QUESTIONS

1. Describe to a businessperson the multiplicity of a relationship between two classes.
2. Why are assumptions important to a structural model?
3. What is an association class?
4. Contrast the following sets of terms: object, class, method, attribute, superclass, subclass, concrete class, abstract class.
5. Give three examples of derived attributes that may exist on a class diagram. How would they be denoted on the class diagram?
6. What are the different types of visibility? How would they be denoted on a class diagram?
7. Draw the relationships that are described by the following business rules. Include the multiplicities for each relationship.

    A patient must be assigned to only one doctor and a doctor can have one or many patients.

    An employee has one phone extension, and a unique phone extension is assigned to an employee.

    A movie theater shows at least one movie, and a movie can be shown at up to four other movie theaters around town.

    A movie either has one star, two costars, or more than ten people starring together. A star must be in at least one movie.

8. How do you designate the reading direction of a relationship on a class diagram?
9. For what is an association class used in a class diagram? Give an example of an association class that may be found in a class diagram that captures students and the courses that they have taken.
10. Give two examples of aggregation, generalization, and association relationships. How is each type of association depicted on a class diagram?
11. Identify the following operations as constructor, query, or update. Which operations would not need to be shown in the class rectangle?

    Calculate employee raise (raise percent)
    Calculate sick days ()
    Increment number of employee vacation days ()
    Locate employee name ()
    Place request for vacation (vacation day)
    Find employee address ()
    Insert employee ()
    Change employee address ()
    Insert spouse ()

12. How are the different structural models related and how does this affect verification and validation of the model?

EXERCISES

A. Create a CRC card for each of the following classes:

    Movie (title, producer, length, director, genre)
    Ticket (price, adult or child, showtime, movie)
    Patron (name, adult or child, age)

B. Create a class diagram based on the CRC cards you created for exercise A.

C. Create a CRC card for each of the following classes. Consider that the entities represent a system for a patient billing system. Include only the attributes that would be appropriate for this context.

    Patient (age, name, hobbies, blood type, occupation, insurance carrier, address, phone)
    Insurance carrier (name, number of patients on plan, address, contact name, phone)
    Doctor (specialty, provider identification number, golf handicap, age, phone, name)

D. Create a class diagram based on the CRC cards you created for exercise C.

E. Create a class diagram showing the following relationships:

    1. A patient must be assigned to only one doctor and a doctor can have many patients.
    2. An employee has one phone extension, and a unique phone extension is assigned to an employee.
    3. A movie theater shows many different movies, and the same movie can be shown at different movie theaters around town.

F. Draw a class diagram for each of the following situations:

    1. Whenever new patients are seen for the first time, they complete a patient information form that asks their name, address, phone number and insurance carrier, which are stored in the patient information file. Patients can be signed up with only one carrier, but they must be signed up to be seen by the doctor. Each time a patient visits the doctor, an insurance

claim is sent to the carrier for payment. The claim must contain information about the visit, such as the date, purpose, and cost. It would be possible for a patient to submit two claims on the same day.

2. The state of Georgia is interested in designing a system that will track its researchers. Information of interest includes researcher name, title, position, researcher's university name, university location, university enrollment, and researcher's research interests. Researchers are associated with one institution, and each researcher has several research interests.

3. A department store has a wedding registry. This registry keeps information about the customer (usually the bride), the products that the store carries, and the products for which each customer registers. Customers typically register for a large number of products and many customers register for the same products.

4. Jim Smith's dealership sells Fords, Hondas, and Toyotas. The dealership keeps information about each car manufacturer with whom they deal so that they can get in touch with them easily. The dealership also keeps information about the models of cars that they carry from each manufacturer. They keep information such as list price, the price the dealership paid to obtain the model, and the model name and series (e.g., Honda Civic LX). They also keep information about all sales that they have made (for instance, they record the buyer's name, the car they bought, and the amount they paid for the car). To contact the buyers in the future, contact information is also kept (e.g., address, phone number).

G. Create object diagrams based on the class diagrams you drew for exercise F.

H. Examine the class diagrams that you created for exercise F. How would the models change (if at all) based on these new assumptions?

1. Two patients have the same first and last names.
2. Researchers can be associated with more than one institution.
3. The store would like to keep track of purchase items.
4. Many buyers have purchased multiple cars from Jim over time because he is such a good dealer.

I. Visit a website that allows customers to order a product over the Web (e.g., Amazon.com). Create a structural model (CRC cards and class diagram) that the site must need to support its business process. Include classes to show what they need information about. Be sure to include the attributes and operations to represent the type of information they use and create. Finally, draw relationships, making assumptions about how the classes are related.

J. Using the seven-step process described in this chapter, create a structural model (CRC cards and class diagram) for exercise C in Chapter 4.

K. Perform a verification and validation walkthrough for the structural model created for exercise J.

L. Using the seven-step process described in this chapter, create a structural model for exercise E in Chapter 4.

M. Perform a verification and validation walkthrough for the structural model created for exercise L.

N. Using the seven-step process described in this chapter, create a structural model for exercise G in Chapter 4.

O. Perform a verification and validation walkthrough for the structural model created for exercise N.

P. Using the seven-step process described in this chapter, create a structural model for exercise I in Chapter 4.

Q. Perform a verification and validation walkthrough for the structural model created for exercise P.

R. Using the seven-step process described in this chapter, create a structural model for exercise L in Chapter 4.

S. Perform a verification and validation walkthrough for the structural model created for exercise R.

T. Using the seven-step process described in this chapter, create a structural model for exercise O in Chapter 4.

U. Perform a verification and validation walkthrough for the structural model created for exercise T.

V. Using the seven-step process described in this chapter, create a structural model for exercise R in Chapter 4.

W. Perform a verification and validation walkthrough for the structural model created for exercise V.

X. Using the seven-step process described in this chapter, create a structural model for exercise U in Chapter 4.

Y. Perform a verification and validation walkthrough for the structural model created for exercise X.

MINICASES

1. West Star Marinas is a chain of twelve marinas that offer lakeside service to boaters; service and repair of boats, motors, and marine equipment; and sales of boats, motors, and other marine accessories. The systems development project team at West Star Marinas has been hard at work on a project that eventually will link all the marina's facilities into one unified, networked system.

The project team has developed a use-case diagram of the current system. This model has been carefully checked. Last week, the team invited a number of system users to role-play the various use cases, and the use cases were refined to the users' satisfaction. Right now, the project manager feels confident that the as-is system has been adequately represented in the use-case diagram.

The director of operations for West Star is the sponsor of this project. He sat in on the role-playing of the use cases and was very pleased by the thorough job the team had done in developing the model. He made it clear to you, the project manager, that he was anxious to see your team begin work on the use cases for the to-be system. He was a little skeptical that it was necessary for your team to spend any time modeling the current system in the first place but grudgingly admitted that the team really seemed to understand the business after going through that work.

The methodology you are following, however, specifies that the team should now turn its attention to developing the structural models for the as-is system. When you stated this to the project sponsor, he seemed confused and a little irritated. "You are going to spend even more time looking at the current system? I thought you were done with that! Why is this necessary? I want to see some progress on the way things will work in the future!"

What is your response to the director of operations? Why do we perform structural modeling? Is there any benefit to developing a structural model of the current system at all? How do the use cases and use-case diagram help us develop the structural model?

2. Holiday Travel Vehicles sells new recreational vehicles and travel trailers. When new vehicles arrive at Holiday Travel Vehicles, a new vehicle record is created. Included in the new vehicle record are a vehicle serial number, name, model, year, manufacturer, and base cost.

When a customer arrives at Holiday Travel Vehicles, he or she works with a salesperson to negotiate a vehicle purchase. When a purchase has been agreed upon, a sales invoice is completed by the salesperson. The invoice summarizes the purchase, including full customer information, information on the trade-in vehicle (if any), the trade-in allowance, and information on the purchased vehicle. If the customer requests dealer-installed options, they are listed on the invoice as well. The invoice also summarizes the final negotiated price, plus any applicable taxes and license fees. The transaction concludes with a customer signature on the sales invoice.

a. Identify the classes described in the preceding scenario (you should find six). Create CRC cards for each class.

Customers are assigned a customer ID when they make their first purchase from Holiday Travel Vehicles. Name, address, and phone number are recorded for the customer. The trade-in vehicle is described by a serial number, make, model, and year. Dealer-installed options are described by an option code, description, and price.

b. Develop a list of attributes for each class. Place the attributes onto the CRC cards.

Each invoice lists just one customer. A person does not become a customer until he or she purchases a vehicle. Over time, a customer may purchase a number of vehicles from Holiday Travel Vehicles.

Every invoice must be filled out by only one salesperson. A new salesperson might not have sold any vehicles, but experienced salespeople have probably sold many vehicles.

Each invoice only lists one new vehicle. If a new vehicle in inventory has not been sold, there will be no invoice for it. Once the vehicle sells, there will be just one invoice for it.

A customer may decide to have no options added to the vehicle or may choose to add many options. An option may be listed on no invoices or it may be listed on many invoices.

A customer may trade in no more than one vehicle on a purchase of a new vehicle. The trade-in vehicle may be sold to another customer who later trades it in on another Holiday Travel vehicle.

c. Based on the preceding business rules in force at Holiday Travel Vehicles and CRC cards, draw a class diagram and document the relationships with the appropriate multiplicities. Remember to update the CRC cards.