



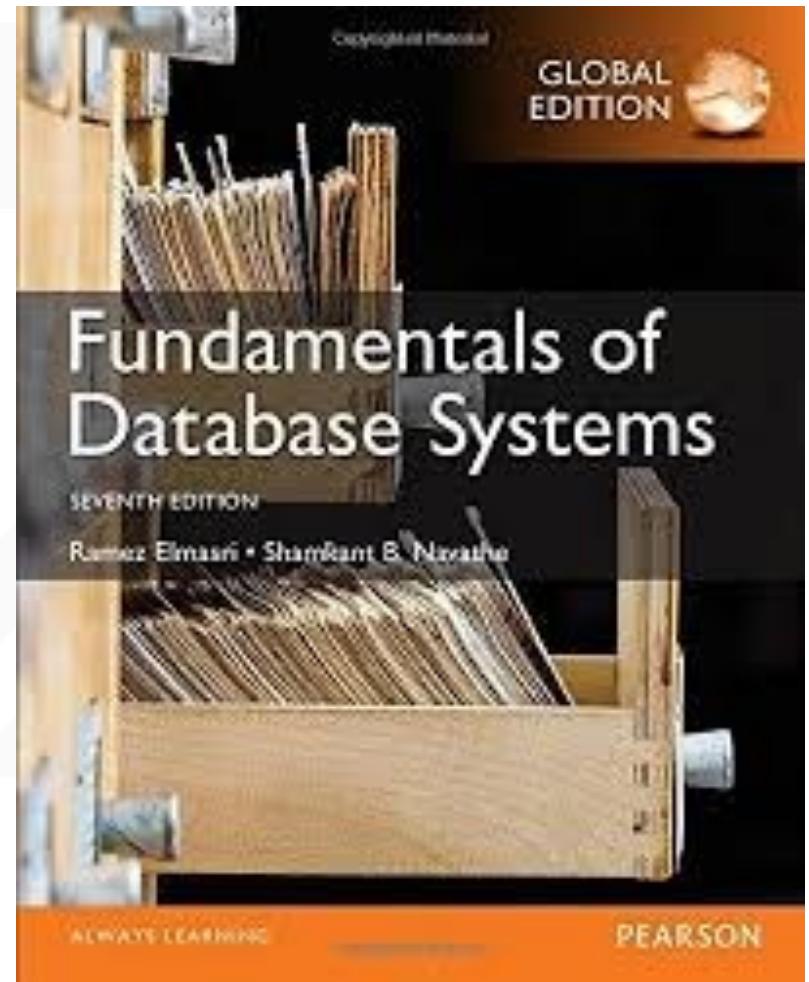
Database Systems

Program in Computer Engineering
Faculty of Engineering

King Mongkut's Institute of Technology Ladkrabang

Text

- Ramez Elmasri and Shamkant B. Navathe.
“**Fundamentals of Database Systems**”
7th Edition., Pearson, 2017

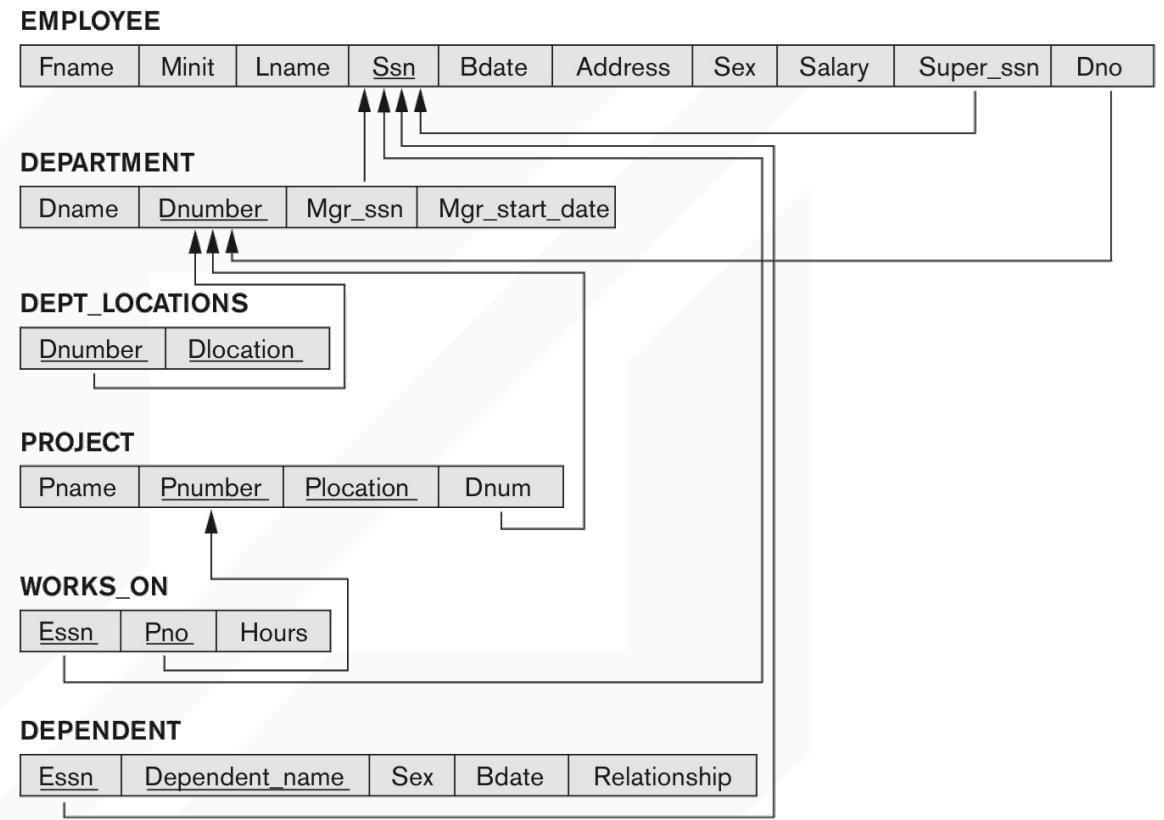
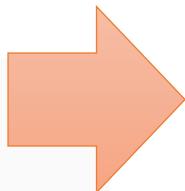
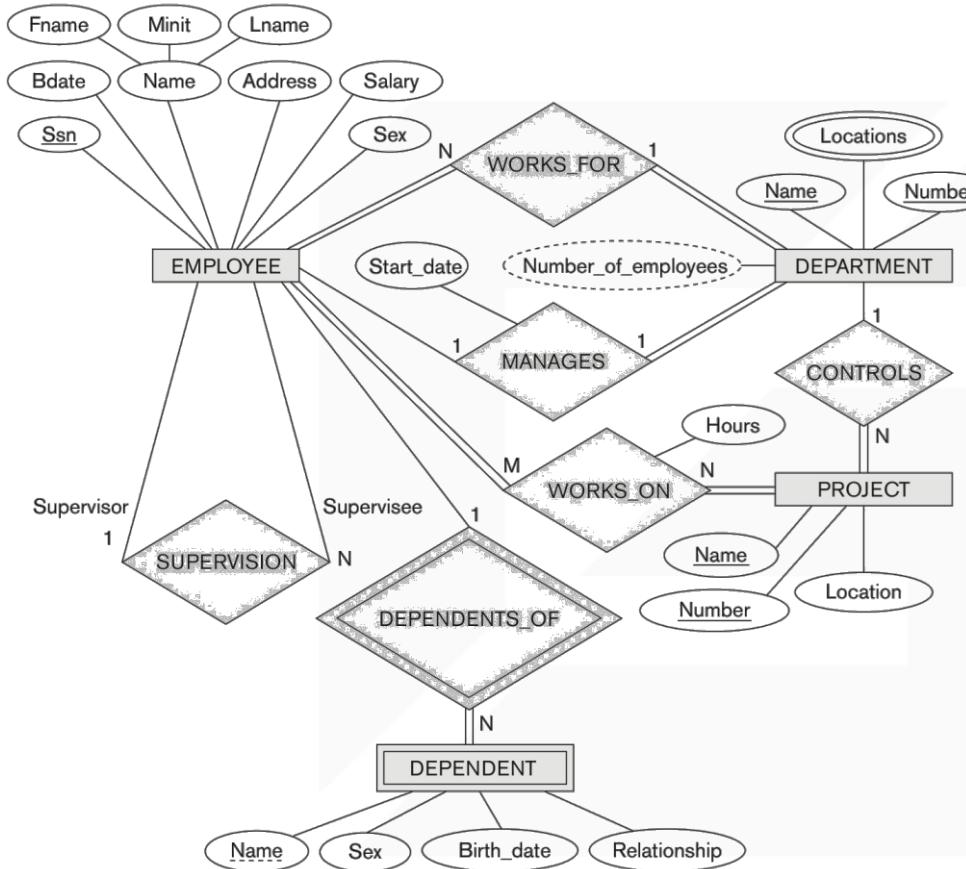


Chapter 9 (Partial)

Relational Database Design by ER to Relational Mapping

Goals during Mapping

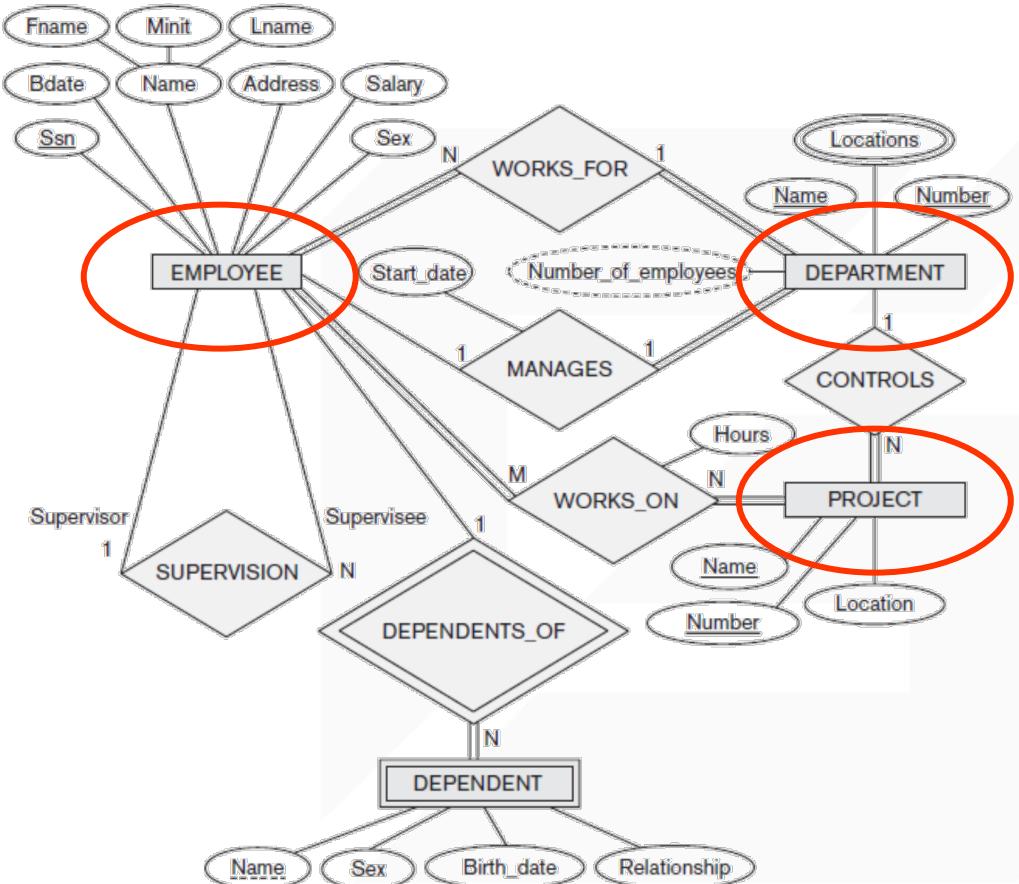
- Preserve all information (that includes all attributes)
- Maintain the constraints to the extent possible (Relational Model cannot preserve all constraints
 - E.g., max cardinality ratio such as 1:10 in ER
- Minimize null values
 - The mapping procedure described has been implemented in many commercial tools.



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.

ໃນ strong entity ໃຈ່າຍຕົວກອບ ເຊິ່ງແບບ non-composite
ໃສ່ຈາກ ພະຍານໄດ້



EMPLOYEE

| Fname | Minit | Lname | <u>Ssn</u> | Bdate | Address | Sex | Salary |
|-------|-------|-------|------------|-------|---------|-----|--------|
|-------|-------|-------|------------|-------|---------|-----|--------|

DEPARTMENT

| Dname | <u>Dnumber</u> |
|-------|----------------|
|-------|----------------|

PROJECT

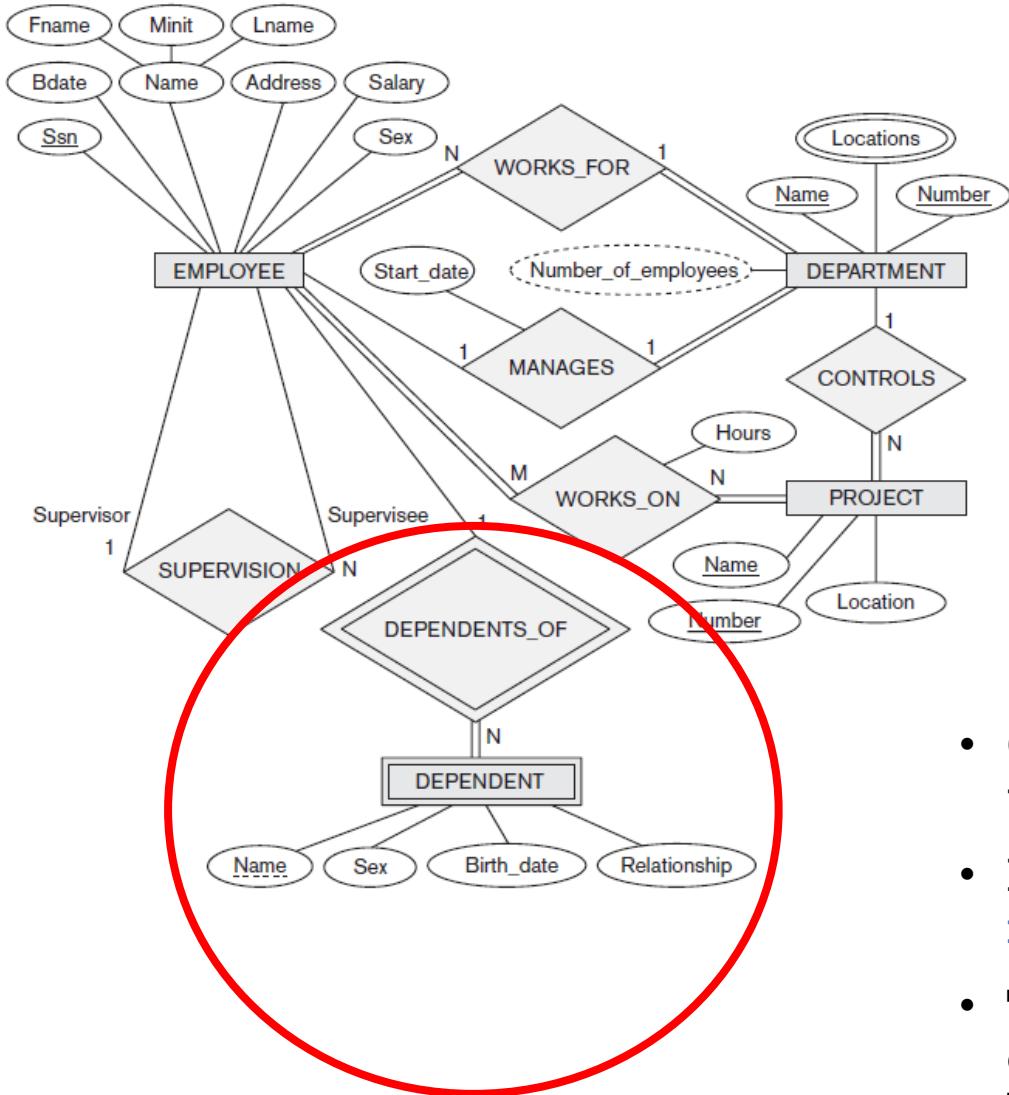
| Pname | <u>Pnumber</u> | Plocation |
|-------|----------------|-----------|
|-------|----------------|-----------|

- 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 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.

↳ weak entity \Rightarrow + 1:1 = f/k



EMPLOYEE

| Fname | Minit | Lname | <u>Ssn</u> | Bdate | Address | Sex | Salary |
|-------|-------|-------|------------|-------|---------|-----|--------|
|-------|-------|-------|------------|-------|---------|-----|--------|

DEPARTMENT

| Dname | <u>Dnumber</u> |
|-------|----------------|
|-------|----------------|

PROJECT

| Pname | <u>Pnumber</u> | Plocation |
|-------|----------------|-----------|
|-------|----------------|-----------|

DEPENDENT

| <u>Essn</u> | Dependent_name | Sex | Bdate | Relationship |
|-------------|----------------|-----|-------|--------------|
|-------------|----------------|-----|-------|--------------|

- 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**.

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• Step 3: Mapping of Binary 1:1 Relation Types

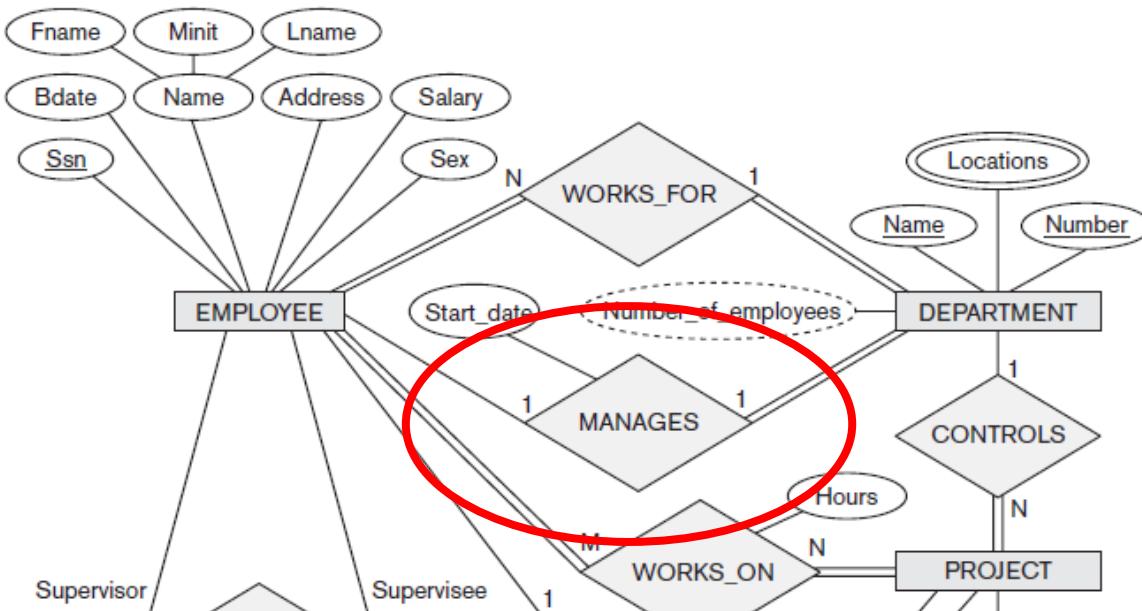
- For each **binary 1:1 relationship** type R in the ER schema, identify the relations S and T that correspond to the entity types participating in R.

- There are three possible approaches:

1. Foreign Key (2 relations) 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.



| EMPLOYEE | | | | | | | |
|------------|---------|---------|----------------|-------|---------|-----|--------|
| Fname | Minit | Lname | Ssn | Bdate | Address | Sex | Salary |
| | | | | | | | |
| DEPARTMENT | | | | | | | |
| Dname | Dnumber | Mgr_ssn | Mgr_start_date | | | | |

2. **Merged relation (1 relation) option:**

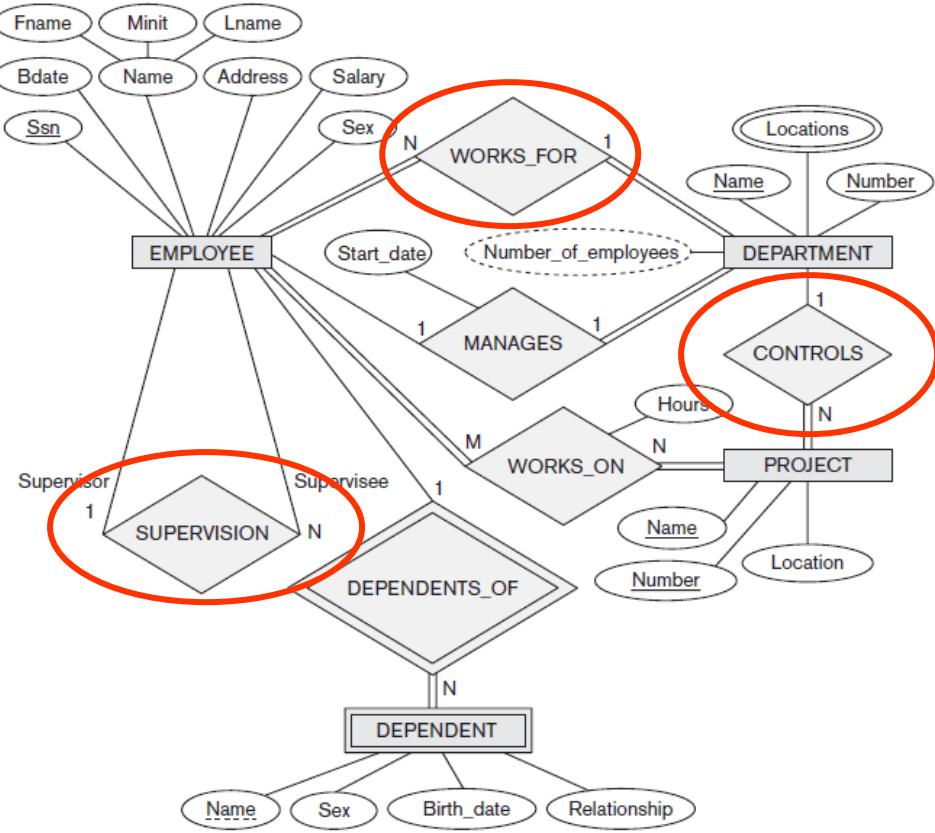
An alternate mapping of a 1:1 relationship type is possible by merging the two entity types and the relationship into a single relation.

This may be appropriate when both participations are total.

3. **Cross-reference or relationship relation (3 relations) 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.

- **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.



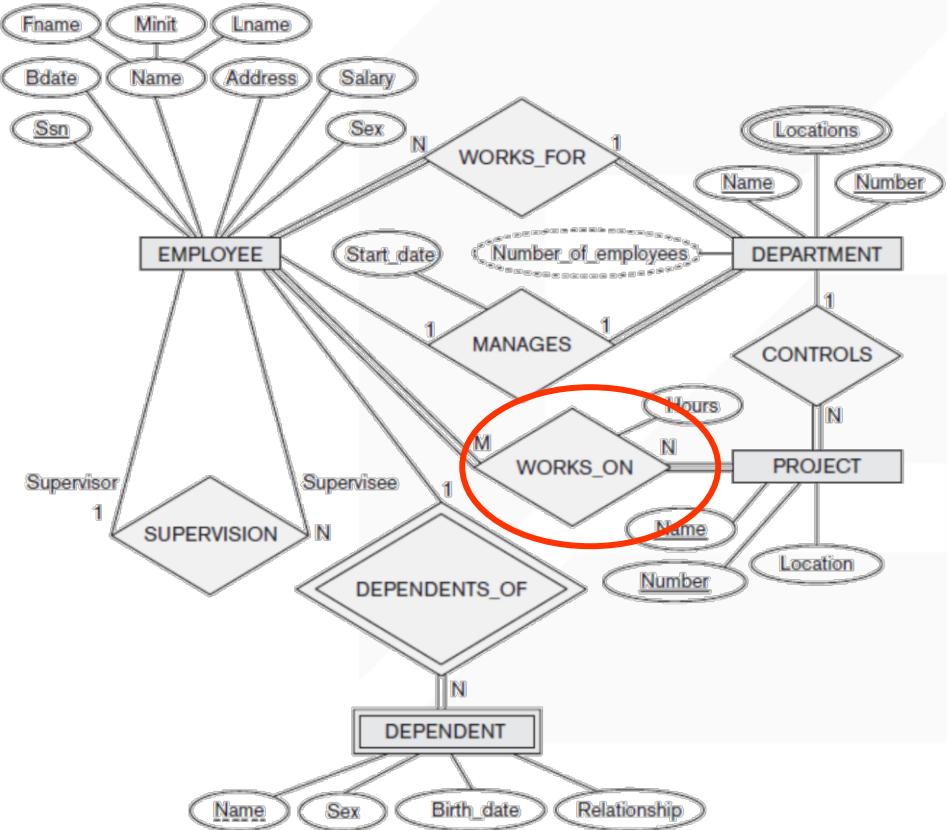
| PROJECT | | | |
|---------|---------|-----------|------|
| Pname | Pnumber | Plocation | Dnum |
| | | | |

| EMPLOYEE | | | | | | | | | |
|----------|-------|-------|-----|-------|---------|-----|--------|-----------|-----|
| Fname | Minit | Lname | Ssn | Bdate | Address | Sex | Salary | Super_ssn | DNO |
| | | | | | | | | | |

- 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**.

• 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. This is a relationship relation.
 - 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.



EMPLOYEE

| Fname | Minit | Lname | <u>Ssn</u> | Bdate | Address | Sex | Salary | Super_ssn | DNO |
|-------|-------|-------|------------|-------|---------|-----|--------|-----------|-----|
|-------|-------|-------|------------|-------|---------|-----|--------|-----------|-----|

WORKS_ON

| <u>Essn</u> | Pno | Hours |
|-------------|-----|-------|
|-------------|-----|-------|

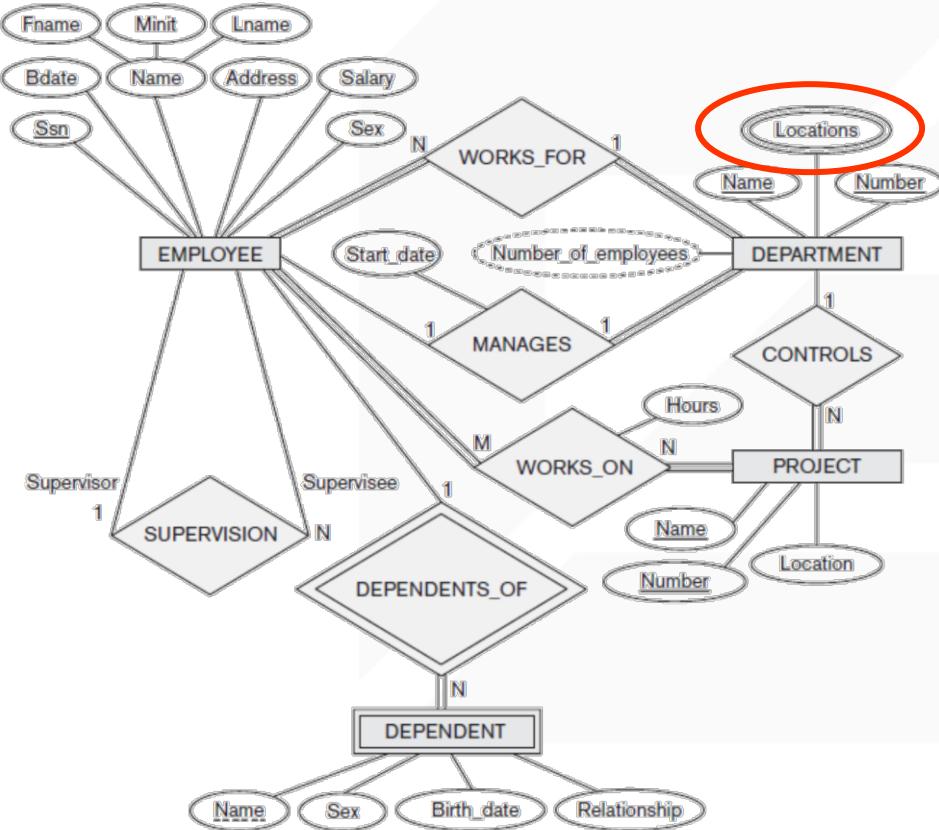
PROJECT

| Pname | Pnumber | Plocation | Dnum |
|-------|---------|-----------|------|
|-------|---------|-----------|------|

- 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**}.

• **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.



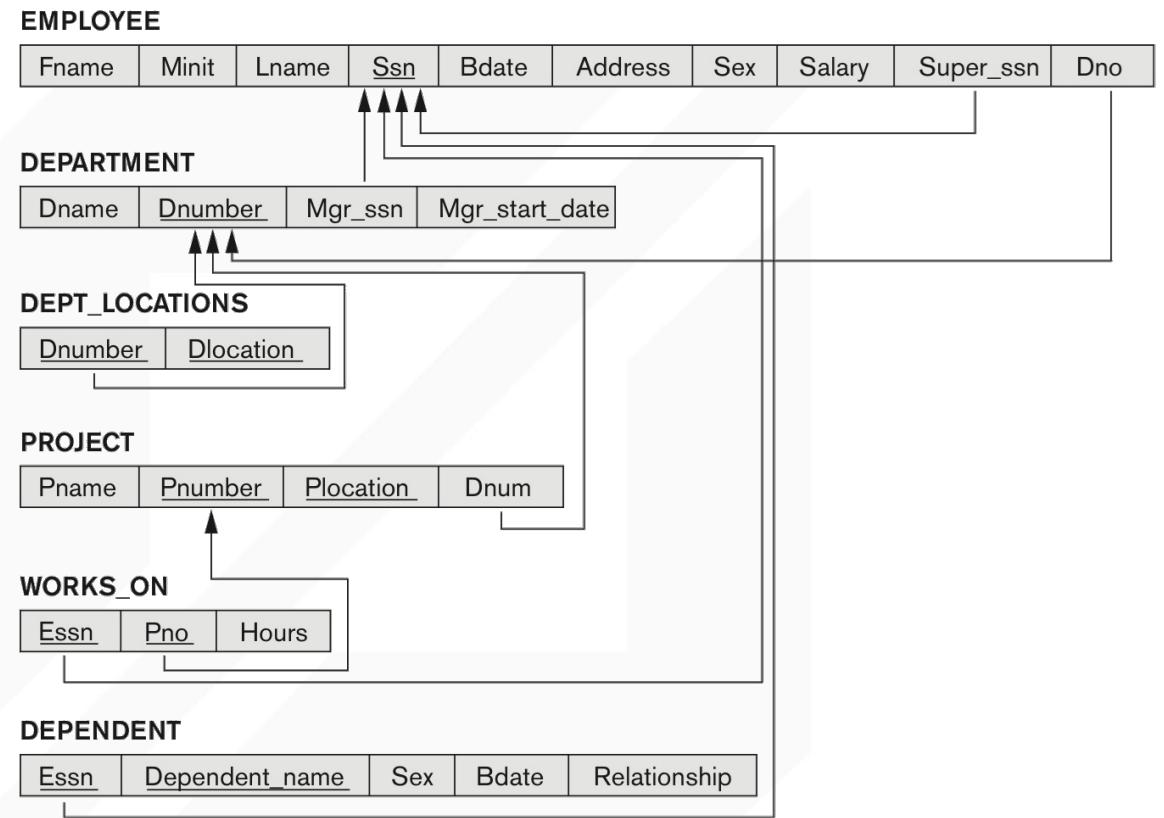
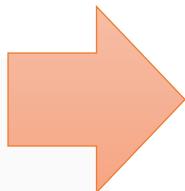
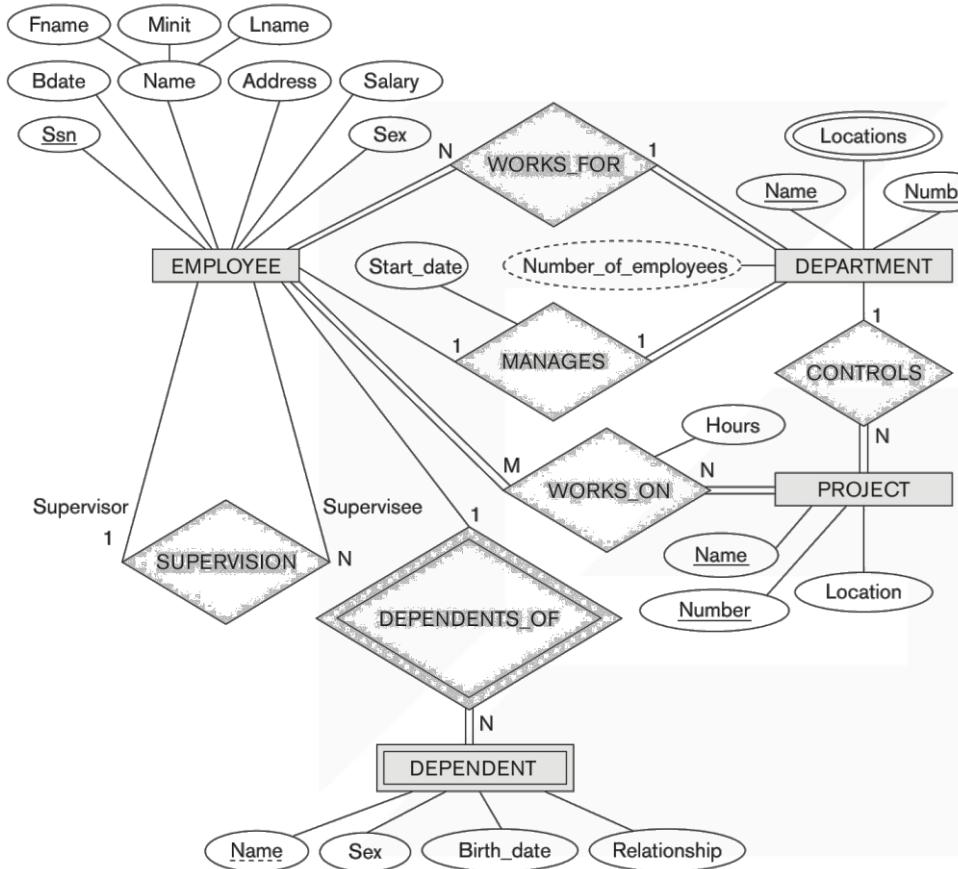
DEPARTMENT

| | |
|-------|---------|
| Dname | Dnumber |
|-------|---------|

DEPT_LOCATIONS

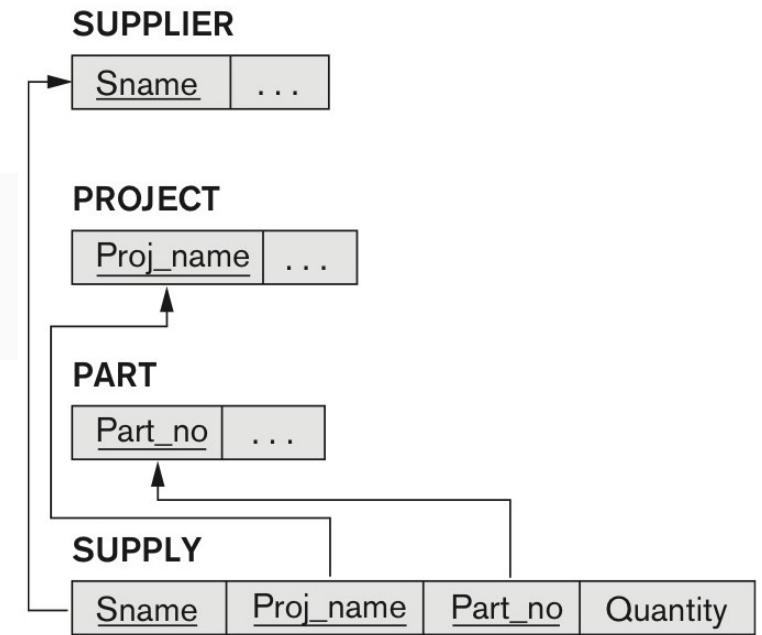
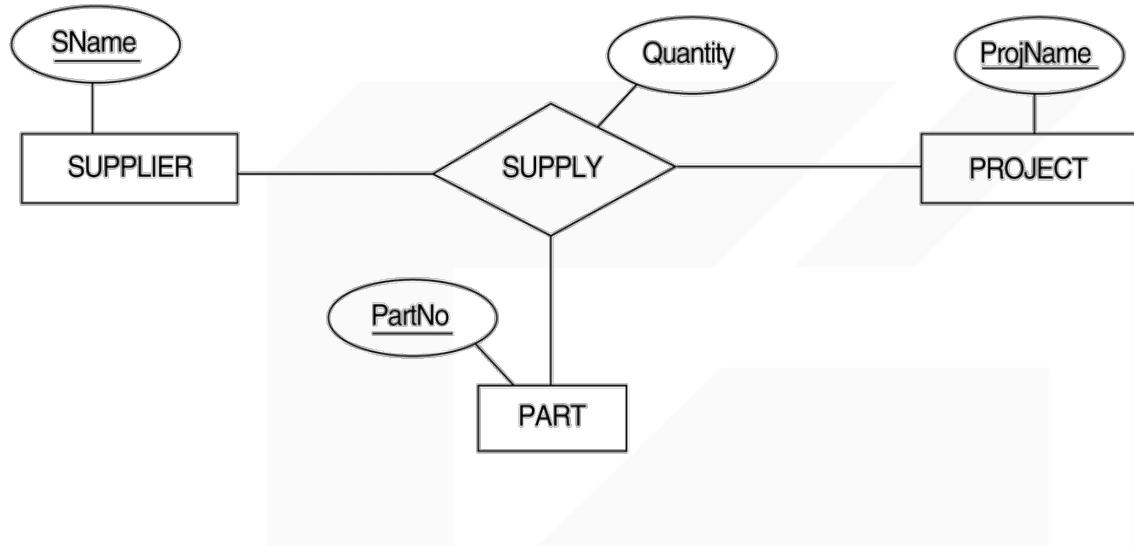
| | |
|---------|-----------|
| Dnumber | Dlocation |
|---------|-----------|

- 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}.



• 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 SUPPLY in the ER.
- 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}.

Table 9.1 Correspondence between ER and Relational Models

| ER MODEL | RELATIONAL MODEL |
|---------------------------------|--|
| Entity type | <i>Entity</i> relation |
| 1:1 or 1:N relationship type | Foreign key (or <i>relationship</i> relation) |
| M:N relationship type | <i>Relationship</i> relation and <i>two</i> foreign keys |
| <i>n</i> -ary relationship type | <i>Relationship</i> relation and <i>n</i> 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 |

