**CHAPTER 17**

**DATA MODELING AND DATABASE DESIGN**

**SUGGESTED ANSWERS TO DISCUSSION QUESTIONS**

**17.1 Why is it not necessary to model activities such as entering information about customers or suppliers, mailing invoices to customers, and recording invoices received from suppliers as events in an REA diagram?**

The REA data model is used to develop databases that can meet both transaction processing and management analysis needs. Only events that either (1) directly change the quantities of resources, (2) represent commitments to future exchange events, or (3) that provide new information about activities that management wants to plan, evaluate, and control need to be included in such databases. None of the activities listed in the question satisfy these requirements.

Customer information is stored in rows in the customer table and supplier data is stored in rows in the supplier table. The bulk of this would have been entered when the database was initially created and the customer and supplier tables created and populated. Subsequently, new rows would be entered in these tables as a by-product of other events that management does want to plan, evaluate, and control – such as a sales call, the receipt of an order from a new customer, or placing an initial order with a new supplier.

Data processing activities, such as preparing reports or transcribing data from a form, are not explicitly modeled because they do not change information about any resources nor are they fundamental activities which management wants to control. (Consider: How often are managers concerned about how many reports a given employee prints in one day?) Indeed, all the information contained in a vendor invoice is already in the purchasing company’s database before the vendor invoice arrives: the quantity ordered is known when the order is placed, as is the quoted price and terms of payment, and the quantity received in good condition is known when the receiving report is stored.

Consequently, there is no need to explicitly model activities such as mailing or recording invoices as events in an REA data model. In fact, many administrative data processing activities are not even necessary steps in the value chain. For example, with the advent of sophisticated AIS, particularly ERP systems, many companies are requesting their suppliers not to send them any invoices.

**17.2** **The basic REA template includes links between two events and links between events and resources and between events and agents. Why do you think the basic REA template does not include direct links between (a) two resources, (b) two agents, or (c) between resources and agents?**

1. The basic REA template was developed to assist in modeling an organization’s economic transactions and, therefore, centers on events, the resources they affect, and the agents who participate in them. Two events can be linked to reflect economic duality (the give-to-get relationship) or causal sequence (orders precede sales).

Most resources are independent of one another and thus do not need to be directly linked. For example, inventory and cash do not directly affect one another, but only do so through events such as the sale of inventory and subsequent receipt of cash. Nevertheless, in chapter 19 we will see that sometimes two resources may be directly linked to one another in order to represent information about location, such as in which warehouse inventory is stored.

1. Similarly, the basic REA template does not directly link agents to one another because they often do not influence one another. As with resources, however, we will see in chapter 19 that it is sometimes desirable to directly model links between agents. One reason would be to represent supervisory relationships; another would be to reflect the assignment of employees to service specific subsets of customers or suppliers.
2. Finally, the basic REA template does not include direct links between agents and resources because in many situations there is no reason to track such relationships. As chapter 19 will show, however, if management wants to assign and track custody over specific resources, it is possible to enhance the basic REA template to include direct links between resources and agents.

**17.3 How can REA diagrams help an auditor understand a client’s business processes?**

An REA diagram presents a model of the company’s database. Included in the model is a representation of all the tables contained in the database as well as all of the relationships that exist between the tables within the database. These tables and relationships reflect the business processes and business events of the company. Thus, an auditor can use an REA diagram to understand which events affect the organization’s resources and which agents participate in them. The information about cardinalities in an REA diagram provides useful information about an organization’s business practices, such as whether it permits customers to make installment payments.

Thus, auditors can use REA diagrams to plan the audit. For example, examination of an REA diagram would reveal whether the organization extends credit to its customers, which would then require audits of accounts receivable, or only makes cash sales.

In addition, an auditor can use an REA diagram to test a client’s business processes for compliance with various controls that the client has created. For example, the auditor can design queries linking various employees to different events in order to evaluate whether there is adequate segregation of duties.

**17.4** **Which parts of Figure 17-6 would accurately depict almost every organization’s revenue cycle? Which parts would change?**

The 1:N relationships between the events and customers depicted in Figure 17-6 would apply to every organization, because it is always necessary to associate an order, sale, and receipt of cash with a specific customer. The 1:N relationships between those events and employees would likely apply to most organizations, but there could be situations in which the relationship would be M:N. For example, a real estate firm may want to split the commission for a sale between the listing agent and the buyer’s agent.

The M:N relationships between inventory and the take customer order and sale events are typical for retail organizations that deal in mass-produced merchandise. Those relationships would become 1:N, however, for businesses, such as art galleries, that sell unique products.

The 1:N relationship between cash and the receive cash event would apply universally, reflecting sound internal control over cash. The cardinalities of the relationships between the events, however, would differ across organizations depending upon their business policies. For example, if an organization did not permit installment payments, then the maximum cardinality from the sale event to the receive cash event would be one, not many.

**17.5 What is the relationship between the things that would be represented as resources in an REA diagram and the different categories of assets found on an organization’s balance sheet? (*Hint:* Are there any assets that would not be modeled as resources? Are there any resources in an REA diagram that are not listed as assets on a balance sheet?)**

There are asset categories listed on a company balance sheet that would not be presented as a resource on an REA diagram. The most noticeable is Accounts Receivable. Accounts Receivable is merely the difference between amount that a company has sold to a customer and the amount the customer has paid for those sales, and, therefore, need not be explicitly modeled as a resource.

There are also some resources in an REA model that do not appear on an organization’s balance sheet as an asset. A noteworthy example is employee skills. The skills possessed by employees are certainly an economic resource to an organization. As we will see in chapter 19, these skills would be recorded in a database to facilitate effective management, plan for future hiring and training needs, etc. According to generally accepted accounting principles, however, employee skills are not recorded as an asset in the financial statements. This does not mean that they lack economic value; indeed, the stock market appears to place considerable weight on intangibles like employee knowledge when determining the market value of a company.

**17.6 How would accounts payable be reflected in an REA diagram? Why?**

Accounts payable is not represented on an REA diagram. Accounts payable represents purchases for which the organization has not yet paid the supplier. Thus, at any point in time, accounts payable can be calculated by comparing two events: purchases and cash disbursements for those purchases. However, this difference must be recorded in financial statements as a liability at a particular point in time. Since the payable recorded in the financial statements is an artifact of reporting time periods, it is not a resource, event, nor an agent. Therefore, it will not appear on an REA diagram.

**17.7 What are the five stages of the database design process? In which stages should accountants participate? Why?**

The five stages of database design are: systems analysis, conceptual design, physical design, implementation and conversion, and operation and maintenance. Accountants can and should participate in every stage of the database design process, but their level of participation will vary across stages. During the systems analysis phase, accountants help evaluate project feasibility and identify user information needs. In the conceptual design stage, accountants participate in developing the logical schemas, designing the data dictionary, and specifying important controls. Accountants with good database skills may directly participate in implementing the data model during the physical design stage. During the implementation and conversion stage accountants should be involved in testing the accuracy of the new database and the application programs that will use that data, as well as assessing the adequacy of controls. Finally, many accountants are regular users of the organization’s database and sometimes even have responsibility for its management.

Accountants may provide the greatest value to their organizations by taking responsibility for data modeling. Data modelingis the process of defining a database so that it faithfully represents all aspects of the organization, including its interactions with the external environment. Data modeling occurs during both the systems analysis and conceptual design stages of database design.

**17.8** **What is the difference between an Entity-Relationship (E-R) diagram and an REA diagram?**

An entity-relationship (E-R) diagram is a graphical representation of a database that depicts the entities of interest and the important relationships among those entities. The entities are represented as rectangles; the relationships are represented as lines that connect entities.

An REA diagram is an E-R diagram that is designed using the REA data model to identity the three basic kinds of entities relevant to transaction processing systems: the resources controlled by the organizations, the events (business activities) that managers want to plan, control, and evaluate, and the agents who participate in those events.

**SUGGESTED ANSWERS TO THE PROBLEMS**

**17.1** **Joe’s is a small ice-cream shop located near the local university’s baseball field. Joe’s serves walk-in customers only. The shop carries 26 flavors of ice cream. Customers can buy cones, sundaes, or shakes. When a customer pays for an individual purchase, a sales transaction usually includes just one item. When a customer pays for a family or group purchase, however, a single sales transaction includes many different items. All sales must be paid for at the time the ice cream is served. Joe’s maintains several banking accounts but deposits all sales receipts into its main checking account.**

**Draw an** **REA Diagram, complete with cardinalities, for Joe’s revenue cycle,.**



**17.2 Joe, the owner of the ice-cream shop, purchases ice cream from two vendors. Over the years, he has developed good relationships with both vendors so that they allow Joe to pay them biweekly for all purchases made during the preceding two-week period. Joe calls in ice-cream orders on Mondays and Thursdays. The orders are delivered the next day. Joe buys ice-cream toppings from one of several local stores and pays for each such purchase at the time of sale with a check from the company’s main checking account.**

**Draw an** **REA Diagram, complete with cardinalities, for Joe’s expenditure cycle.**



**17.3** **Sue’s Gallery sells original paintings by local artists. All sales occur in the store. Sometimes customers purchase more than one painting. Individual customers must pay for purchases in full at the time of sale. Corporate customers, such as hotels, however, may pay in installments if they purchase more than 10 paintings. Although Sue’s Gallery has several bank accounts, all sales monies are deposited intact into the main checking account.**

**Draw an** **REA Diagram for the gallery’s revenue cycle. Be sure to include cardinalities.**



**17.4 Sue’s Gallery only purchases finished paintings (it never commissions artists). It pays each artist 50% of the agreed price at the time of purchase, and the remainder after the painting is sold. All purchases are paid by check from Sue’s main checking account.**

**Draw an REA Diagram, complete with cardinalities, of the gallery’s expenditure cycle.**



**17.5 Develop a data model of Fred’s Train Shop’s expenditure cycle activities related to the acquisition of office equipment and other fixed assets. Fred sometimes orders multiple pieces of equipment. Vendors usually ship the entire order, but sometimes are out of stock of some items. In such cases, they immediately ship to Fred what they have in stock, and then send a second shipment when they obtain the other items. Conversely, several orders placed within a short time period with the same vendor might be filled with one delivery. Assume that Fred makes installment payments for most fixed-asset acquisitions, but occasionally pays for some equipment in full at the time of purchase.**

**Draw an REA Diagram of your data model. Be sure to include cardinalities.**



**17.6 Provide an example (in terms of companies with which you are familiar) for each of the business situations described by the following relationship cardinalities:**

**a**.



A company may receive multiple cash payments on a single sale or a company may receive one payment for several sales. This scenario could take place between any vendor and any customer. The vendor is allowing customers to make multiple payments on a single invoice and is allowing customers to pay for multiple invoices with a single payment.

**b**.



A sale can include multiple items, but an item can be included in only one sale. This type of arrangement would involve individual items like art work or automobiles.

**c**.



In this scenario, some inventory purchases can be paid for with multiple payments, while at times a single disbursement may pay for multiple purchases. This scenario represents a revolving credit plan offered by suppliers.

**d.**



In this scenario, inventory purchases are to be paid for with a single payment. For example, a vendor sends a monthly bill for merchandise delivered to a customer. The supplier does not accept or allow installment payments. This is typical for many business to business transactions that involve low-priced items.

**e**.



In this scenario, a single purchase of inventory is paid for with multiple payments. For example, a car dealership makes installment payments for cars delivered from the manufacturer.



In this scenario, each sale must be preceded by one and only one order. The fact that both the order and sales events are recorded implies that there is probably a time lag between taking the customer’s order and filling that order, so that the selling organization needs to be able to track the status of orders. An internet sale is an example of this type of scenario. When a customer places an order with Amazon.com, there is a time lag between the time the order is sent by the customer and the time Amazon fills the order.



In this scenario, each sale can be comprised of multiple orders and each order can be associated with multiple sales. Thus, we have here a situation where the selling company batches orders and only ships periodically – e.g., with restaurants, suppliers may take orders daily but fill them only on Mondays and Thursdays. Moreover, suppliers may occasionally run out of some items, requiring multiple deliveries (sales) to fill a specific order.



Payment upfront for a single sale similar to the way DELL sells computers; i.e., no installment payments are allowed, the customer must pay in full in advance (prior to shipment).



In this scenario, a sale can include multiple inventory items. Also, a single inventory item can be included in multiple sales. For example, Wal-Mart customers can purchase many inventory items such as detergent, tires, and clothing items. These mass-produced inventory items can also be sold to many customers. Therefore, a sale can include a box of detergent, a set of tires, and a sweatshirt. By the same token, the same brand of detergent can be included in many different sales.



Sales need not be preceded by orders, but any orders are associated with only one sale (filled individually, not batched). An example is a hardware store in which some sales are made to walk-in customers (sales without preceding orders), but which also allows contractors to place orders by phone, fax, or over the Internet in advance and then pick up the order later.

**17.7 Model the cardinalities of the following business policies:**

1. **The relationship between the Sale and Receive Cash events for installment sales.**



1. **The relationship between the Sale and Receive Cash events at a convenience store.**



**c**. **The Take Customer Order–Sale relationship in a situation when occasionally several shipments are required to fill an order because some items were out of stock.**

The solution presented here presumes that one sale (order fulfillment event) can be linked to multiple orders, with occasional partial deliveries because items need to be back ordered.



Alternate solution, if each order is filled individually but sometimes requires multiple deliveries:



1. **The Sale-Inventory relationship for a custom homebuilder.**

This solution assumes that customers only purchase one home at a time. This is likely to be the case for custom homes. Situations in which an investor purchases multiple homes from a builder are most likely going to involve “tract” homes (e.g., several homes that follow a standard floor plan).



1. **The relationship between the Sale and Receive Cash events for Dell computers, which requires customers to pay the entire amount of their purchase in advance, prior to Dell shipping the merchandise.**



1. **The relationship between the Sale and Receive Cash events for a retail store that has some in-store sales paid in full by customers at the time of the sale but that also makes some in-store sales to customers on credit, billing them later and permitting them to make installment payments.**

This solution assumes that customers also occasionally pay for multiple sales with one payment. If, however, this never occurs, the alternate solution would be appropriate.



Alternate solution assuming all payments are for one and only one sale.



1. **The relationship between the Receive Inventory and Disburse Cash events in the case where suppliers require payment in advance, in full.**



1. **The relationship between the Call on Customers event (i.e., the visit by a salesperson to a potential customer) and the Take Customer Order event for a business that is only conducted door-to-door (e.g., kitchen knives, certain books, etc.) so that the only way to order the items is when a salesperson visits the customer. (*Hint:* do you think every call results in an order?)**



**i. The relationship between the Call on Customers and Take Customer Orders events for a manufacturer which also accepts orders on its Web site.**



1. **The relationship between the Receive Inventory and Disburse Cash events for a company which receives monthly bills from its suppliers for all purchases made the previous month; some suppliers require payment of the entire bill, in full, within 30 days or they will not accept any subsequent orders, but other suppliers accept installment payments.**



**17.8 The Computer Warehouse sells computer hardware, software, and supplies (such as paper). Individual customers just walk into the store, select merchandise, and must pay for their purchases in full before leaving the store. Corporate customers, however, call in orders in advance, so that the items are waiting to be picked up. Corporate customers may charge their purchases to their account. The Computer Warehouse mails corporate customers monthly statements that summarize all purchases made the prior month. Corporate customers pay the entire balance, as listed on the monthly statement, with one check or EFT transaction.**

**Draw an REA Diagram for Computer Warehouse revenue cycle, complete with cardinalities.**



**17.9 The Computer Warehouse purchases its inventory from more than a dozen different vendors. Orders are placed via telephone, fax, or on the supplier’s Web site. Most orders are delivered the next day. Most orders are filled completely in one shipment, but sometimes a supplier is out of stock of a particular item. In such situations, the bulk of the order is shipped immediately and the out-of-stock item is shipped separately as soon as it arrives (such shipments of back orders are never combined with any new orders placed by the Computer Warehouse). The Computer Warehouse pays for some of its purchases COD but usually pays by the 10th of the month for all purchases made the prior month. None of its suppliers allows it to make installment payments.**

**Draw an REA Diagram for Computer Warehouse expenditure cycle, complete with cardinalities.**



**17.10 Stan’s Southern Barbeque Supply Store orders mass-produced barbecue products from various suppliers. Stan’s maintains information about a contact person at each supplier along with all required address information. Each purchase order has the order number, date, tax, and total. Purchase orders also contain the following information for each product ordered: stock number, description, and price. The manager of Stan’s places orders by fax several times a day, whenever he notices that an item is running low. Some suppliers fill each individual order separately. Others, however, consolidate orders and fill all of them in one weekly delivery. Stan's suppliers never make partial shipments; if they are out of stock of a certain item, they wait until they obtain that item and then ship the entire order. Some suppliers require payment at the time of delivery, but others send Stan’s a monthly statement detailing all purchases during the current period. Two suppliers allow Stan’s to make installment payments for any individual purchase orders that exceed $20,000.**

**Draw an REA Diagram for Stan’s Southern Barbecue expenditure cycle, complete with cardinalities**



**SUGGESTED ANSWERS TO THE CASES**

**17.1** **Sparky’s Amusement Park is an entertainment park run by recent college graduates. It caters to young people and others who are young at heart. The owners are very interested in applying what they have learned in their information systems and marketing classes to operate a park better than any other in the area. To accomplish these goals, guests of the park are given a personal “membership card” as they enter. This card will be used to identify each guest. Assume that a new card is issued each time a guest comes to the park. As a result, the system does not have to track one person over a period of time. As at other parks, guests pay a flat fee for the day and then are able to ride all of the attractions (such as a double-looping roller coaster and the merry-go-round) for no extra charge. The owners, however, want to track the rides each guest takes and the attractions the guests use. They plan to have guests swipe their membership card through a computerized card reader, which automatically enters information into the computer system. This should allow the owners to gather data about the following:**

* **Number of people who use each piece of equipment. (How many people rode the Ferris wheel today?)**
* **Number of times each piece of equipment is operated daily.**
* **Times of day the attraction is busy or slow. (When was the carousel the busiest?)**
* **Number of attractions each guest uses. (How many different pieces of equipment did customer 1122 ride?)**
* **Number of rides each guest enjoys. (How many different rides did customer 1122 enjoy? Did each guest go on any rides more than once?)**

**Draw an REA diagram for Sparky’s *revenue* cycle only. Be sure to include cardinalities. State any assumptions you had to make.**

***(This problem is adapted from one developed for classroom use by Dr. Julie Smith David at Arizona State University.)***

The entities of interest include the equipment, cash accounts, the events of running the rides and collecting cash, the guests, and the employees.

Note that there is no event called “sell membership card” because the economic exchange is the providing of rides in return for money. The membership card is just a means of tracking who uses what rides and could be replaced with tokens, hand stamps, or any other mechanism.

Be sure students understand that the membership cards are not a resource – Sparky’s is not better off by printing up more cards. (This is a good point to discuss).

The suggested REA diagram solution is as follows:



The relationships of interest are those shown in the REA diagram. Most cardinalities are standard, except for the following:

* The “Give Ride” event involves running one particular piece of equipment. This solution assumes that attractions are run (e.g., the Ferris Wheel is turned on) at regular intervals, even if no customers happen to be on it. If, however, an attraction is only run if there is at least one customer who wants to go on that ride, then the diagram would have to be modified to show that each “Give Ride" event is linked to at least one customer.
* Many guests can ride the same piece of equipment at the same time.
* The “Receive Cash” (or “Get Cash”) event can involve receiving money for a group of people.
* The cardinalities also reflect the fact that the “Receive Cash” event precedes the “Give Ride” event.
* The unique number assigned to an activated membership card represents each “Guest” – this is how Sparky can track who uses what rides. Hence, a new row is only added to the Guest table for each paying customer. Since Sparky does not know the personal identity of his patrons, a new row in that table is created each separate day that the same person pays for admission. Note that customers do not, however, have to ride any rides – they may just be “babysitting” for example. On the other hand, most paying customers probably go on many different rides.