


Database Design Example

- ❖ *I hear it and I forget it,*
- ❖ *I see it and I remember it,*
- ❖ *I do it and I learn it.*
– Old Chinese Proverb

- ◆ Chapter 6: Database Design
 - *I hear it and I forget it*
- ◆ Chapter 7: Conceptual Design Example
 - *I see it and I remember it*
- ◆ Chapter 8: The rest of DB Life Cycle
 - *I see it and I remember it*
- ◆ Project 4: Database Design Project
 - *I do it and I learn it.*


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Database Initial Study

- ❖ University Computer Lab Application
- ❖ Key intended users of the UCL Database
 - ◆ The lab director
 - ◆ The lab assistants
 - ◆ The secretary of the CIS department
- ❖ UCL Objectives
 - ◆ Provide users with controlled access to the UCL's assets.
 - ◆ Guide users working with UCL's assets and provide general problem-solving services.

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Database Initial Study

- ❖ UCL's Operations
 1. Inventory/storage/order management
 2. Equipment maintenance and repair management
 3. Equipment check-out and check-in management
 4. Lab assistant payroll management
 5. Lab reservations management
 6. Computer lab access management

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UCL's Operations

- ❖ Inventory/storage/order management
 - ◆ Classifications of UCL's inventory items
 - Hardware
 - Software
 - Literature
 - Supplies
 - ◆ Each inventory item is classified by inventory type in a four-part hierarchy: category, class, type, and subtype.

TABLE 7.2 INVENTORY TYPE HIERARCHY

ITEM	CATEGORY	CLASS	TYPE	SUBTYPE
Gateway computer; Pentium II, 330MHz	Hardware	Computer	Desktop	Pentium
Laser printer paper; 8.5 x 11	Supply	Paper	Laser	8.5 x 11
Diskettes, 3.5" high density (HD)	Supply	Diskettes	3.5	HD

UCL's Operations

- ❖ **Inventory/storage/order management (Cont'd)**
 - ◆ Non-serialized vs. serialized items.
 - ◆ Inventory's items are updated when:
 - An ordered item is received.
 - An item is checked out or checked in.
 - A consumable item is withdrawn.
 - Inventory adjustment is needed.
- ❖ **Equipment maintenance and repair management**
 - ◆ Maintenance and management information is kept in the Bad Equipment Log and the Hardware Returned for Service Log.

UCL's Operations

- ❖ **Equipment check-out and check-in management**
 - ◆ Check-out form is filled when equipment is checked out.
 - ◆ Notice is sent when the equipment is not returned.
- ❖ **Lab assistant payroll management**
 - ◆ Time sheets are used to pay LAs on an hourly basis for a fourteen day pay period.
- ❖ **Lab reservation management**
 - ◆ A faculty member fills out a reservation form with date, time, department, and course number of the class.
- ❖ **Computer lab access management**
 - ◆ Lab users sign in the users' log and deposit a University ID card. (Table 7.3)

Table 7.3 A Sample Volume of Information Log

TABLE 7.3 A SAMPLE VOLUME OF INFORMATION LOG

TYPE OF INFORMATION	EXPECTED NUMBER OF ENTRIES PER PERIOD
Lab assistants:	14 per semester
Work schedule	8 per work day per lab assistant
Hours worked	1 per pay period per lab assistant
Users:	
Faculty	300
Students	15,000
Staff	650
Reservations	4 per week
Daily Lab users	570 per day
Orders	20 per month
Items ordered	3 per order
Inventory types	15
Locations	5
Repairs	20 per month
Vendors	40

Database Initial Study

❖ Problems and Constraints with Current Manual System

- ◆ Never up-to-date and prone to errors.
- ◆ Too much data duplication and data inconsistency.
- ◆ Incapable and impractical to generate useful information.
- ◆ Incapable of ad hoc queries.
- ◆ Too much time spent on manual data processing.
- ◆ Difficult inventory data management.

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Database Initial Study

❖ Areas of Operational Problems

- ◆ **Inventory/Storage/Order Management**
 - The CLD does not have ready access to crucial inventory manage data.
 - The UCL needs to know the available stock and average use of suppliers to effectively manage the inventory.
 - The CLD does not always know the actual location of any item at any given time.
- ◆ **Equipment maintenance and repair management**
 - The CLD cannot easily generate repair and maintenance history for each piece of equipment.
 - The CLD cannot easily determine the status of items currently subject to maintenance procedures.

Database Initial Study

❖ Areas of Operational Problems (Cont'd)

- ◆ **Equipment check-out/check-in management**
 - The CLD lacks timely and correct information about the Lab assets.
- ◆ **Lab assistant payroll management**
 - The CLD spends too much time reconstructing summaries of hours worked by each LA.
 - The CLD cannot easily estimate student work loads.
- ◆ **Lab reservations management**
 - The manual reservations system is inadequate.
 - The current system does not provide statistical information useful for scheduling Lab reservations.
- ◆ **Computer lab access management**
 - The user log is not properly maintained.
 - Some students do not return certain items.
 - Increasing security problems are a major concern.

Database Initial Study

❖ Constraints

- ◆ **Time Frame**
 - The new system needs to be fully operational within 3 months.
- ◆ **Hardware and Software**
 - It must be developed with existing UCL hardware and software. It must run on the existing LAN.
- ◆ **Distributed Aspects and Expandability**
 - It must be able to operate within a multi-user environment.
 - Its operation will be independent of existing administrative systems on campus.
- ◆ **Cost**
 - The programming costs must be minimal.
 - The new system will use no more than two additional terminals.
 - It must operate without requiring additional personnel.
 - CIS department has set aside \$9,500.

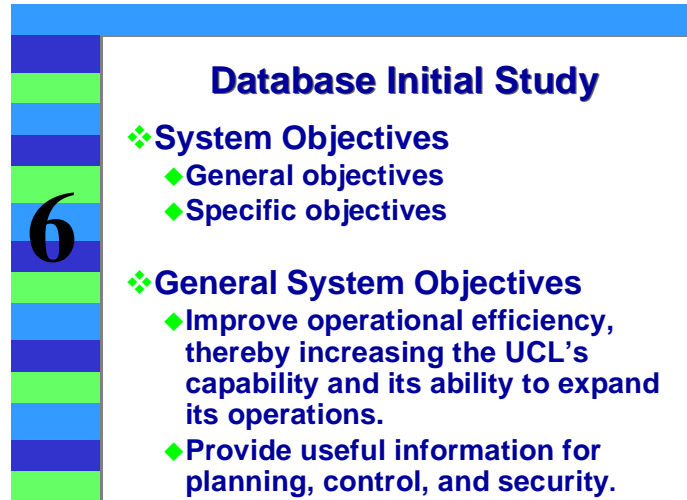
Database Initial Study

❖ System Objectives

- ◆ General objectives
- ◆ Specific objectives

❖ General System Objectives

- ◆ Improve operational efficiency, thereby increasing the UCL's capability and its ability to expand its operations.
- ◆ Provide useful information for planning, control, and security.



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Specific System Objectives

- ❖ **Inventory/storage/order management**
 - ◆ Provide better control of purchase orders.
 - ◆ Monitor the stock of supply items.
 - ◆ Control inventory by type (group) as well as by individual item.
 - ◆ Provide quick and efficient information about the location and status of each individual item.
 - ◆ Provide timely information about the use of supplies and generate the statistical information.
- ❖ **Equipment maintenance and repair management**
 - ◆ Monitors the maintenance history of each item.
 - ◆ Tracks items that have been returned to the vendor for repair or replacement.
- ❖ **Equipment check-out/check-in management**
 - ◆ Tracks the items that are checked out.

Specific System Objectives

- ◆ Monitors the item check-out time.
- ◆ Generates usage statistics for reference purposes.
- ❖ **Lab assistant payroll management**
 - ◆ Provides scheduling and work load information.
 - ◆ Provides work summaries for each LA.
- ❖ **Lab reservations management**
 - ◆ Decrease the time spent processing a reservation.
 - ◆ Produce reservation schedules.
 - ◆ Generate statistical summaries by department, faculty, staff member and date.
- ❖ **Computer lab access management**
 - ◆ Provide tighter control over users and resources in the Lab.
 - ◆ Reduce the sign-in time

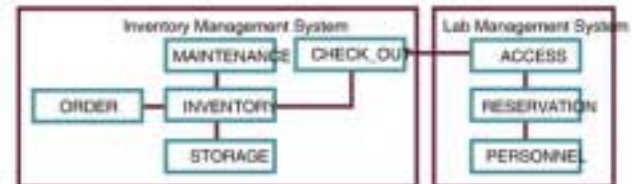
Database Initial Study

- ❖ **Scope and Boundaries**
 1. **What will be the system's extent?**
 - It will cover only the CIS portion of the organizational chart presented in Figure 7.1.
 - It will be independent of other database systems currently used on campus.
 2. **What operational areas will be covered by the system**
 - It will cover the six operational areas and will address the specific objectives listed previous
 3. **What design and implementation strategy should be adopted to bring the system online within the specified time constraints?**
 4. **What modules must be included in the system?**
 5. **How do the modules interface?**

Table 7.4 Required UCL System Modules

MODULE	OPERATIONAL AREA	PROCESS NAME
Lab Management System	Computer Lab access Reservations Lab assistants' payroll	ACCESS RESERVATION PERSONNEL
Inventory Management System	Inventory Order Storage Equipment maintenance and repair Equipment check-out and check-in	INVENTORY ORDER STORAGE MAINTENANCE CHECK_OUT

Figure 7.2 The University Computer Lab Management System



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Conceptual Design

- ❖ **Information Sources and Users**
 - ◆ **Conceptual design begins with confirming good information sources.**
 - Computer Lab director (CLD)
 - Computer Information Systems (CIS) department secretary and chair
 - Computer Lab assistants (LA)
 - Students, faculty, and staff who use the Lab's resources
 - All current computer lab forms, file folders, and report forms

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TABLE 7.5 DATA SOURCES AND USERS

MODULE	PROCESS	SOURCES(S)	USERS	REFERENCE	
Inventory Management System	INVENTORY	Inventory Type	University, CLD	CIS, CLD	Order Placement
		Item Data	Orders, inventory forms	CIS, CLD	Check-out
		Withdrawal	Inventory forms	CIS, CLD, LA	Storage
		Request	Bot Equipment Log	CIS, CLD	Inventory
		Check-out	Check-out forms	CIS, CLD	
	Location	Inventory forms	CIS, CLD		
	ORDER	Order Data	PO forms	CIS, CLD	Inventory Maintenance
		Items Ordered	Inventory forms	CIS, CLD	Inventory
		Items Received	University, CLD	CIS, CLD	Inventory
		Inventory Type	PO forms, CLD	CIS, CLD	Order
Vendor		CLD	CIS, CLD	Inventory	
STORAGE	Inventory forms		CIS, CLD	Access	
	Locations	Bot Equipment Log	CIS, CLD, LA		
	Item Data	Inventory forms	CIS, CLD		
MAINTENANCE	Request	PO forms	CIS, CLD		
	Item Data	Inventory forms	CIS, CLD, LA		
	Vendor Data	Check-out Log	CIS, CLD, LA		
CHECK-OUT	Item Data				
	User				
Lab Management System	ACCESS	User	Lab usage log	CIS, LA	Inventory
		Item Data			Check-out
	RESERVATION	Reservation Data	Lab reservation forms Lab access forms	CIS, CLD, LA, Faculty	Reservation Access
PERSONNEL	Lab accounts	Lab schedule form	CIS, CIS	Personnel	
	Schedule	Time sheet forms	CIS, CIS	Reservation	
	Hours Worked		CIS, CIS		

Note: CLD = Computer Lab director; Users = Student/faculty/staff; PO = Purchase order; CIS = Computer Information Systems; LA = Lab assistant

Conceptual Design

- ❖ **Information Needs: User Requirements (General System Requirements)**
 1. The system must be easy to use.
 2. The system must provide security measures by using passwords and access rights.
 3. The system must be fully integrated, thus eliminating redundant data entry and updates. It must ensure database integrity.
 4. Users must be able to access the system concurrently from several workstations. (See Table 7.6 and Figure 7.3)

FIGURE 7.3 UNIVERSITY COMPUTER LAB MANAGEMENT SYSTEM: A SETUP SUMMARY VIEW

USER	PROCESSES ACCESSED	USE	STATION ID(S)
Lab director	ALL	System administration	WS3
CIS department chair and secretary	INVENTORY ORDER	Queries only	WS4
Lab assistants	ACCESS RESERVATION CHECK-OUT INVENTORY	Updates and queries	WS1, WS2

Conceptual Design

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5. The system processes must perform the following functions:

- a. PERSONNEL process
- b. INVENTORY and storage process
- c. ORDER process
- d. MAINTENANCE process
- e. RESERVATION process
- f. CHECK_OUT process
- g. ACCESS process

6. The system's input requirements are driven by its output requirements: Query and Reports.
(See Table 7.7)

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TABLE 7.7 UCLMS REPORTS

NUMBER	REPORT	DESCRIPTION
1	Inventory movements	Inventory movements by date and type
2	Inventory	Inventory by inventory type
3	Location inventory	Inventory of items by location
4	Orders	Orders by date, vendor, and status
5	Open orders	Open orders by date and vendor
6	Orders payable	Orders received but not paid
7	Payment history	Orders paid by date and vendor
8	Maintenance	Maintenance history by date and item
9	Check-out	Items checked out by date and user
10	LA schedule	Lab assistants' schedule
11	LA hours worked	Hours worked by Lab assistants
12	Reservation schedule	Reservations by date and user
13	UCL usage statistics	Computer Lab usage statistics

Conceptual Design

❖ Developing the Initial Entity Relationship Model

TABLE 7.8 UCL ENTITIES

ENTITY NAME	ENTITY DESCRIPTION	ENTITY TYPE
USER	User data	
LAB_ASSISTANT	Lab assistant data	
WORK_SCHEDULE	Lab assistant work schedule data	
HOURS_WORKED	Lab assistant hours worked data	Weak
LOG	Daily users of the UCL	
RESERVATION	Lab reservation data	
INV_TYPE	Inventory types	
ITEM	Item data	
LOCATION	Item storage locations	
REPAIR	Repair data by item	Weak
VENDOR	Vendor data	
ORDER	Order data	

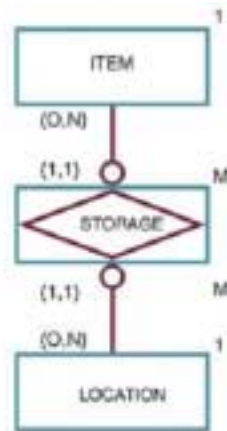
Business Rule 1:
Each item belongs to only one inventory type, and each inventory type may have zero, one, or many items belonging to it.

TABLE 7.9 AN EXAMPLE OF INVENTORY TYPE

INVENTORY TYPE				ITEM	
Category	Class	Type	Subtype	Item ID	Description
Hardware	Personal computer	Desktop	Personal	3233452	Gateway 2800 64 MB
Hardware	Personal computer	Laptop	Personal	3312455	Toshiba 33 MB
Hardware	Printer	Laser		2122146	HP LaserJet 77
Supply	Paper	Laser	8.5 x 11		Laser printer paper
Supply	Disks	3.5"	HD		3.5" HD diskette
Supply	Cartridges	Ink-jet	Color		Color ink-jet cartridge

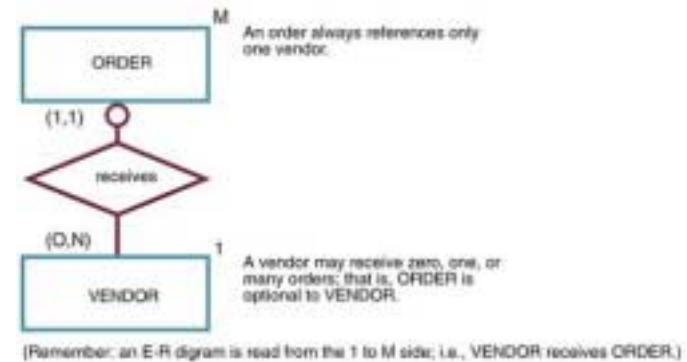
Business Rule 2:

An item may be placed in use upon its arrival, or it may be stored. Some items may be stored in more than one location. Therefore, an item may be stored in zero, one, or more locations. Each storage location may store zero, one or many items.



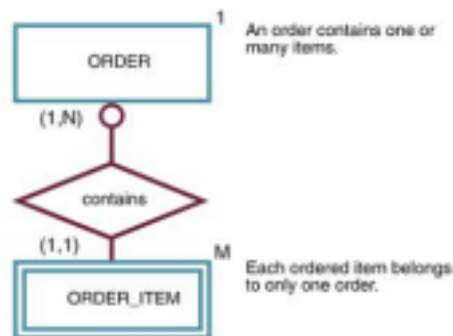
Business Rule 3:

An order references only one vendor, and each vendor may have zero, one, or many orders.



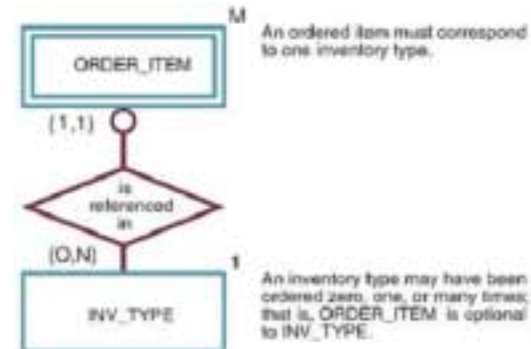
Business Rule 4:

Each order contains one or many ordered items.



Business Rule 5:

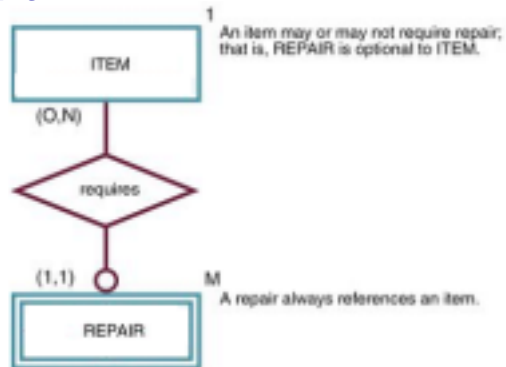
Each ordered item corresponds to one inventory type.



Slide Set 6: Conceptual Design

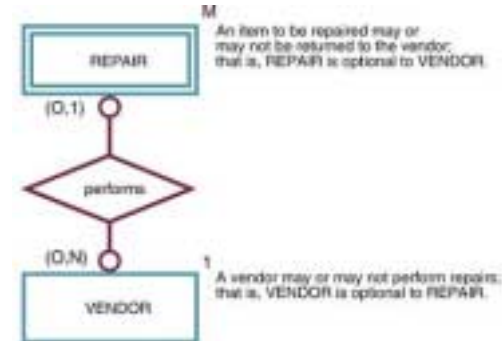
Business Rule 6:

Each item may require zero, one, or many repairs.



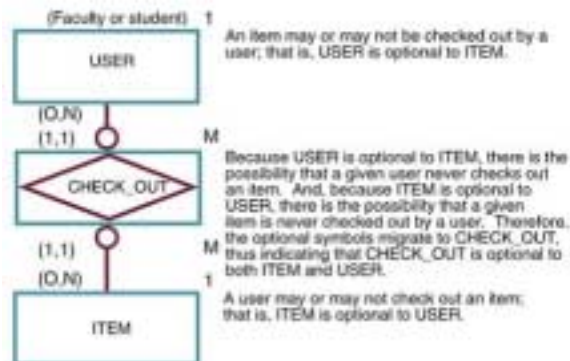
Business Rule 7:

Each item to be repaired may or may not be returned to the vendor (The CLD repairs some of them), and each vendor may have zero, one, or many repair items returned.



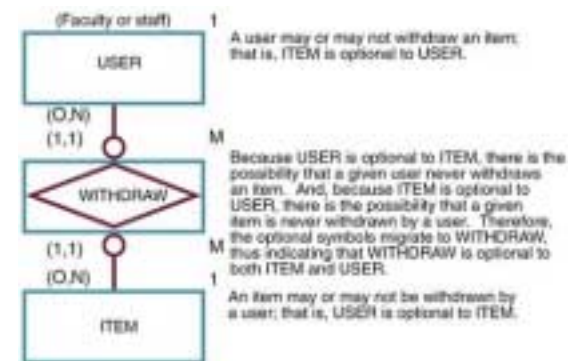
Business Rule 8:

Each user may check out zero, one, or many items, and each item may be checked out by zero, one, or many users during the semester.



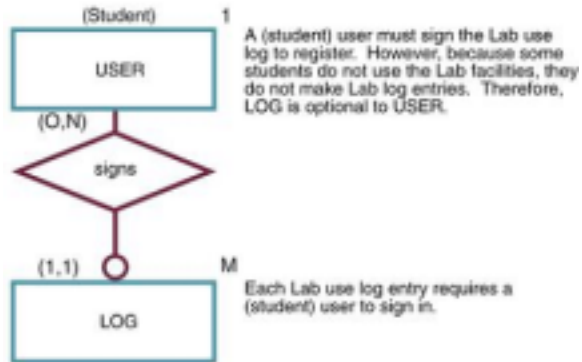
Business Rule 9:

Each user may withdraw zero, one, or many items, and each item may be withdrawn by zero, one, or many users during the semester.



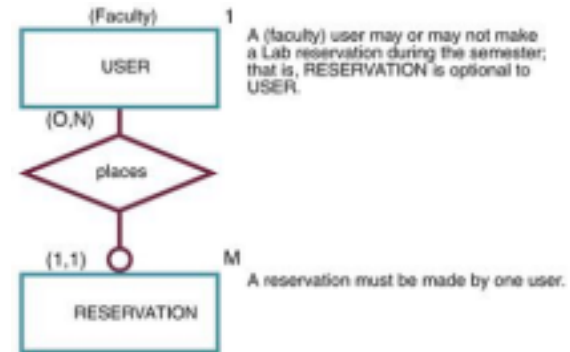
Business Rule 10:

Each (student) user may sign into the user log many times during the semester.



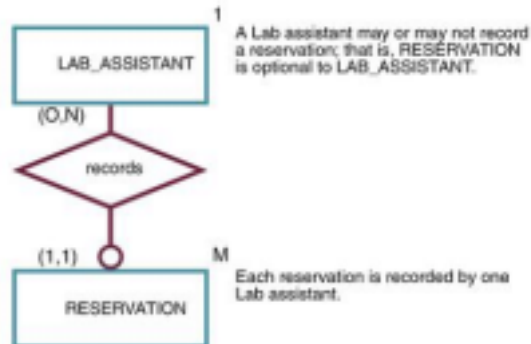
Business Rule 11:

Each (faculty) user may place zero, one, or many reservations during the semester.



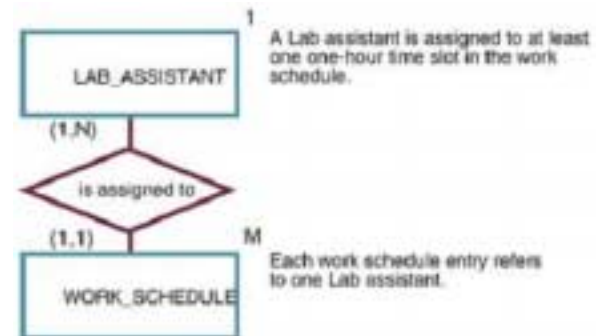
Business Rule 12:

Each reservation is recorded by an LA, and each LA may record zero, one, or many reservations during the semester.



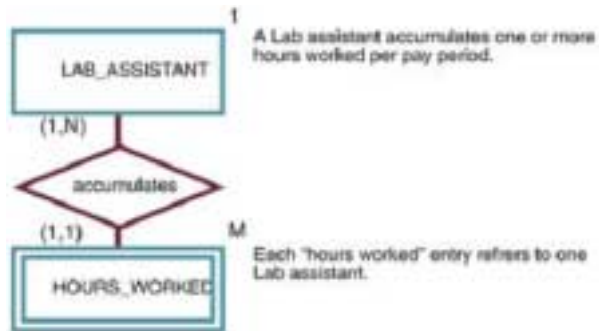
Business Rule 13:

Each LA is assigned to work at least one day in each week's work schedule.



Business Rule 14:

Each LA accumulates hours worked during each two-week pay period.



Business Rule 15:

Each item is supplied by a specific vendor, and each vendor may supply several different items.

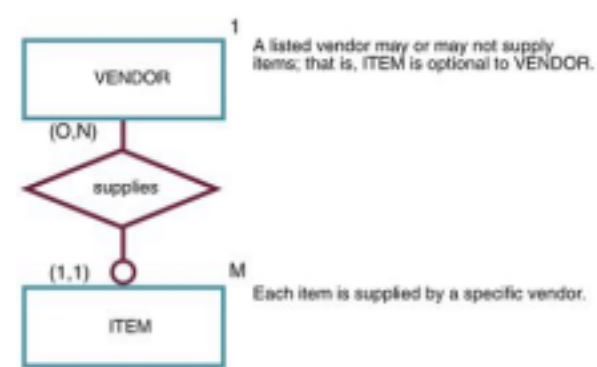


TABLE 7.10 UCL ENTITIES BASED ON THE BUSINESS RULES

ENTITY NAME	ENTITY DESCRIPTION	ENTITY TYPE
USER	User data	
LAB_ASSISTANT	Lab assistant data	
WORK_SCHEDULE	Lab assistant work schedule data	
HOURS_WORKED	Lab assistant hours worked data	Weak
LOG	Daily users of the UCL	
RESERVATION	Lab reservations data	
INV_TYPE	Inventory type data	
ITEM	Items data	
CHECK_OUT	Check-out data	Composite
WITHDRAWN	Withdrawal data	Composite
LOCATION	Locations where items are stored	
STORAGE	Items stored by location	Composite
REPAIR	Repair data	Weak
VENDOR	Vendor data	
ORDER	Order data	
ORDER_ITEM	Items ordered data	Weak

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Figure 7.19

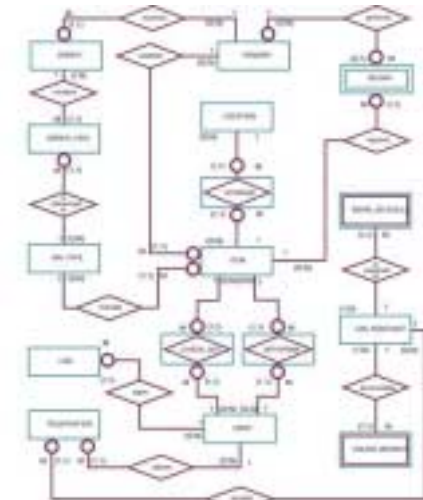


FIGURE 7.19 The UCL Measurement System's schema, 2002