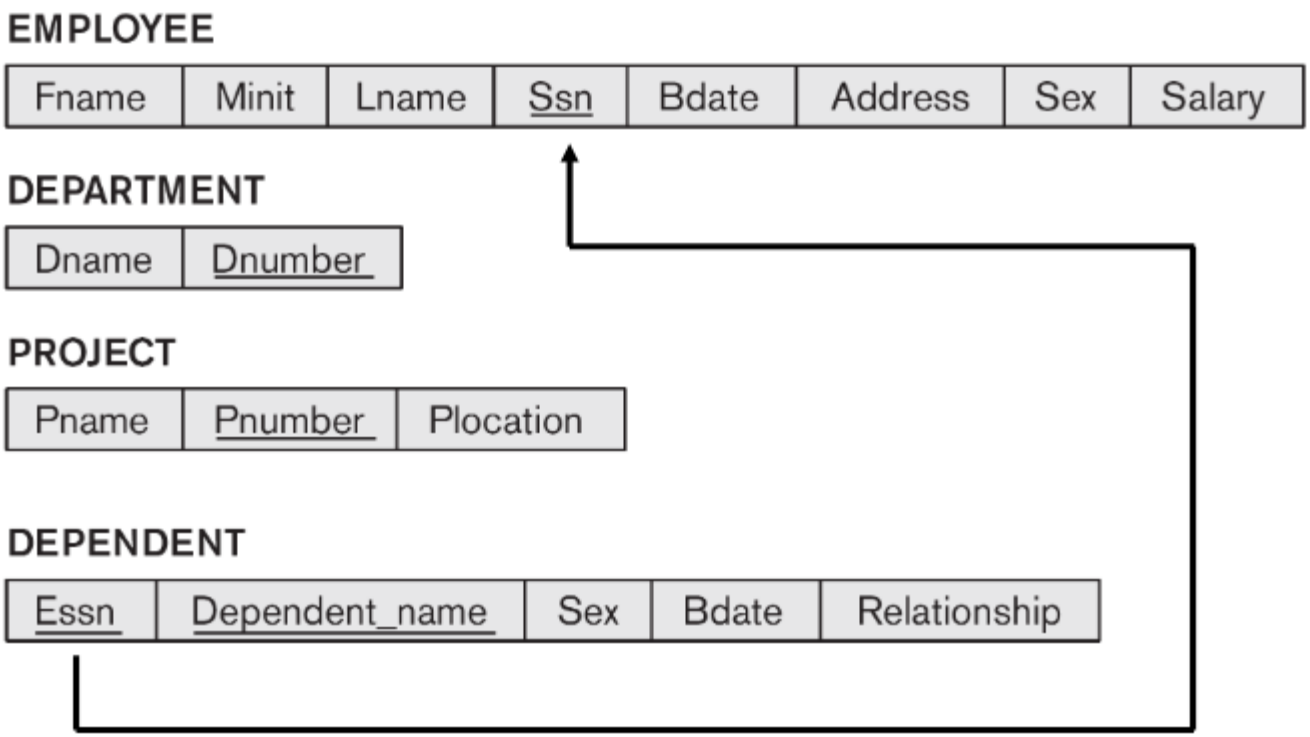
- **Step 2: Mapping of Weak Entity Types**
  - For each weak entity type W in the ER schema with owner entity type E, create a relation R & include all simple attributes

    (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.

ER-to-Relational Mapping Algorithm (contd.)

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

- **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.


EMPLOYEE
Fname
Minit
Lname
Ssn
Bdate
Address
Sex
Salary
DEPARTMENT
Dname
Dnumber
PROJECT
Pname
Pnumber
Plocation
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.
  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.

ER-to-Relational Mapping Algorithm (contd.)

- **Step 3: Mapping of Binary 1:1 Relation Types**

Foreign Key approach:

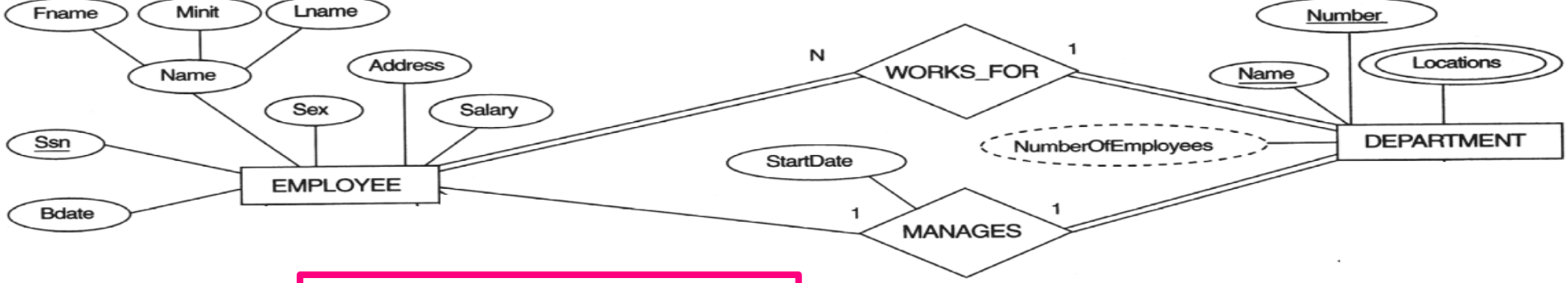
i. Choose one relation as S, the other T

Better if S has total participation

(reduces number of NULL values)

ii. Add to S, all the simple attributes of the relationship

Iii. Add the primary key attributes of T as a foreign key in S



T		S
1	:	1
Emp		Dept
PK	->	FK
SSN	->	MgrSSN

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary

DEPARTMENT

Dname	Dnumber

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

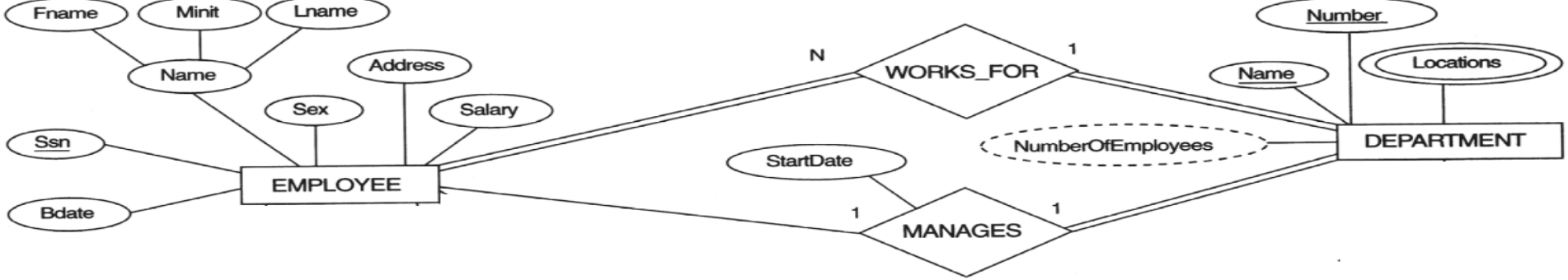
ER-to-Relational Mapping Algorithm (contd.)

- Step 4: Mapping of Binary 1:N Relationship Types.

- Choose the S relation as the type at the N-side of the relationship, other is T
- Add all of the primary key attribute(s) of T, as a foreign key to S

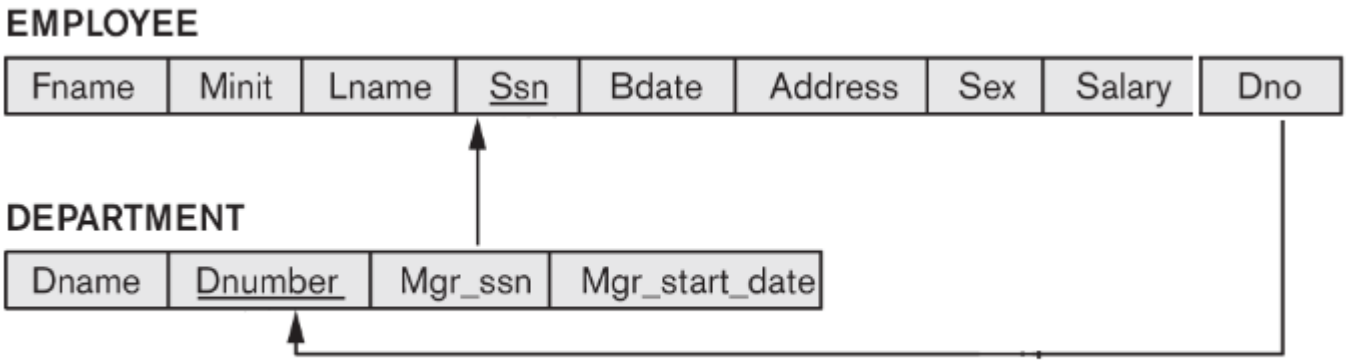
Example: 1:N relationship types

- WORKS_FOR,
- CONTROLS, and
- SUPERVISION in the figure.



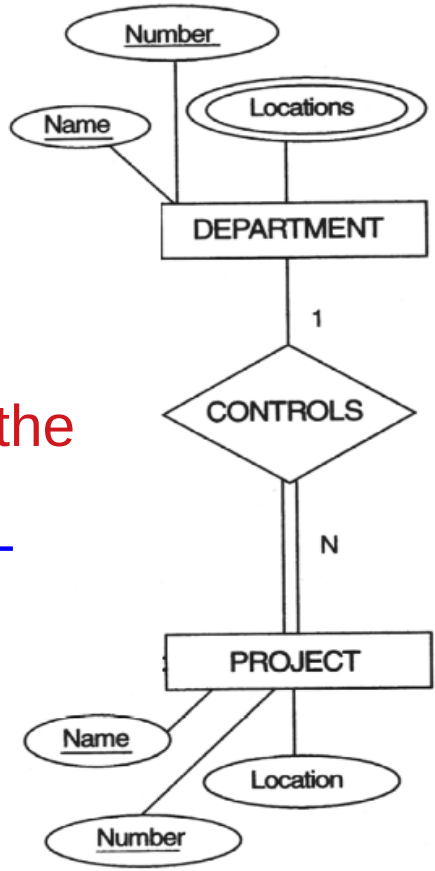
T		S
1	:	N
Dept		Emp
PK	->	FK
DNUM	->	DN0

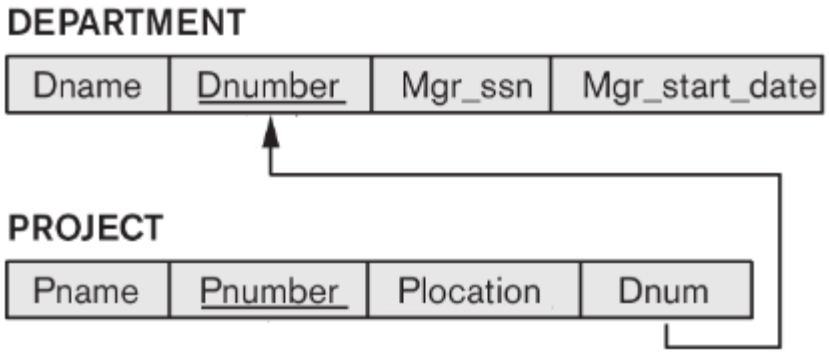
For WORKS_FOR we include the primary key DNUMBER of the DEPARTMENT relation as foreign key in the EMPLOYEE relation and call it DNO.



T		S
1	:	N
Dept		Project
PK	->	FK
DNUM	->	DNum

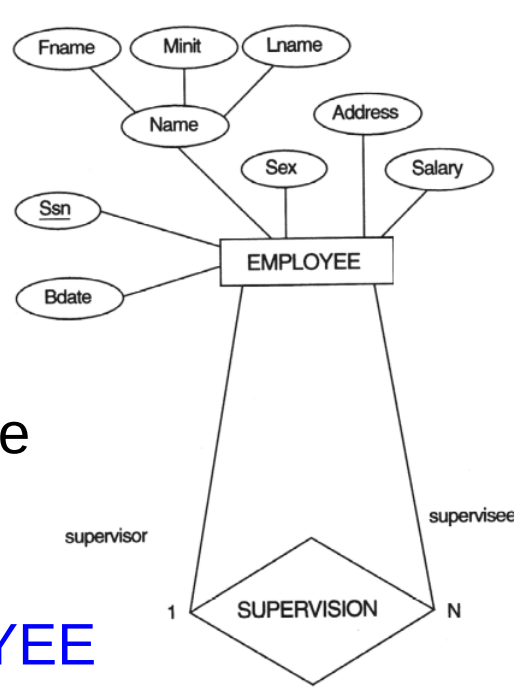
For CONTROLS we include the primary key DNUMBER of the DEPARTMENT relation as foreign key in the PROJECT relation and call it DNum.





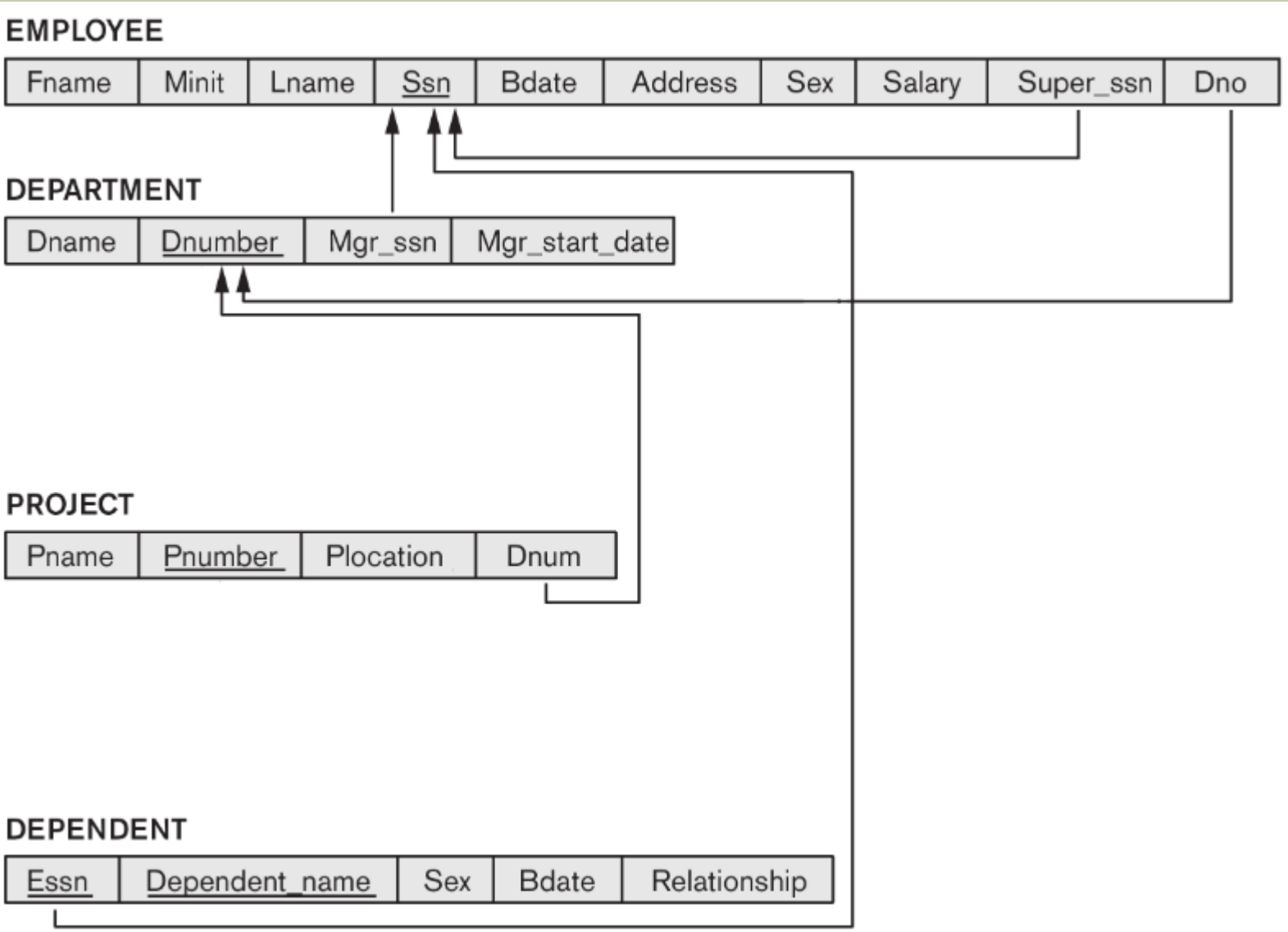
T		S
1	:	N
Emp		Emp
FK		PK
Super		
SSN	<-	SSN

For SUPERVISION we include the primary key SSN of the EMPLOYEE relation as foreign key in the EMPLOYEE relation and call it Super_SSN



EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

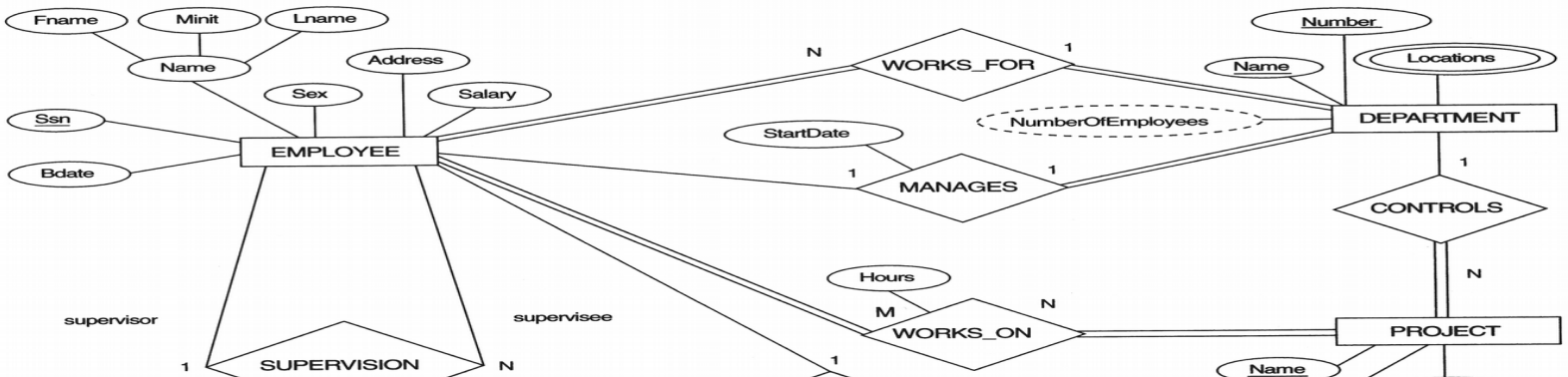

EMPLOYEE
Fname
Minit
Lname
Ssn
Bdate
Address
Sex
Salary
Super_ssn
Dno
DEPARTMENT
Dname
Dnumber
Mgr_ssn
Mgr_start_date
PROJECT
Pname
Pnumber
Plocation
Dnum
DEPENDENT
Essn
Dependent_name
Sex
Bdate
Relationship

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.

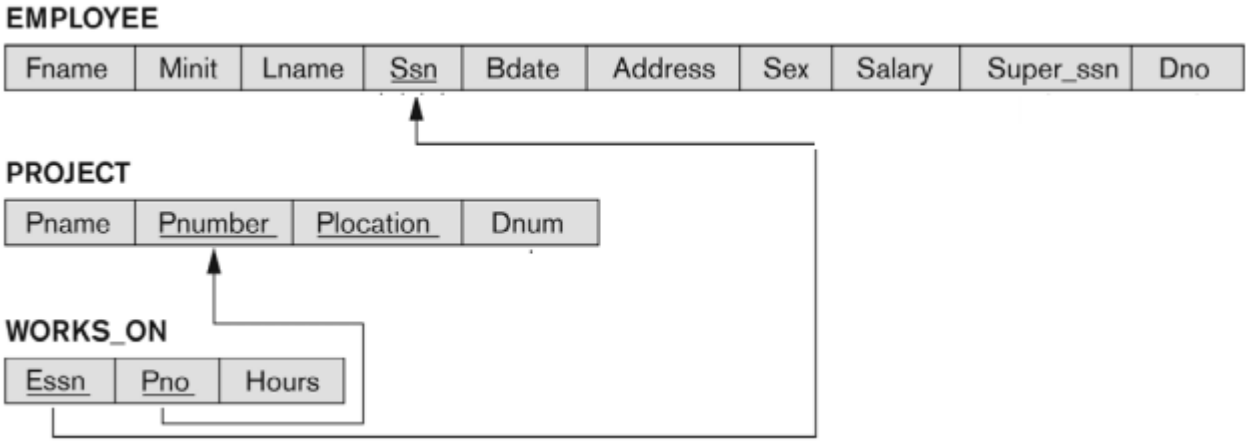
ER-to-Relational Mapping Algorithm (contd.)

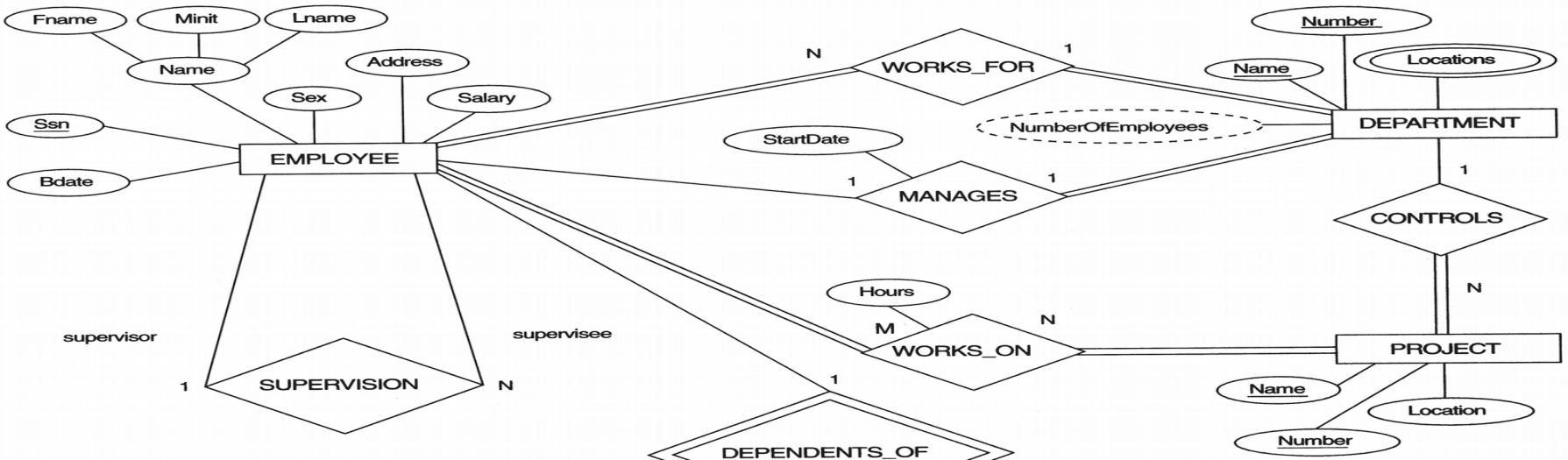
- **Step 5: Mapping of Binary M:N Relationship Types.**
- Example: The M:N relationship type WORKS_ON from the ER diagram is mapped by creating a relation WORKS_ON in the relational database schema.
  - The primary keys of the PROJECT and EMPLOYEE relations are included as foreign keys in WORKS_ON and 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}.



ER-to-Relational Mapping Algorithm (contd.)

- **Step 5: Mapping of Binary M:N Relationship Types.**





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.

ER-to-Relational Mapping Algorithm (contd.)

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

- **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}.

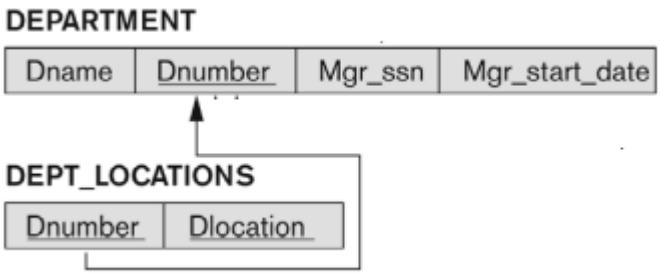


FIGURE
Result of mapping the COMPANY ER schema into a relational schema.

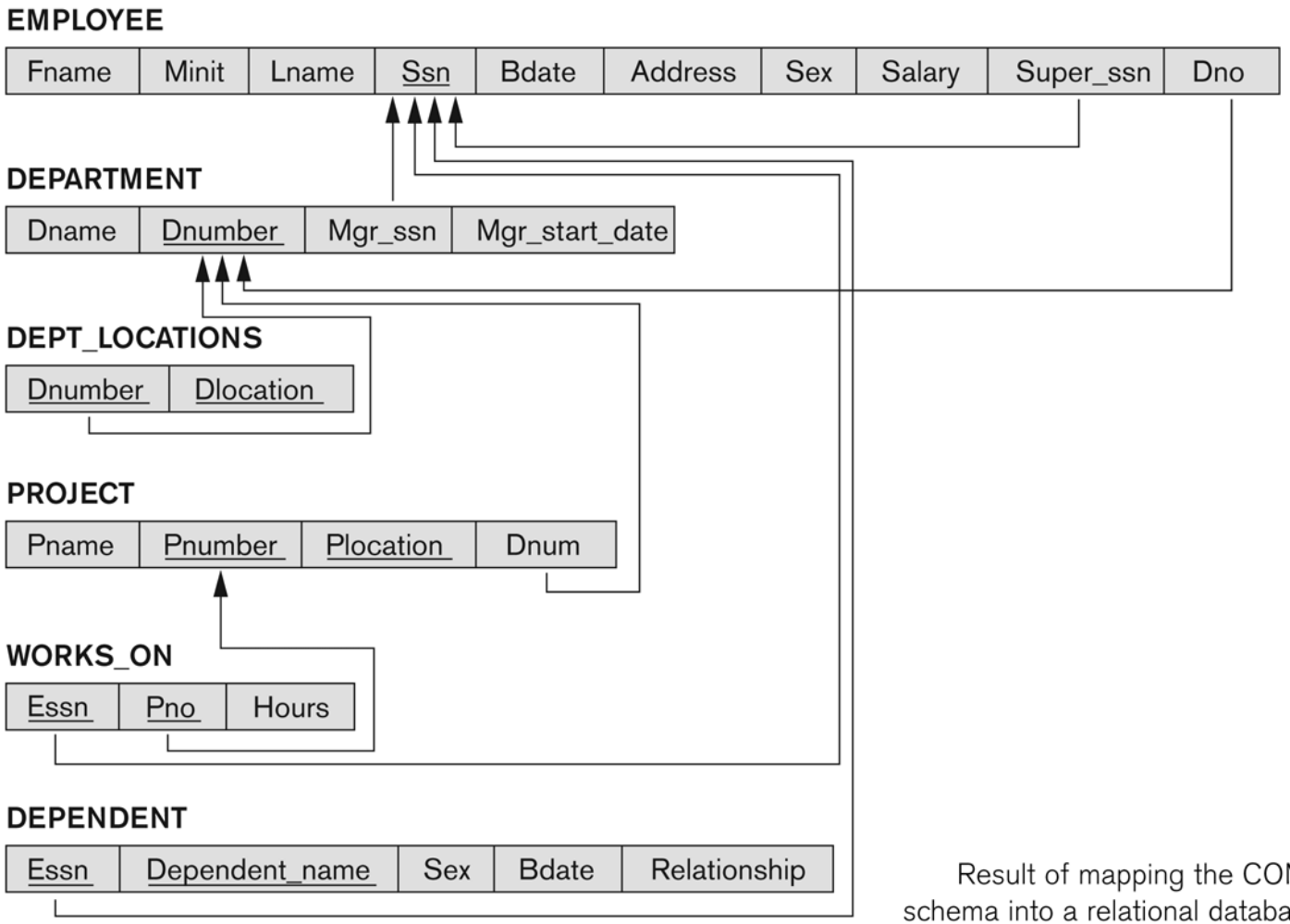
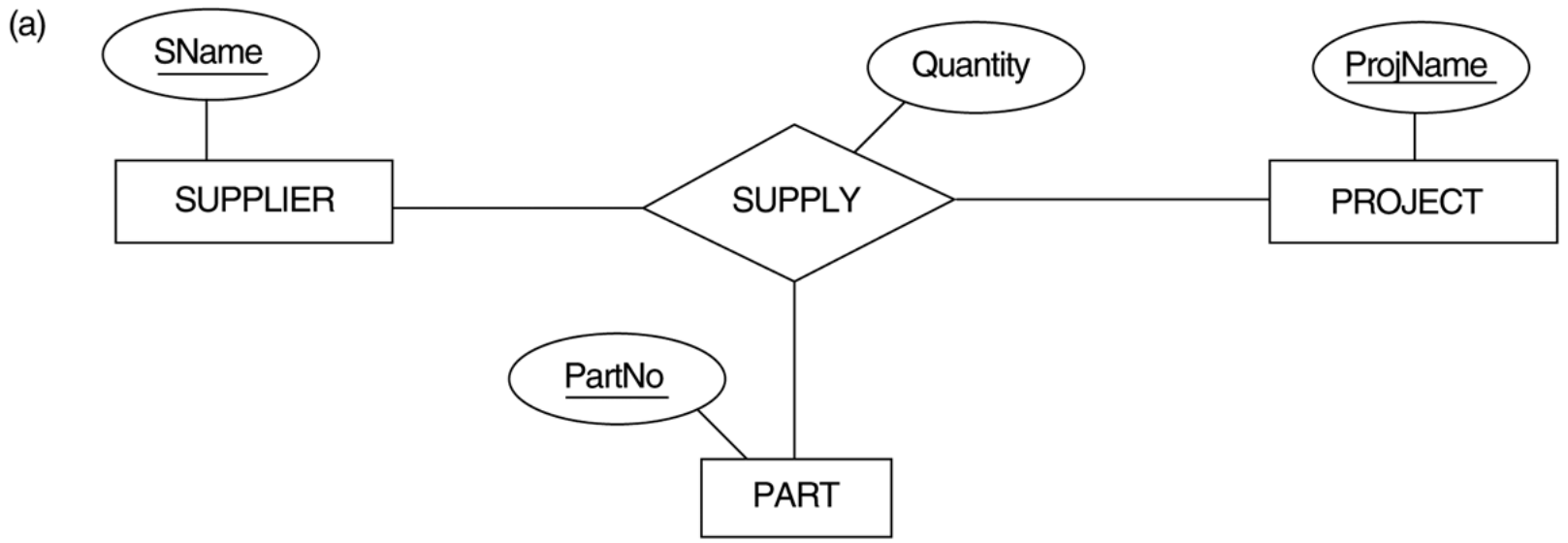


Figure 7.2
Result of mapping the COMPANY ER schema into a relational database schema.

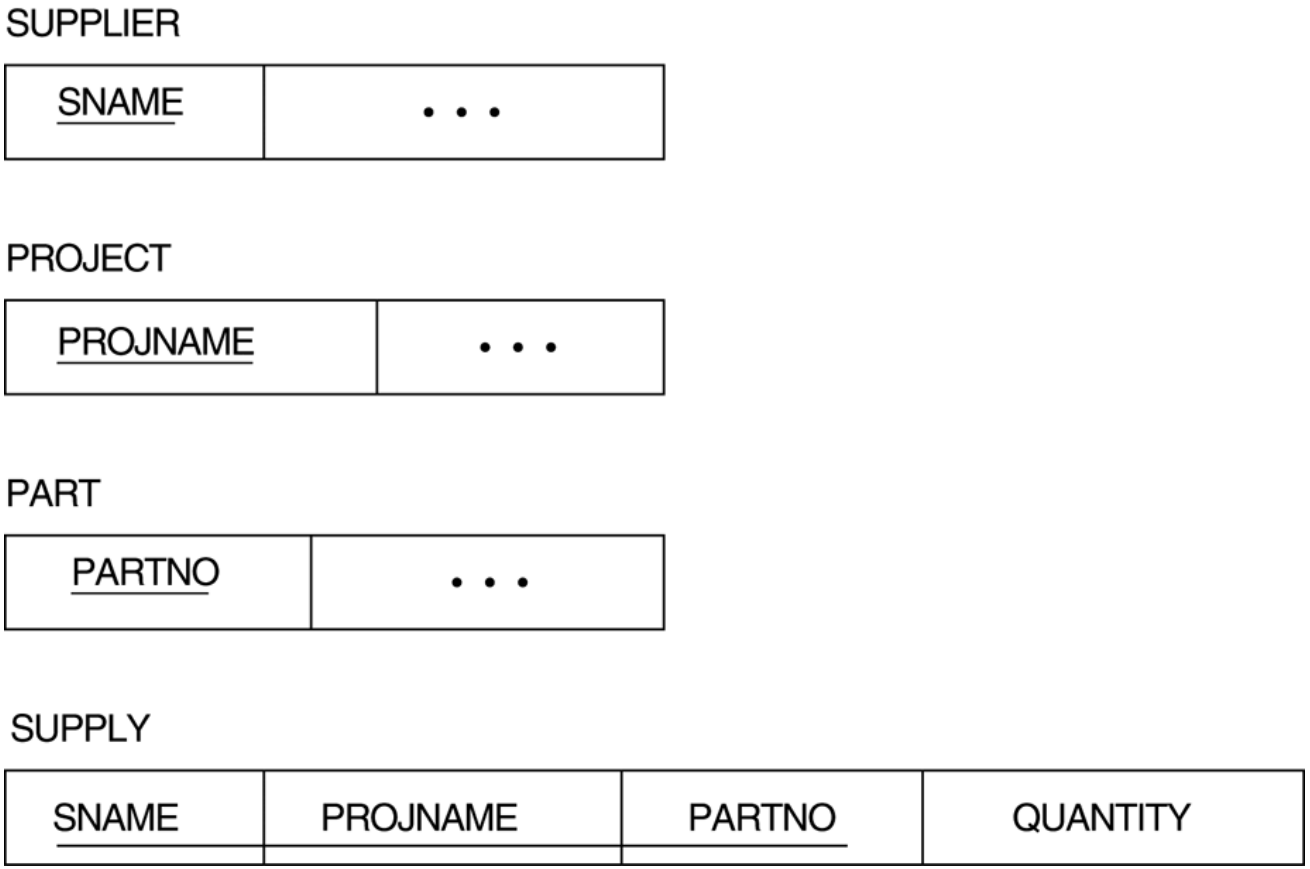
ER-to-Relational Mapping Algorithm (contd.)

- **Step 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}

Ternary relationship types. (a) The SUPPLY relationship.



Mapping the *n*-ary relationship type SUPPLY.



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

Chapter Summary

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  - 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.
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  - Step 6: Mapping of Multivalued attributes.
  - Step 7: Mapping of N-ary Relationship Types.