An associative entity with three binary relationships).If you are forced to draw three binary relationships,then do not draw the binary relationships with names,and be sure that the cardinality next to the three strong entities is a mandatory one.

**Modeling Time-Dependent Data**

Database contents vary over time.With renewed interest today in traceability and reconstruction of a historical picture of the organization for various regulatory requirements,such as HIPAA and Sarbanes-Oxley,the need to include a time series of date has become essential.For example,in a database that contains product information, the unit price for each product, may be changed as material and labor costs and market conditions change.If only the current price is required,Price can be modeled as a single-valued attribute .However,for accounting,billing,financial reporting,and other purposes,we are likely to need to preserve a history of the prices and the time period during which each was in effect .As Figure 2-19 shows,we can conceptualize this requirement as a series of prices and the effective date for each price.This results in the (composite) multivalued attribute named Price History ,with components Price and Effective Date.An important characteristic of such a composite, multivalued attribute is that the component attributes go together.Thus,in Figure 2-19,each Price is paired with the corresponding Effective Date.

In Figure 2-19,each value of the attribute Price is time stamped with its effective date.A time stamp is simply a time value,such as date and time,that is associated with a date value. A time stamp may be associated with any data value that changes over time when we need to maintain a history of those data values.Time stamps may be recorded to indicate the time the value was entered (transaction time);

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the relationships between the entity types EMPLOYEE and DEPARTMENT.In this figure, we use the notation with names for the relationship in each direction ;this notation makes explicit what the cardinality is for each direction of the relationship(which becomes important for clarifying the meaning of the unary relationship on EMPLOYEE).One relationship associates employees with the department in which they work..This relationship is one-to-many in the Has Workers direction and is mandatory in both directions.That is,a department must have at least one employee who works there(perhaps the department manager),and each employee must be assigned to exactly one department.(Note:These are specific business rules we assume for this illustration.It is crucial when you develop an E-R diagram for a particular situation that you understand the business rules that apply for that setting.For example,if EMPLOYEE were to include retirees,then each employee may not be currently assigned to exactly one department:further,the E-R model in Figure 2-20a assumes that the organization needs to remember in which DEPARTMENT each EMPLOYEE currently works,rather than remembering the history of department assignments.Again,the structure of the data model reflects the information the organization needs to remember.)

The second relationship between EMPLOYEE and DEPARTMENT associates each department with the employee who manages that department.The relationship form DEPARTMENT to EMPLOYEE(called Is Managed By in that direction)is a mandatory one,indicating that a department must have exactly one manager.Form EMPLOYEE to DEPARTMENT,the relationship(Manages)is optional because a given employee either is or is not a department manager.

Figure 2-20a also shows the unary relationship that associates each employee with

his or her supervisor,and vice versa.This relationship records the business rule that each employee may have exactly one supervisor(Supervised By).Conversely,each employee may supervise any number of employee or may not be a supervisor.s

The example in Figure 2-20b shows two relationships between the entity types PROFESSOR and COURSE. The relationship Is Qualified associates professors with the Courses they are qualified to each. A given course must have a minimum two qualified instructors(an example of how to use a fixed value for a minimum or maximum cardinality). This might happen, for example, so that a course is never the “property” of One instructor. Conversely, each instructor must be qualified to teach at least one course (a reasonable expectation).

The second relationship in this figure associates professors with the courses they are actually scheduled to teach during a given semester.Because Semester is a characteristic of the relationship,we place an associative entity. SCHEDULE,between PROFESSOR and COURSE.

One final point about Figure 2-20b:Have you figured out what the identifier is for the SCHEDULE associative entity?Notice that Semester is a partial identifier; thus,the full identifier will be the identifier of PROFESSOR along with the identifier of COURSE as well as Semester. Because such full identifiers for associative entities be created for each associative entity;so,Schedule ID would be created as the identifier of SCHEDULE,and Semester would be an attribute.What is lost in this case is the explicit business rule that the combination of the PROFESSOR identifier, COURSE identifier, and Semester must be unique for each SCHEDULE instance(because this combination is the identifier of SCHEDULE).Of course,this can be added as another business rule.

Naming and Defining Relationships

In addition to the general guidelines for naming data objects,there are a few special guidelines for naming relationships,which follow:

A relationship name is a verb phrase (such as Assigned To,Supplies,or Teaches).Relationship represent actions being taken,usually in the present tense,so transitive verbs(an action on something)are the most appropriate.A relationship name states the action taken,not the result of the action(e.g,use Assigned To,not