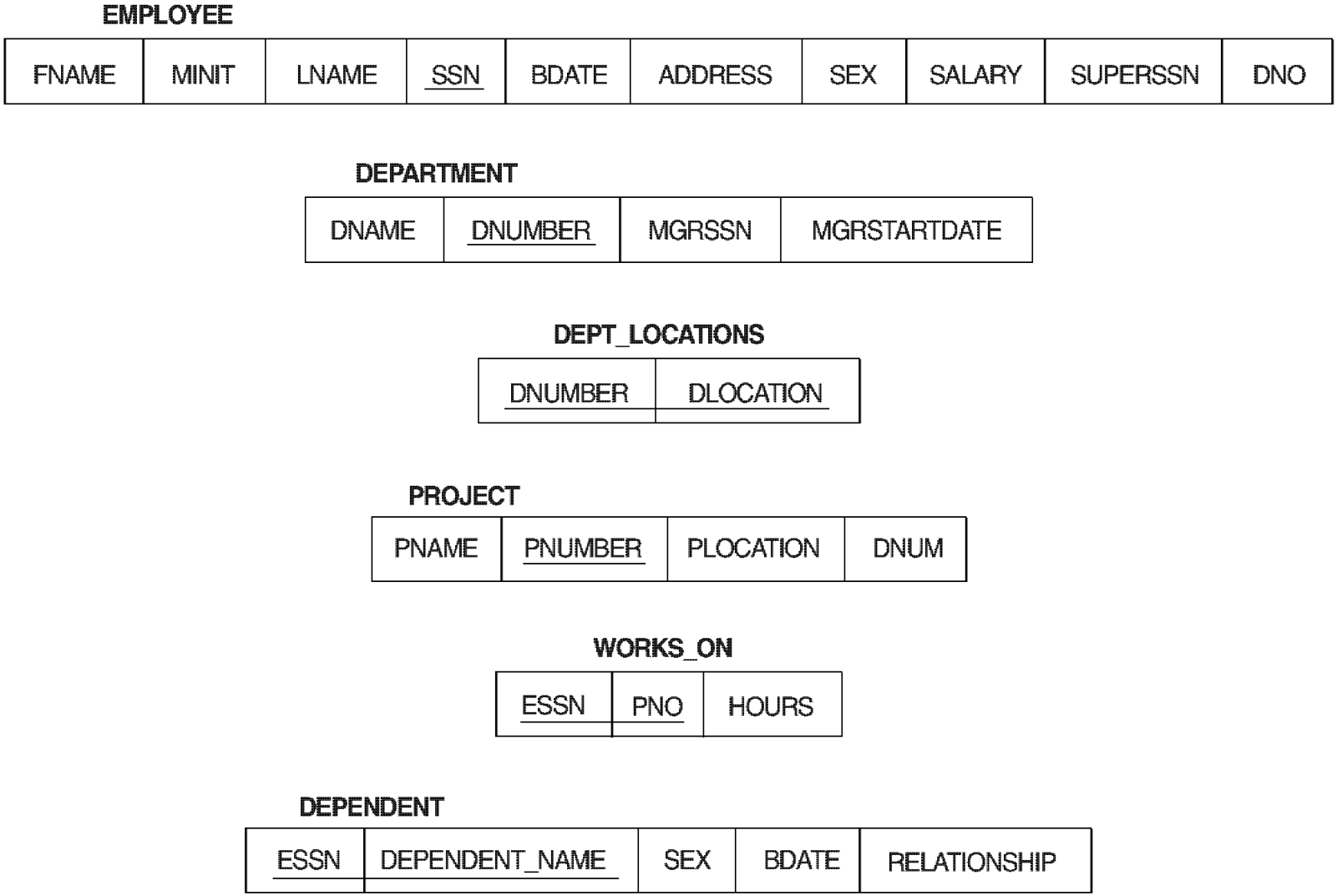
Relational Database Design by ER- and EER-to-Relational Mapping

Handout 4

Schema diagram for the COMPANY relational database schema; the primary keys are underlined.



One possible relational database state corresponding to the COMPANY schema.

EMPLOYEE	FNAME	MINIT	LNAME	SSN	BDATE	ADDRESS	SEX	SALARY	SUPERSSN	DNO
	John		Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
	Franklin		Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
	Alicia		Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
	Jennifer		Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
	Ramesh		Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
	Joyce		English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
	Ahmad		Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
	James		Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	null	1

DEPT_LOCATIONS	DNUMBER	DLOCATION
		Houston
		Stafford
		Bellaire
		Sugarland

DEPARTMENT	DNAME	DNUMBER	MGRSSN	MGRSTARTDATE
	Research	5	333445555	1988-05-22
	Administration	4	987654321	1995-01-01
	Headquarters	1	888665555	1981-06-19

WORKS_ON	ESSN	PNO	HOURS
	123456789	1	32.5
	123456789	2	7.5
	666884444	3	40.0
	453453453	1	20.0
	453453453	2	20.0
	333445555	2	10.0
	333445555	3	10.0
	333445555	10	10.0
	333445555	20	10.0
	999887777	30	30.0
	999887777	10	10.0
	987987987	10	35.0
	987987987	30	5.0
	987654321	30	20.0
	987654321	20	15.0
	888665555	20	null

PROJECT	PNAME	PNUMBER	PLOCATION	DNUM
	ProductX	1	Bellaire	5
	ProductY	2	Sugarland	5
	ProductZ	3	Houston	5
	Computerization	10	Stafford	4
	Reorganization	20	Houston	1
	Newbenefits	30	Stafford	4

DEPENDENT	ESSN	DEPENDENT_NAME	SEX	BDATE	RELATIONSHIP
	333445555	Alice	F	1986-04-05	DAUGHTER
	333445555	Theodore	M	1983-10-25	SON
	333445555	Joy	F	1958-05-03	SPOUSE
	987654321	Abner	M	1942-02-28	SPOUSE
	123456789	Michael	M	1988-01-04	SON
	123456789	Alice	F	1988-12-30	DAUGHTER
	123456789	Elizabeth	F	1967-05-05	SPOUSE

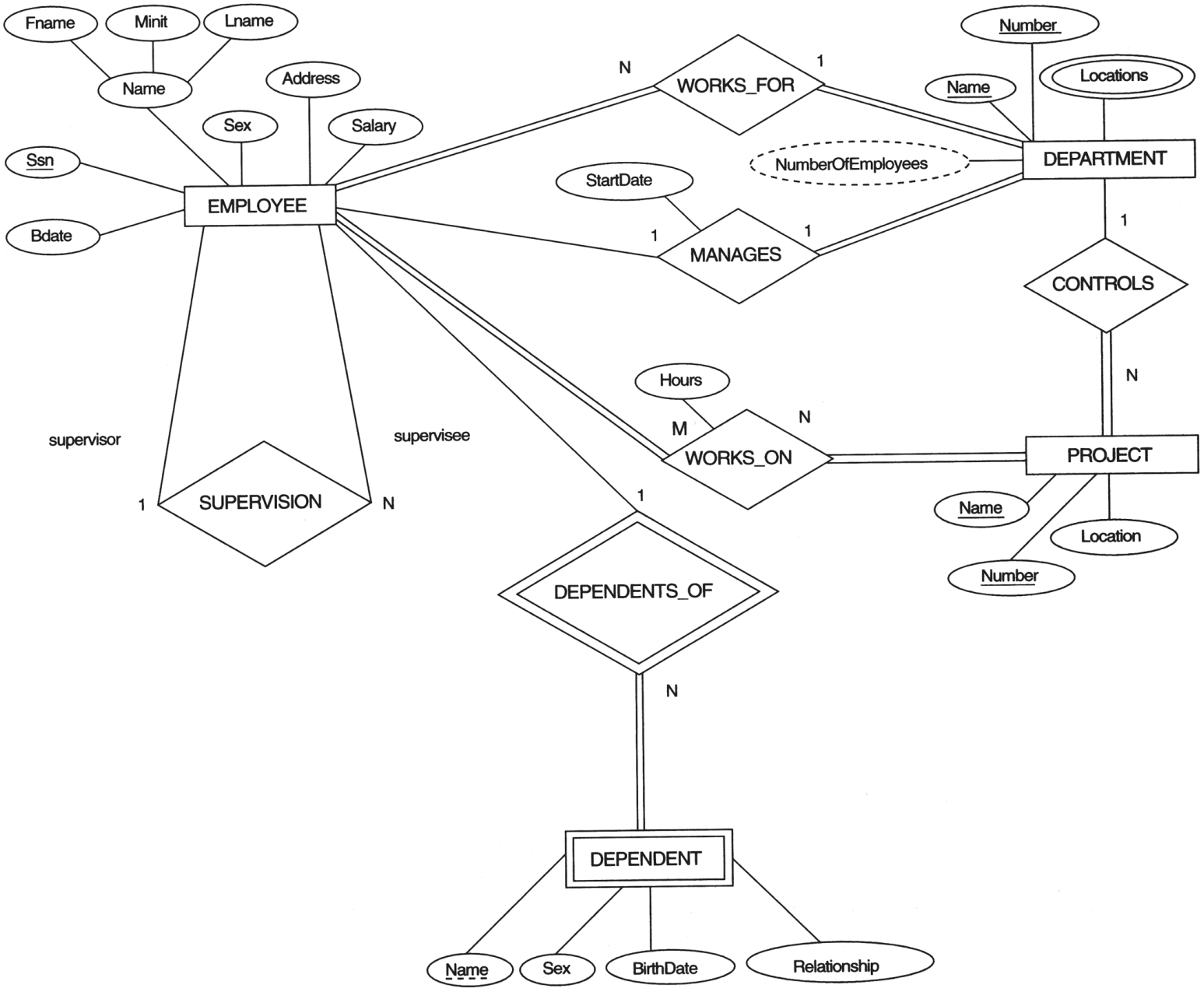
- **ER-to-Relational Mapping Algorithm**

  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.

- **Mapping EER Model Constructs to Relations**

  Step 8: Options for Mapping Specialization or Generalization.
  Step 9: Mapping of Union Types (Categories).

The ER conceptual schema diagram for the COMPANY database



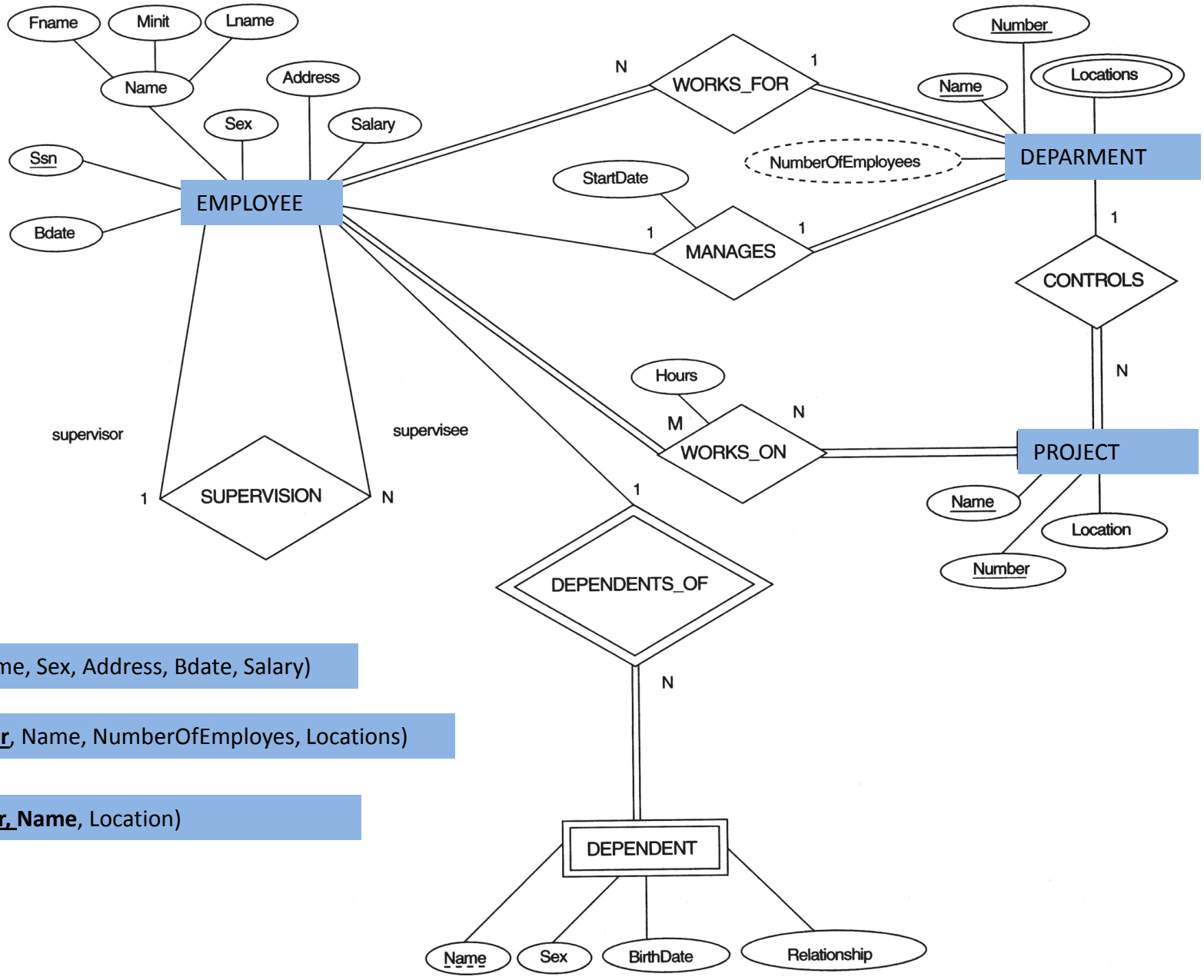
ER-to-Relational Mapping Steps

Step 1: Mapping of Regular Entity Types.

- For each regular (strong) entity type (E), 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 the relation.

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.



(**Ssn**, Name, Sex, Address, Bdate, Salary)

(Number, Name, NumberOfEmployes, Locations)

(Number, Name, Location)

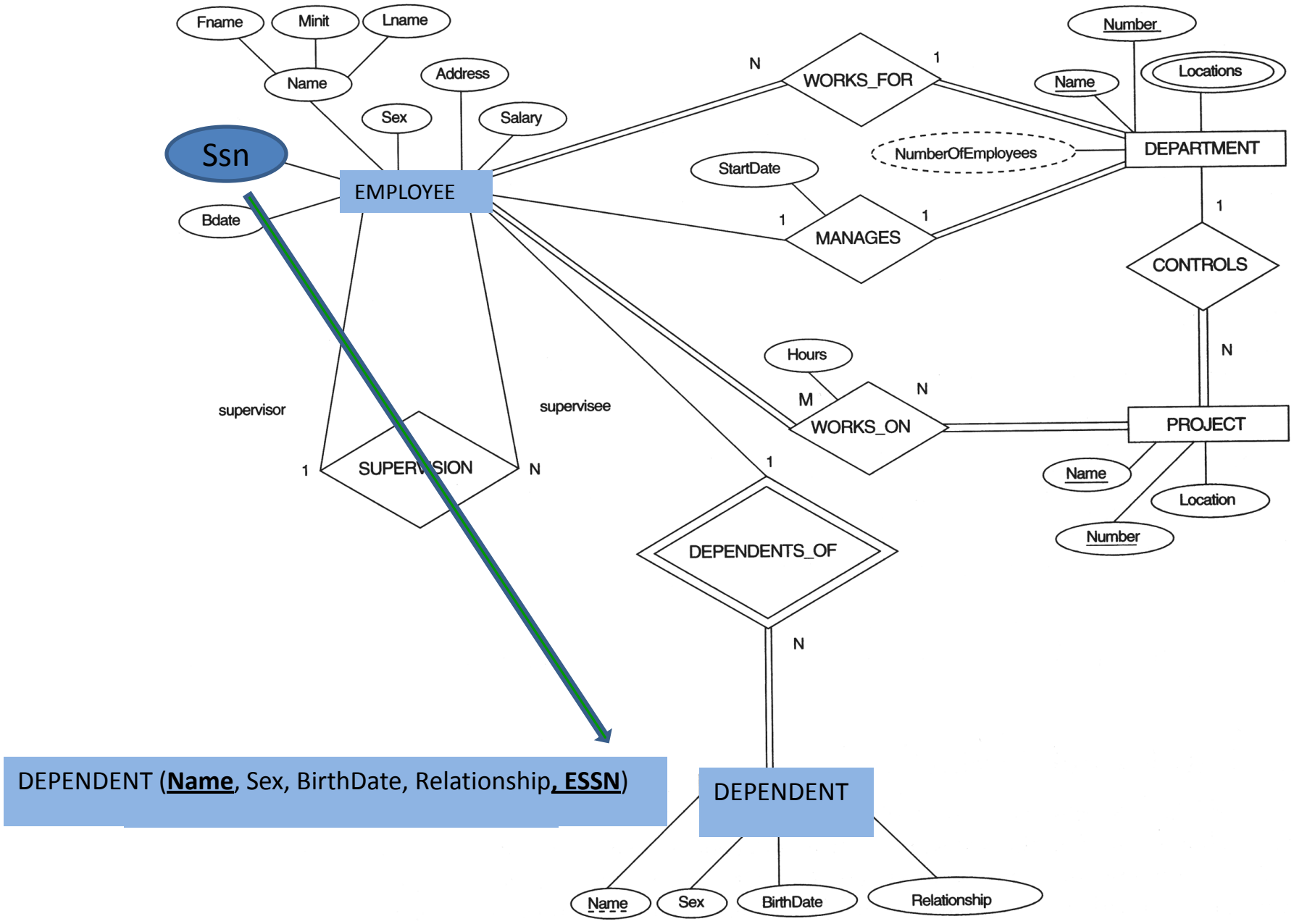
ER-to-Relational Mapping Steps

Step 2: Mapping of Weak Entity Types

- For each weak entity type W with owner entity type E, create a relation R. Include all attributes of the weak entity in R.
- Then, include the primary key of the owner entity (E) as foreign key 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.

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.



DEPENDENT (**Name**, Sex, BirthDate, Relationship**, ESSN**)

ER-to-Relational Mapping Steps

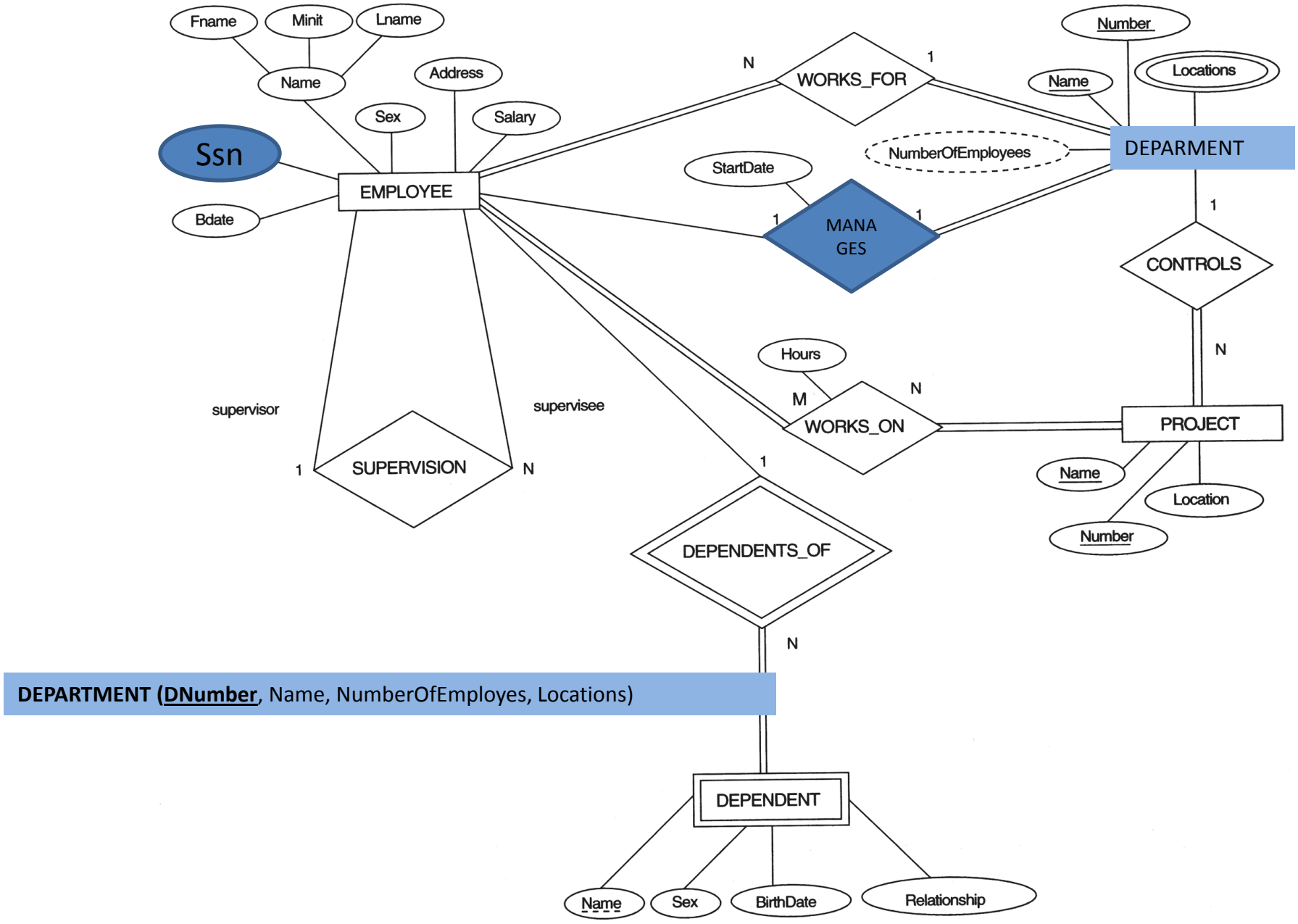
Step 3: Mapping of 1:1 Relation Types

For each 1:1 relationship type identify the entities participating in the relationship. There are two possible approaches below:

(1) **Foreign Key approach:**

- Choose one of the relations (T) include its primary key as foreign key of the other relation (S). It is better to choose an entity type with *total participation* in the relationship 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.



DEPARTMENT (<u>DNumber</u>, Name, NumberOfEmployes, Locations)

ER-to-Relational Mapping Steps

Step 3: Mapping of 1:1 Relation Types

(2) **Merged relation option:**

- Merge the two entity types and the relationship into a single relation. This may be appropriate when *both participations are total.*

ER-to-Relational Mapping Steps

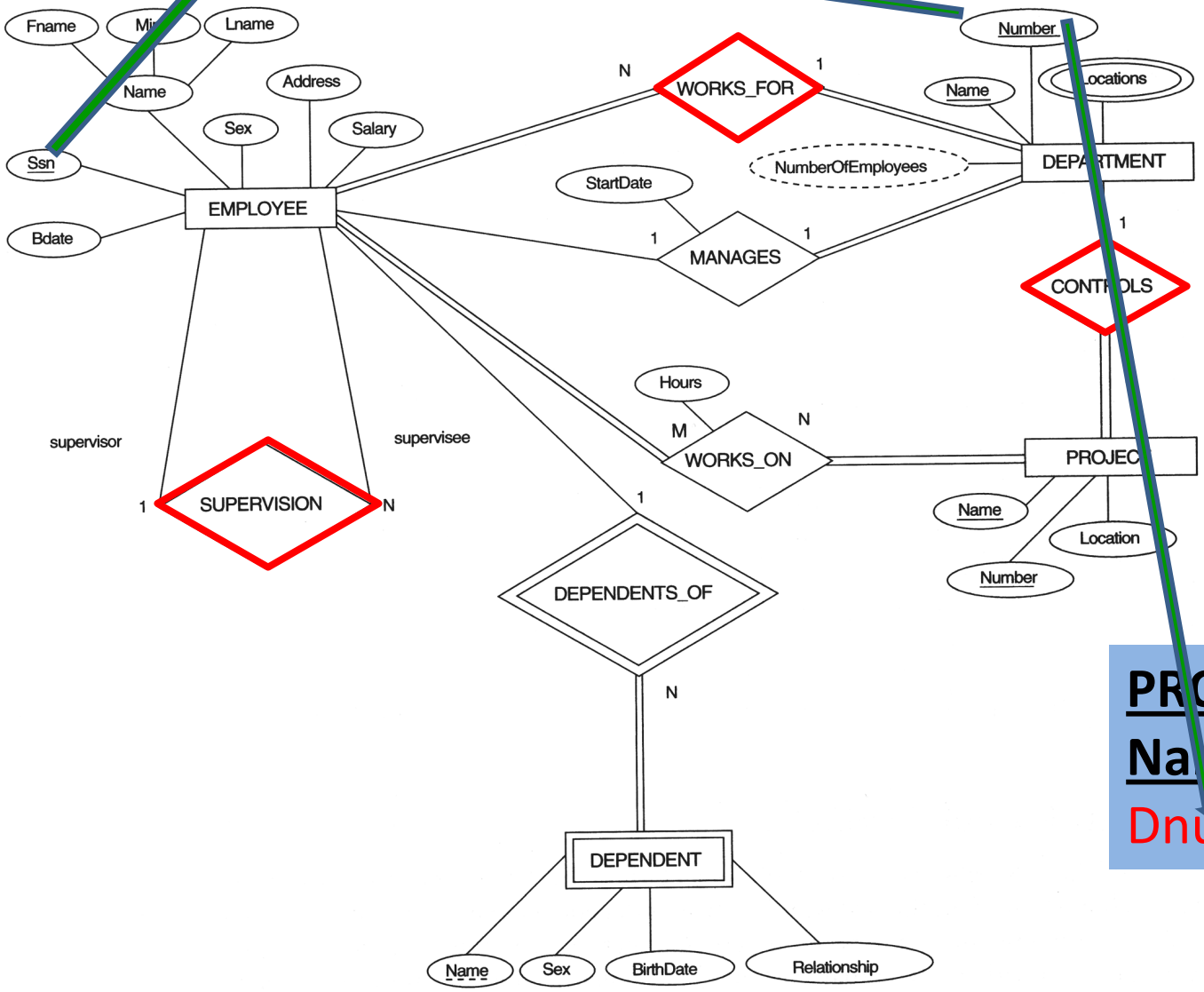
Step 4: Mapping of Binary 1:N Relationship Types.

- For each regular 1:N relationship type R, identify the relation S, which is the entity on the N-side of the relationship.
- Include primary key of the relation in 1 side in the relation in N side(S).
- 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.

EMPLOYEE(**Ssn**, Name, Sex, Address, Bdate, Salary, SuperSsn, Dno)



PROJECT(Number, Name, Location, Dnum)

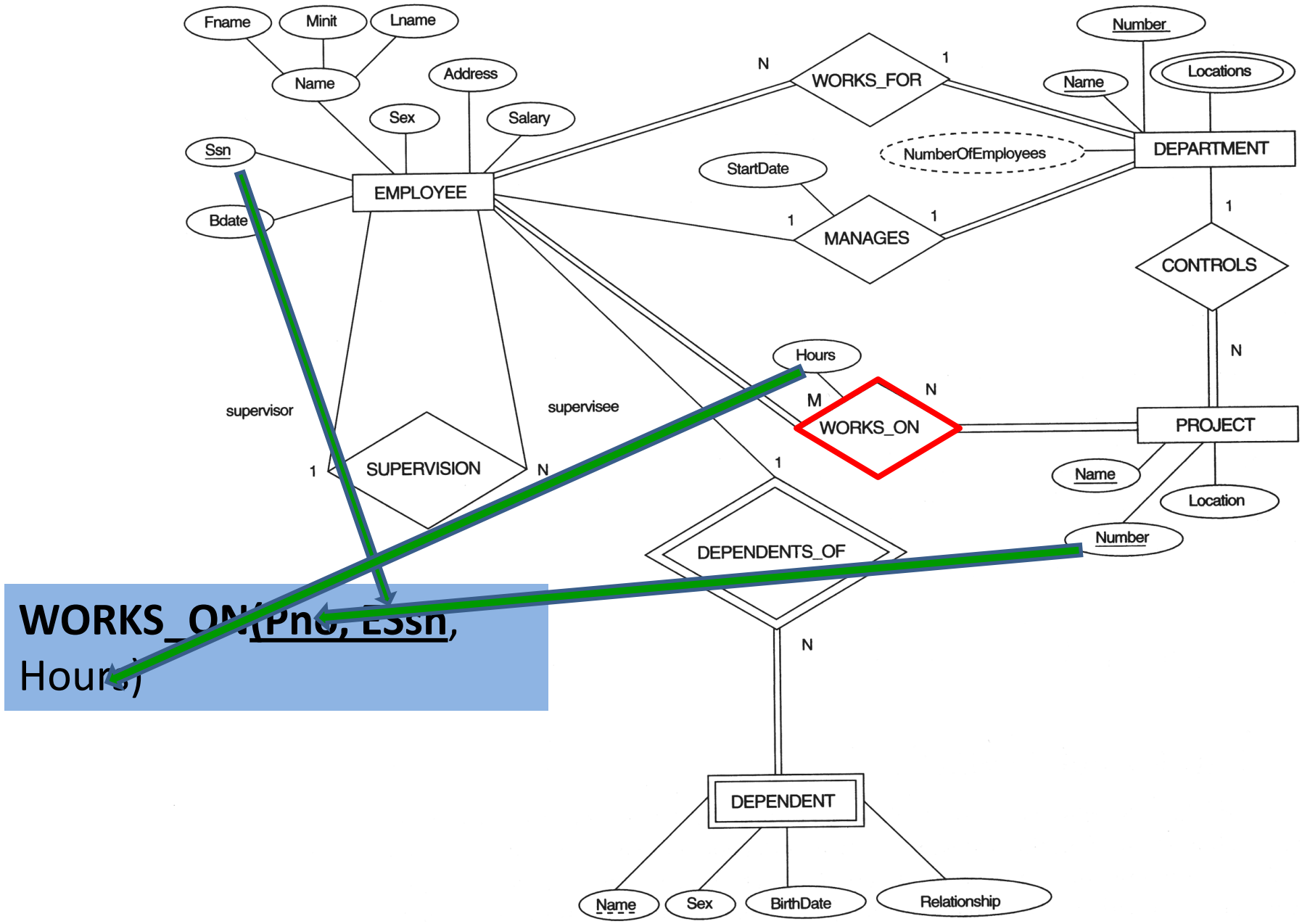
ER-to-Relational Mapping Steps

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

- For each M:N relationship type, *create a new relation* S to represent the relationship.
- Include primary keys of the entities on each side of the relationship as foreign key attributes in S ; *the combination of the two primary keys will form the primary key* of S.
- Also include any simple attributes of the M:N relationship type 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}.



WORKS_ON(Pno, ESsn,
Hours)

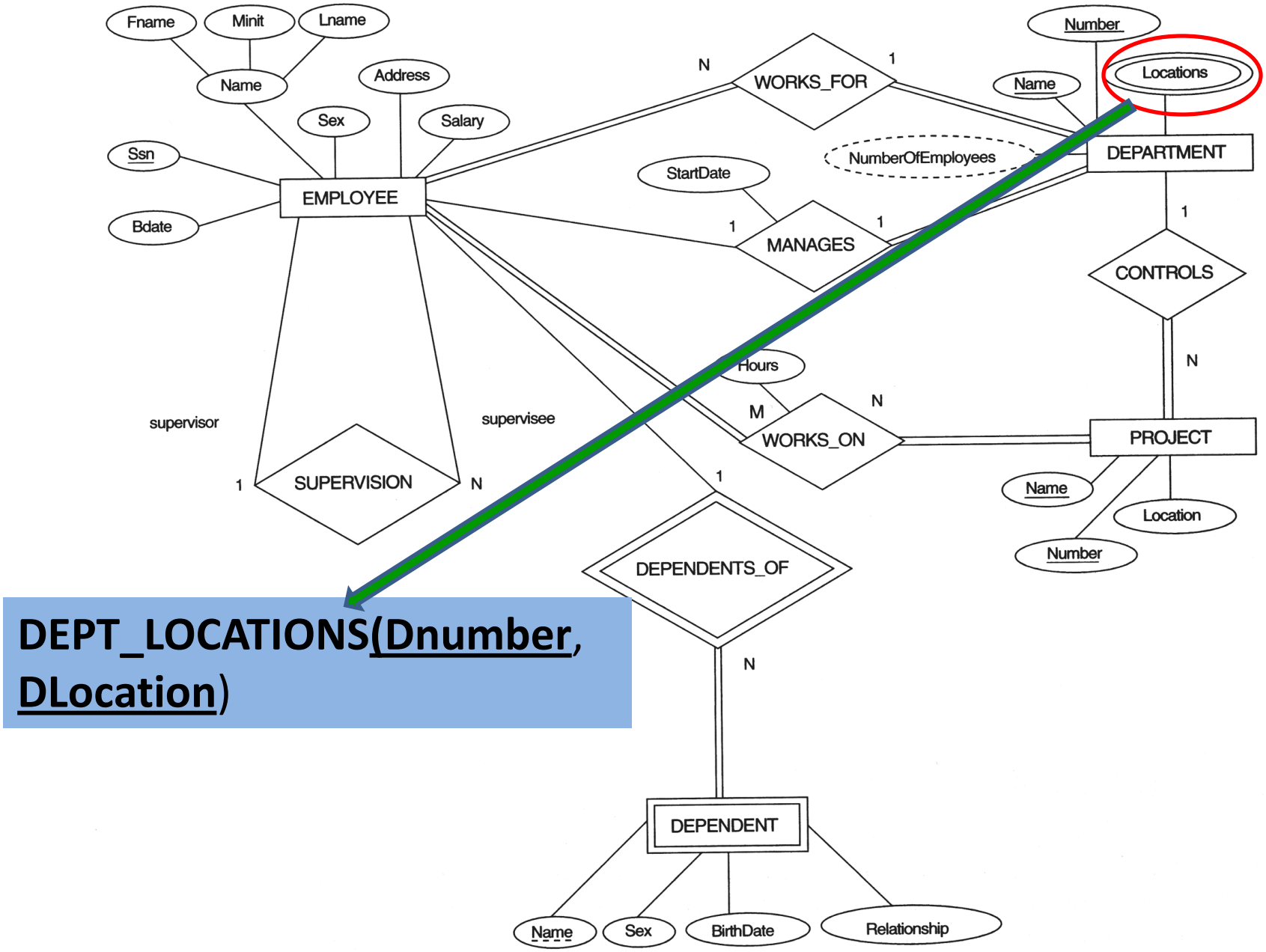
ER-to-Relational Mapping Steps

Step 6: Mapping of Multivalued attributes.

- For each multivalued attribute A, create a new relation (R). Include in R, multi-valued attribute(A) and primary key (k) of the relation that has the multi-valued attribute.
- The primary key of R is the combination of A and K.

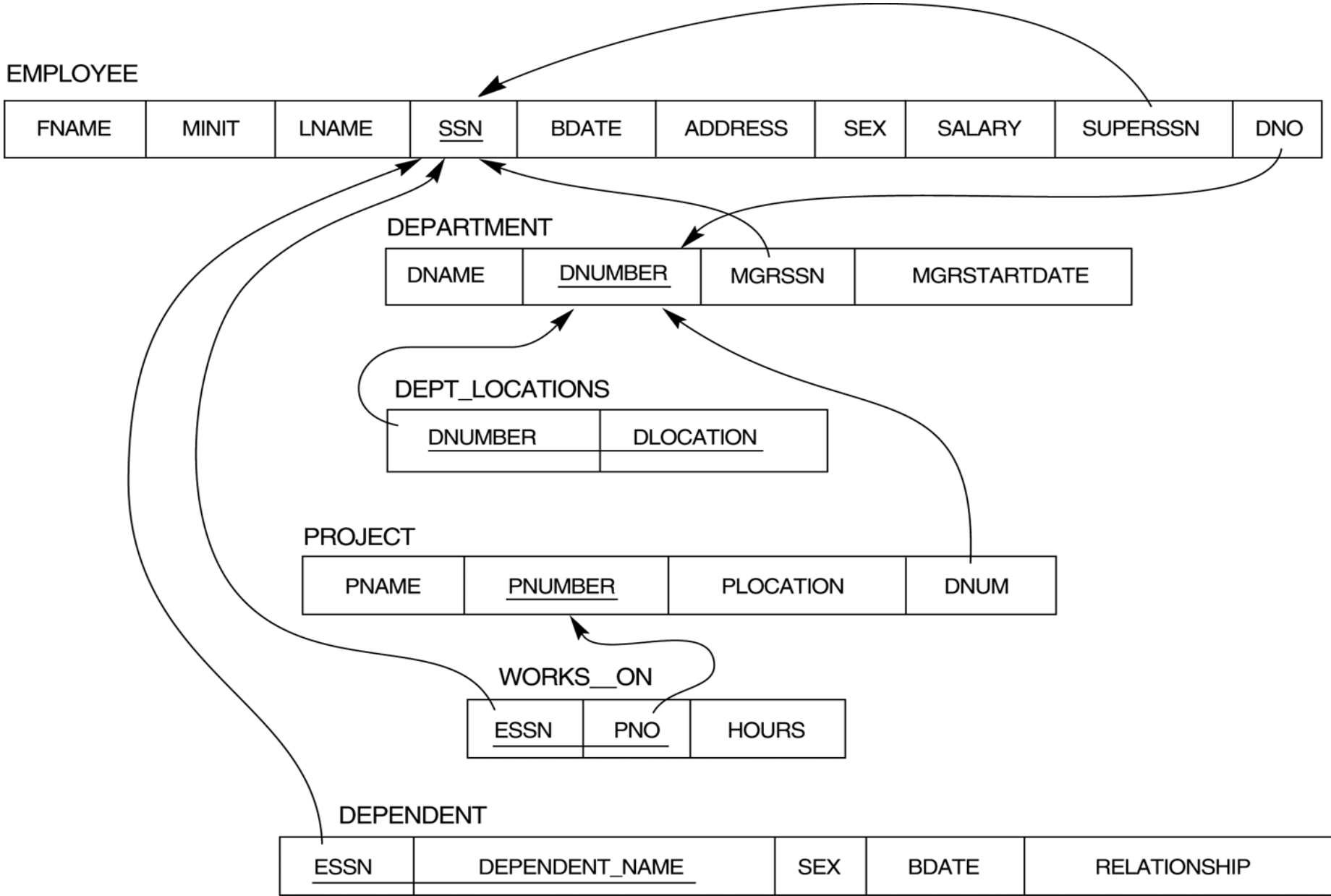
Example:

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}.



DEPT_LOCATIONS(Dnumber, DLocation)

Result of mapping the COMPANY ER schema into a relational schema



ER-to-Relational Mapping

Step 7: Mapping of N-ary Relationship Types.

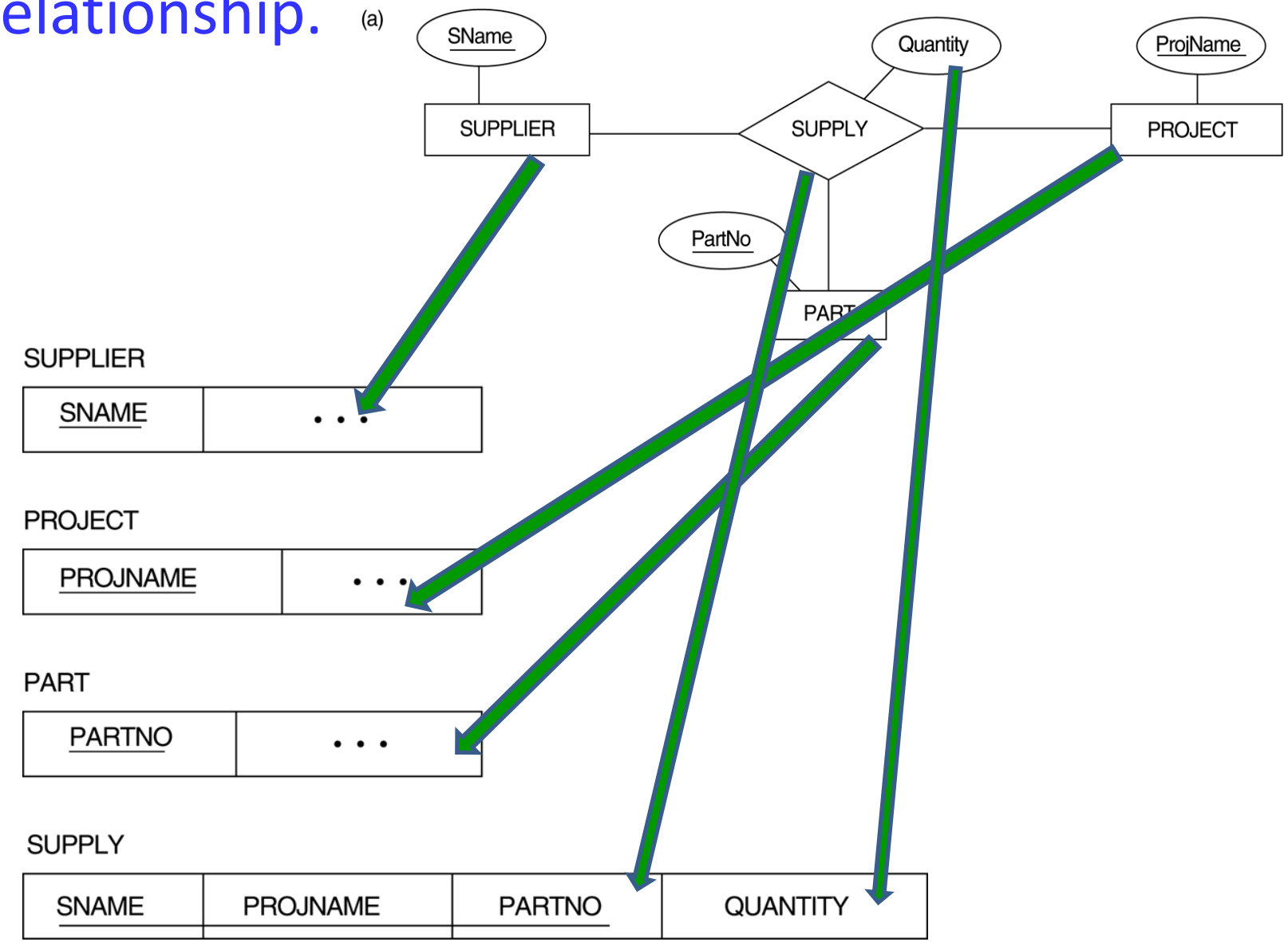
(Non-binary relationships)

- For each n-ary relationship type R, where n>2, create a new relation S.
- Include as foreign key attributes in S the primary keys of the relations that represent the participating entities.
- Also include any simple attributes of the n-ary relationship type 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 EER Model to Relations

Step8: Options for Mapping Specialization or Generalization.

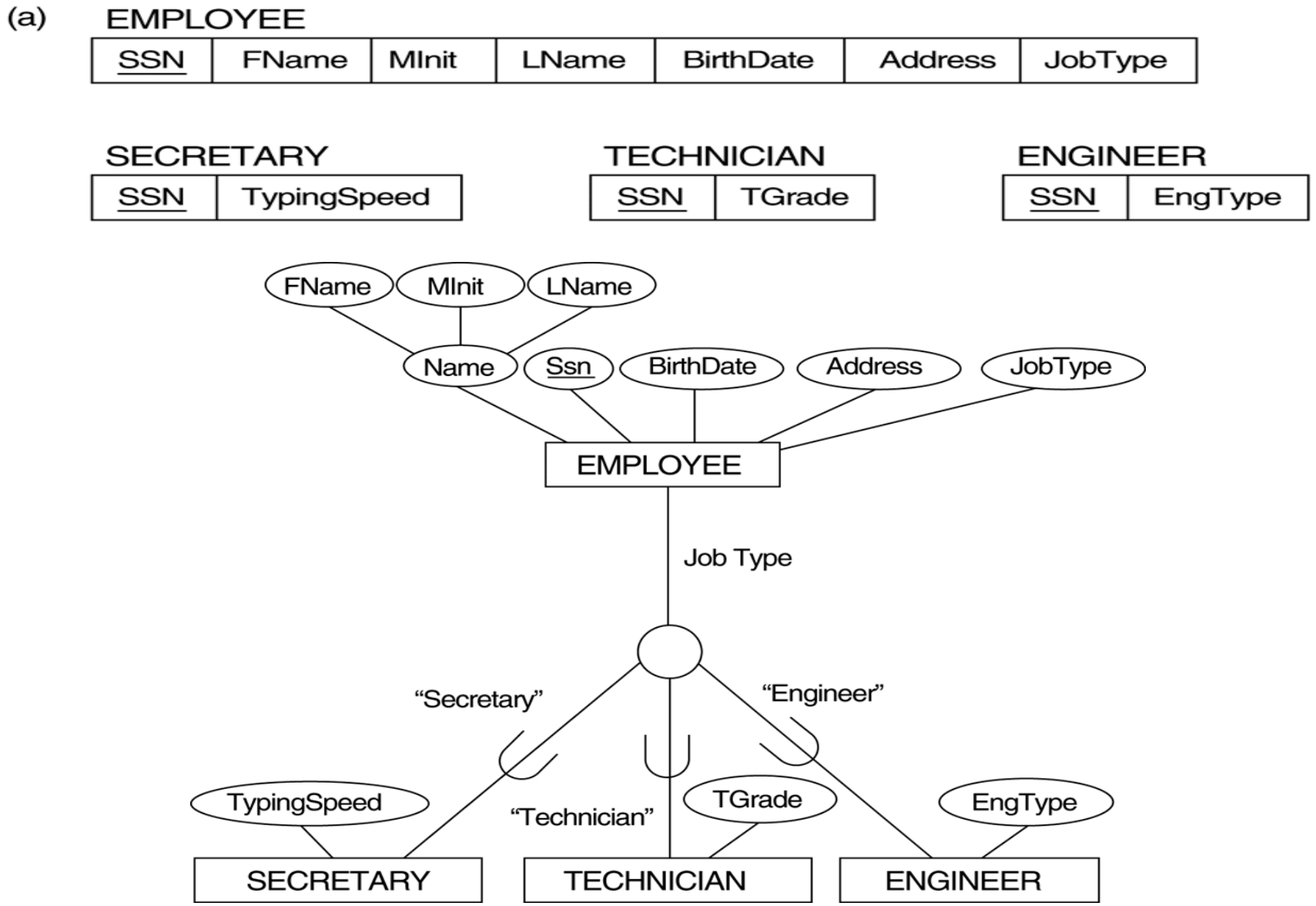
Option 8A: Multiple relations, Super class and subclasses.

- Create a relation for the super class, including the super class attributes.
- Create a relation for each subclass, which includes the primary key of the super class and the attributes of the subclass.
- This works for any specialization (partial, total, disjoint, overlapping)

Option 8B: Multiple relations, Subclass relations only

- Create a relation for each subclass, with the attributes of both the super class and the attributes of the subclass.
- This only works for total specializations, meaning that every entity in the super class must belong to at least one subclass. Otherwise members of the super class that don't belong to a subclass will not be represented.

Using Option 8A



Using Option 8B

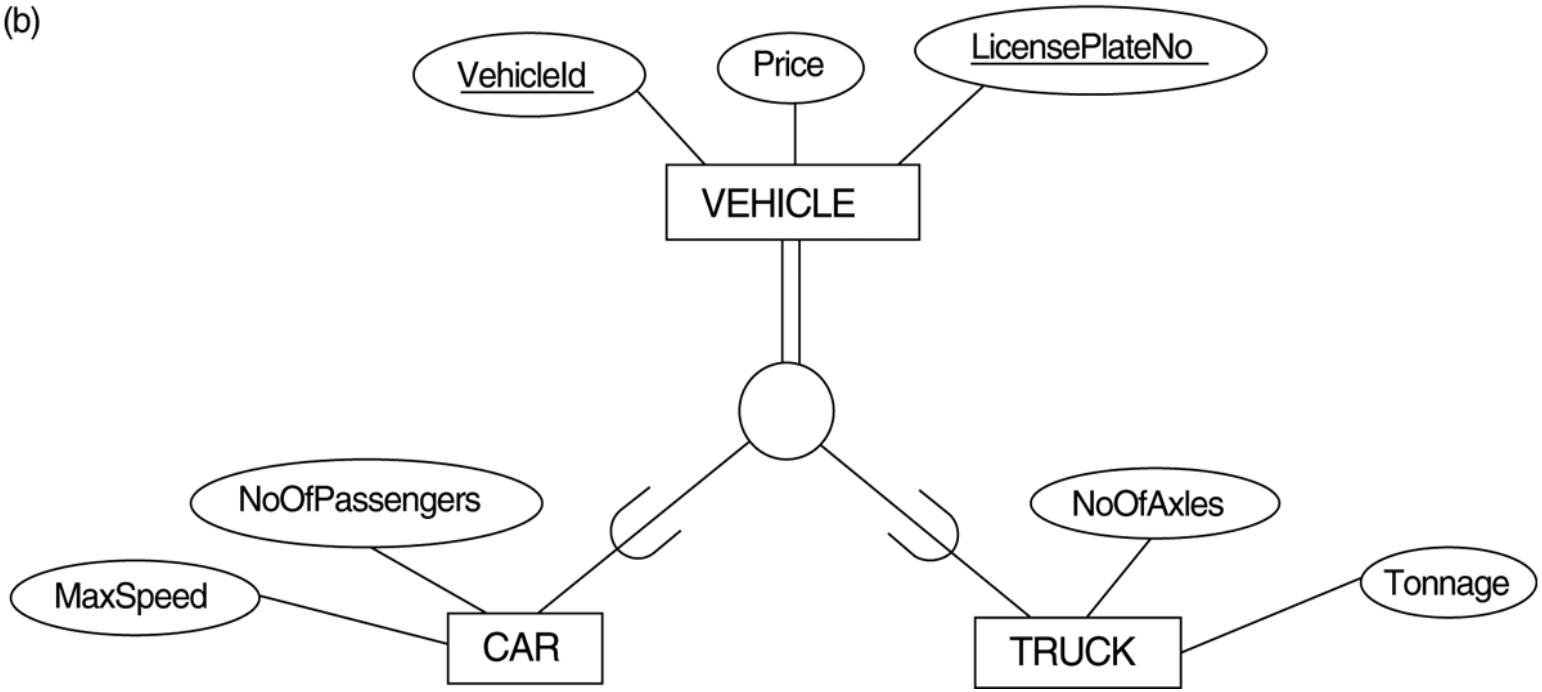
(b) CAR

VehicleId	LicensePlateNo	Price	MaxSpeed	NoOfPassengers

TRUCK

VehicleId	LicensePlateNo	Price	NoOfAxles	

(b)



Mapping EER Model to Relations

Option 8C: Single relation with one type attribute.

- Create a single relation, with all the attributes of the super class and all the attributes of a subclass.
- Include a 'Type' attribute, which is the discriminating attribute which indicates which subclass the row belongs to.
- This only works if the specialization is disjoint, meaning the super class entity cannot be a member of more than one subclass.

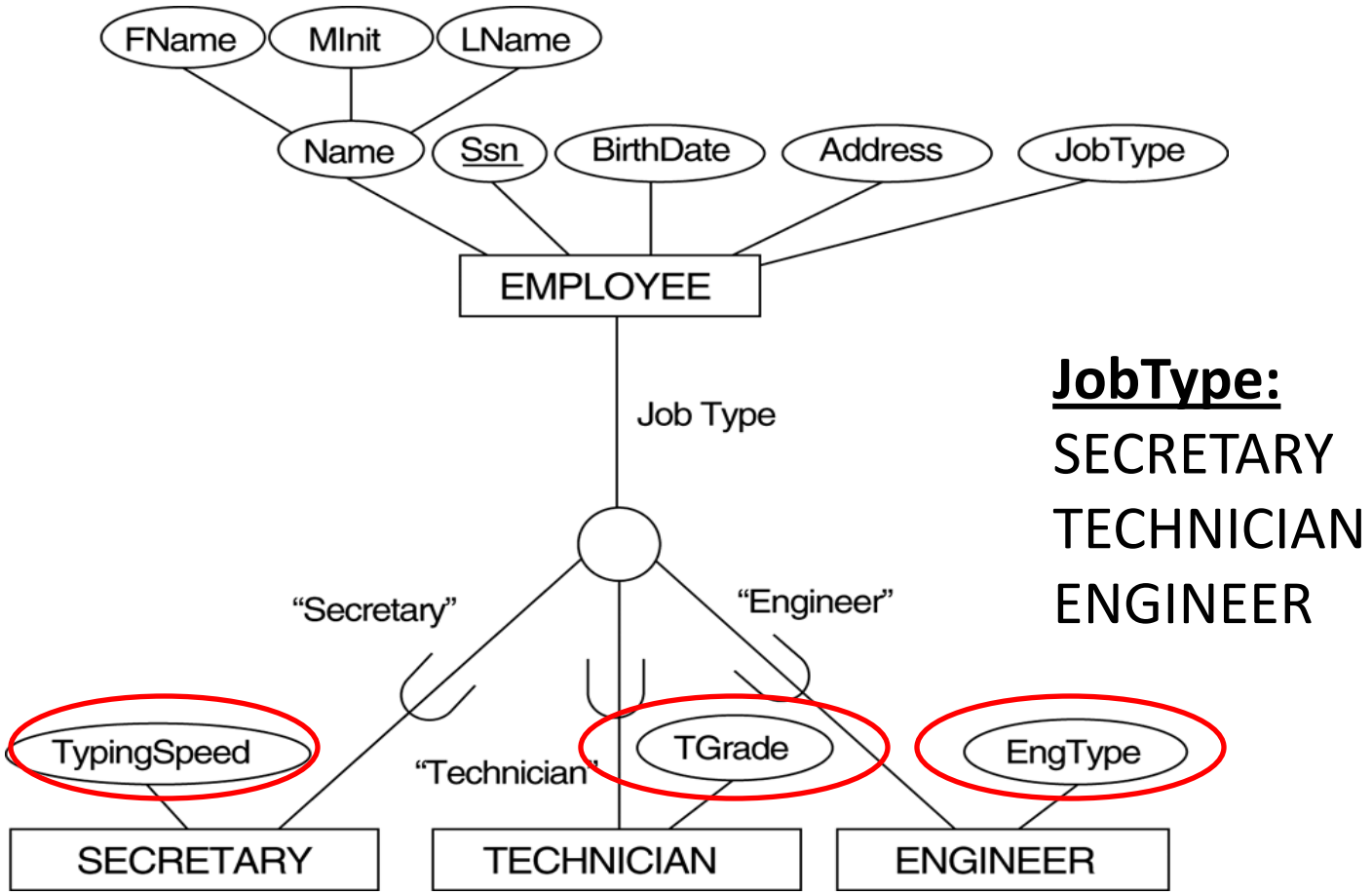
Option 8D: Single relation with multiple type attributes.

- Create a single relation with all the attributes of the super class and all the attributes of the subclass.
- Include a Boolean "Type" attribute for each subclass, which indicates whether the row belongs to that subclass.
- This works with overlapping specializations, to indicate if the super class entity belongs to more than one subclass.

Using Option 8C

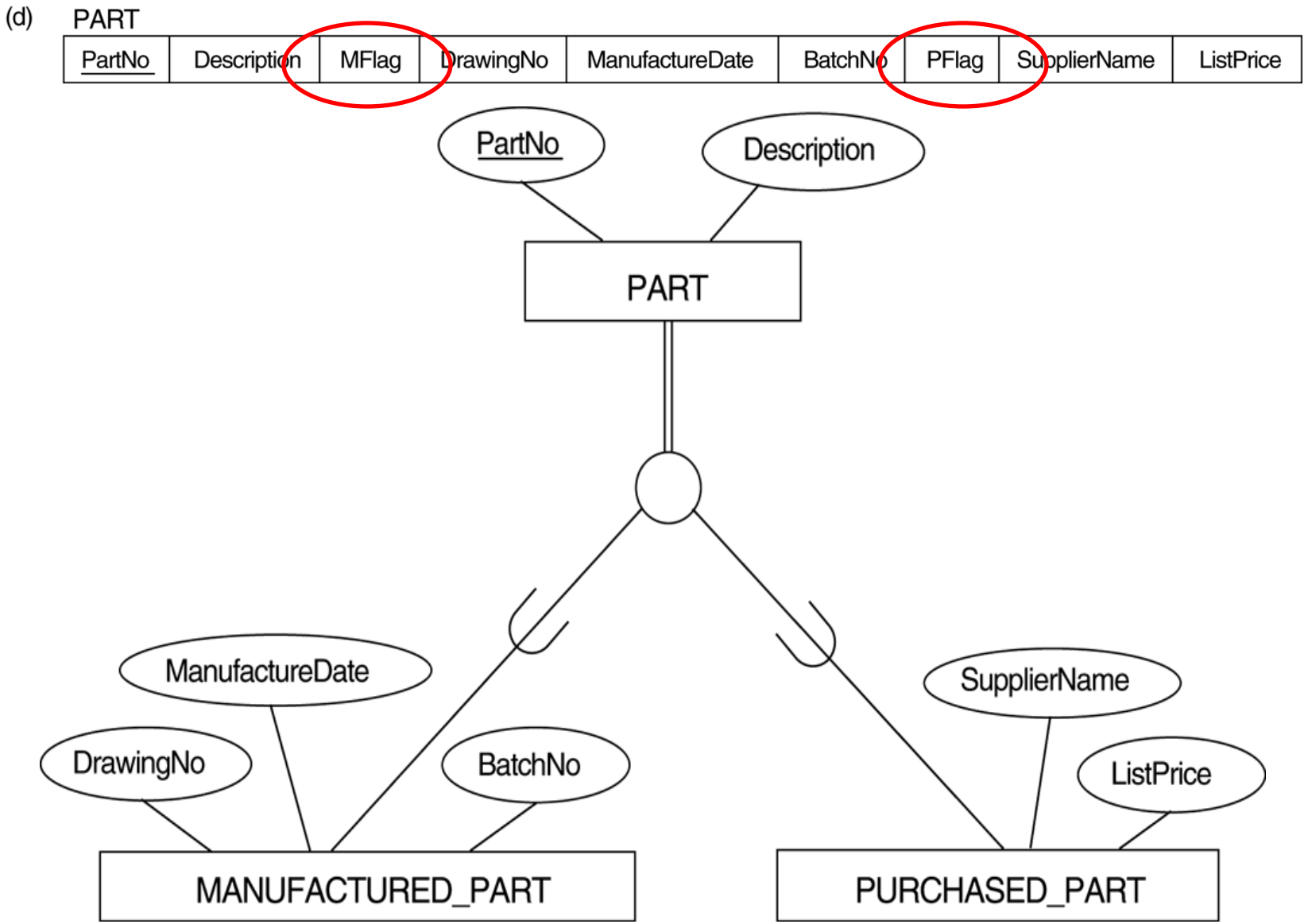
(c) EMPLOYEE

SSN	FName	MInit	LName	BirthDate	Address	JobType	TypingSpeed	TGrade	**EngType**



JobType:
SECRETARY
TECHNICIAN
ENGINEER

Using Option 8D



Mapping EER Model to Relations

Step 9a: Mapping of Union Types (Categories).

For mapping a category whose defining super classes have different keys:

- Create a new relation corresponds to the category
- Specify a new key attribute, called a **surrogate key** for the relation category.
- Includes the attributes of the category and the surrogate key in the new relation
- Include surrogate key in super classes as foreign key.

Example:

- We can create a relation OWNER to correspond to the OWNER category and include any attributes of the category in this relation. The primary key of the OWNER relation is the surrogate key, which we called OwnerId

Mapping EER Model to Relations

Step 9b: Mapping of Union Types (Categories).

For mapping a category whose defining super classes have the same key:

- Create a new relation corresponds to the category
- Include the attributes of the category and key of the defining supper class in the new relation
- Key of the new relation is the key of the defining class

Two categories (union types): OWNER and REGISTERED_VEHICLE.

PERSON

SSN	DriverLicenseNo	Name	Address	**OwnerId**

BANK

BName	BAddress	OwnerId

COMPANY

CName	CAddress	OwnerId

OWNER

OwnerId

Surrogate key

REGISTERED_VEHICLE

VehicleId	LicensePlateNumber

CAR

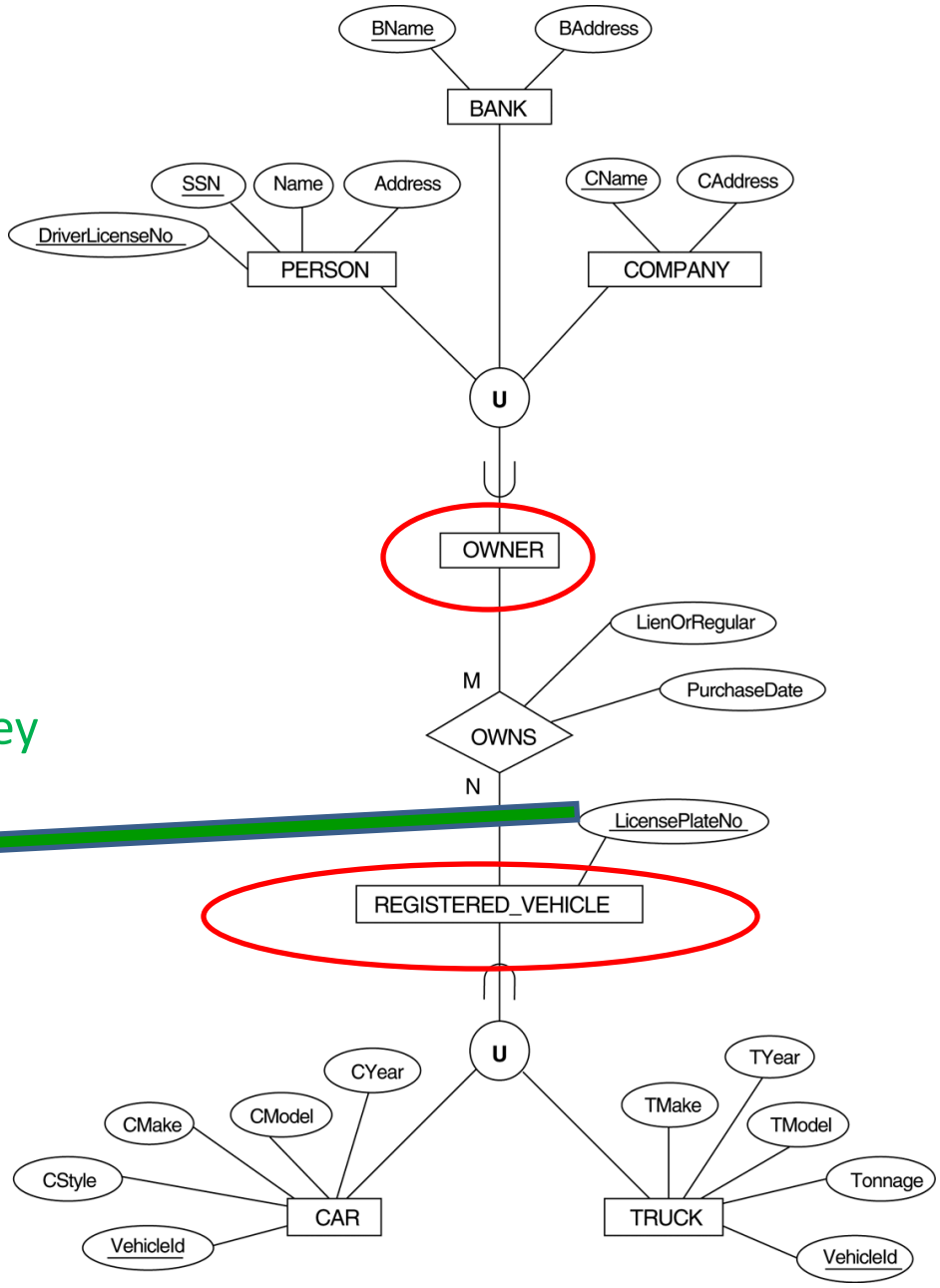
VehicleId	CStyle	CMake	CModel	

TRUCK

VehicleId	TMake	TModel	Tonnage	TYear

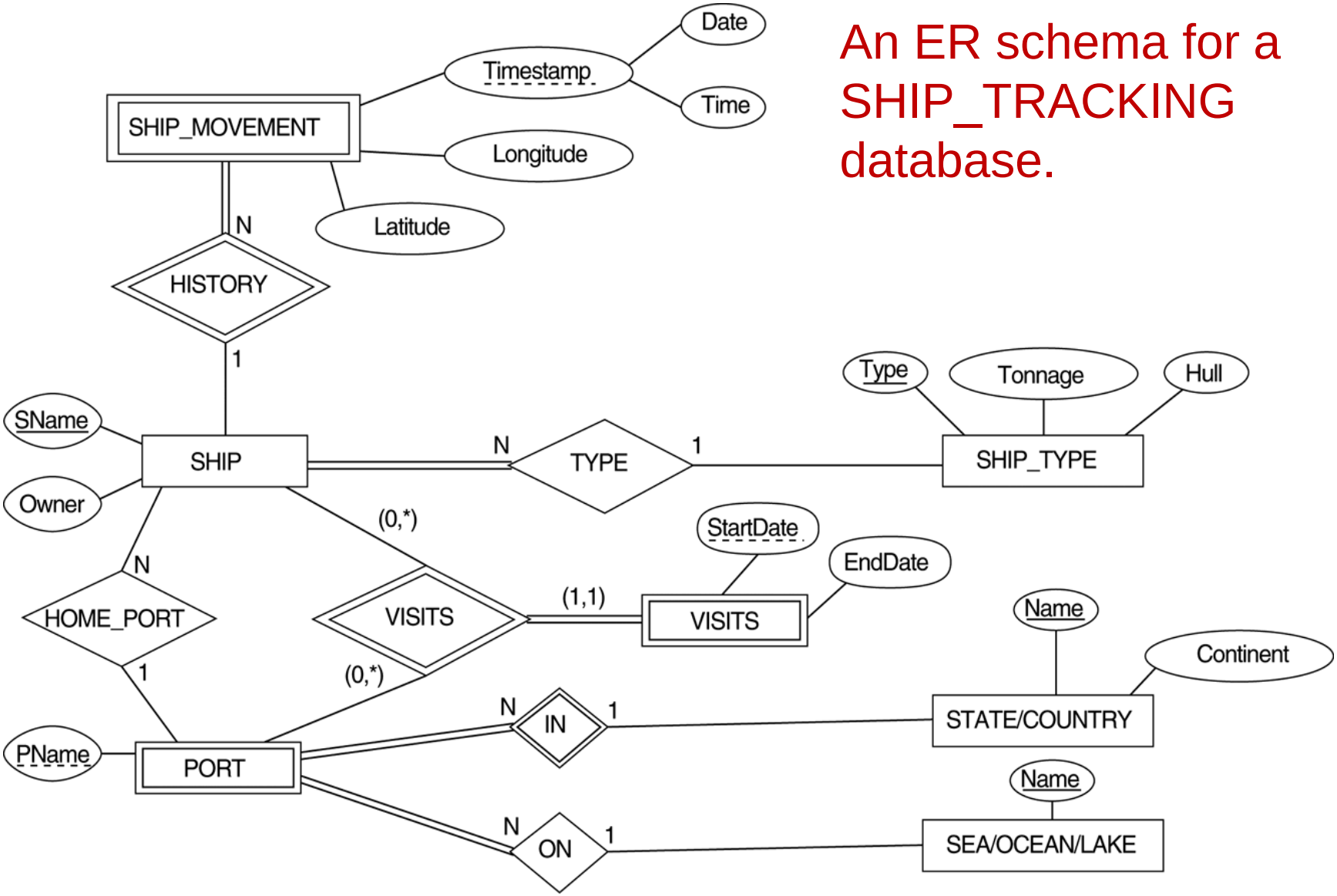
OWNS

OwnerId	VehicleId	PurchaseDate	LienOrRegular

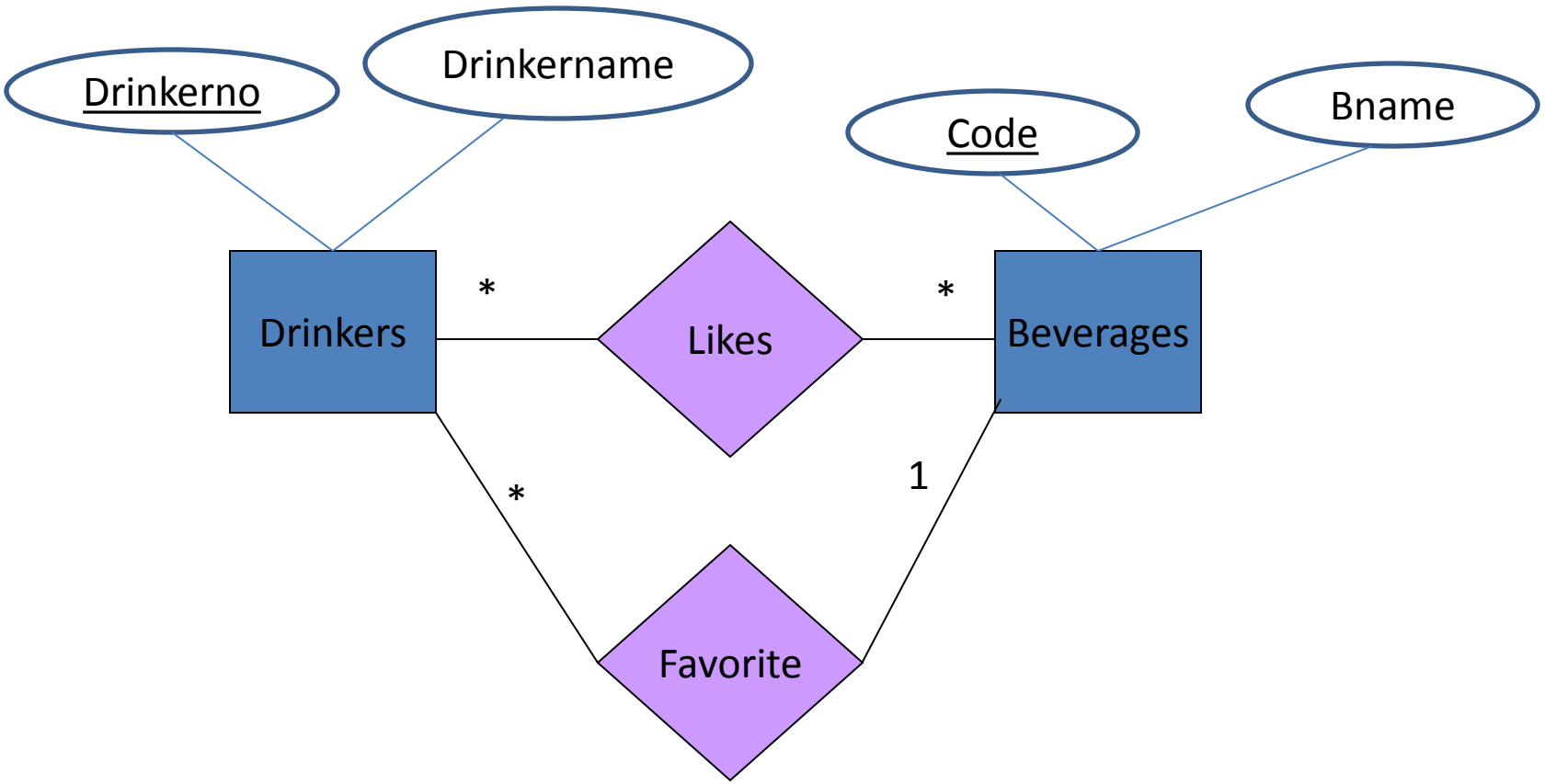


Mapping Exercise (Tute)

An ER schema for a SHIP_TRACKING database.



Mapping Exercise (Tute)



Mapping Exercise (Tute)