The Enhanced E-R Model

The basic E-R model was first introduced during the mid-1970s. It has been suitable for modeling most common business problems and has enjoyed widespread use. However, the business environment has changed dramatically since that time. Business relationships are more complex, and as a result, business data are much more complex as well.

The term **enhanced entity-relationship (EER) model** is used to identify the model that has resulted from extending the original E-R model with these new modeling constructs. These extensions make the EER model semantically similar to object-oriented data modelling.

The most important modeling construct incorporated in the EER model is supertype/subtype relationships. This facility enables us to model a general entity type (called the *supertype*) and then subdivide it into several specialized entity types (called *subtypes*). Thus, for example, the entity type CAR can be modeled as a supertype, with subtypes SEDAN, SPORTS CAR, COUPE, and so on. Each subtype inherits attributes from its supertype and in addition may have special attributes and be involved in relationships of its own.

Representing Supertypes and Subtypes

The E-R model has been extended to include supertype/subtype relationships.A **subtype** is a subgrouping of the entities in an entity type that is meaningful to the organization. A **supertype** is a generic entity type that has a relationship with one or more subtypes.

Basic Concepts and Notation

The notation that is used for supertype/subtype relationships in this text is shown in Figure 3-1. The supertype is connected with a line to a circle, which in turn is connected with a line to each subtype that has been defined.

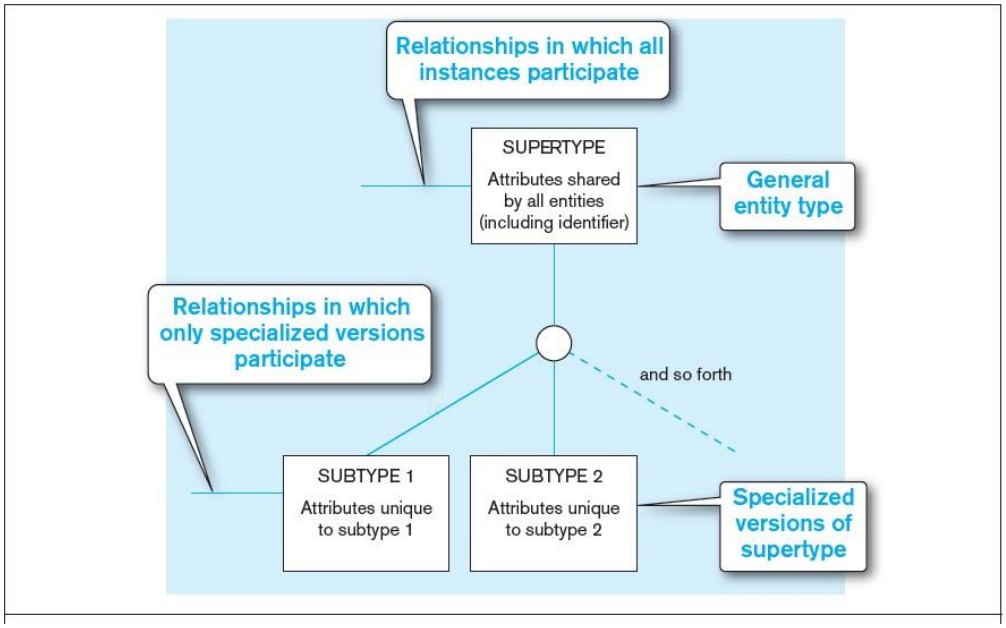

Figure 3-1 Basic notation for supertype/subtype relationships

Attributes that are shared by all entities (including the identifier) are associated with the supertype. Attributes that are unique to a particular subtype are associated with that subtype. The same is true for relationships.

An Example of a Supertype/Subtype Relationship

Let us illustrate supertype/ subtype relationships with a simple yet common example.

Suppose that an organization has three basic types of employees: hourly employees, salaried employees, and contract consultants. The following are some of the important attributes for each of these types of employees:
• ***Hourly employees*** Employee Number, Employee Name, Address, Date Hired, Hourly Rate

• ***Salaried employees*** Employee Number, Employee Name, Address, Date Hired, Annual Salary, Stock Option

• ***Contract consultants*** Employee Number, Employee Name, Address, Date Hired, Contract Number, Billing Rate

Notice that all of the employee types have several attributes in common: Employee Number, Employee Name, Address, and Date Hired. In addition, each type has one or more attributes distinct from the attributes of other types.

For this example we define a supertype called EMPLOYEE with subtypes HOURLY EMPLOYEE, SALARIED EMPLOYEE, and CONSULTANT. Figure 3-2 shows a representation of the EMPLOYEE supertype with its three subtypes, using enhanced E-R notation. Attributes shared by all employees are associated with the EMPLOYEE entity type. Attributes that are peculiar to each subtype are included with that subtype only.

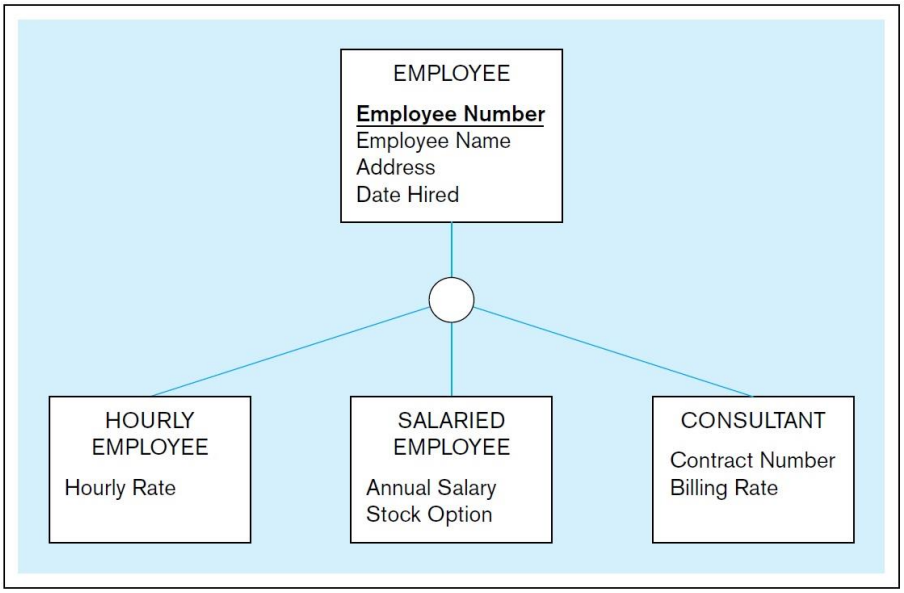

Figure 3-2 Employee supertype with three subtypes

Attribute Inheritance

A subtype is an entity type in its own right. An entity instance of a subtype represents the same entity instance of the supertype. For example, if “Therese Jones” is an occurrence of the CONSULTANT subtype, then this same person is necessarily an occurrence of the EMPLOYEE supertype. As a consequence, an entity in a subtype must possess not only values for its own

attributes, but also values for its attributes as a member of the supertype, including the identifier.

Attribute inheritance is the property by which subtype entities inherit values of all attributes and instance of all relationships of the supertype.

For example, Employee Name is an attribute of EMPLOYEE (Figure 3-2) but not of the subtypes of EMPLOYEE. Thus, the fact that the employee's name is "Therese Jones" is inherited from the EMPLOYEE supertype. However, the Billing Rate for this same employee is an attribute of the subtype CONSULTANT.

We have established that a member of a subtype must be a member of the supertype. Is the converse also true—that is, is a member of the supertype also a member of one (or more) of the subtypes? This may or may not be true, depending on the business situation.

When To Use Supertype/Subtype Relationships

So, how do you know when to use a supertype/subtype relationship? You should consider using subtypes when either (or both) of the following conditions are present:

1. There are attributes that apply to some (but not all) instances of an entity type. For example, see the EMPLOYEE entity type in Figure 3-2.

2. The instances of a subtype participate in a relationship unique to that subtype.

Figure 3-3 is an example of the use of subtype relationships that illustrates both of these situations.

In figure 3-3 the entity type PATIENT has two subtypes: OUTPATIENT and RESIDENT PATIENT. (The identifier is Patient ID.) All patients have an Admit Date attribute, as well as a Patient Name. Also, every patient is cared for

by a RESPONSIBLE PHYSICIAN who develops a treatment plan for the patient.

Each subtype has an attribute that is unique to that subtype. Outpatients have Checkback Date, whereas resident patients have Date Discharged. Also, resident patients have a unique relationship that assigns each patient to a bed.

Earlier we discussed the property of attribute inheritance. Thus, each outpatient and each resident patient inherits the attributes of the parent supertype PATIENT: Patient ID, Patient Name, and Admit Date. Figure 3-3 also illustrates the principle of relationship inheritance. OUTPATIENT and RESIDENT PATIENT are also instances of PATIENT; therefore, each Is Cared For by a RESPONSIBLE PHYSICIAN.

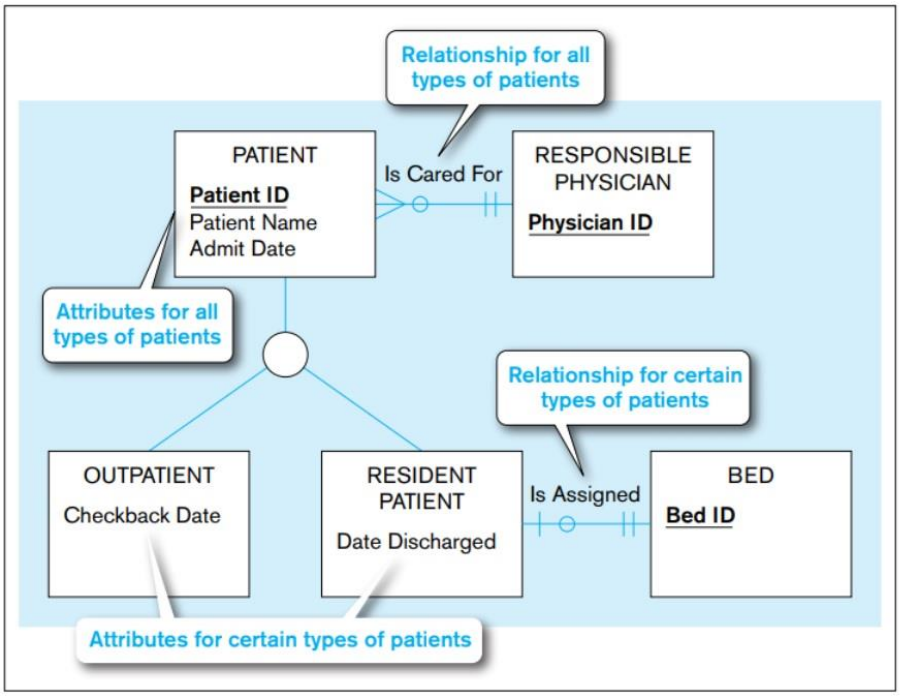

FIGURE 3-3 Supertype/subtype relationships in a hospital