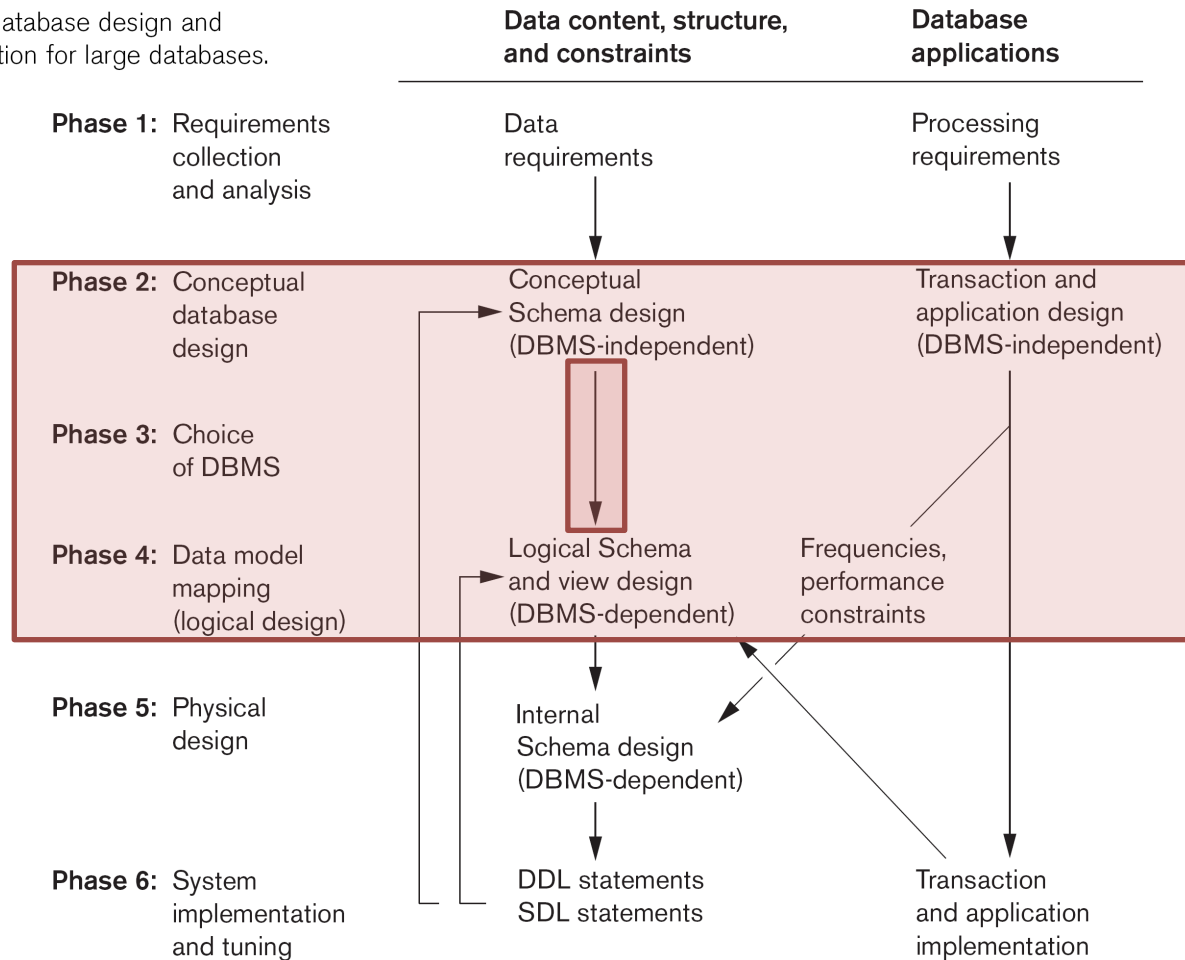# ER-to-Relational Mapping

Lecture 8

Outline

1. Context

2. The Algorithm

Database Design and Implementation Process
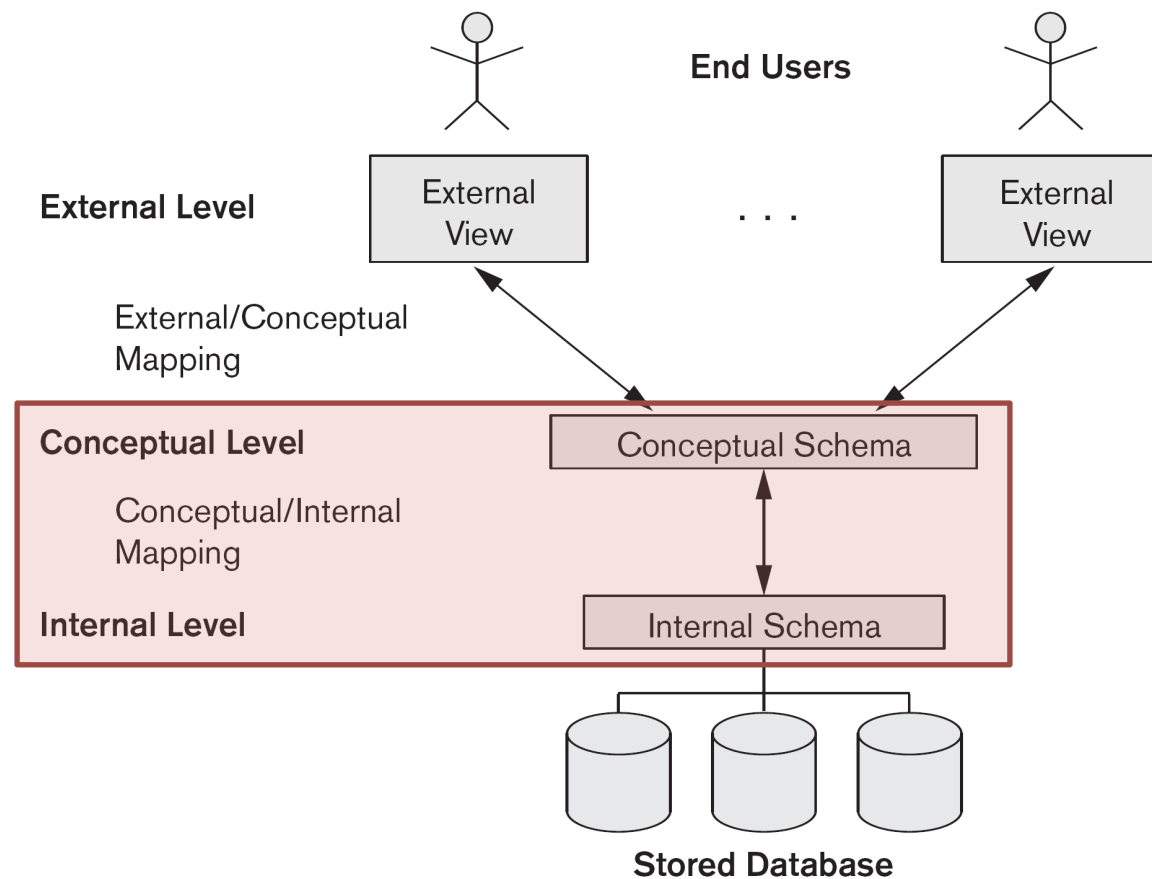
Figure 10.1
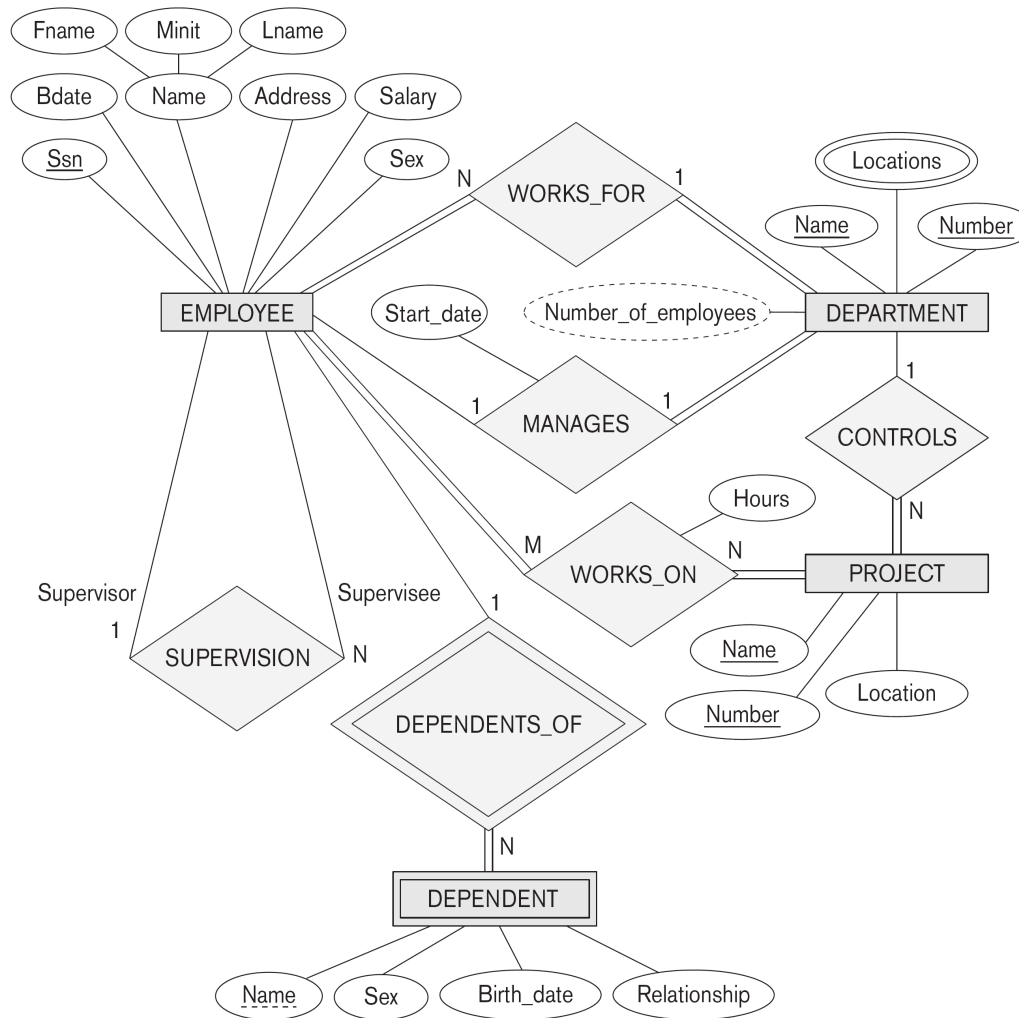Phases of database design and
implementation for large databases.

	Data content, structure, and constraints	Database applications
Phase 1: Requirements collection and analysis	Data requirements	Processing requirements
Phase 2: Conceptual database design	Conceptual Schema design (DBMS-independent)	Transaction and application design (DBMS-independent)
Phase 3: Choice of DBMS		
Phase 4: Data model mapping (logical design)	Logical Schema and view design (DBMS-dependent)	Frequencies, performance constraints
Phase 5: Physical design	Internal Schema design (DBMS-dependent)	
Phase 6: System implementation and tuning	DDL statements SDL statements	Transaction and application implementation

ER-to-Relational Mapping

Data Models

Figure 2.2
The three-schema
architecture.

Example ERD

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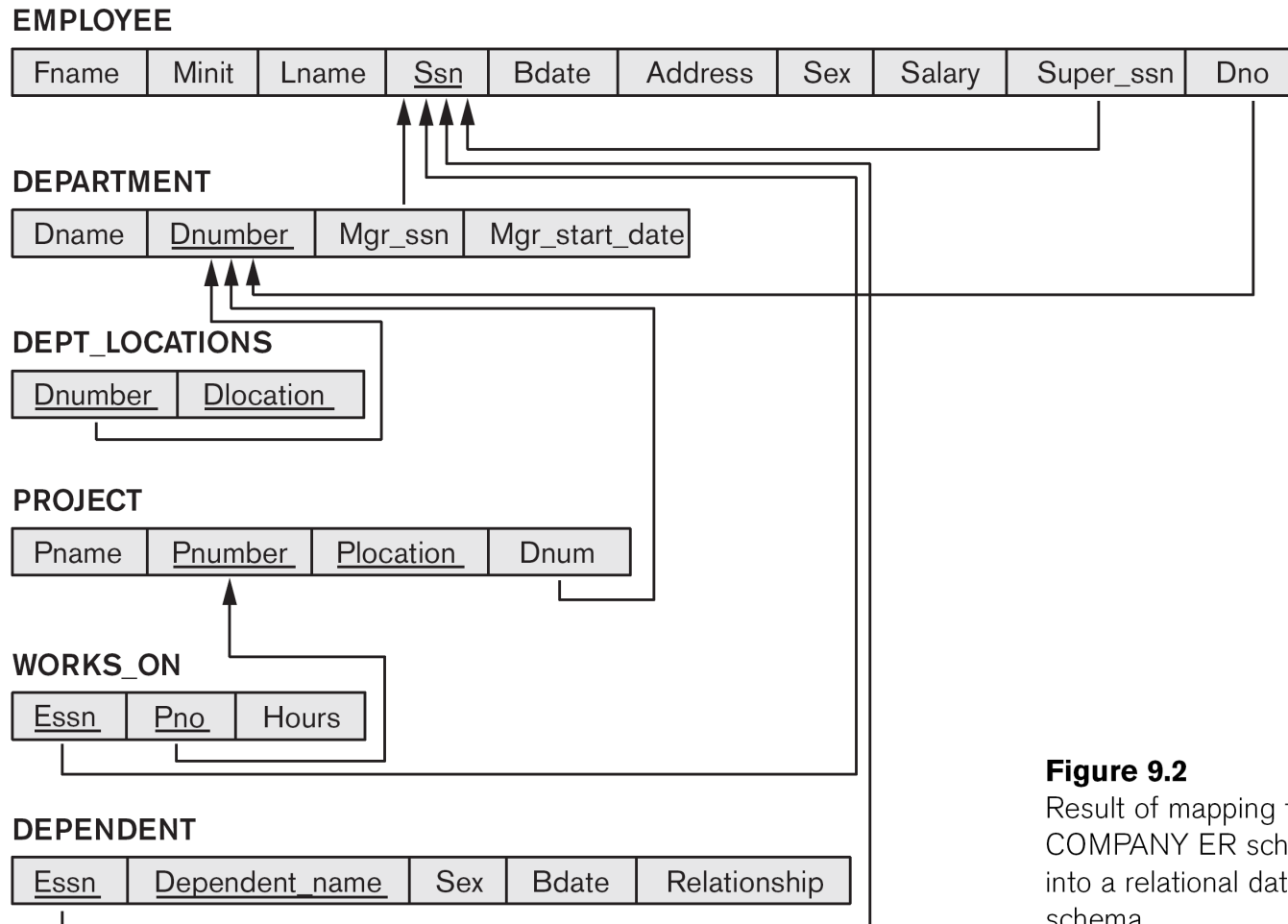
Figure 9.2
Result of mapping the COMPANY ER schema into a relational database schema.

Step 1: Regular Entity Types

i.   For each regular/strong entity type, create a corresponding relation that includes all the <u>simple</u> attributes (includes simple attributes of composite relations)

ii. Choose one of the key attributes as primary

   ▪ If composite, the simple attributes together form the primary key

iii. Any remaining key attributes are kept as secondary unique keys (these will be useful for physical tuning w.r.t. indexing analysis)

Example ERD
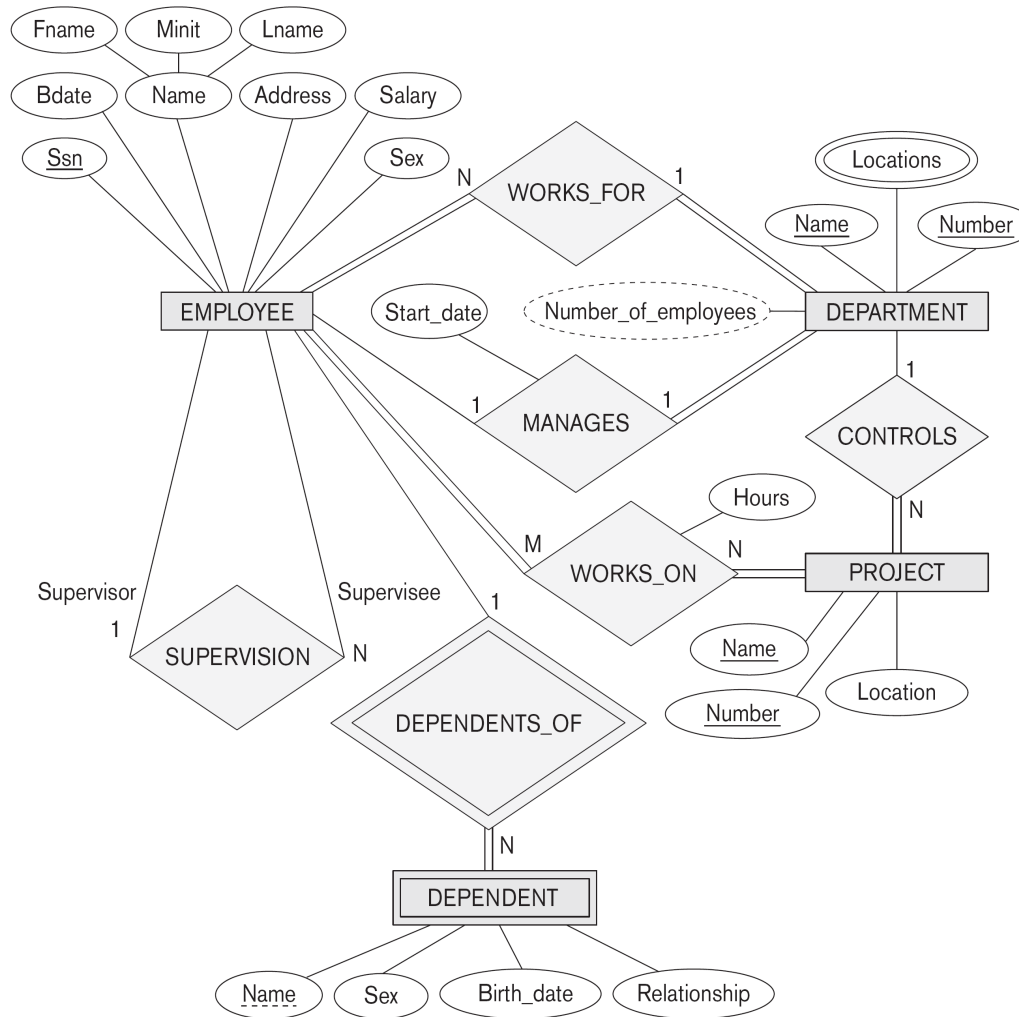
Step 1 Result

Figure 9.3
Illustration of some
mapping steps.
a. *Entity* relations after
step 1.

(a)   **EMPLOYEE**

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary

DEPARTMENT

Dname	Dnumber

PROJECT

Pname	Pnumber	Plocation

ER-to-Relational Mapping

Step 2: Weak Entity Types

i. For each weak entity type, create a corresponding relation that includes all the simple attributes

ii. Add as a <u>foreign key</u> all of the primary key attribute(s) in the entity corresponding to the owner entity type

iii. The primary key is the combination of all the primary key attributes from the owner and the partial key of the weak entity, if any

ER-to-Relational Mapping

Example ERD
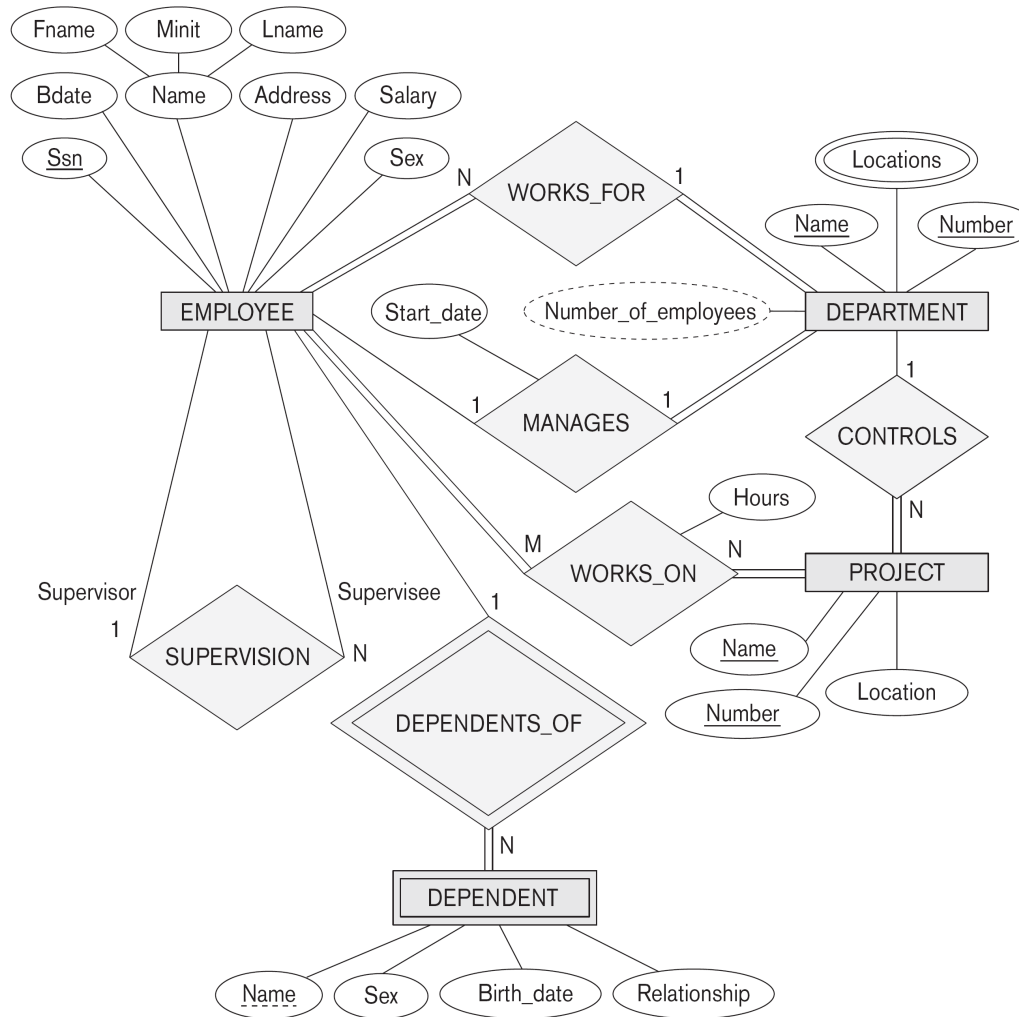
Step 2 Result

Figure 9.3
Illustration of some mapping steps.
a. *Entity* relations after step 1.
b. Additional *weak entity* relation after step 2.

(a)　**EMPLOYEE**

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary

DEPARTMENT

Dname	Dnumber

PROJECT

Pname	Pnumber	Plocation

(b)　**DEPENDENT**

Essn	Dependent_name	Sex	Bdate	Relationship

ER-to-Relational Mapping
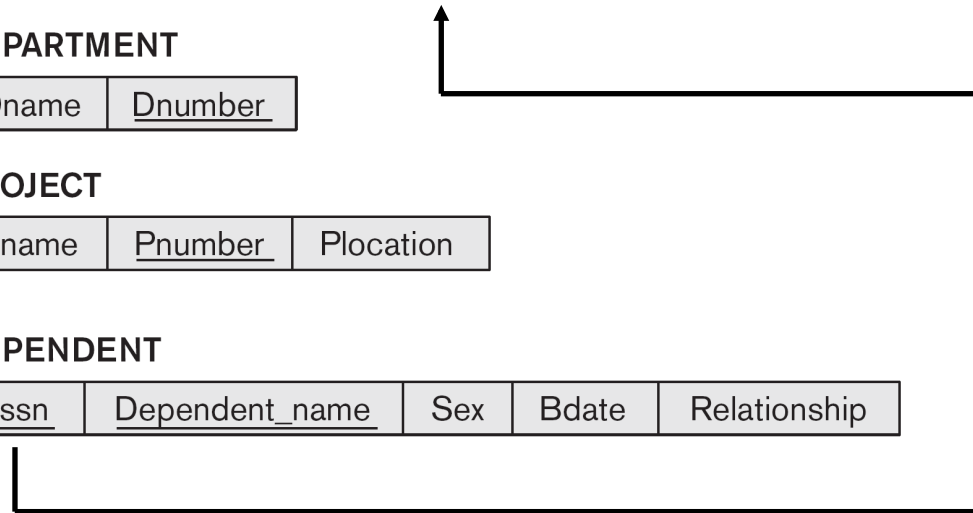
Step 3: Mapping Binary 1-to-1

Three approaches
- **Foreign Key**
  - Usually appropriate
- Merged Relation
  - Possible when both participations are total
- Relationship Relation
  - Not discussed

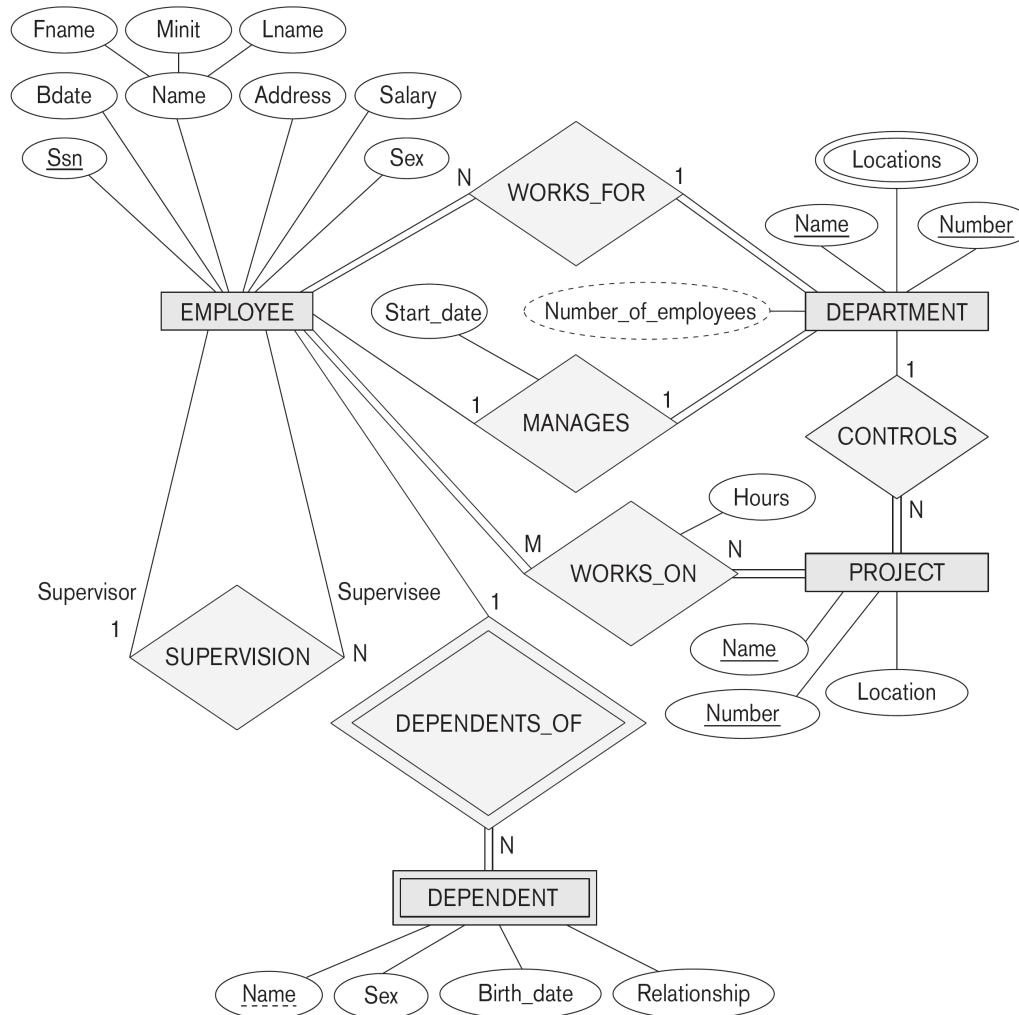# Step 3: Mapping Binary 1-to-1
Foreign Key

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 as a foreign key in *S* the primary key attributes of *T*

ER-to-Relational Mapping

Example ERD

Step 2 Result

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary

DEPARTMENT

Dname	Dnumber

Step 3 Result

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex

DEPARTMENT

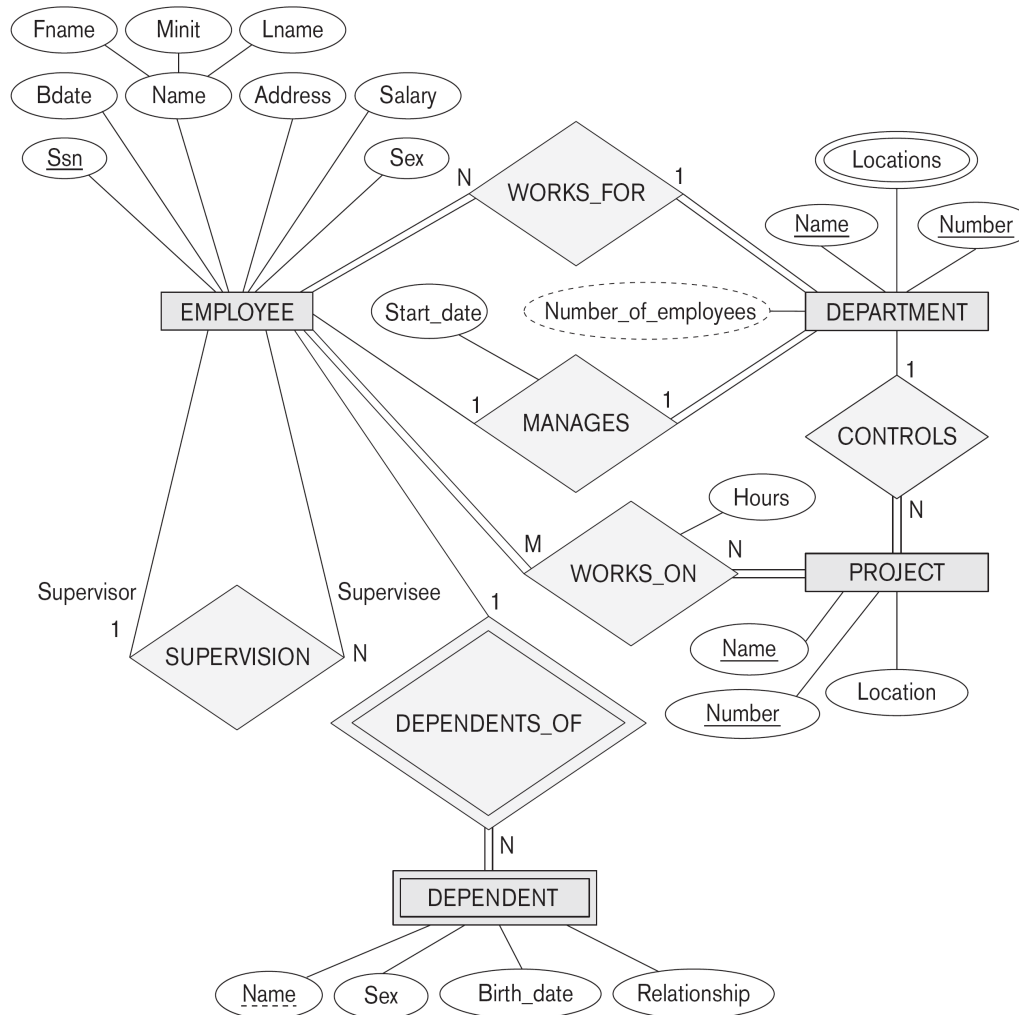| Dname	Dnumber	Mgr_ssn	Mgr_start_date

Step 4: Binary 1-to-N

i.   Choose the *S* relation as the type at the N-side of the relationship, other is *T*

ii. Add as a <u>foreign key</u> to *S* all of the primary key attribute(s) of *T*

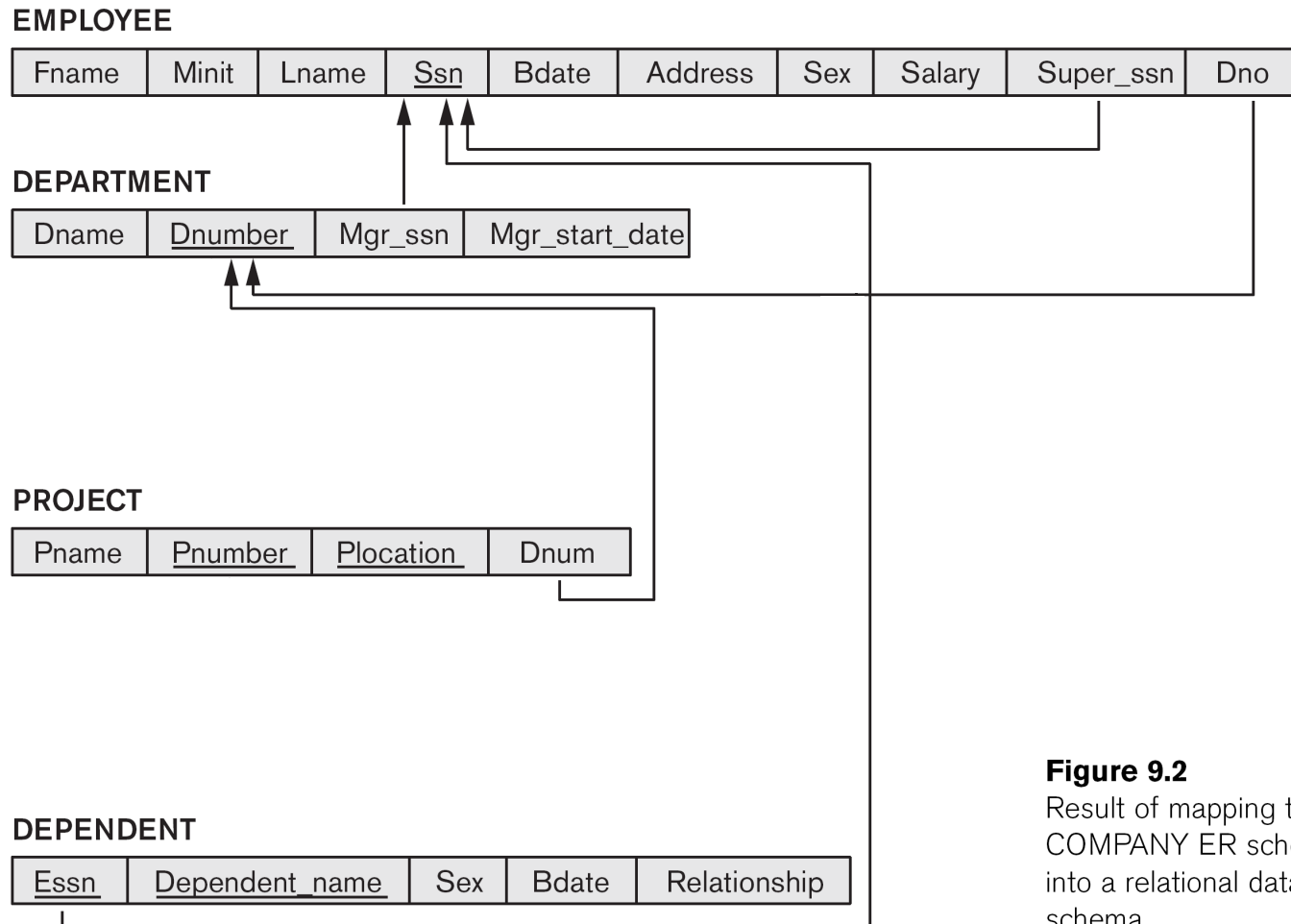Another approach: create a relationship relation

ER-to-Relational Mapping

Example ERD

Step 4 Result

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

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

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

ER-to-Relational Mapping

Step 5: Binary M-to-N

i.   Create a <u>new</u> relation *S* (termed: relationship relation)

   –   In some ERD dialects, actually drawn in

ii. Add as foreign keys the primary keys of both relations; their <u>combination</u> forms the primary key of *S*

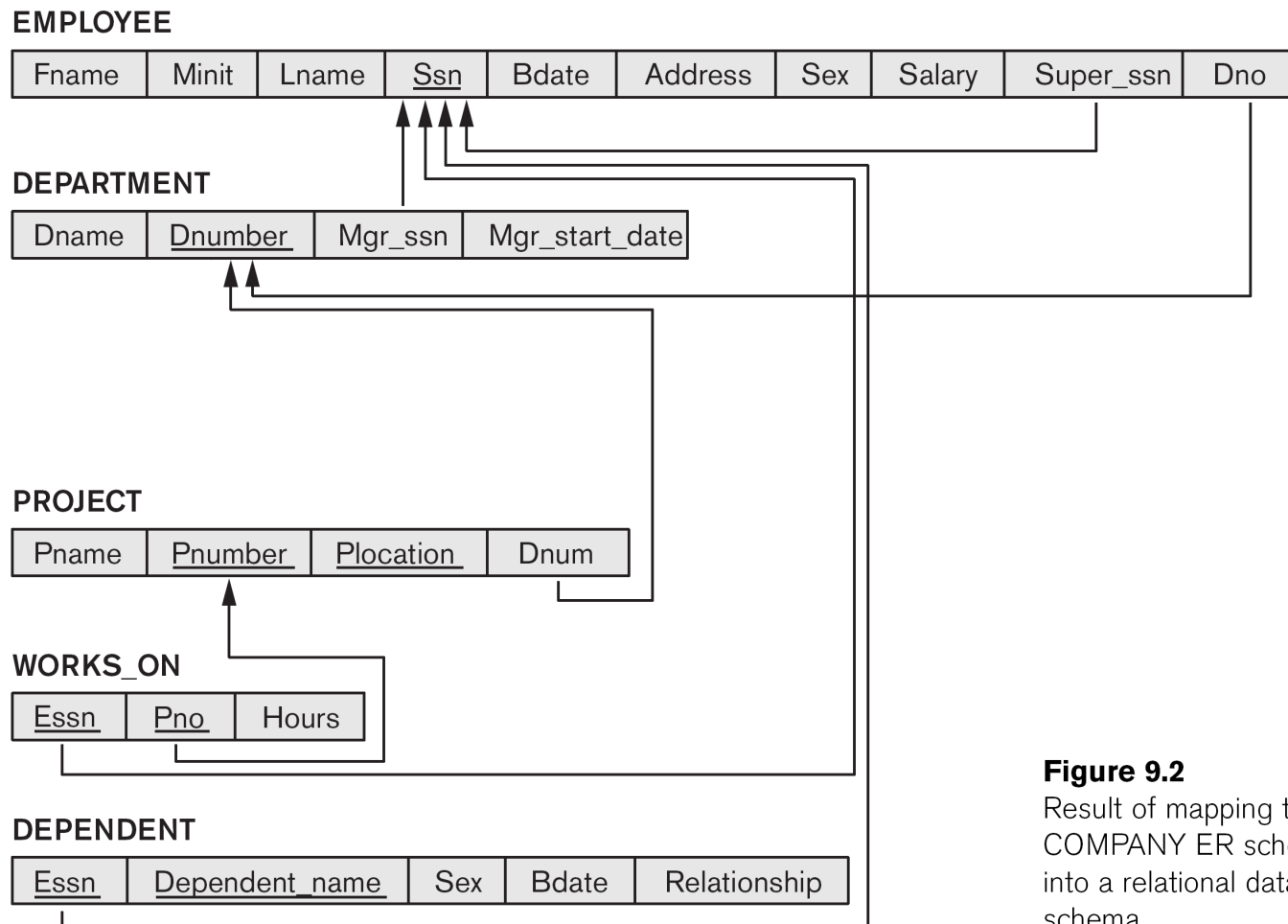iii. Add any simple attributes of the M:N relationship to *S*

ER-to-Relational Mapping

Example ERD
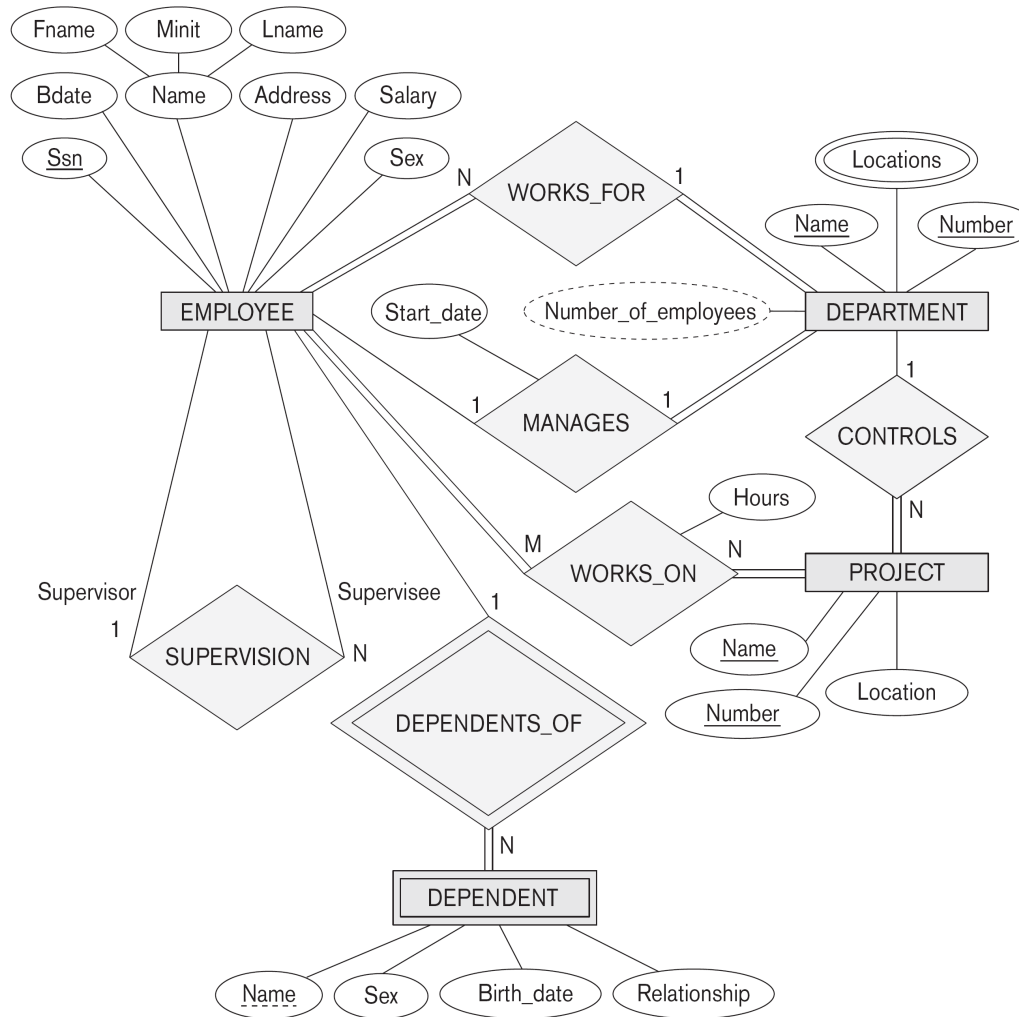
Step 5 Result

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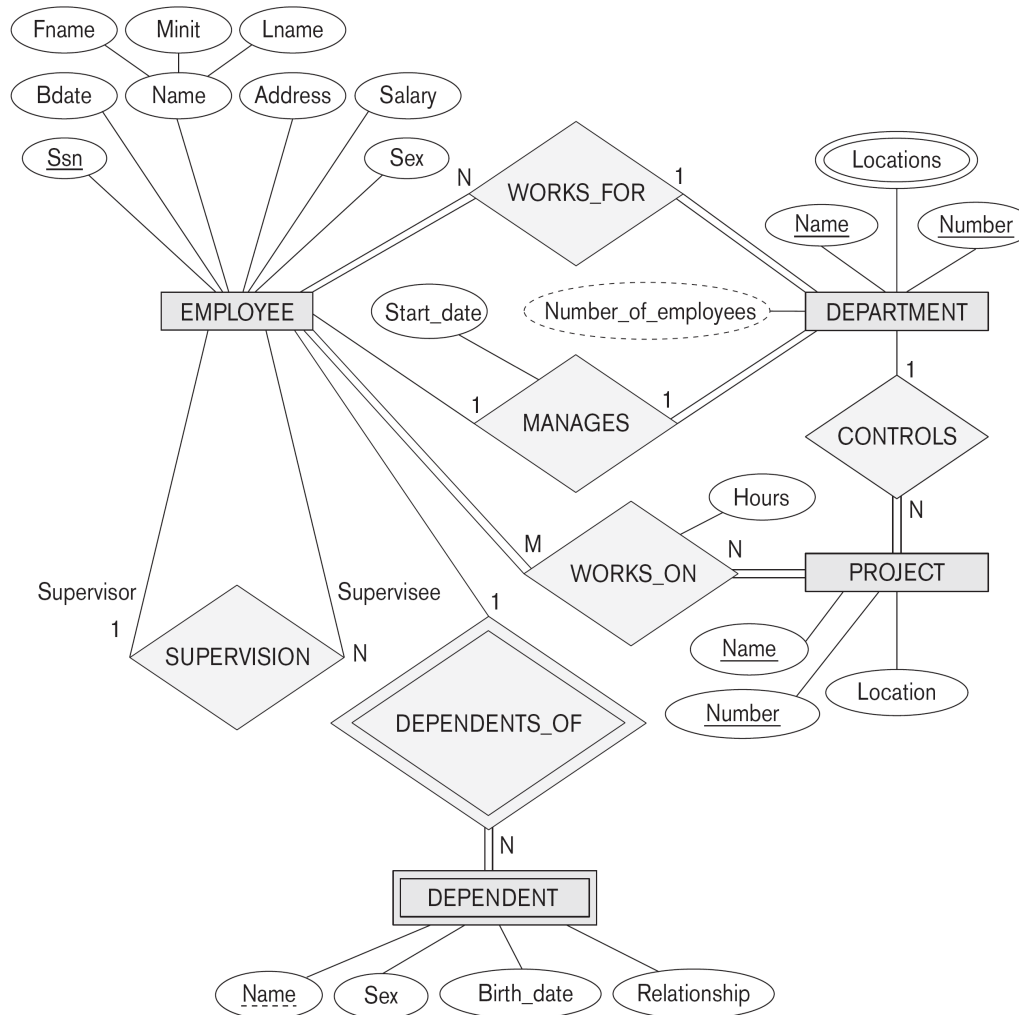Result of mapping the COMPANY ER schema into a relational database schema.

Step 6: Multivalued Attributes

i.   Create a <u>new</u> relation *S*

ii. Add as foreign keys the primary keys of the corresponding relation

iii. Add the attribute to *S* (if composite, the simple attributes); the combination of all attributes in *S* forms the primary key

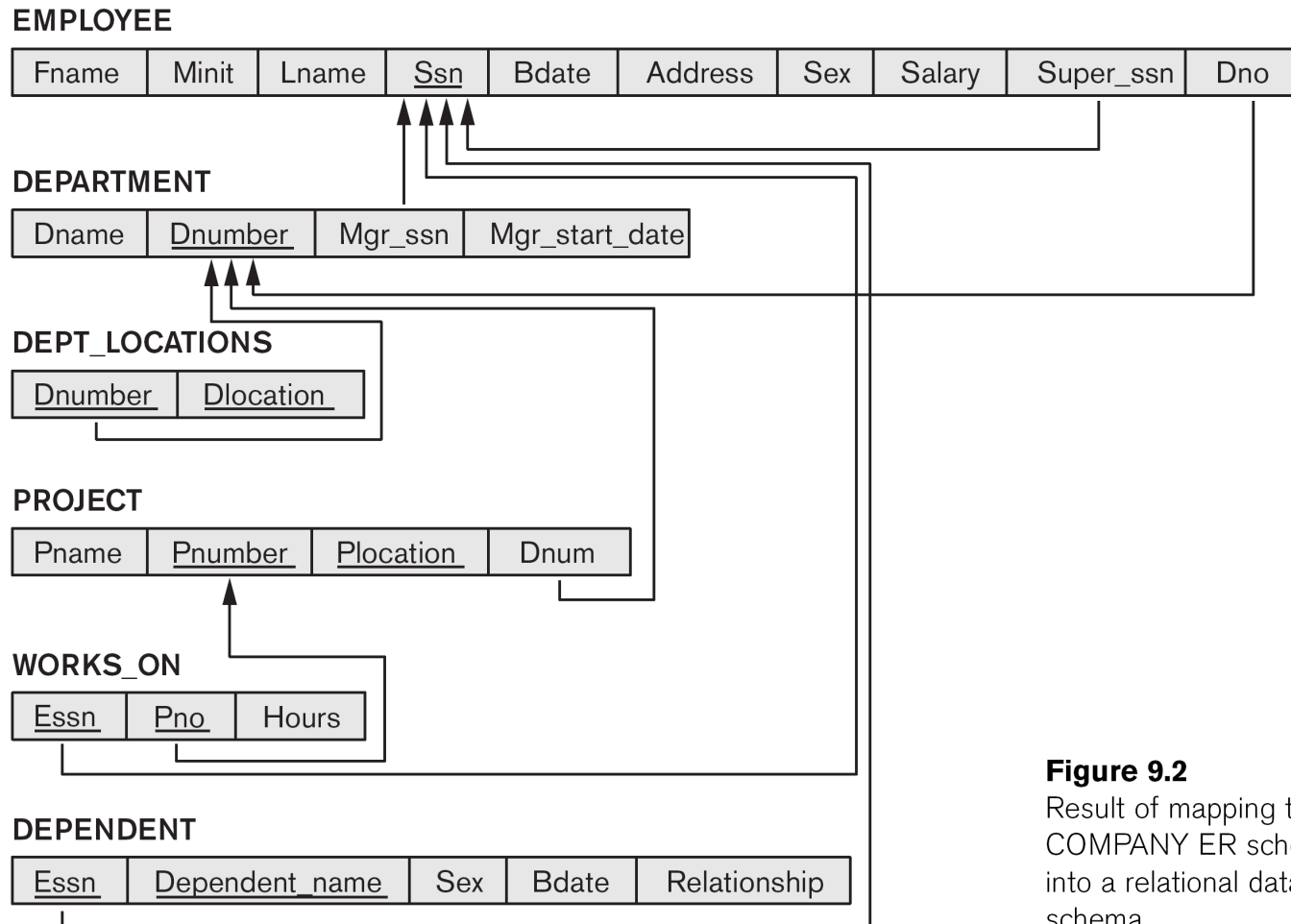**ER-to-Relational Mapping**

Example ERD

Step 6 Result

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

Step 8: Specialization/Generalization

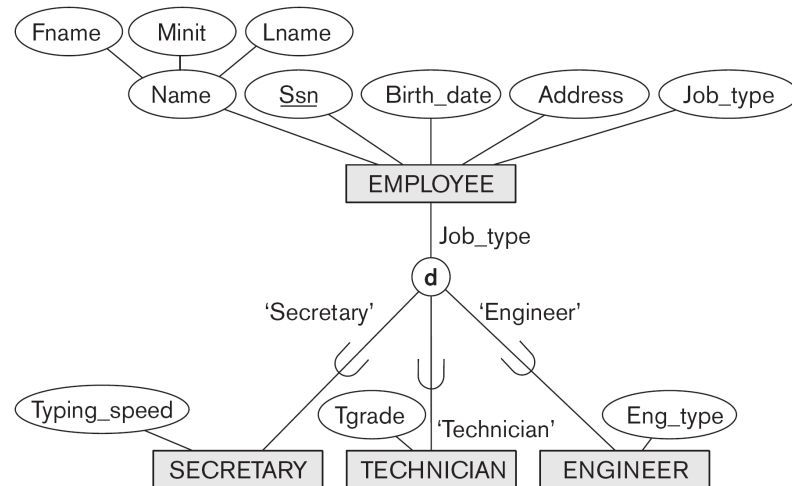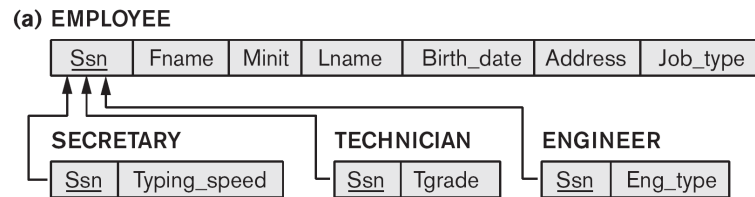A. Multiple relations – subclass and superclass
- Always works

B. Multiple relations – subclass only
- Should only be used for disjoint

C. Single relation with one type attribute
- Only for disjoint, can result in many NULLs

D. Single relation with multiple type attributes
- Better for overlapping, could be disjoint

**ER-to-Relational Mapping**

Specialization/Generalization (A)

(a) EMPLOYEE

Ssn	Fname	Minit	Lname	Birth_date	Address	Job_type

SECRETARY

Ssn	Typing_speed

TECHNICIAN

Ssn	Tgrade

ENGINEER

Ssn	Eng_type

Specialization/Generalization (B)

(b) CAR

Vehicle_id	License_plate_no	Price	Max_speed	No_of_passengers

TRUCK

Vehicle_id	License_plate_no	Price	No_of_axles	Tonnage

ER-to-Relational Mapping
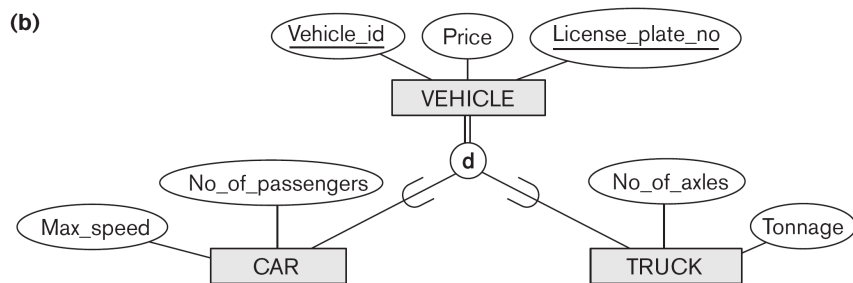
Specialization/Generalization (C)

(c) EMPLOYEE

Ssn	Fname	Minit	Lname	Birth_date	Address	Job_type	Typing_speed	Tgrade	Eng_type
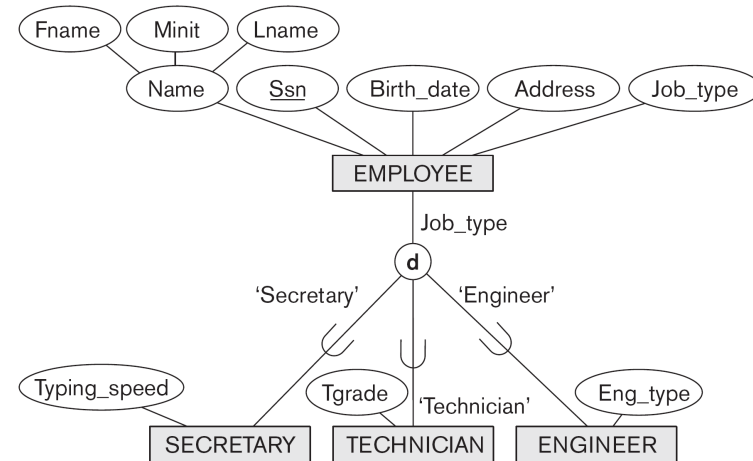
Specialization/Generalization (D)

(d) PART

Part_no	Description	Mflag	Drawing_no	Manufacture_date	Batch_no	Pflag	Supplier_name	List_price

ER-to-Relational Mapping