Chapter 6
Use Case Modeling and Detailed Requirements

Thinking Critically

1.   **The following description identifies the business need for a simple university library system. Based on the description, develop the following diagrams:**
      a. **Develop a domain class diagram**

      b. **Develop a use case diagram**

      c. **Do a CRUD analysis to ensure that the identified classes and use cases are consistent. Update both your class diagram and use case diagram as necessary.**

      Submit your class diagram, your use case diagram, and your CRUD matrix to your instructor.

      This case is a simplified (initial draft) of a new system for the University Library. Of course, the library system must keep track of books. Information is maintained about both book titles and the individual book copies. Book titles maintain information about title, author, publisher, and catalog number. Individual copies maintain copy number, edition, publication year, ISBN, book status (whether it is on the shelf or loaned out), and date due back in.

      The library also keeps track of patrons to the library. Since it is a university library, there are several types of patrons, each with different privileges. There are faculty patrons, graduate student patrons, and undergraduate student patrons.   Basic information about all patrons is name, address, and telephone number. For faculty patrons, additional information is office address and telephone number. For graduate students, information such as graduate program and advisor information is maintained.   For undergraduate students program and total credit hours are maintained.

      The library also keeps information about library loans. A library loan is a somewhat abstract object. A loan occurs when a patron approaches the circulation desk with a stack of books to check out. Over time a patron can have many loans. A loan can have many physical books associated with it. (And a physical book can be on many

loans over a period of time. Information about past loans is kept in the database.) So, in this case, it is recommended that an association class be created for loaned books.
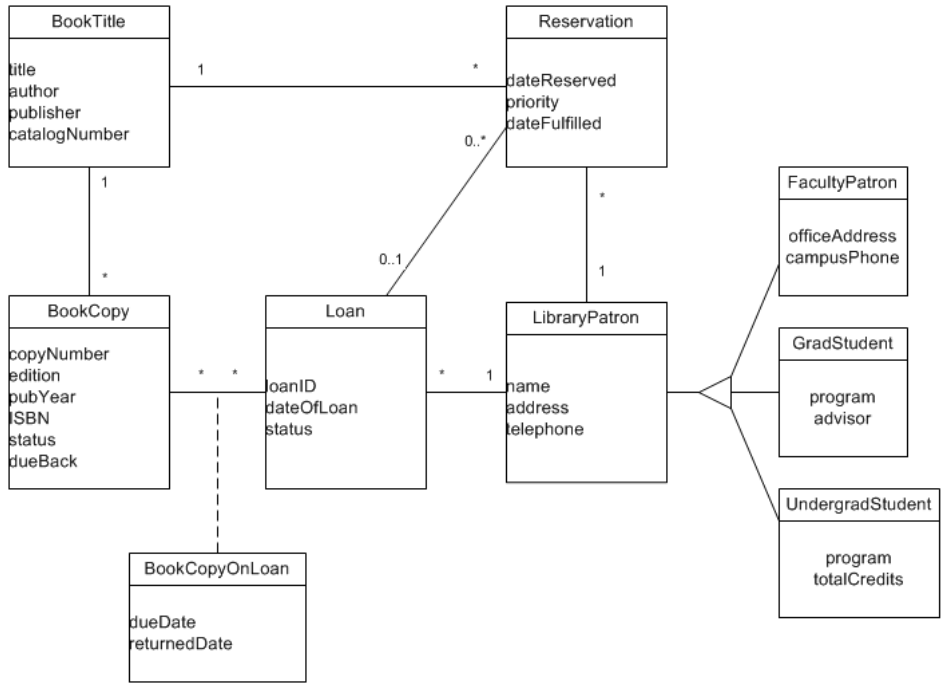
If a book is checked out that a patron wants, he/she can put that title on reserve. This is another class that does not represent a concrete object. Each reservation is for only one title and one patron. Information such as date reserved, priority, and date fulfilled is maintained. When it is fulfilled, the system associates it with the loan on which it was checked out.

Patrons have access to the library information to search for book titles and to see whether a book is available. A patron can also reserve a title if all copies are checked out. When patrons bring books to the circulation desk, a clerk checks out the books on a loan. Clerks also check books in. When books are dropped in the return slot, the clerks check them in. Stocking clerks keep track of the arrival of new books.
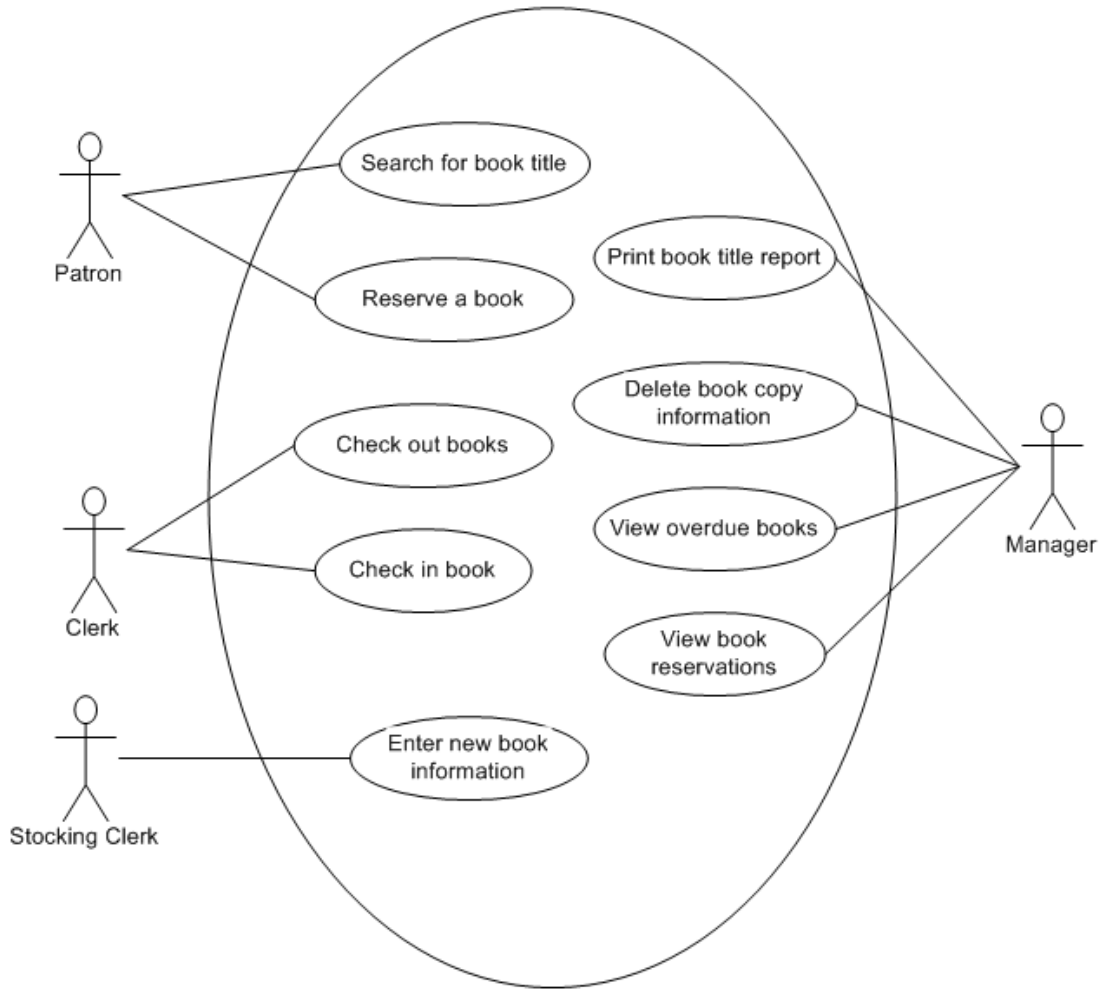
The managers in the library have their own activities. They will print out reports of book titles by category. They also like to see (online) all overdue books. When books get damaged or destroyed, they will delete information about book copies. Managers also like to see what books are on reserve.

1a. Domain class diagram

BookTitle
title
author
publisher
catalogNumber

Reservation
dateReserved
priority
dateFulfilled

BookCopy
copyNumber
edition
pubYear
ISBN
status
dueBack

Loan
loanID
dateOfLoan
status

LibraryPatron
name
address
telephone

FacultyPatron
officeAddress
campusPhone

GradStudent
program
advisor

UndergradStudent
program
totalCredits

BookCopyOnLoan
dueDate
returnedDate

1b.   Use case diagram

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1c. CRUD analysis

Use Case	Book Title	Book Copy	Loan	Book Copy onLoan	Patron	Reservation
Search for book title	R	R				
Reserve book						C
Check out books		U	C	C		U
Check in book			U	U		
Enter new book information	C	C				
Print book title report	R					
Delete book copy information		D				
View overdue books				R		
View reservations						R
NEW USE CASES						
Update book information	U	U				
Update Patron information					U	
Correct reservation						U
Print loaned book reports			R	R		
View Patron information					R	
Remove book from library	D	D				
END OF PERIOD CLEANUP						
Remove old loan information			D	D		

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Remove old reservation information						D	

2.	The following description identifies the business need for a dental clinic system. Based on the description, develop the following diagrams:
   a. Develop a domain class diagram

   b. Develop a use case diagram

   c. Do a CRUD analysis to ensure that the identified classes and use cases are consistent. Update both your class diagram and use case diagram as necessary.

   Submit your class diagram, your use case diagram, and your CRUD matrix to your instructor.

A clinic with three dentists and several dental hygienists needed a system to help administer patient records. This system does not keep any medical records. It only processes patient administration.

Each patient has a record with his/her name, date of birth, gender, date of first visit, and date of last visit. Patient records are grouped together under a household. A household has attributes such as name of head of household, address, and telephone number. Each household is also associated with an insurance carrier record. The insurance carrier record contains name of insurance company, address, billing contact person, and telephone number.

In the clinic, each dental staff person also has a record that tracks who works with a patient (dentist, dental hygienist, x-ray technician). Since the system focuses on patient administration records, only minimal information is kept about each dental staff person, such as name, address, and telephone number. Information is maintained about each office visit, such as date, insurance copay amount (amount paid by the patient), paid code, and amount actually paid. Each visit is for a single patient, but, of course, a patient will have many office visits in the system. During each visit, more than one dental staff person may be involved in the patient's treatment. For example, the x-ray technician, dentist, and dental hygienist may all be involved on a single visit. In fact, it is even possible that more than one dentist may be involved with a patient, since some dentists are specialists in such things as crown work. For each *staff member does procedure in a visit* combination (many-to-many) detailed information is kept about the procedure. This information includes type of procedure, description, tooth involved, the copay amount, the total charge, the amount paid, and the amount the insurance company denied.

Finally, the system also keeps track of invoices. There are two types of invoices: invoices to insurance companies and invoices to heads of household. Both types of invoices are fairly similar, listing each visit, the procedures

involved, the patient copay amount, and the total due. Obviously, the totals for the insurance company are different from the patient amounts owed. Even though an invoice is a report (printed out), it also maintains some information such as date sent, total amount, amount already paid, amount due and also the total received, date received, and total denied. (Insurance companies do not always pay the full amount they are billed for.)

The receptionist keeps track of patient and head of household information. He/she will enter information about the patients and head of household. He/she will also keep track of office visits by each patient. Patient information is also entered and maintained by the office business manager. In addition, the business manager maintains the information about the dental staff.

The business manager also prints the invoices. Patient invoices are printed monthly and sent to the head of household. Insurance invoices are printed weekly. When the invoices are printed, the business manager double-checks a few invoices against information in the system to make sure it is being aggregated correctly. The business manager also enters the payment information when it is received.

Each member of the dental staff is responsible for entering information about the dental procedures that he/she performs.

The business manager also prints an overdue invoice report showing heads of household who are behind on their payments. Sometimes dentists like to see a list of the procedures they performed during a week or month, and they can request that report.

2a. Domain class diagram
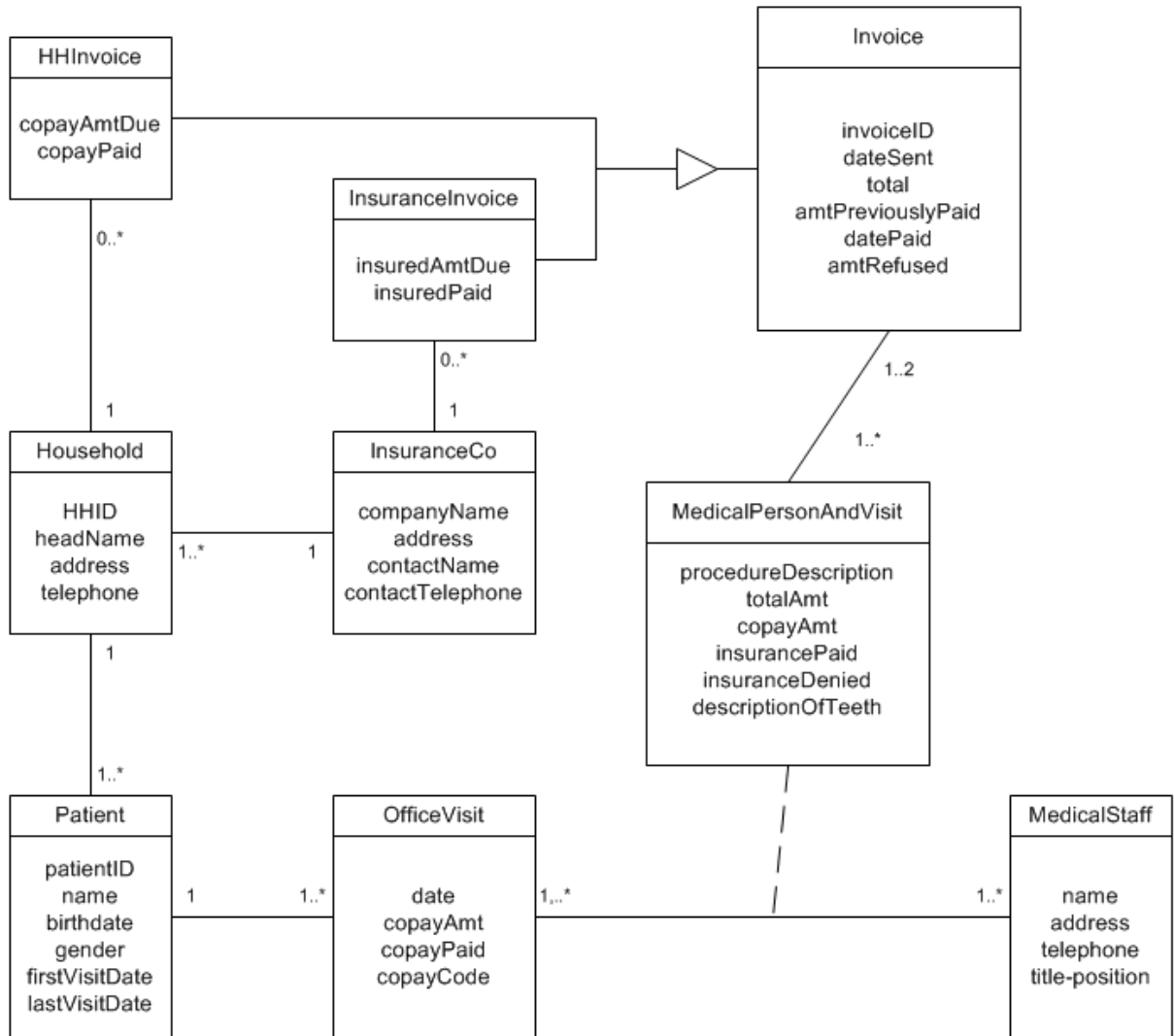
2b.   Use case diagram

2c. CRUD diagram

Use Case	House hold	Patient	Visit	Medical Staff	Medical Staff on Visit	Insurance company	Invoice
Record office visit information			C, U				
Maintain patient information	C, U	C, U					
Print invoices							C, R
Enter payment	U						U
View procedure information					R		
Print overdue accounts	R						
Record dental procedure					C		
Print procedure report					R		
NEW USE CASES							
Maintain dental staff				C, U, D			
Update procedure					U		
Maintain Insurance company						C, U	
END OF PERIOD CLEANUP							
Remove old patient information	D	D	D		D		D
Remove old Invoices							D

3. Interpret and explain the use case diagram in Figure 6-29. Explain the various roles of those using the system and what functions each role requires. Explain the relationships and how the use cases are related to each other.

There are three actors who invoke use cases, a Purchasing Clerk, a Receiving dock clerk, and a Shipping Clerk. Note that these three actors represent roles, and could be done by the same physical person.

The purchasing clerk uses the system to "Enter new inventory items."

The Shipping clerk only uses the system to "Ship items." However, the "Ship items" use case also includes the "Update quantity on hand" use case. This means that the Ship items use case will invoke the Update quantity on hand use case to carry out its function.

The Receiving dock clerk uses the system to do three things, to "Enter receipt of inventory," to "Update quantity on hand," and to "Enter a return." Both the "Enter receipt of inventory" and the "Enter a return" also include the "Update quantity on hand." Thus the "Update quantity on hand" use case can be invoked directly by the Receiving dock clerk, or by three other use cases.
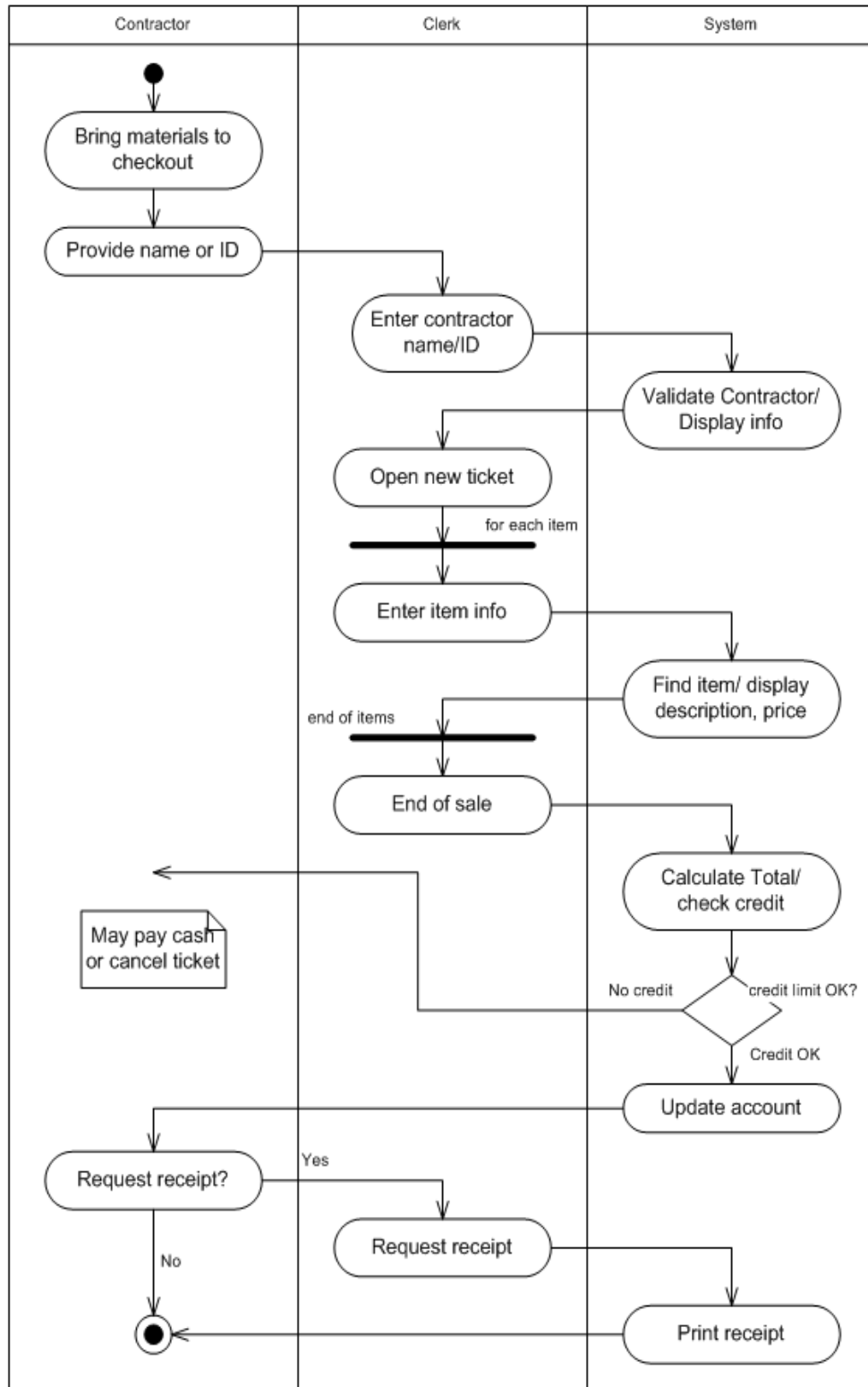
4. **Given the following narrative, do the following:**
   a. **Develop an activity diagram for each scenario.**
   b. **Complete a fully developed use case description for each scenario.**

   Quality Building Supply has two kinds of customers: contractors and the general public. Sales to each are slightly different.

   When a contractor buys materials, he or she takes them to the contractor checkout desk. The clerk enters the contractor name into the system. The system displays the contractor information, including his/her current credit standing.

   The clerk then opens up a new ticket (sale) for the contractor. Next, the clerk then scans in each item to be purchased. The system finds the price of the item and adds the item to the ticket. At the end of the purchase, the clerk indicates end of sale. The system compares the total amount against the contractor's current credit limit, and if it is acceptable, finalizes the sale. The system creates an electronic ticket for the items, and the contractor's credit limit is reduced by the amount of the sale. Some contractors like to keep a record of their purchases, so they request that the ticket details be printed out. Others aren't interested in a printout.

   A sale to the general public is simply entered into the cash register and a paper ticket is printed as the items are identified. Payment can be by cash, check, or credit card. The clerk must enter the type of payment to ensure that the cash register balances at the end of the shift. For credit card payments, the system prints out a credit card voucher that the customer must sign.
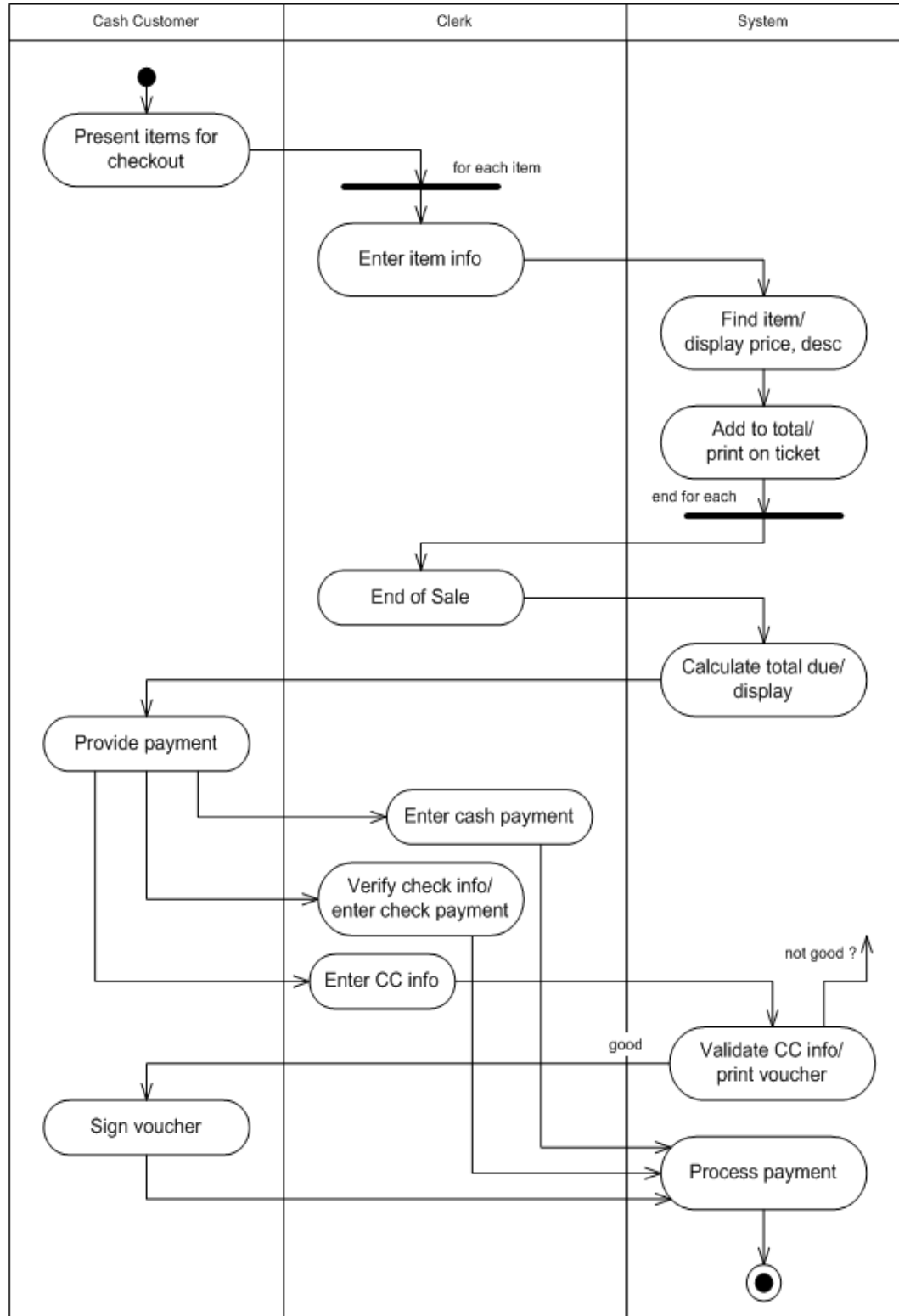
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Use Case Name:	Create a new sale	
Scenario:	A new sale to a contractor (on account sale)	
Triggering Event:	New sale	
Brief Description:	A contractor has items to purchase. The clerk rings up the items and then adds them to the contractor's account.	
Actors:	Sales clerk	
Stakeholders:	Sales clerk, accounting department, Sales department	
Preconditions:	Customer account must exist Inventory items must exist	
Postconditions:	New sale created Sales line items created and connected to sale Customer (contractor) account updated	
Flow of Events:	Actor	System
	1. Clerk enters contractor ID	1.1 System validates contractor account
	2. Clerk enters each item	2.1 System finds item in inventory, finds price, adds to total.
		3.1 System calculates total and adds to contractor account
	3. Clerk indicates end of sale	4.1 System prints receipt
	4. If contractor wants receipt, request receipt	
Exception Conditions:	1.1 If contractor account out of balance, then either treat this sale as a cash sale, or stop process and send contractor to accounting clerk. 2.1 If system has information missing, sales clerk calls manager and manually enters information. 3.1 If contractor account balance over the limit then treat as cash sale, or	

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	cancel, or send contractor to accounting clerk.

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Cash Customer	Clerk	System

- Present items for checkout
- for each item
- Enter item info
- Find item/ display price, desc
- Add to total/ print on ticket
- end for each
- End of Sale
- Calculate total due/ display
- Provide payment
- Enter cash payment
- Verify check info/ enter check payment
- Enter CC info
- not good ?
- Validate CC info/ print voucher
- good
- Sign voucher
- Process payment

Use Case Name:	Create a new sale	
Scenario:	A new cash sale	
Triggering Event:	New sale	
Brief Description:	A cash customer has items to purchase. The clerk enters the item ID and the system creates a sales ticket. Customer pays with cash, check or credit card	
Actors:	Sales clerk	
Stakeholders:	Sales clerk, accounting department, Sales department	
Preconditions:	Inventory items must exist	
Postconditions:	New sale created Sales line items created and connected to sale Payment transaction created	
Flow of Events:	Actor	System
	1. Clerk starts new cash sale	
	2. Clerk enters each item	2.1 System finds item in inventory, finds price, displays information, adds to total.
		3.1 System calculates total
	3. Clerk indicates end of sale	
	4. Clerk indicates type of payment and enters information	4.1 System processes payment and creates payment transaction
Exception Conditions:	2.1 If system has information missing, sales clerk calls manager and manually enters information. 4.1 If customer credit card fails approval, then require cash or cancel sale.	

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5. **Given the following narrative, develop either an activity diagram or a fully developed description for a use case of *Add a new vehicle to an existing policy* in a car insurance system.**

    A customer calls an insurance clerk at the insurance company and gives his/her policy number. The clerk enters this information, and the system displays the basic insurance policy. The clerk then checks the information to make sure the premiums are current and the policy is in force.

    The customer gives the make, model, year, and vehicle identification number (VIN) of the car to be added. The clerk enters this information, and the system validates that the given data is valid. Next the customer selects the types of coverage desired and the amount of each. The clerk enters the information, and the system records each and validates the requested amount against the policy limits. After all of the coverages have been entered, the system validates the total coverage against all other ranges, including other cars on the policy.

    Finally, the customer must identify all drivers and the percent of time they drive the car. If a new driver is to be added, then another use case, *Add new driver,* is invoked.

    At the end of the process, the system updates the policy, calculates a new premium amount, and prints the updated policy statement to be mailed out to the policy owner.

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Problem 7.
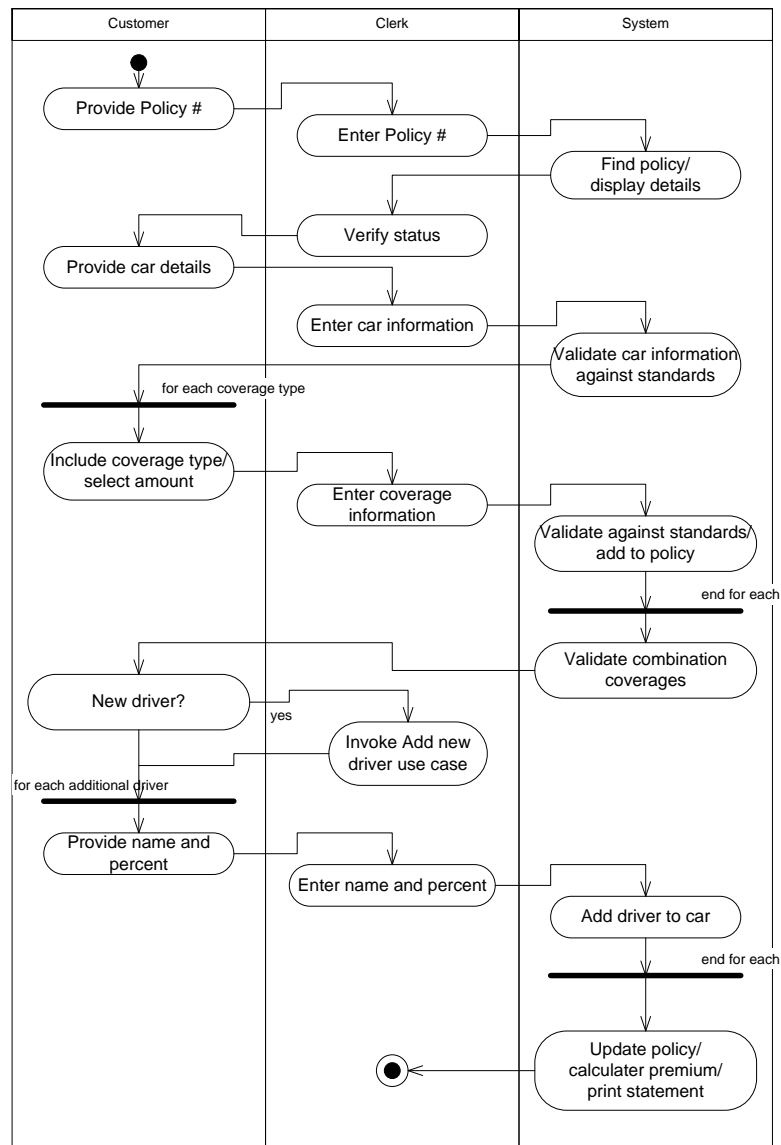
Use Case Name:	Add a new vehicle to an existing policy
Scenario:	Telephone instance with customer and clerk
Triggering Event:	New vehicle
Brief Description:	Customer provides car information, requests coverages with amounts, identifies drivers of the new car. System updates the policy.
Actors:	Customer service clerk

Stakeholders:	Customer, customer service department	
Preconditions:	Customer policy must exist and be up to date. StandardVehicle control tables for this vehicle type and year must exist. StandardCoverage tables exist.	
Postconditions:	New vehicle object created and connected to policy. Also connected to StandardVehicle. New coverage objects created and connected to vehicle. Also connected to StandardCoverage. New driver (InsuredPerson) (if necessary) created and added to policy. Existing drivers and percentages updated. Policy updated with new premiums.	
Flow of Events:	Actor	System
	1. Clerk enters customer information	1.1 System finds policy and displays details
	2. Clerk verifies policy is current.	3.1 System validates that car has known standard.
	3. Clerk enters car identification information	4.1 System validates coverage requests.
	4. Clerk enters each type of coverage customer requests, including deductibles and coverage amount	5.1 System does combination validation on policy
	5. Clerk indicates all coverages have been entered	
	6. Clerk invokes *Add new person* use case if necessary.	7.1 System updates driver information.
	7. Clerk changes driver percentages on this car and other cars.	
	8. Clerk indicates everything complete	8.1 System updates policy, calculates new premium, prints new statement.

Exception Conditions:	2.1 If policy is not current, then clerk requests payment or collects necessary information. 3.1 If car type is not in system, clerk refers customer to underwriting to handle this situation. 4.1 If coverage requests are out of range, then clerk asks customer for changed amount. 5.1 If some combination is invalid, then return to step 4.

6. **Given the following list of classes and relationships for the car insurance system in the previous exercise, list the preconditions (i.e., the objects that need to exist in the system before the use case begins) and the postconditions (i.e., the objects and relationships that must exist after the new case is completed). The use case you should consider is *Add a new vehicle to an existing policy*.**

   Classes in the system:
   - **Policy**
   - **InsuredPerson**
   - **InsuredVehicle**
   - **Coverage**
   - **StandardCoverage (list standard insurance coverages with prices by rating category)**
   - **StandardVehicle (lists all types of vehicles ever made)**

   Relationships in the system:
   - **Policy has InsuredPersons (one to many)**
   - **Policy has InsuredVehicles (one to many)**
   - **Vehicle has Coverages (one to many)**
   - **Coverage is a type of StandardCoverage**
   - **Vehicle is a StandardVehicle**

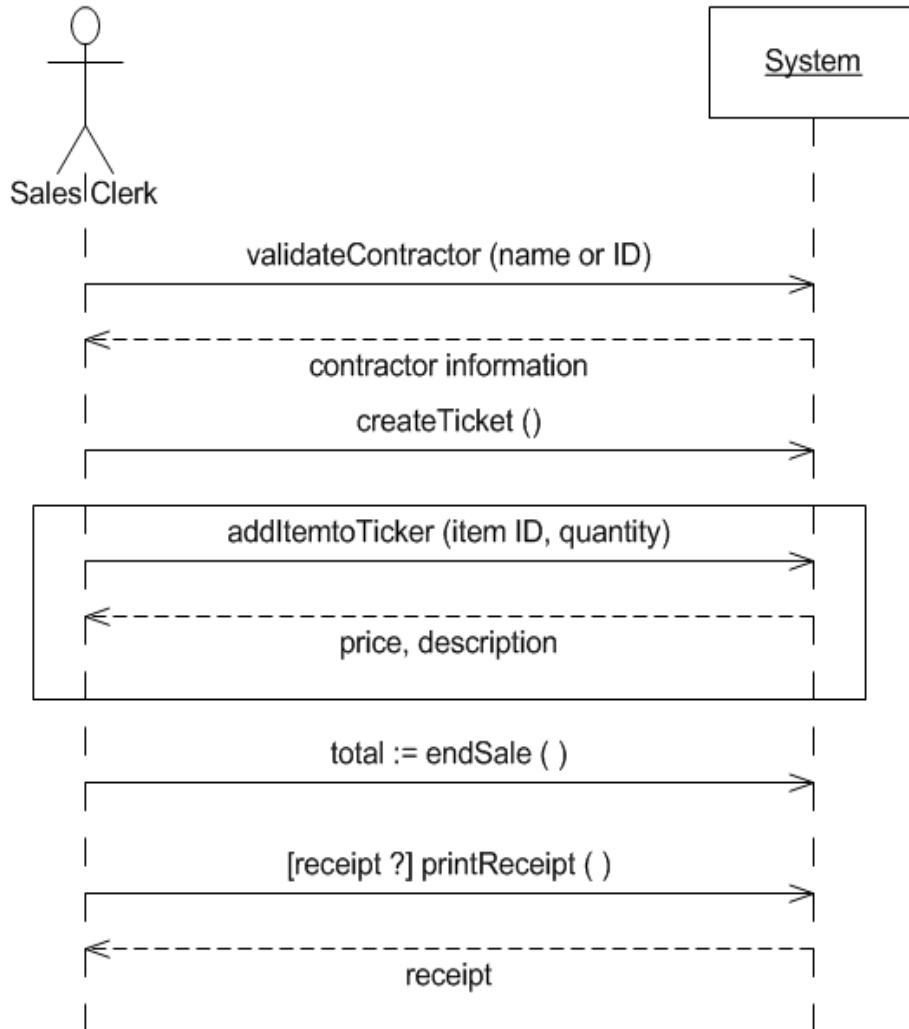| Preconditions:	Customer policy must exist and be up to date. StandardVehicle control tables for this vehicle type and year must exist. StandardCoverage tables exist.
Postconditions:	New vehicle object created and connected to policy.

	Also connected to StandardVehicle.
	New coverage objects created and connected to vehicle.
	Also connected to StandardCoverage.
	New driver (InsuredPerson) (if necessary) created and added to policy.
	Existing drivers and percentages updated.
	Policy updated with new premiums.

7.   Develop a system sequence diagram based on the narrative and your activity diagram for Thinking Critically problem 4.

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Sales Clerk — System

validateContractor (name or ID)

contractor information

createTicket ()

addItemtoTicker (item ID, quantity)

price, description

total := endSale ( )

[receipt ?] printReceipt ( )

receipt

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8. Develop a system sequence diagram based on the narrative and your activity diagram for Thinking Critically problem 5.

Insurance Clerk

System

validatePolicy (policy#)

policy details

addVehicle (VIN, other vehicle information)

expande vehicle information

* addCoverage (type, amount, deductible)

[new driver] invoke *Add New Driver*

* assignDrivers (driver, percent)

completeChange ( )

premium, policy statement

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9. **Review the cellular telephone statechart in Figure 6-30, then answer the following questions (note that this telephone has unique characteristics that are not found in ordinary telephones. Base your answers only on the statechart):**

a. **What event turns on the telephone?**

You have to switch it on.

b. **What states does the telephone go into when it is turned on?**

It goes into the Quiet state for one path. It can also go into any of Charged, Low warning, or Discharged.

c. **What are the three ways that the telephone can be turned off? Identify what must be true for each case.**

SwitchOff, (2) Quiet and Low warning, or (3) Discharged. The telephone must be turned on.

d. **Can the telephone turn off in the middle of the Active (Talking) state.**

Yes, if it is discharged, it leaves the Discharged nested state and the On composite state.

e. **How can the telephone get to the Active (talking) state?**

Through the origin state of connecting or by answering from the origin state of ringing.

f. **Can the telephone be plugged in while someone is talking?**

No. The state chart says it can only be plugged in from the Quiet state.

g. **Can the telephone change battery states while someone is talking? Explain which movement is allowed, and which is not allowed.**

It can go from Charged to Low warning and from Low warning to Discharged. However, since it cannot be Plugged in while someone is talking, it cannot move back up from Discharged to Low warning or to Charged.

h. **What states are concurrent with what other states? (Make a two column table showing states with concurrent states.**
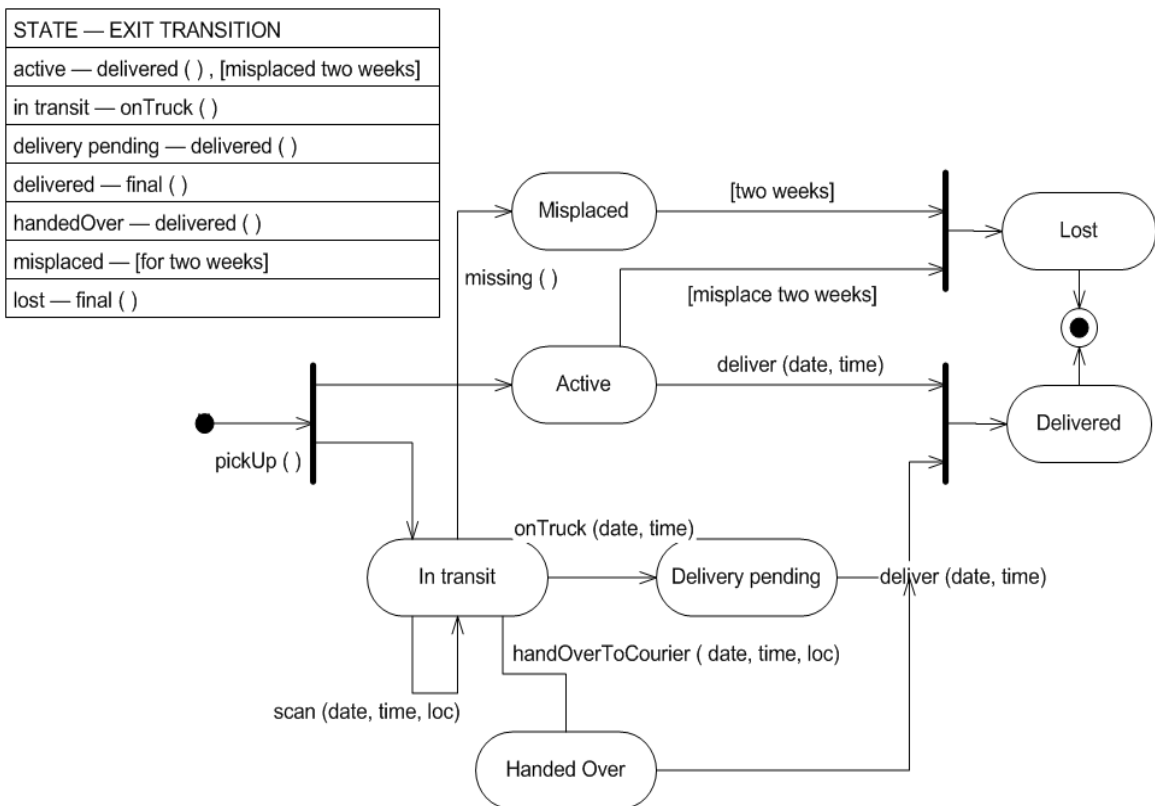
Concurrent states	
Quiet, Dialing, Connecting, Ringing, Active, and Plugged in	Charged, Low warning, Discharged

10. **Given the following description of a Certified Parcel Shipments (CPS) shipment first identify all of the states and exit transitions, then develop a statechart.**

A shipment is first recognized after it has been picked up from a customer. Once it is in the system it is considered to be active and in transit. Every time it goes through a checkpoint, such as arrival at an intermediate destination, it is scanned and a record is created indicating the time and place of the checkpoint scan. The status changes when it is placed on the delivery truck. It is still active, but now it is also considered to have a status of delivery pending. Of course, once it is delivered the status changes again.

From time to time, a shipment has a destination that is outside of the area serviced by CPS. In those cases, CPS has working relationships with other couriers. Once a package is handed off to another courier, it is noted as being handed over. In those instances, a tracking number for the new courier is recorded (if it is provided). CPS also asks the new courier to provide a status change notice once the package has been delivered.

Unfortunately, from time to time a package gets lost. In those cases, it remains in an active state for two weeks, but is also marked as misplaced. If after two weeks it has not been found, it is considered lost. At that point the customer can initiate lost procedures to recover any damages.

STATE — EXIT TRANSITION
active — delivered ( ) , [misplaced two weeks]
in transit — onTruck ( )
delivery pending — delivered ( )
delivered — final ( )
handedOver — delivered ( )
misplaced — [for two weeks]
lost — final ( )

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