Database Management Systems Projects

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Projects

Chapter Outline

Introduction to Database Projects

To learn how to build business applications, you need to work on a database project. The projects described in this appendix are simpler than real-life projects but complex enough to illustrate common problems that you will encounter.

The projects are designed to be built throughout the term. Students should demonstrate a completed database application at the end. Preliminary assignments are given for each project to get you started. However, the most important aspect of the case is to build the final, complete application. To provide additional feedback, the instructor should also evaluate the projects at two intermediate stages: (1) the list of normalized tables and (2) some initial forms and reports.

The most important advice to students is that you must begin work on the project as soon as possible. Do not put the project off until the end of the term. To have any chance at completing the project, most students will have to put in 20 to 40 hours of time. The project will reinforce the concepts discussed in the chapters—particularly data normalization and application design. If you work on the project throughout the semester, you will gain a better understanding of the topics, and you will finish most of the project before the end-of-term crunch.

Class projects are slightly different from real-world applications, but have many features in common. One of the most challenging aspects is that any project contains a level of uncertainty and ambiguity. When you start a real-life project, you never know exactly what the project is going to involve. As you talk with users, you encounter contradictions, uncertainty, and confusion over terms and goals. In real-life, you resolve these problems through experience and discussions with managers. With class projects, you do not have direct access to the managers and users. The instructor can answer some questions, but you will need to make your own decisions and interpretations.

When you first read the case, try to focus on the big picture. Identify the environment, goals, and objectives of the proposed system. Take notes on the company and jot down additional questions. Research the industry and similar firms to help identify terms, goals, and potential problems. When you begin to analyze the individual forms and reports, identify the overall purpose of each form. You should be able to describe the purpose of each form in one sentence. For any of the cases, you should make this list and keep it handy so you always remember the overall purpose of the application.

Remember that you will probably have to rework the normalization several times before the project is complete. Remember that every time you change the primary keys, you have to delete relationships. Try to develop a good normalized list before you begin creating forms and reports, but leave yourself enough time to go back and change the tables if you find problems.

In many cases it pays to start small and add tables and features slowly. Start with an initial set of tables and keys that you are certain are correct. Then begin building forms. Add columns and tables as you need them. If your initial tables are correct, you should be able to add new columns and tables without altering the existing design. For the final project, it is usually better to complete half a project where everything works, instead of a large mess where nothing works.

One final word of advice: Back up your work. Always keep a backup copy of your project on a different disk. Two or three copies are even better. Disks are cheap.

RMN Auto Sales (2005)

Purchase				
Date Location Seller/Dealer TaxID Auction yes/no				
VIN Make Model Year Color Miles Condition Book Price Price Paid	**#**	**Problem**	**Est. Repair Cost**	**Actual**
(more vehicles)				

Figure 1

RMN, a local used-car dealer needs a database to track the cars purchased and sold. Most cars are bought at auction, but a few are picked up from other dealers. The company pays cash at the auctions and brings the cars back to clean them up. When the cars are sold, the company generally finances the sale. Customers rarely have good credit, so the company prices the cars so that buyers cover the original purchase cost of the car with a down payment. The rest of the purchase price is financed, but even if the customer stops paying on the loan, the company has not lost any money. Consequently, a key aspect of the company's profitability is finding cars at low prices.

Purchases

The company has buyers that travel the state to attend various auctions looking for good deals. To get the best prices, the company is willing to pick up cars that other buyers do not want. In particular, the cars often need minor repairs. These repairs and costs are estimated at the time of the purchase by the buyer, and then actual costs are recorded as the work is done. The repairs generally involve simple body work to repair scratches and dents or cosmetic work on the interior. The company does not purchase cars that need major repairs. Consequently, all work is performed by the dealer at a small shop. The cost of the repair includes the materials and the labor costs—usually young workers just out of high school working for low wages to gain experience. Figure 1 shows the basic form the buyers fill out when a car is purchased. The individual problems spotted are numbered, but not in any particular order. Remember that the buyer is looking at dozens of cars at a time and needs to quickly record basic data about the car during an initial inspection before the bidding begins. The book value is the average price for the vehicle as listed in the industry guide books, but the owners never allow the buyer to pay that much. At some point, the buyers would like a portable version of the database so they can fill out this form and have it calculate totals while at the auction.

Sales

Sales of the cars are relatively traditional. A salesperson helps the customer select a car and negotiate the price. Figure 2 shows the basic form to record the sale. The employee commission is usually added to the form after the customer signs it, but

Sale Date Total Due Down Payment Financed Amount		Employee Last Name, First Name Commission			
Customer Phone Last Name, First Name Address City, State ZIP	Employment				
	Employer	**Title**	**Super.**	**Phone**	**Address**	**Start**
VIN Miles Condition List Price Sale Price Style (sedan, SUV, …) Interior Color					

Figure 2

sometimes employees list a lower-than-normal commission to help sell the car. Because RMN finances part of the price, customers are asked to list their current and last few employers—in case the company needs to repossess the vehicle.

Warranties and Payments

RMN also offers a variety of warranties as a major selling strategy. The warranties help to sell cars because people believe a warranty lowers the risk. Yet, because the cars are relatively sound to begin with, few warranty claims arise, so the company makes a solid profit on the warranties. Consequently, salespeople are encouraged to sell the warranties and receive a relatively high 25 percent commission on them. As shown in Figure 3, separate warranties are offered for various components. For instance, an exterior warranty covers the paint, while a drive-train warranty covers various engine and transmission elements. Note that each warranty only covers the listed items. Customers are given several options,

VIN Customer Co-signer Warranty Sale Date Total Cost Monthly Cost	Salesperson Phone
Warranty1 StartDate Length Cost Deductible	
Items Covered	
Warranty2 StartDate Length Cost Deductible	
Items Covered	

Figure 3

Payment History				
Customer Gender Date of Birth Taxpayer ID				
Number of late payments				
Average number of days late				
Pmt Date	**Due**	**Paid Date**	**Amount**	**Bank Acct**

Figure 4

including the length of the warranty and the level of the deductible. Of course, longer warranties and lower deductibles cost more. These values are specified in the warranty policies, but the salesperson needs to enter them on this form so everyone knows exactly which warranty was purchased. The customer also has the option of paying the warranty fees upfront as a lump sum, but most decide to finance them over time in the form of monthly payments. These values are entered by the salesperson using a chart—essentially the company charges a one percent per month interest rate for financing the warranty costs.

To provide documentation for situations when complaints arise, or when RMN has to repossess a car, the company records all of the payments made by the customer. Figure 4 shows the basic form. To provide faster lookups (on the paper forms), the clerk also updates the number of late payments and the average number of days late whenever a payment is late. The company uses date of birth, gender, and taxpayer number to obtain credit reports on the customer. Really bad customers are also reported to the credit bureaus.

On average, the company sells 5-10 cars a week, and generally tries to keep no more than 50 cars on the lot at one time. However, if good deals pop up at auctions, the buyers are encouraged to purchase them, but then they hold off on buying the marginal cars.

Exercises

1. Create the feasibility study (initial proposal).

2. Create a list of all of the forms and reports that the company might use.

3. Create a normalized list of tables for each form and report.

4. Create an integrated list of normalized tables for the entire application. Draw the corresponding class diagram.

5. Create the basic tables in a DBMS along with all necessary relationships and integrity constraints. Enter sample data into the tables to test your design.

6. Evaluate the normalized tables and estimate the size of the database—both current size and estimated size in 3 years.

7. List the initial security conditions for the data tables. Create a list of user groups and identify their basic access needs.

8. Design the overall structure of the application. Outline the overall structure and the primary forms. Select a design scheme, including layouts, effects, and colors.

9. Build three initial input forms.

10. Build three initial reports.

11. Improve the forms and reports to make them easier to use.

12. Test your forms and reports with sample users.

13. Build additional forms and reports. Improve all of them. Test all of them.

14. Connect all of the forms and reports into an application. Add help files. Test all the links. Test the forms and reports. Check for consistency.

15. Add security, backup and recovery, and other management features to the application.

16. Move the data tables to a centralized server, leaving the application to run on a client. Build the necessary links and retest the application.

17. Move the entire application to a Web server. Build the forms so that they run on a Web browser.

18. Create an OLAP evaluation query and graphs. Build in a way to create the links so new annual data can be generated automatically. Link the data so that the spreadsheet is updated automatically.

Monster Video (2005)

Appraisal						
Customer Location Address City, State ZIP Code						

Room Dimensions Drawing Primary seating distance	Lighting Windows Floor Ceiling height Acoustic comments

Item	Location	Distance	Type	Max Size	Cable Run	Comments

Figure 1

Monster Video is a company that specializes in designing and installing home theater systems. Most of the time, these are complex systems costing thousands of dollars. Some vendors (notably Sony) are offering customized equipment that can be tailored for the specific environment—for the truly discerning consumer. With multiple speakers, large video screens, and high-power amplifiers, these systems require careful design to match the room characteristics. It often takes several days to install the systems—mostly because of upgrades to the electrical and lighting systems. Installing cable for the speakers also takes time—particularly in older houses. The company needs a database to track the customers, estimates, sales, and installations.

Initial Appraisal

A key element in the success of the firm is the initial evaluation of the location by a trained salesperson. Figure 1 shows the basic elements collected during this appraisal. The salesperson records the dimensions of the room, the most likely location of the seating arrangements, and creates a small drawing to show the overall layout of the room. Later, engineers will select the best locations for the speakers. Usually, the customer already has an opinion about where to put the video screen. The salesperson records existing lighting, and adds notes about possible improvements. The number of windows plays an important role—in terms of positioning the screen and in the need for supplementary lighting. The floor and ceiling affect the acoustics, as well as limit the potential locations for speakers. Additional acoustic comments (such as "too much echo") are given to the engineers. Sometimes, the engineers need to add acoustical tiles or even acoustical blocks to reduce or change the reflected sound.

The salesperson also identifies possible locations for speakers—modern systems require six speakers at a minimum: subwoofer, center channel, front-left, front-right, rear-left, and rear-right. The placement of the front and rear channel speakers can sometimes be difficult—particularly in modern-style houses with non-uniform walls and high ceilings. Ultimately, an engineer will narrow down

Proposals		Salesperson
Customer		Engineer
Phone		
Subdivision		Date
Option 1: Description		
Comments		

Item	**Description**	**Quantity**	**Price**	**Value**

Option 2
...

Figure 2

the final location, but due to the training, the salespeople are usually close. The distance from the speakers to the main seating position are critical, as is the maximum size allowed. For example, some people object to having large speakers at the front of the room, and in other cases, the walls may not be wide enough to hold large hidden speakers. Additional comments are used to warn the engineer about potential problems.

Proposal Options

An engineer looks over the room and the various comments and then creates three or four proposals for the room. Generally, the options on a proposal are similar in location and installation issues, but contain different levels of hardware. For example, one proposal might use a video projector, while a second uses a flat-panel display. To the customer, the major difference between options is generally the price; but the functionality of the options is also different. If the customer truly gets bogged down on the price, the salesperson can generate additional options by swapping in less-expensive equipment for some areas (such as a less powerful amplifier). As shown in Figure 2, some options have higher installation costs. For example, a video projector requires expensive cable between the amplifier and the projector. To make this difference clear the installation cost is listed separately for each option. After consulting with the salesperson, and sometimes the engineer, the customer chooses one of the options. However, customers sometimes change components out of the options—such as a cheaper DVD player.

Installation

Installation is always a challenge and must be scheduled around the customer. First, the electrician has to install cables and outlets. Sometimes the circuits or even the main power must be upgraded. A finishing-carpenter usually works with the electrician to minimize damage to walls and woodwork. Sometimes customers have the electrician install the wiring during construction of a new house—saving time and hassle. In fact, an increasing number of jobs come through builders who offer the home theater as an (expensive) option. In these cases, the salesperson has to be careful to identify the actual customer and the separate billing client (the builder).

Installation				Date Start		
Customer				Date Finish		
Location Directions				Cleanup		
				Total Material		
Room				Total Labor		
Number of seats				Total Costs		

Cables

Cable	Length	Type	Cost	Installer	Labor	Total

Electrical

Description	Materials	Time	Installer	Labor	Total
Video					
Amplifier					
Circuit					
Lights					

Speakers

Speaker	Location	Item	Cost	Installer	Labor	Total

Figure 3

Figure 3 shows the basic worksheet filled out by the installers. Many of the installers work for Monster Video, but when the company is busy, it hires external contractors—particularly electricians. In these cases, the electricians staple their business cards to the sheet to ensure the checks get sent to the correct address.

The main worksheet itemizes the audio cables, in terms of the type of cable, the length, and which speaker it connects. Additional electrical work includes power and cables needed for the video (particularly for projectors), the amplifier, lights, and any additional circuit, main line, or breaker work needed.

Speakers are also listed on the installation sheet because they are often installed at the same time as the cables. For large-scale systems, the speakers can be expensive, so each one is listed separately. Sometimes the installation is tricky and requires additional finish work to hide the speakers. In all cases, Monster Video tracks the name of the actual installer in case there are problems, and to identify the good contractors for use on later jobs.

The amplifiers, DVD players, tuners, satellite dishes, and video screens can all be expensive in these large systems. Also, they often need additional components, such as cables and signal boosters. These items are installed and fine-tuned by technicians working for Monster Video. One employee is always in charge of this final installation and tuning to minimize problems. Figure 4 shows the selection of the final components and their total costs. Although it is not shown here, customers are given a final bill that summarizes all of the individual subtotals. Monster

Audio Video Components Customer	Billing Address City, State ZIPCode					
Date Installed Employee Cell Phone						
Item	**Description**	**Category**	**Size**	**Sale Price**	**Quantity**	**Subtotal**
					Subtotal Tax Total Date Due	

Figure 4

Video does not finance the purchases, but it does accept credit cards. It also has contacts with various finance agencies for people who want to borrow the money. In most cases, Monster Video asks for a 30 percent deposit before installation starts. But, then it is willing to wait a month after the final installation to collect the total payment. This feature is appealing to some customers in case they have problems in the first few days.

As shown in Figure 5, Monster Video also offers extended warranties or service contracts on most of the equipment. For example, bulbs for video projects generally last only a year, so customers like to buy a contract where a technician comes out once a year and replaces the bulb and cleans the projector. The form is also useful in reminding the customer and the company when each warranty expires and when the overall system is no longer under any warranty. Generally, the salesperson writes down the serial numbers and other information needed to obtain warranty service from the manufacturer. If anything does go wrong, the customer simply calls the salesperson who looks up the appropriate numbers and obtains a replacement part from the vendor. This high level of service has made Monster Video popular among the wealthier clients and has led to many referrals.

Warranties Customer Location Start Date	Employee Title			
Item	**Mfg Warranty**	**Add. Warranty**	**Coverage**	**Cost**
	Total Date all warranties end			

Figure 5

Currently, the company has been in business for a little over three years, and has installed almost 500 systems. Although the firm has 10 full-time employees, the margins on the equipment and the service charges have enabled the firm to be profitable for the last two years. The owners are hoping to double the business in the next couple of years. Based on the number of appraisals under way, this level of sales might be possible. Depending on the economy, salespeople often generate 5-10 appraisals before a sale is made.

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Big Chemical, Inc. (2005)

Big Chemical, Inc is a large company specializing in custom chemistry research and production. Its researchers often work on highly-sensitive projects for various government agencies. Even the work it does for other companies tends to be secretive because client firms do not want others learning about their new product ideas. Consequently, the company is extremely sensitive about security issues. Although they are cautious about hiring and use background checks, they still want to keep closer track of their employees. They are in the process of installing sensors on every door and gate in building on the main campus. Employees will be issued badges that are automatically read at each point. The system will be able to track each person crossing through a door. But, the company also wants the ability to check data for the last week or month, so it needs a database to hold the data and produce reports on employee activity.

Employee Information

Figure 1 shows the basic data collected on employees. Note that the company randomly tests employees for the presence of various drugs (including alcohol). The results of the tests and any comments are summarized. The details of the test are kept in a different system indexed by the LabTestID. On this form, the results can be one of three values: Clear, Fail, Caution. After two cautionary results or one failure, the employee is fired.

Sensors

Figure 2 shows the location of the sensors. Each door will be fitted with a sensor that will send the data to the main system as a stream of bytes. This system will be able to insert rows into data tables created in the new application. Several types of sensors are used to compensate for different sizes and characteristics of doors. The company needs to keep track of the type of sensor in case one needs to be replaced. Also, most of the sensors are capable of indicating the direction the person

Employee				
	Internal ID		TaxpayerID	

Date Hired
Department   Address Home Phone
Supervisor   City, State ZIP

Education

School	Start Date	End Date	Degree	GPA

Drug Tests

Date	Lab Used	Test Used	Lab Test ID	Results	Comments

Figure 1

Sensor List

SensorID	Building	Floor	Room	Door	Sensor Type	Date Installed

Figure 2

traveled through the door—which is labeled "in" or "out" by the installer. Ultimately, all of the sensors will be displayed on an electronic map of the building.

Figure 3 is a basic sensor repair log. Although the sensors are fairly reliable, the company needs to track any downtime. If a sensor is not working, some queries will give misleading results. For example, it might appear that a person never leaves a room if the room has two doors and one of the sensors is broken. While this log does not completely solve the problem, at least it will make it possible for users to realize that a problem might exist.

Employee Access

As shown in Figure 4, employees have to be graded access to specific buildings and rooms. Data from this from is transferred to the entry control system for the building. Some rooms are not locked, but still have sensors. Other rooms are locked, and the sensors open the door only for employees who have been granted access. Access is granted by project directors who have control over certain rooms and the employees who report to them. Directors are responsible for keeping the lists up to date. To provide stronger security, directors are required to enter a starting and ending date for the access right. Beyond the ending date, employees will be denied access. In general, employees are also restricted to specific times. For example, an employee could be allowed into a research lab during normal working hours, and then locked out at night. The main gate sensor is similar to the door sensors, but it is monitor differently. Some employees are required to be off the premises after a certain time of day.

Figure 5 would never be printed in real life, because there would be too much data. It represents the sensor activation data collected by every sensor in the company. The sensors record the date and time as well as the person going through the door. The direction of travel is also noted. The sensors are relatively accurate and can even handle two people entering a door at approximately the same time. If one person enters a room and immediately turns around, it would be recorded

Sensor Repair Log

SensorID	Date Down	Date Restored	Technician	Cause	Repair

Figure 3

Employee Access Rights			Main Gate Times			
Employee			Earliest Entry			
Security Clearance Level			Latest Departure			
Title BadgeID						

Building1

Floor	**Room**	**Start Time**	**End Time**	**Director**	**Start Date**	**End Date**

Building2

Floor	**Room**	**Start Time**	**End Time**	**Director**	**Start Date**	**End Date**

Figure 4

as an entrance followed by an exit—adding two rows of data. With almost 20,000 employees on the main campus, a dozen buildings with several floors of offices and labs, the sensors collect a large amount of data every day.

In general, security personnel want the ability to track the movements of employees throughout the day. In most cases, the report shown in Figure 6 is displayed only when security personnel become suspicious of an employee. The report is slightly tricky to create when rooms have several doors. Also, remember that sometimes sensors fail, so the system might not record a person entering or leaving a room. Ultimately, managers would like to see a graphical display of this data—based on an electronic map of the campus. But, for now, they will be happy with this report that shows all of the activities of a suspicious employee.

Sensor Activation

Sensor	**Date Time**	**BadgeID**	**Direction**

Figure 5

Tracking Log			
Employee		Start - End	
Office Phone Cell Phone			

Time-In	**Location (Building/Room)**	**Time-Out**	**Door**

Figure 6

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Big Teeth Reality TV (2005)

Application	Photo
Name Address City, State PostalCode Country Daytime phone Night phone E-mail address Date of birth Gender	VideoID
Candidate essay	Ratings Producer Director

Medications	**Reason**

Jobs	**Start**	**End**	**Description**

Figure 1

A new reality show is entering production. A cross between Animal Planet and Fear Factor, it focuses on conflicts between humans and animals with big teeth (crocodiles, tigers, lions, and so on). Contestants never know if they will be chased by the animals or if they will be eating them. The insurance costs will be huge, but the producers think there is a big audience. Producers always think that, but at least they are willing to pay money to find out. The next step is to find people crazy enough to sign the waivers and participate in the show.

Applications

Figure 1 shows the basic contestant application form, but this copy does not include the lengthy waivers that must be signed. The producers are adding a twist and recruiting worldwide. The goal is to build more suspense by adding communication problems among contestants and perhaps to foster some nationalistic audience participation. Contestants are asked to submit a photo, which is scanned and stored in the database. They are also encouraged to submit a short video interview. These interviews are only used for evaluating the final tier of candidates and portions might be used during a broadcast. The videos for the most likely applicants are copied to a master tape and given a location identifier. The lead producer and the director evaluate each applicant and provide a quick rating. The highest-rated candidates get a second look and become a finalist in the selection process.

All applicants undergo a background check. Several reality-based shows have experienced problems when contestants were revealed to have unsavory pasts—including being arrested for violent crimes. Although the producers want risk-taking contestants, they also want to avoid embarrassing public disclosures. Figure 2 shows the basic background data that investigators obtain on the finalist contestants. It is not foolproof, but by making a few phone calls, the investigators get a reasonable idea of the candidate's background. All finalists are interviewed on

Background Check			
Applicant			
National ID Appearance Rating			
Religion Strength Rating			

Employer	Phone	Comments

Education	Contact	Degree	Comments

Police and Judicial Records

Date	Category	Description	Outcome

Figure 2

camera and evaluated in terms of appearance and physical strength. The producers and directors then select the contestants for an episode.

Episodes and Events

Actual episodes consist of one or more events. Generally, there is only time for one or two events per episode, but the producers are thinking about the possibility of an hour-long special. Figure 3 shows the two main aspects of the event: the setup from the perspective of the director, and the results from the perspective of the contestants. The director focuses on the sequence of actions, where the cameras will be located, and the estimated time of each section. For each event a contestant is given one primary task. Sometimes they work in teams, so two or three people might be given the same task. The task result might just be a completion,

Event					Producer			
Title					Director			
Description					Episode			
Estimated time								
Estimated danger								
Contestants					Actions			
Name	Task	Result	Points	Prize	Seq.	Description	Cameras	Est. Time

Figure 3

Voting			
Episode Title Episode Air Date			
Contestant	**Region**	**Method**	**Votes**
			Total
Contestant	**Region**	**Method**	**Votes**
			Total
...			

Figure 4

or it might include a time for races. Either way, contestants are awarded points (sometimes negative points) for their role in the task. Occasionally, small prizes are awarded for completing a task, but contestants are really competing for the overall prizes in the event.

When the episode is aired, the audience is asked to participate by voting for favored contestants. The vote totals are used to determine which contestants to bring back for future episodes, and to give prizes for the overall season leader. The executive producers are trying to entice advertisers by supporting several means of voting. Consequently, they want to track the actual method used to cast a vote. Common methods include telephone, cell phone/text messaging, e-mail, and a website. They also need to track audience participation by geographic region. On the report shown in Figure 4, the regional level is global (largely by continent), but at a minimum, statistics have to be kept at the national level, and probably even down to state level in the United States.

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Cerulean Bee (2005)

Artwork Order		
Customer Contact Phone Discount Total Price		Order Date Date Approved Scheduled Print Date
Apparel/Item Base Color Maximum Colors		Event Theme
Art Location Description Cost Employee Date Complete		Colors _____ _____
Art Location Description Cost Employee Date Complete		Colors _____ _____

Figure 1

Bob Bee is an artist who has chosen to make his living designing and printing shirts and jerseys for various clubs and events. He named the company after himself and his favorite color. Although he has been in business only a couple of years, it has been successful. Several local clubs sponsor several events each year and want commemorative apparel that they either give to everyone who registers for the event or sell as a separate item. Either way, Bob makes money because he is paid for the work regardless of the number of items that actually sell.

Artwork

Sometimes customers have only a vague idea of the artwork needed. Other times, they come with computer-printed designs. In most cases, an artist still has to clean up the artwork so that it will display reasonably well on the desired item. Ultimately, the art must be color-separated so that each color has its own film. The individual films are assigned to a single print color on the press, and the colors are placed in layers on the final object. Registration, or matching the color separations so the colors do not overlap and the separate layers align perfectly, is a key element in creating a professional product. As shown in Figure 1, an individual item, such as a shirt, could have art in several locations (front, back, sleeve, and so on). Each location requires a separate pass through the print process. Each color requires a separate film and a separate imprint. Although the newer print systems automatically rotate an object through several colors, each print station requires a separate setup, so customers are charged by the number of artwork elements and the number of colors. The total price of the artwork generally includes a setup fee as well as the per item charges. Some organizations are given discounts, but these are somewhat arbitrary and determined by Bob. Most customers create t-shirts associated with some event, such as a festival, race, or bike ride. The artists work the event's theme into the designs.

Employee Work Log					
Employee Phone Full Time/Part Time					
Date	**Start Time**	**Project**	**Art Item**	**Task**	**Time**

Figure 2

As shown in Figure 2, all workers keep a log of the time spent on each project. The most important times are the hours spent on the artwork, but the log does include time spent running the printing press. The log is relatively simple, and employees basically fill out a time card each day. Each major customer order is given a project number, and employees enter this number into their logs. So far, the company does not have a standard method to identify the individual art items for a project, so employees tend to make up descriptions.

Print Order

Customer   Order Date
Contact   Art/Slide Date
Phone   E-Mail   Due Date

Setup charge   Apparel Order Date
Deposit   Art/Film Date
Discount   Print Date
Total Cost   Date Delivered

Apparel/Item

Base Color   Vendor

Size	**Number**	**Add. Charge**
X-Small		
Small		
Medium		
Large		
X-Large		
XX-Large		

Per unit base price   Color Charge
Total blank price

Art Print

Location Size   # Colors Charge
Color List: _____

                      _____
                      Total

Figure 3

Project Cost Analysis

Project   Event   Item
Customer
Order Date   Delivery Date

Material Costs

Item	Per-unit Cost	Price Charged	Units	Cost	Revenue
				Total	Total

Labor Costs

Employee	Task	Time	Wage Rate	Cost
				Total

Total Money Received
          Material Charge Artwork Fees   Fixed Charges
Total Material Costs
Total Labor Costs
Shipping Costs/Other
Discounts   Net Profit

Figure 4

Orders

Once in a while customers just place orders for the artwork, but generally, they really want the art imprinted onto some item—usually a t-shirt. Figure 3 shows the main print order form. This form is also used to guide the overall project time-frame, so several dates are added to it as the order progresses through the system. The first major step is to select the apparel item. The company keeps samples of common items and colors on hand to help the customer visualize the final product. Many other items can colors can be ordered from a selection of vendors. The price of the item is an important consideration in the selection, and vendors have different prices based on fabric and size. Basic sizes are listed at a standard price, but the larger sizes carry an additional charge. The customer has to estimate the number of items desired at each size. Per unit prices also depend on the quantity ordered—with typical breakpoints of 100, 500, and 1000 unit orders. The other in-teresting twist is that most vendors charge higher prices for darker-colored items. The actual costs and the price Bob charges fluctuate, so they are determined by the clerks at the time of the sale. This form also contains the pricing breakdown for printing the individual artwork. The price is determined by the number of imprints and the number of colors. It is critical for clerks to enter all of the exact colors on the form.

At the end of the month, Bob develops a report that displays a cost analysis for each recent project. He uses the information to help set prices and to iden-tify which jobs are the most profitable. Figure 4 shows the basic arrangement of

the report. Bob usually looks at the net profit data first followed by the subtotal breakdown. He only looks through the detail material and labor costs in cases that seem unusual. Note that all items used in the production of a particular item are listed—including the apparel, film sets, and ink. The labor costs are summarized by task. Even though an employee might have worked on the artwork three different times over four days, there will be one entry for the artwork development. One of the important steps in this case is identifying a standard list of tasks—because employees tend to invent strange names every month, and it is difficult to put the data together to create this report.

Exercises

1. Create the feasibility study (initial proposal).

2. Create a list of all of the forms and reports that the company might use.

3. Create a normalized list of tables for each form and report.

4. Create an integrated list of normalized tables for the entire application. Draw the corresponding class diagram.

5. Create the basic tables in a DBMS along with all necessary relationships and integrity constraints. Enter sample data into the tables to test your design.

6. Evaluate the normalized tables and estimate the size of the database—both current size and estimated size in 3 years.

7. List the initial security conditions for the data tables. Create a list of user groups and identify their basic access needs.

8. Design the overall structure of the application. Outline the overall structure and the primary forms. Select a design scheme, including layouts, effects, and colors.

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10. Build three initial reports.

11. Improve the forms and reports to make them easier to use.

12. Test your forms and reports with sample users.

13. Build additional forms and reports. Improve all of them. Test all of them.

14. Connect all of the forms and reports into an application. Add help files. Test all the links. Test the forms and reports. Check for consistency.

15. Add security, backup and recovery, and other management features to the application.

16. Move the data tables to a centralized server, leaving the application to run on a client. Build the necessary links and retest the application.

17. Move the entire application to a Web server. Build the forms so that they run on a Web browser.

18. Create an OLAP evaluation query and graphs. Build in a way to create the links so new annual data can be generated automatically. Link the data so that the spreadsheet is updated automatically.

Orange Blossom Nursery (2007)

The Orange Blossom is a local plant nursery that specializes in providing hard-to-find plants to contractors and homeowners. The company also carries most of the common plants and trees, but the owners take pride in their ability to grow more unusual varieties and colors. Contractors and landscape design firms within a couple hundred miles come to the Orange Blossom for unique specimens, often used as highlights in their designs. Prices reflect the uniqueness and high quality of items offered by the firm.

Despite the company's reputation, Orange Blossom faces the same pressures of any nursery. Weather can be a problem—particularly dry spells or hail. But, bad weather also boost sales. Homeowners and businesses lose plants during difficult times and they come to Orange Blossom to replace them. The biggest challenge is trying to forecast the demand for new housing and landscaping. It takes time to grow many of the plants to the size requested by contractors and landscapers, so Orange Blossom managers have to plan ahead and estimate the number of plants that will be needed. If the local economy slumps, building rates fall, and the company is left with unsold plants. Fortunately, most of them can be protected and sold in future years, but the costs of growing the plants cuts into current-year profits.

Plant Orders

As much as possible, Orange Blossom managers encourage contractors and landscapers to order plants in advance. Many large projects are designed a year or two in advance of construction, providing time for the nursery to grow or locate the larger specimens required. Of course, homeowners rarely plan ahead, so almost

OrderID
Order Date
Date Modified

Employee
Phone

Client
Contact
Phone
Address
City, State ZIP

Project
Location/Address
City, State ZIP
Client Project Number, Phase
Description

Project Start Date
Estimated Installation Start
Project Type

Design Segment

Segment description
Location

Item	Description	Size	Color	Stock or External	Location	Price	Date Needed	Date Installed

Figure 1

all of the advance orders are placed by established clients. To assist the clients, Orange Blossom wants to keep many of the plan details in the computer system. Clients will be able to select a project and find the list of plants, along with the planned locations of each plant. Locations of flowers and small plants are simply specified in terms of a growing area. Trees and highlight specimens are given more detailed locations. Traditionally, landscape designers use a grid system. Each section of the landscape design will be drawn on a scale grid that matches the property. Each major tree will be displayed as a circle centered on a grid point that corresponds to a location in the ground. A few designers of large projects have started listing GPS coordinates (latitude and longitude).

Figure 1 shows the basic information collected on the order form. Large projects are often completed in stages or phases, so the form has a place for clients to record that information. Plants are ultimately identified by their species and variety using specific Latin names. However, general descriptions are provided using common names. Plants and trees have different types of measurements. Trees are generally measured by their caliper or diameter, usually in inches. Small shrubs or flowers can be measured by the container size (such as 1 or 5 gallon). Larger shrubs or even smaller trees might be measured by height, in feet.

Orange Blossom Nursery Statement			Client Account Manager Fax E-Mail Billing Address City, State ZIP				
Billing Date Time Period							
Starting Balance							
New Orders							
Project	**Special Orders**	**Pick Up**	**Custom**	**Regular**	**Deposit**	**Net Due**	
Amount Increased							

Payments Received				
Date	**Project**	**Project Total**	**Amount Paid**	**Balance**

Total Received

Outstanding Balance
Interest Charges

Ending Balance

Figure 2

Orange Blossom Delivery						
Delivery Date Delivery Time Contact Person Cell Phone			Client Billing Account Number Address City, State ZIP			
Project Customer Delivery Location Address City, State ZIP Directions						
Planting						
Item	Size	Truck	Planting Time	Delivery Charge	Planting Charge	Total
Tax Total Charges Driver Distance (miles) Cell Phone Comments						

Figure 3

Payments and Billing

Landscape designers and contractors purchase items for other customers. As a result, Orange Blossom maintains accounts for its major clients. Ultimately, the contractors and designers are responsible for payment, but it takes time to install a project and collect money from the end customers. Orange Blossom allows clients to identify a project when making a payment, and tracks their spending for them. Consequently, Orange Blossom allows its clients to pick up items and pay for them later. If "later" turns into months, it can be a problem. So, the accounting manager wants to track payments based on projects and be able to send billing notices to the contractors. After more than two months, the bills should include an interest charge. Additionally, expensive plants, special orders, and large orders require down payments. Designers almost always collect some money upfront from customers, so Orange Blossom wants some of the money to avoid problems with nonpayment. Some clients make payments over time—particularly as a project progresses. As shown in Figure 2, Orange Blossom sends a monthly billing statement that lists the balance at the start of the period, new purchases, and any payments received.

Delivery

Orange Blossom also delivers items and will plant larger trees. Few contractors have the equipment to move or plant the big trees, so it is a popular service. To schedule deliveries efficiently, the planting manager requires clients to schedule

	Orange Blossom Purchase Order							
Purchase Order Number				Order Date				
Employee								
Contact Phone								

Vendor	Accounting Manager (for payments)
Location	Phone
Address	Address
City, State ZIP	City, State ZIP

Items

Mfg Item	OB Item	Description	Quantity	Price	Delivery Date	Quantity Delivered	Quantity Rejected	OrderID

Total Due

Amount Paid
Date Paid

Figure 4

deliveries in advance. The delivery charge depends on the distance traveled. Orange Blossom drivers have the equipment to dig holes to plant the trees, but the company requires that the buyer contact the utility companies to have the location inspected and marked for underground utility lines. The installation or planting charge depends on the size of the tree and the time and labor required. Figure 3 shows the basic form that is used for scheduling deliveries. It is also completed by the driver after an item has been delivered. The Delivery Date is initially filled out by the clerk to match the requested date. It is either accepted or changed by the driver when the items are delivered. Similarly, the Delivery Charge and Planting Charge are estimated by the clerk when the request is made, and the final planting charge is computed later based on the actual planting time.

Purchases

Orange Blossom Nursery purchases several items from manufacturers and large growers. The company goes through thousands of pots every year, along with tons of fertilizer and other chemicals. Most of the products are used to grow and sell the plants. A few are sold directly to clients. Additionally, some plants are grown or started at large wholesale nurseries and purchased in bulk. Some of the vendors have multiple locations, so the purchase order generally specifies which location was contacted to provide the products. Item numbers are tricky. Each vendor uses a different numbering system, and Orange Blossom employees are careful to list both the vendor's number and the Item ID assigned by Orange Blossom.

Figure 4 shows the details of the purchase order form. Some of the key features are shown in the detail section for the items ordered. Orange Blossom employees inspect all of the items as they are received. If the quality is too low, the items are rejected and Orange Blossom will not pay for them. Also, special orders for clients are recorded on the form to help the accounting manager track unique

items. The Orange Blossom OrderID is entered onto the appropriate line as a cross reference.

Exercises

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Round Avon Theater Troupe (2007)

The Round Avon Theater Troupe is a regional group of actors that commonly work out of one theater, but also stages plays and variety shows at several theaters in neighboring cities in a three-state area. The group's name is a play on Shakespeare and the actors jokingly call themselves RATTs. With several dozen active actors, hundreds of donors, and close to 20 new shows a year, the troupe finds itself in need of a database application. But, like many arts organizations, it has almost no money. In fact, several commercial systems exist to handle ticket sales, but the main theater still relies on sales of paper tickets at the box office because the business manager is unwilling to spend the money for an electronic system. If it can be built for a reasonable cost and run reliably with minimal intervention, the business manager is interested in talking about a simple Web-based system to sell tickets to shows. However, the most important project at the moment is a system to track individual shows, actors, and schedules.

The troupe is organized as a not-for-profit company, but is run by a general manager and governed by a board of directors. Most of the members of the board are donors interested in theater, but it includes business people. A business manager handles the money and accounting. The company also has a marketing manager to maintain contacts with the press, help design publicity campaigns, and interact with other theaters. Individual producers and directors are hired for each show. In this organization, the producer is responsible for organizing the business details and helping with marketing the project to other theaters.

Round Avon Theater Troupe Show

Title — Category (comedy, tragedy…)

Author
Description
Producer
Director

Opening Date
Budget
Actors
Set

Characters/Roles

Role	Gender	Show	Actor	Backup

Production Milestones

Date	Description	Director Evaluation	Producer Comments

Figure 1

Shows

A show is a play (or similar event) that runs for several weeks. It generally premieres at the troupe's home theater where it runs for a couple of weeks. Then the group takes the show on the road to other regional theaters. Sometimes they do classic Broadway shows; other times they do experimental or first-run plays. In many ways, a show is an exercise in project management. There is a scheduled opening date, actors to hire and train, sets to construct, lighting to create, and dozens of employees to coordinate. The issue of actors (and employees) is important. For long-running plays, it is critical to have backup actors for all of the characters. The Troupe often schedules multiple versions of a show using different combinations of the cast. For example, every year they do a special show near the first of July that takes place at several of the regional theaters. Different cast members are in each version of the play to reduce travel costs. For these shows, the backup for the lead characters is usually handled by actors with minor roles. If an actor falls ill, the backup fills the spot and the minor character is usually deleted for that performance.

Figure 1 shows a version of the form that producers use to track progress on a show. The actors/backups list is relatively flexible in the early days. Some directors will experiment with several different actors at the early stages. The production milestones have evolved over the years into a relatively solid list of steps followed in every production. They include casting actors, getting the sets built, establishing the lighting, producing the marketing materials, getting costumes fitted, and the major rehearsals. Although the steps remain the same, the sequence can vary depending on the complexity of the production. For instance, sometimes the set construction is finished early, but for detailed sets, it might not be finished

Weekly Expenses

Start Date – End Date

Production

	Name	Role	SSN	Amount	Date Paid
Actors					

Actor Total

	Item	Vendor	Description	Amount	Category
Fixed					

Fixed Total
Production Total   Budget   Percent of Budget Spent

Operating Expenses

Item	Amount	Category	Person/Vendor	Tax ID

Operating Total   Weekly Total

Figure 2

until just before the opening day. At each milestone, the director and producer evaluate the overall status, adjust timing of other events, and make suggestions for improving the process in the future.

Bills and Salaries

Actors are paid by the week when they are performing. Typically each actor receives $200, but a few of the experienced actors negotiate slightly higher salaries. Many of the other jobs are staffed by unpaid volunteers who get free tickets for themselves and a couple of friends. Expenses for sets and utilities (it costs a lot to heat and cool a theater), are largely paid from donations. The general manager, office manager, and marketing manager are paid a salary that also comes from the general budget. Budgets are relatively simple and are estimated before a show is selected.

As shown in Figure 2, actual expenses are tracked weekly by the business manager. Fixed costs are assigned to productions whenever possible and include materials for sets (e.g., wood and paint), as well as estimates of utilities for a show's rehearsal and performance. Vendor information includes the standard name, address, city, state, and ZIP Code data. Items are given categories such as utilities, costumes, music, lighting, and paint, so the manager can print summary reports. There can be several productions in progress during any week, but rarely more than five. Operating expenses are costs that are not assigned to specific productions. Manager salaries, rent, some utilities, and some contractor fees fall into this category. The decision of which costs to include in a production versus operating

Travel Expenses

Show

Theater   Fax   City
Manager   Phone
Start Date   End Date
Hotel   # Nights
Transportation Cost

Actors' Expenses

Name	Cell Phone	Lodging	Meals	Total
				Total

Box Office Receipts

Date	Receipts	Percent	Amount
			Total

Figure 3

expenses is generally left to the business manager, but sometimes directors argue and costs are reorganized.

Traveling Shows

The Troupe handles travel arrangements and pays for lodging and a basic stipend for meals for actors when the group is traveling. Depending on the distance, the Troupe might rent a bus to carry everyone. Otherwise, individual actors simply drive to the destination. Many of them car pool, but they are not reimbursed for travel costs for these shorter trips. The Troupe itself gets a percentage of the box office receipts from other theaters. This percentage is usually a fixed number that is negotiated with individual managers. However, sometimes the percentage depends on the day of the week or is tied to the attendance levels. Taking the shows on the road requires selling the theater managers on the value of the play and convincing them that enough customers will show up. Often, the statistics from the initial runs at the home theater are used to demonstrate demand for a specific play. Towards that end, the marketing manager would like to find some way to track sales, even if the list is only totals for each day. Figure 3 shows the summary report that producers use to analyze expenses and receipts for the road shows.

Sales Analysis

Figure 4 shows the summary revenue report that the business manager prints for the producers. It breaks receipts into three categories: (1) Donations specifically listed for the show, which include cash or products, (2) Revenue received from the

Revenue Analysis Report

Show   Royalty Fee
Producer
Primary Backer/Donor

Donor	Date	Amount	Cash/Products
		Total	

Traveling Theater	# Days	Audience	Amount
			Total

Date	Free Tickets	Adults	Students	Amount
				Total

Total Audience
Total Receipts

Figure 4

partner theaters for traveling shows; and (3) Daily receipts from the home theater. The daily receipts include estimates of the audience size based on the number of adults, students, and free tickets. These detail numbers are often provided to other theaters to help them set ticket prices and estimate comparative demand for planning purposes. Many shows also require performance royalty payments to the copyright holders based on the revenue. The fee could be a fixed number or it could be a percentage of the revenue. The details are set by the copyright holders. This report simply lists the current royalty total that needs to be paid for the listed show.

Exercises

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2. Create a list of all of the forms and reports that the company might use.

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Joe's Chops (2007)

Customizing cars is popular. Several TV shows even evolved to show how small firms can take a car and customize it with a larger engine, new suspension, fancy paint jobs, and plush interiors. In most cases, the car is stripped down to its frame, sanded, repainted, and rebuilt with new components from the ground up. Joe's Chops is one of those small garages, led by Joe, who has a vision of creating unique rides for people with the money (and sometimes courage) who want to drive something different from everyone else. Joe's has done well over the past few years, garnering several first-place awards at some of the regional and national competitions. The shop has built cars for several celebrities and gets considerable business through word-of-mouth. Even with only simple advertising, the company receives enough work to keep the shop busy through the year. A few customers have suggested that Joe expand or even open a second shop, but he feels it would be hard to manage and difficult to find the quality workers he needs, so he is content to stick with the single location. However, Joe routinely encounters two basic problems: (1) As his customer base move upscale, he finds they have almost no time to spend discussing options or making decisions; and (2) He hates doing paperwork, so his accountant keeps yelling at him about documenting expenses and the need to do a better job at pricing the jobs to make enough profit.

Choosing Options

Joe needs a better way to communicate with customers. In some cases, the customer drops off the vehicle and lets Joe and his team work their magic any way they want. Other customers want more control over options (and costs). Some-

Joe's Chops Customization Plan					
Customer Address City, State ZIPCode Phone Email		Employee Title Phone EMail			
Vehicle Make Model Year Engine Trim Interior Exterior Body condition Frame condition Engine condition Interior condition					
Basic Customization Plan					
Item	**Days**	**Description**	**Parts**	**Labor**	**Employee**
Estimated Price Deposit Start Date Estimated Delivery Date					

Figure 1

times Joe encounters problems getting parts or comes up with a new idea in the middle of a renovation. In these situations, he wants to be able to show the choices to the customer and let them make a decision. But, he cannot afford to wait for several days or weeks for the customer to make the trip to the shop. Also, he wants to post daily photos on a Web site so the customer can check on the progress.

Figure 1 shows the basic information that is collected when a customer wants a vehicle customized. The initial plan can be relatively general, but sometimes the employee (or customer) lists very specific engines. For example, it is relatively common to list a particular engine—in part because some cars can handle only one or two engine types. Pricing is somewhat subjective. The employee writing up the initial order writes estimates for the cost of parts and labor when they are known. All orders are eventually examined by the business manager and by Joe. Highly specialized items or hard-to-find parts are often not priced until they are located and purchased from a vendor. With considerable experience, Joe is pretty good at estimating the overall time and arriving at an estimated price. However, he has suggested that it would be helpful to have a simple report that shows the actual costs incurred for similar vehicles.

Web Site Communications

After a little persuasion, Joe has agreed that a Web site would be a convenient way for customers to check on the progress of a conversion and to answer questions or provide feedback. He is willing to get a digital camera and upload photos. Most of the employees take pride in their work and he figures this is also a good way to motivate the employees who work on the earlier stages, such as sanding and painting. For the basic site structure, each customer will have a separate page. Once the customer logs in, the page will display the most recent photo for the day. As shown in Figure 2, critical questions will also be listed on the main page. When the customer clicks the question, the details will be provided along with a simple form for the customer to answer the question or provide additional details. E-mail addresses and phone numbers of the employees will also be provided in case the customer wants to call and discuss more of the details before making a decision. To make it easy to search the questions and answers, they should be stored in the database. Depending on the final DBMS chosen, the photos will probably be stored as digital files on the server, with the link stored as a filename in the database. Observe that one of the options is a slide show that lets the customer scroll

Customized Customer Web Site			
Current Photo	Links to Other Photos Original Frame Body Engine Interior Photos by Day		
Critical Questions			
Q#	Date	Question	Answer

Figure 2

Joe's Chops Itemized Billing					
Finish Date					

Vehicle VIN Overhaul description	Customer Delivery address City, State ZIP

Items

Stage	Part ID	Manuf	Price	Quantity	Total

Parts Total

Labor

Stage	Task	Employee	Time	Cost

Labor Total

Overhead

Total Price   Tax
Amount Due (Price + Tax minus deposit)

Payment Method   Payment Date

Figure 3

through the photos sequentially. This slideshow should be handled by assigning a date and sequence to the photos when they are uploaded. Similarly, be sure to include dates for any answers or questions added by employees or customers.

Itemized Billing

When the vehicle rebuild is completed, the customer is given a detailed bill that itemizes the various parts. For total overhauls, this list could be lengthy. However, major subsystems are often contracted to outside partners and the bill will show only the total cost charged by the contractor. For instance, Joe rarely rebuilds engines. Instead, he prefers to buy them from a custom engine shop across town. They make most of the components and will customize them to fit specific vehicles and then bill a single price for the work. Items are usually purchased from manufacturers. Ultimately, the accountant records the cost as well as the price charged to the customer, but the cost is not listed on the billing form. Joe usually bills the labor costs at the prices that he pays the workers. He then covers his fixed costs (utilities and so on) and profit by adding an overhead charge to the bill. He figures this method is fairer and more accurate than pretending that his employees receive $150 an hour and pocketing the difference. Figure 3 shows the basic billing form. It lists parts and labor separately. This approach results in some duplication. It would be possible to display the labor needed to install a part on the same line as the part itself. However, Joe likes to keep the parts and labor values

separate. Partly because it highlights the importance of the labor that is a critical factor in his shop, and partly because he likes to see the separate totals when he looks back over old projects when estimating costs of new jobs. Notice that both the parts and labor are identified by phases of the project. For complete overhauls, these phases are relatively standard, including dismantling, work on the frame, body work, painting, interior, engine, exhaust, and electrical. The phases are used as categories that he uses to compare time and cost values across projects. For instance, he wants to be able to run a query that tells him the average time spent on building interiors.

Exercises

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16. Move the data tables to a centralized server, leaving the application to run on a client. Build the necessary links and retest the application.

17. Move the entire application to a Web server. Build the forms so that they run on a Web browser.

18. Create an OLAP evaluation query and graphs. Build in a way to create the links so new annual data can be generated automatically. Link the data so that the spreadsheet is updated automatically.

Rational Room Reservations (2010)

Most companies and universities have a variety of conference rooms and theaters that are shared by people in the organization for meetings and events. Most rooms are relatively small, with a large table and chairs for 10-20 people. These rooms are relatively standard with a small projection screen and a white board. Meetings in these rooms are usually informal and people often want to use them on short notice. A few larger rooms exist for special meetings. Theater-type rooms have formal stages with large screens, lighting, and sound systems. Some have theater-type chairs that are fixed. A few of the larger rooms are more like ballrooms with a large open floor with the ability to set up rows of chairs. The company wants a Web-based system so that employees can check to see which rooms are open and reserve rooms in advance. At first glance, this goal seems straightforward; however, it is more challenging than it appears. This case describes some of the problems and desired options. Some of the options might take too long to implement, so a key feature of the project is to determine how to design and create an initial functioning system and then explain how features can be added later.

Rooms

The first step is to create an inventory of the available rooms that will be entered in the system. Initially, this task seems easy—even if there are dozens of rooms that could be reserved. Figure 1 shows the basic problem: Each room includes different items that might be needed for a meeting. Some of these items are fixed in place; others can be added if needed. The items to be added need to be provided by facilities management, and that step requires additional contacts and separate reservations. For the most part, these separate requests are granted, but sometimes conflicts arise because other people are using the equipment or equipment breaks down and is not available.

Each room has an official owner—a group or person who controls the room. Some of the larger rooms are completely controlled by the facilities management group. Others are owned by individual departments. For example, a conference room within the accounting group is controlled by that group and is generally

Room Inventory				
Room number Building, Address Floor Description			Owner, Phone Size (square feet) Height (feet) Capacity GIS coordinates	
Equipment/Features				
Item	**Description**	**Number**	**Fixed**	**Charge**
Total Item Charge Room charge				

Figure 1

used by them. If they want to add special equipment to the room, it comes out of their budget. Consequently, they usually have priority in using and scheduling that room. Other departments have similar arrangements. Conflicts do not arise very often because small groups do not want to travel to other departments to hold a meeting unless there is some reason to include both departments.

The size of the room is listed in square feet. Where possible, the height of the room is included as well. Sometimes people want to bring in large displays and they need to know if the room has enough clearance. In cases where the height is variable, the listed height is the main display area. For instance, a theater might have a sloping floor, but the relevant height is the space available on stage itself. Capacity is the number of people allowed in the room. This number might be set by the number of seats or by the fire codes if standing room is allowed.

Each room has a list of items that are either fixed in the room or can be provided relatively easily. For example, rooms typically have chairs and tables as well as projection equipment and screens. Most of the fixed items are provided with the room. Sometimes additional items can be added such as more chairs or room dividers. For larger spaces, there is usually a charge for this service—because it costs money to pay people to move and install the equipment. The non-fixed items listed here are items that are usually available for this room. It is also possible to obtain specialty items, such as food service or special projection screens; but these are not listed as part of the room inventory because they are generic. The items in this list are those that are typically associated with a specific room.

One of the more challenging aspects of rooms is that the larger spaces can be subdivided. For example, the ballrooms have built-in dividers and multiple entry doors. By opening or closing partitions, the space can become one large room or a collection of smaller rooms. You need to decide how to handle this flexibility.

People

Somehow the system needs to identify people who can make reservations. In a large organization, some of this data can be provided by the internal login database. For example, many companies have a lightweight directory access protocol (LDAP) database or Kerberos facility that handles logins. If the Web server is connected to one of these systems, the application can pick up the user's name from the login credentials. For instance, Microsoft Active Directory uses a Kerberos authentication scheme and if the Web server is connected to that system, it can use that system to identify the user. Additional user information can be added to that directory. This approach has the benefit of consolidating user information and login credentials to a single system. But, you need the running system and its connections to your server to set up and test the application. Initially, it is easier to build the system with its own list of people, which makes it easier to test the features and identify exactly what information is needed.

Figure 2 shows that the basic information need on each person consists of their name, phone, and e-mail address. For login purposes, the e-mail address can serve as the username or identifier because it must be unique. A password column is used to authenticate the user. The password should be encrypted, but that process is not critical at the start. Ultimately, the username, password, and authentication will be handled by the LDAP or Kerberos system. An important element of defining people is to identify them with a department. Remember that some rooms are owned by various departments, so you need to know which people are in each department so that you can give priority to them for rooms within their departments.

EID Last Name, First Name Department Office		Phone E-mail Password Priority Level	
Proxy Person	**Password**	**Level**	

Figure 2

However, the concept of departments can be more complicated in large organizations. Departments can be hierarchical. For example, *Research* might be a top-level department that has several subdivisions. If the *Research* department owns a building, it could control several meeting rooms; but each sub-department might control individual rooms as well. An employee is probably listed as a member of the lowest-level sub-department. So, the system needs to track the hierarchy of departments to know that someone in the *Failure Testing* department is also a member of the *Research* department.

In any system where people compete for fixed resources, conflicts can arise and you need some method to resolve these conflicts. In this case, what happens if someone wants to reserve a room that is already reserved by another person? Should first-come, first-served always be the rule? What if the president needs a specific room for a major presentation, but some group of employees reserved it weeks ago for a rehearsal space? Do you want to be the one to explain to the president that the room is not available? Not if you want to keep your job. In effect, people have priority levels. If a conflict arises, the person with the higher priority should have the ability to override a reservation made by a lower-level employee. As indicated in Figure 2, the process gets more complicated because the president is unlikely to make his or her own reservations. Instead, an administrative assistant makes the reservations for the president. But, the administrative assistant has a relatively low personal priority level. So, some executives need the ability to assign higher priority levels to proxies—people who work for them. Without proxies, the executive would have to give his or her personal login information to the assistant—which is a really bad idea if the system is going to use the company-wide login system. Because some executives might have several assistants and want to give them different priority levels, the figure contains a repeating list of proxy entries. For added security, the system might want to require a separate password for the proxy user to invoke the higher priority level.

Reservations

Figure 3 shows that the basic reservation data is straightforward. Although it is not shown, each reservation should be given a unique ID. At a minimum, a reservation must specify the room, the starting and ending date and time, the date the reservation is made, and the person reserving the room. For rooms that require chargebacks or additional items, you will also need the internal account number that will be used to pay for the charges. Note that users should include any preparation and clean-up time when making the reservations. So if it takes an hour to

Room Start Date, Time End Date, Time Purpose Anticipated number of people		Date Made Person Proxy
Person Priority Level Account number for charges		
Item	**Quantity**	**Charge**
Total item charges Room charge Total billed		

Figure 3

set up the room before a meeting, that extra hour should be used to move up the start time. The individual making the reservation is responsible for determining the specific time requirements, but it would be helpful if the room descriptions included some time estimates for basic tasks.

To track who actually made the reservation, the system should record the person making the reservation—who might be a proxy. And it must track who is actually going to use the room (e.g., the responsible executive). The purpose is basically a short description that can be posted online so other people know how the room is being used. For instance, even though the president has higher priority than a marketing manager, the president might choose not to override a meeting scheduled with key customers.

A person can enter a priority level for the room reservation. This priority can be anything from that person's level or lower. For example, a top executive might reserve a room to use for rehearsing a presentation and assign a lower priority in case someone else needs the room.

You should also think about what to do if a reservation is overridden and replaced with a higher-priority event. In particular, you might want to keep the original reservation and flag it instead of deleting it. Then, if the new meeting is canceled for some reason, you could contact the original person who reserved the room and ask if it should be rescheduled.

Remember that concurrent access could be a significant problem. You do not want to allow two people to reserve the same room at the same time. Web systems typically use optimistic concurrency, but you might want to think about building some type of pessimistic locking. For instance, you might temporarily lock out a room when one person starts making a reservation for it, so that others cannot even start a reservation of that room at the same time. It would be frustrating for a user to go through all of the steps to reserve a room only to find that someone else was faster and had just reserved the room.

Exercises

1. Create the feasibility study (initial proposal).

2. Create a list of all of the forms and reports that the company might use.

3. Create a normalized list of tables for each form and report.

4. Create an integrated list of normalized tables for the entire application. Draw the corresponding class diagram.

5. Create the basic tables in a DBMS along with all necessary relationships and integrity constraints. Enter sample data into the tables to test your design.

6. Evaluate the normalized tables and estimate the size of the database—both current size and estimated size in 3 years.

7. List the initial security conditions for the data tables. Create a list of user groups and identify their basic access needs.

8. Design the overall structure of the application. Outline the overall structure and the primary forms. Select a design scheme, including layouts, effects, and colors.

9. Build three initial input forms.

10. Build three initial reports.

11. Improve the forms and reports to make them easier to use.

12. Test your forms and reports with sample users.

13. Build additional forms and reports. Improve all of them. Test all of them.

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Pliable Plastic Production (2010)

To an economist, manufacturing seems like such a simple concept: Buy some equipment (capital), purchase a bunch of raw materials (inputs), hire some workers (labor), and make a product. Refine the process and drive down costs, make enough products and sell them at high enough prices to cover the fixed and marginal costs. Today's manufacturing is more complex—even for relatively small shops. Flexibility is critical to most manufacturers—particularly those who focus on custom products. This company specializes in molding and fabricating plastic items—and many of the things you buy today use plastic components. Entrepreneurs who invent new products typically require many plastic components. All of these have to be designed, custom molds built, and the factory has to schedule inputs and production time on the machines. The goal of this case is to build a database that helps track the main steps of design, purchase, and production.

Design

The first step in creating a new product is to design it. In terms of production of plastic parts, design consists of detailed diagrams of the product along with molds and various extrusion techniques. The type of plastic also needs to be specified because each type has different levels of hardness, flexibility, and strength. For a moment, think about a small plastic box with an attached lid and snap clasp. With the proper equipment, this box can be produced in one piece by extrusion—pushing plastic through a set of molds that shape and contour each element of the box. The key lies in the design and then building a prototype to test and refine the design. In a custom shop, the designs are provided by outside companies who need the product.

Figure 1 shows the basic data needed regarding a design. Typically, designs go through several versions—both during prototyping and once production starts.

Product ID Description Approximate Size: height, width, depth Primary material		Customer Contact Person Phone E-mail Address City, State, Postal Code Country	
Version	**Date**	**File**	**Comments**

Input	**Quantity per 1000 units**	**Vendor**	**Message Commands**

Figure 1

Item Order ID Date Vendor Phone Delivery Date Confirmation ID		Customer Job ID Item Quantity		
Item	**Description**	**Quantity**	**Price**	**Value**
Total Price Shipping Cost Total Due				

Figure 2

The basic product information identifies the general product and the customer. Each version has a design file that specifies the details. The database will store the name of the file, but the file is stored separately on the computer system. Typically, the associated file is for the CAD/CAM production system. It contains drawings and exact specifications for the entire product. Engineers generally save the file as a new version when changes are made to the design. Engineering and production notes are stored in the separate file so they can be attached to individual components of the product. The design file also contains information to configure the production machines electronically. When the design file is loaded into the computer-aided manufacturing system, it sends configuration commands to the machines.

Input Purchases

Each product requires the purchase of input items—primarily plastic pellets and color dyes. The quantity needed depends on the size of the product, the number of units to be produced, and the waste percentage. This company maintains inventories of some basic plastics, but generally prefers to place just-in-time orders to have vendors deliver the materials the day they are needed. Ideally, when a production job is scheduled for a specific design, the system would compute the required number of inputs and place the orders electronically with the standard suppliers. To know how much to order, the company engineers need to estimate the various input quantities for each design based on the number of units produced. This data has to be stored along with the design. The bottom section of the Figure 1 shows the basic data needed for the input, the quantity needed per 1,000 units produced, and the standard vendor for that item. The message configuration field contains the information needed to send an electronic order to that vendor. Ultimately, the order would include the exact quantity and delivery date needed. These values could be plugged into the message as parameters.

Figure 2 shows the basic order that is generated when it is placed with a supplier. Most orders contain only a limited number of items, but each product might involve scheduling deliveries from several different vendors. When the job is scheduled, the system transmits this information to the supplier. The vendor's electronic system returns a confirmation number which needs to be stored in case questions arise later. Each order is tied to a specific customer job and product design. Sometimes multiple jobs are scheduled on the same day and use similar

Product Design Version		Customer E-mail	
Machine Start Date/Time Operator End Date/Time Quantity Produced Defective Count Overall Quality Comments/Problems			
Input	**Quantity**	**Vendor**	**Quality Comments**

Figure 3

inputs. In these situations, a vendor might receive multiple orders. Most vendors simply add up the total amount needed for the similar items and make one shipment. When the shipment arrives, it is checked in against the multiple orders—so even though it is one shipment, it is treated as if multiple items were received. The shipping costs are then split among the multiple orders based on the percentage of product needed.

Production

Many production companies record detailed information about each production step, such as the time, the employees involved, the quantity produced, and quality control measures from the individual machines and the inputs. It is also helpful to record any problems that arise such as broken parts and power outages. For an initial design, it is easier to start with the basic production information. Figure 3 tracks production by steps based on the individual machines. The figure shows basic data for one machine, but a production run can often use multiple machines. Note that a production can use a specific version of a product—which is not necessarily the latest version on file. Sometimes customers want to use earlier versions, so this version needs to be tracked. Each machine is run by an employee operator. The total quantity produced is recorded as well as the number of defective items that are discarded or recycled. An inspector records the overall quality and lists any specific comments or problems that were found.

The firm also needs to track the amount of each input used at each step of production. These values are processed by engineers to refine the design estimates and to track the amount of wastage. When possible, the vendor of the input is recorded to see if some inputs are more efficient than others. Input quality control examines the input resources for obvious defects and records any problems in the comments section. More specific quality control measures and testing processes are conducted separately with that data recorded in a different system. For example, chemists perform tests on samples of the inputs to determine if they meet the desired standards. Because this process is handled outside of the normal production, the results are stored in a different system.

Destination Address City, State, Postal Code Country			Expediter Date shipped		
Item	**Order**	**Production run**	**Quantity**	**Weight**	**Price**
Total Price Date Billed					

Figure 4

Shipping

Once the items are produced, they are boxed and shipped to a location specified by the customer. Often, the destination is overseas so customs forms have to be filed. These steps are handled by an international expediter. The expeditor is also responsible for ensuring delivery and handling any taxes and insurance. Once the items are picked up by the expeditor, our role is over and the customer is billed based on the negotiated prices.

Figure 4 shows the basic information collected for the shipping. Each box shipped is entered as a separate row. A box contains only one type of item. If the boxes are small, the expediter might combine them into larger boxes, but we track them at the detail level. The Order ID represents the specific order placed by the customer. The production run is an identifier that enables the company to track a product back to the day it was produced in case the customer claims there are problems. To assist in quality control tracking, individual boxes contain items only from a single production run. The quantity of items in the box is tracked along with the weight of the entire box. The weight is basically included to assist the expediter and represents the shipping weight including the box.

Exercises

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2. Create a list of all of the forms and reports that the company might use.

3. Create a normalized list of tables for each form and report.

4. Create an integrated list of normalized tables for the entire application. Draw the corresponding class diagram.

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On the Hoof Dairy (2010)

To the casual observer, farming might seem like a simple business little changed over the centuries. But even as a casual food shopper, you must realize that food prices have remained relatively steady over many years—although demand has steadily increased through population growth. The only way prices can remain stable or even decrease is because farming has become increasingly more efficient. Management principles including information systems are important aspects to running agricultural businesses. Consider some of the basic aspects of the dairy industry. Efficiency and production are heavily dependent on individual cows. Animals exhibit a wide variance in the production of milk. When building a herd it is critical to breed the most productive cows, using selective genetics to increase the overall herd production capabilities. Other factors such as feed inputs, disease, and weather need to be tracked so that patterns affecting production can also be identified and potentially controlled.

Cows

Monitoring and caring for cows is obviously important to a dairy farm. Figure 1 shows some of the basic items that need to be tracked. The basic genetics include tracking the sire and cow (father and mother). Many cows are bred through artificial insemination so the details are generally available from the source provider.

For each cow, the company tracks the amount of milk given on each date. At the farm, milk is weighed in pounds. From this data, the firm creates reports that display average production by day and week. By tracking the births and the resulting genealogy, the company can compute the average production of the offspring of a given cow to see how production capability is passed genetically. Sometimes cows die, and other cows are sold. This information is recorded as the date along with the cause; so the managers know which cows are no longer active.

Cow ID Date Born Date Acquired Source Breed		Sire Cow Lineage comments Date removed Cause/location	
Date	**Milk Quantity**	**Comments**	
Date	**Births**	**Comments**	

Figure 1

PurchaseID Date Delivery Cost		Supplier Phone Address City, State, ZIP		
Item	**Protein**	**Quantity**	**Cost**	**Amount**
Total Cost				

Figure 2

Feed

Feed costs are a major component of expenses. Some feed is grown on the farm itself, but this feed is not free because it requires land, capital, fertilizer, and labor to produce. The firm does track individual expenses for the production of feed crops, but the simpler way to measure the cost of home-grown feed is to use the market cost of equivalent feed. Economically, it is the opportunity cost because the grown products could be sold on the open market for that price. Effectively, if the farm can produce feed cheaper than the cost of purchasing it, those profits are assigned to the farm, not to the production of milk.

Figure 2 shows the basic purchase order for feed. It is similar to a purchase in any industry, except notice the addition of the protein data. Sophisticated feed analysis would track the complete nutrient levels of all inputs. For now, it is sufficient to track the protein content because protein is a critical element in the feed of any animal. Later, you can think about how to track the complete nutrient profile.

Purchases are often made in bulk—particularly for pseudo-purchases of home-grown feed. The silage is stored and fed to animals each day. It would be nice to track the precise amount of feed eaten by each cow—but that is exceedingly difficult. Instead, as shown in Figure 3, animals are grouped into herds and the daily feed for the herd is recorded. Some animals will eat more than others, but if the herd is relatively evenly balanced, the average consumption should be reasonably accurate. With multiple barns and feed stations, herds might be defined in terms of barns; otherwise herds have to be rotated in and out of the feeding and milking

Herd Location			
Date/time	**Feed Source**	**Quantity**	**Waste**

Figure 3

Cow Birth weight Treatment Date Weight		Vet Address City, State, ZIP Tech Name, Phone	
Symptom	**Severity**	**Comments**	
Treatment	**Medication**	**Quantity**	**Cost**
Additional costs for visit Total Charges			

Figure 4

stations and data recorded each time a herd is moved. One complication that is not obvious in Figure 3 is that the farmers might use multiple feed sources at any specific feeding time. For instance, they might feed 500 pounds of basic silage and 200 pounds of corn mixed into one feeding. The silage and corn come from different sources and both have to be recorded.

Medical Treatments

Basic medical data is also tracked by date in terms of treatment and any infections or diseases. Figure 4 shows the basic data tracked for a standard vet service. Note that some treatments are preventative and not necessarily a response to a problem. For example, any medications added to the feed are recorded as medication with no symptoms, and sometimes without a vet visit. Also notice that the company tracks the price or cost of treatments to help determine the ultimate value of the cow. For some treatments, the cow is weighed—because medications are sometimes based on the weight of the cow. Tracking the weight is useful to provide a basic medical and growth history, but it is time consuming to weigh animals, so this step is often skipped. The farm is thinking about installing a walk-on scale on the track to the feed troughs so cows can be weighed more often, but cost is an issue as is problem of keeping it clean. If the scale is added, the weights could be tracked in on this form with null values for treatment, disease, and cost.

Exercises

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2. Create a list of all of the forms and reports that the company might use.

3. Create a normalized list of tables for each form and report.

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Cool Wheels Shipping Company (2013)

This firm handles shipping for various companies. It has around 10 trucks and 20 – 30 drivers at any time. The business office signs contracts to pick up and deliver products on specific days. Some deliveries are short hauls, often with smaller trucks, other deliveries might be cross country. In these cases, the company books additional trips back so drivers do not have to wait and the company gets paid for the return trip. Trucks are loaded by customers—usually they are the big trailers, and drivers simply pick up and drop off the trailers. The company wants to enable customers to book trips and make it easy for truckers to check on their schedules. Ideally, the application would be built as a Web site or perhaps a mobile application. The actual schedules are entered manually by the shipping manager, so there is no need to try and compute optimal routes at the moment. But several of these administrative inputs are needed to make the system work. Managers would also like to track mileage and maintenance schedules. At some point, the managers would like to track the progress of trucks—either by automatic GPS units or by having drivers enter waypoints throughout the day. But this feature has a lower priority.

Customers

Business managers or salespeople are responsible for finding customers and keeping current data on them. Some of the customers can be large, with multiple shipping points including factories, distribution centers, or transportation hubs such as shipping ports. Other customers are smaller, and a few are one-time jobs that require a simple pick-up and drop-off; usually for large items. Figure 1 shows the basic form used to collect customer data. The main purpose of the form is to identify contacts and addresses to be used for billing and resolving any problems. The data is also useful for marketing, to help marketing managers track jobs and contact customers who have not used the company's services in a while. Note that the locations are basic points where the customer commonly ships or receives items, and any company might have several locations.

Customer Name Billing Address Billing Address2 City, State, ZIP	Primary contact Name Phone E-mail	Date contacted Our employee Comments
Primary business category One-time or regular shipping		
Location	**Address, City, State, ZIP, Phone**	**Comments**

Figure 1

Shipping Requests

When a customer wants to schedule a shipment, the shipping manager fills out a shipment request. Customers can fill out some of the information, but ultimately, the Cool Wheels business managers set the fees and mileage charges. If a customer asks for a shipment with minimal notice (such as next day), Cool Wheels might add on an express charge. The value depends on whether the company is fully booked and needs to alter other shipments or hire additional drivers. Cool Wheels has a reputation of trying to meet customer needs even on short notice, so it uses the express charge to cover its costs. Basic content descriptions are needed along with estimated weight to help select the proper truck, and sometimes it influences the routing if the cargo is particularly heavy. Eventually, locations need to be geocoded so the routing and tracking can be automated. But, Google maps can always be used to convert addresses to latitude and longitude when needed. Figure 2 shows the basic form data used for a single shipping request.

Shipment Request Pickup date Desired delivery date Contents Estimated Weight Estimated miles Truck size needed	Base fee Mileage charge Express charge
Pickup location Address, City, State, ZIP	
Delivery location Address, City, State, ZIP	

Figure 2

Drivers

The HRM department keeps detailed data on drivers and other employees. But the scheduling system needs to include basic information about drivers so managers can contact them. Figure 3 shows the basic data needed. In addition to contact information, the system includes some licensing information. In some states, the licensing data can be more detailed, such as special training for large trailers (dual

Driver Last name, First name Cell phone Home address City, State ZIP	Date hired Birthdate License # Expiration date Gender Taxpayer ID
Driving preferences Truck size, local/distance Reliability comments	

Figure 3

or triple), or training for hazardous materials handling. These additional elements are lower priority at the moment. But tracking license expiration is useful because it helps the scheduler know if a driver might run into problems with a long-haul trip that might take several days. Although, the good drivers all renew their licenses well in advance of the expirations; sometimes events happen that cause delays such as illness. Some drivers also have preferences about trucks or do not want to handle long-distance loads.

Trucks

Trucks are the other basic element that needs to be tracked. Figure 4 shows the basic data needed by this system. Mechanics keep additional data, and accounting managers have detailed financial data on the purchase and financing arrangements. But the basic maintenance log is helpful when scheduling trucks. If the shipping manager sees that a truck is going to be due for extensive maintenance, the truck can be scheduled for short hauls until the maintenance is performed, reducing the cost of having to handle the maintenance on the road. Simpler things such as oil changes are often handled on the road using vendors that have facilities scattered around the U.S. near major truck stops. Cool Wheels has standing contracts with some of these companies, but ultimately the shipping manager and the driver settle on a location and vendor for each stop. Trucks can be identified by the vehicle identification number (VIN) which is alphanumeric and defined by the manufacturer and guaranteed to be unique.

Truck VIN Year, Make, Model Engine Color				Date acquired Price paid Initial miles		
Maintenance Log						
Date	Miles	Action	Price	Comments	Vendor/location	Next
Next refers to the next scheduled interval for the specific action, such as when an oil change is needed. It is listed as number of miles.						

Figure 4

Trips

Actual shipments or trips combine the data from the previous items but the form shown in Figure 5 is a bit more complex than the others. When booking a trip weight and miles are estimated. For the actual shipment, actual data has to be recorded. Weight is obtained from weigh stations scattered around most towns. Truck mileage is a little tricky because it is measured at several points: when the truck leaves the Cool Wheels location, when it arrives at the pickup location, and arrival at the customer destination. The last measure might be the value when the truck returns to Cool Wheels base. But for long-distance hauls, the truck probably

picks up another load for a different customer. In this case, the "ending" miles would be null for the first shipment, and the starting miles for the second shipment would be the same as the delivery miles for the first shipment. Draw a map and you can see the chain. Many trips require refueling stops. Long-haul trips might have multiple stops per trip. For short-haul trips, drivers are encouraged to top-off the truck fuel when returning to the Cool Wheel base so the truck has full tanks for the next trip. Cool Wheels has contracts with a couple of the big truck-stop vendors; and these vendors provide detailed electronic receipts, but drivers are encouraged to track their own data so it can be compared to the vendor receipts.

Shipment/Trip	Driver		Truck
Customer			Miles at start
Pickup location	Date/Time	Weather	Miles at pickup
Actual weight			Miles at delivery
			Miles at end
Delivery location	Date/Time	Weather	
Driver comments			
Customer comments			

Refueling Costs						
Date/Time	Miles	Quantity	Price	Location	Vendor	Comments

Figure 5

Exercises

1. Create the feasibility study (initial proposal).

2. Create a list of all of the forms and reports that the company might use.

3. Create a normalized list of tables for each form and report.

4. Create an integrated list of normalized tables for the entire application. Draw the corresponding class diagram.

5. Create the basic tables in a DBMS along with all necessary relationships and integrity constraints. Enter sample data into the tables to test your design.

6. Evaluate the normalized tables and estimate the size of the database—both current size and estimated size in 3 years.

7. List the initial security conditions for the data tables. Create a list of user groups and identify their basic access needs.

8. Design the overall structure of the application. Outline the overall structure and the primary forms. Select a design scheme, including layouts, effects, and colors.

9. Build three initial input forms.

10. Build three initial reports.

11. Improve the forms and reports to make them easier to use.

12. Test your forms and reports with sample users.

13. Build additional forms and reports. Improve all of them. Test all of them.

14. Connect all of the forms and reports into an application. Add help files. Test all the links. Test the forms and reports. Check for consistency.

15. Add security, backup and recovery, and other management features to the application.

16. Move the data tables to a centralized server, leaving the application to run on a client. Build the necessary links and retest the application.

17. Move the entire application to a Web server. Build the forms so that they run on a Web browser.

18. Create an OLAP evaluation query and graphs. Build in a way to create the links so new annual data can be generated automatically. Link the data so that the spreadsheet is updated automatically.

e-Gadget Production (2013)

Most common companies that sell electronic devices do not handle their own manufacturing. Production of devices such as cell phones, televisions, and headsets is handled in bulk. The production facilities to crank out huge numbers of devices are equally huge. Items have to be quickly built in large quantities. If a company built its own devices, the production facilities would be small and take a long time to put out enough items to meet demand. Or they would be huge and sit empty most of the time. Instead, companies such as e-Gadget have large factories, hire a huge number of workers, and have contracts with many suppliers. The company signs contracts and uses the facilities to produce massive quantities of one product at a time. A few weeks later, it shifts to the next product, usually for a different customer. The product design is specified by the original company (such as Apple or Microsoft), but e-Gadget helps with innovative products. Because of the close ties with suppliers, e-Gadget is able to suggest uses for new items or new manufacturing techniques. Quality control is critical to any production, but particularly for electronic items that have hundreds of component parts. Quality is evaluated on incoming shipments of parts, through final-product testing, and through returns of failed items. Additional tests are often performed at intermediate steps, but these tests typically relate to the quality of the workers (or sometimes the tools).

Customer **Primary Contact** **Phone** **e-mail** **Address** **City, State, Postal Code** **Nation**			Product Name Version General Description Target Cost Target Date Initial Quantity Revision ID		
Design Doc.	Date	Person	Time-Zone	Comments	
Component List					
Item	Quantity	Source	Contact/Phone	Est. Cost	

Figure 1

Product Designs

Products are ultimately designed by the outside companies, but the designers collaborate with the e-Gadget production engineers to ensure that the design is feasible with existing materials and that it can be produced at a reasonable cost. Figure

1 shows the most important design information that is collected during the design phases. It contains basic information about the customer and the product. The Target Cost and Target Date are the estimated cost that will be charged to the customer for the production of one item, and the target production date. Each design goes through several revisions and the target values can change along with the detailed designs. The detailed designs for each revision are specified in different documents. Most of these documents are electronic and each one has a primary person in charge of the document. Any questions are directed to that person. The person's time zone is important to minimize problems with calling. Each revision has a list of components and the number required. The engineers for e-Gadget find an initial source for each component and estimate their cost. These costs are not released to the company designing the product, but are used by the cost engineers to estimate the production costs.

Component Quality

Almost every item that is delivered to e-Gadget goes through a quality inspection process. Electronic components are particularly critical. Because they are purchased in large quantities, inspectors usually draw random samples of the elements and run them through various tests. Most electronic tests have ranges (low/high) for acceptable elements, such as resistance values for resistors. Inspectors run the sampled items through a collection of pre-defined tests and count the number of items that pass each test. As shown in Figure 2, these results are then combined into an overall score for the shipment. The scoring method is defined by the engineers and not handled within the database, but the total value is recorded. If the score is too low, the entire shipment might be rejected. The inspector writes up any overall comments, which become important if a shipment is rejected. Accepted shipments are assigned an internal lot number and each shipment is stored separately. The lot number is unique and important. When products fail or are returned, the lot number is used to track back to the original supplier and the inspection. If too many failures are noted, then the inspection criteria are tightened, and the company probably switches suppliers.

Supplier Factory ID Contact		ItemID Description Quantity delivered Lot # Assigned			Delivery Date Inspector/emp.		
TestID	Name	Low	High	Sample		#Pass	Pct
Overall score: Evaluation comments							

Figure 2

Production Shift Product ID, name, version Serial Number Start Serial Number End Station ID, location	Date Start Time/End Time Stage Number Task Description			
Employee, Date Hired, Title Shift supervisor				
Output Name Quantity Produced Quantity Inspected Quantity Passed	Input Item Lot	Quantity Used	Quantity Rejected	Quantity Broken
Supervisor comments				

Figure 3

Production Stage

Each product goes through several stages of production. Most of the stages are handled with a production line approach where a worker at each stage handles specific tasks. Work product from one stage is passed to the next worker at the next stage. In theory, it would be useful to collect a huge amount of data at each stage, but this data collection cannot interfere with or slow down the production line. Figure 3 shows the basic data that is collected at each stage. Most of it concentrates on the productivity of the individual worker in terms of output at each stage. Tracking the input components proved to be difficult. To avoid recording every single input item from each lot for each assembly step, the company decided to simplify production. For a given shift stage, each worker gets input items from a single lot. For example, if a worker is installed a certain capacitor, all of those capacitors for that session come from a single lot. Then the supervisor or inspector simply has to count the number of rejected or broken items at the end of the shift. And every output device for that shift is recorded as using the components from the same lot ID. The final product is given a unique serial number which is assigned sequentially at the start of the production process. For a production shift, the starting and ending serial numbers are recorded so each step relates directly to a range of products.

Shipments

As a final step, the factory packages items for bulk shipping. Items are individually boxed as a normal production stage, but shipping requires the boxes to be packaged into larger boxes and bundled into packets or pallets. In most cases, the packets are loaded onto standard shipping containers which are typically trucked to a sea port and loaded with other cargo. Most of the shipping details are handled by specialized shipping companies. Sometimes the customer handles the details of the shipping but in other cases, e-Gadget needs to track the ship and receive dates

as well as a tracking ID. As shown in Figure 4, each packet (typically a bundled pallet) is given a unique ID. Again, to simplify record keeping, items are loaded sequentially so it is only necessary to track the starting and ending serial numbers; instead of recording the SN of every single package. Note that a few items are often removed for testing, and these serial numbers are recorded in a different database, so there might be gaps in the serial numbers for a specific packet, but these gaps are recorded at e-Gadget. It is also important to note that a given shipment usually consists of multiple packets and that some of these packets might be shipped to different destinations. Typically, they are handled by the same shipper, but they might be diverted to different cities at some point in the shipping so they are recorded separately. Generally, the customer is billed once the items are shipped, so this data is important to the accounting managers.

Customer Billing Address City, State, Postal Code Nation		Packing Date Employee Emp. Experience Rating
Packet ID Quantity Destination Shipper Method	Start SN End SN	Date Shipped Date Received Tracking ID

Figure 4

Exercises

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