Database Design
Supplemental Project Book

Instructor Version

Contents

Introduction

This Supplemental Project Book contains a collection of projects designed to allow students to apply the concepts described in the Database Design portion of the "Database Design and Programming with SQL" course. It includes five projects, each comprising an introduction, case study describing the project specifics, and steps to be followed during implementation, exercises, and examples. Projects may be completed in tandem with the completion of corresponding lessons for the duration of the course. The goal of the projects is to make a presentation of an entity relationship diagram based on the data acquired during the steps of the project.

How to Use this Project Book

The projects may be used at various stages of the course to allow students the opportunity to put into practice what they are learning during the curriculum. Each project Introduction specifies approximately when the projects may be most applicable during the curriculum and approximately the duration for the projects.

The Case Study section of the project book contains all supporting information related to the DJs on Demand and Global Fast Foods projects. The same section provides support questions for the remaining three interview-based projects, which are more advanced. This section includes the structural business rules, a few procedural business rules and other examples referencing concepts described in the Database Design course. This information will be helpful when completing the exercises of the project.

The practice Steps allow students to apply their understanding of entities and their attributes, recognize different relationships between entities, increase their understanding of business concepts (such as CRUD analysis and checking data integrity) and finally enhance their presentation skills. Each step is designed for completion at the end of a specific lesson in the course.

Project Difficulty

The projects are ranked from 1 to 5, 5 being the most difficult, to help teachers determine the best project(s) to use for their students.

The DJs on Demand project is rated 2 and provides a great deal of guidance. This project is recommended to reinforce the concepts students are just learning. Many examples are given in the curriculum.

The Global Fast Foods project is rated 2.5 and provides a great deal of guidance. This project is recommended to reinforce the concepts students are just learning on arcs, normalization, and many-to-many relationships.

The Animal Shelter project is rated 3.5 and provides some guidance while encouraging practice of interviewing skills with the instructor, online research, and accurate and creative data modeling.

The Natural Science Lab project is rated 4 and provides minimal guidance while encouraging practice of interviewing skills with a science teacher and accurate and creative data modeling.

The Recycling Center project is rated 4 and provides minimal guidance while encouraging practice of interviewing skills with an outside person, and accurate and creative data modeling.

Project 1: DJs on Demand

1.1. Introduction

Difficulty Scale: 2

Project Use: Apply basic concepts of database modeling

Application: Start this project following Section 2 Lesson 2.

The DJs on Demand project describes the business scenario for a disc jockey music service. The project states the business rules to be considered before designing a database model. No interviews are required for this project. The goal of this project is to ensure that all students have the same information before preparing the final presentation and creating the ERD. Most other projects contained in the Project Book will require students to work on their interviewing skills – since the goal of each database modeling project is to satisfy the clients' needs. Project success is demonstrated with successful interviews, creative solution creation, and an effective presentation.

Since this is an introductory project, most of the entities and relationships in the ERD for the DJs on Demand project are presented as examples in the Database Design lessons of the course. The tasks outlined in the practices and examples focus on problem recognition and methods for improving the example presented. This project is complete when students have fully incorporated the final ERD into the presentation delivered to their instructor.

The DJs on Demand project can be a useful tool for applying the basic concepts of the Database Design course.

The lessons practices that reference this project are:

- Section 2 Lesson 2
- Section 3 Lessons 1 and 2
- Section 4 Lesson 2
- Section 5 Lessons 3, 4
- Section 7 Lessons 1 and 2
- Section 15 Lessons 4 and 5

Note: If lessons are skipped, students may not be able to successfully complete the corresponding practice step, or any later steps in the project.

On a scale of 1-5, the difficulty rank for this project is 2. It is recommended that instructors teach this project first as it helps students solidify their understanding of the basic concepts of data modeling. The final ERD can be found in the Solutions section of this project.

1.2. Case Study

Read the complete scenario for the DJ business below.

"We started out as a group of friends who organized parties and customized our own music. Then we thought we'd turn it into a business to pursue our interests and earn some money. We called ourselves the "DJs on Demand.

"Everyone who works here is a partner. Every partner has a specific responsibility. The project manager makes the first contact with the client to discuss the event. Is it a birthday party, a wedding, an anniversary, a graduation? What is the date for the party or event?

"Once that's decided, the event planner gets in touch with the client about specific locations, catering, decorations, and other specific details. The DJ talks with the client about the kind of music wanted. The project manager supervises the event planners and DJs. He/she also authorizes expenditures related to a project.

"We have a large collection of CDs. Each CD contains several songs, and the same song can appear on several CDs. We like to classify each song by type (hip hop, salsa, R&B (rhythm and blues), techno, polka, rock, jazz, new age, classical, etc.)

"We can propose an initial list of songs to the client depending on the event. Of course, a client can request other songs as well.

"Our client list is growing. We have a lot of repeat business – customers who like what we've done and ask us to work their other events. We have some very busy customers who can have more than one event going on at the same time.

"We also have a list of themes that we can use to categorize these events. For example: a wedding may have a tropical theme, a party may have a carnival theme, an anniversary could have a sixties theme, etc. This helps us pick a venue and also gives us an idea of what the DJ (and other musicians) should wear. Some partners have a specialty or expertise – so a theme can also help us assign the right person to the job.

"Events are held either in a public space or a private home. The event manager visits both and makes arrangements with the public-space renter or the private-home owner.

"Since several partners can work on an event, and an event can be assigned to several partners, we like to keep track of who is working on which event. We keep a log of what each event planner and DJ has done on an event, and when they did it."

Below is the business scenario describing relationships.

"We like to classify all our music – each song or soundtrack – by type. The different types are rock, jazz, country, classical, pop, new age, etc. We can add new types as the need arises – in fact we recently added a new type for rap music. We realize that a song can really be classified under more than one type, but for our purposes we select only one main classification type for each song."

DJs on Demand clients, events, and themes are listed below.

"Our client list is growing. We have a lot of repeat business – customers who like what we've done who ask us to work for them again. We have some very busy customers who can have more than one event going on at the same time! Each partner has some specialty or expertise – so when it's appropriate, we like to classify our events by theme to help us assign the right person (partner) to the job. An event theme can be a beach party, medieval, carnival, retro sixties or seventies, etc. We keep adding event themes as we go."

Procedural business rule examples are listed below.

"Initial contact with the client from DJs on Demand must be made by the project manager.

"Approval for travel requests to an event must be signed by the project manager for that event."

1.3. Steps, Exercises, and Examples

Step 1 – Recognizing attributes for an entity

This step may be undertaken following Section 2 Lesson 2.

Three entities that play a role in a DJ business (SONG, EVENT, and CUSTOMER) are listed as the first three column headings of the table below. The fourth column contains a collection of attributes. Use a check mark to indicate if the attribute listed could be an attribute for the entities listed. (For example, could Title be an attribute for Song, for Event, and for Customer?)

Table 1: Entity and attribute assignment

SONG	EVENT	CUSTOMER	Attributes
			Title
			Description
			Venue
			First Name
			Phone Number
			Release date
			Last Name
			Type
			Email address

Step 2 – Understanding relationship between SONG and TYPE

This step may be undertaken following Section 3 Lesson 1.

You have learned about the relationship between SONG and TYPE. Answer the following questions:

- Must every SONG have a TYPE?

- Can you have a SONG that doesn't fall under any one TYPE? What would you do in this case?
- Must every TYPE describe or classify a SONG? Why would we want to have a TYPE with no songs under it?
- How many songs can fall under one type?
- Think about attributes for both of these entities.

Can you categorize the following music into playlists the same way SONGS are categorized into TYPES?

Table 2: Musical listings

SONG	ARTIST	GENRE
Viva la Vida	Coldplay	Alternative
Bach: The Cello Suites	Yo-Yo Ma	Classical
What a Wonderful World	Louis Armstrong	Jazz
4 Minutes	Madonna	Pop
Exclusive	Chris Brown	R&B/Soul
High and Dry	Radiohead	Alternative
We are the champions	Queen	Rock
Help Me	Elvis Presley	Pop, Rock
Brahms: The 4 Symphonies	Berliner Philarmoniker & Herbert von Karajan	Classical
One more time	Daft Punk	Electronic
Come on over	Shania Twain	Country
Just my imagination	The Rolling Stones	Rock
The show must go on	Pink Floyd	Rock
Thriller	Michael Jackson	Pop
So what	Miles Davis	Jazz
Mississippi Girl	Faith Hill	Country
Back to black	Amy Winehouse	R&B/Soul

Step 3 – Understanding relationship between clients, events, and types

This step may be undertaken following Section 3 Lesson 2.

You learned about entities and saw how the CLIENT, EVENT and THEME entities relate. Can you think of other entities for the DJs on Demand project? You can go back to the structural business rules described in the Case Study section of this project.

Step 4 – Procedural business rules

This step may be undertaken following Section 4 Lesson 2.

You are already familiar with the structural business rules presented in the Case Study section. Another important piece of information, important when effectively modeling a database, is represented by the procedural business rules.

An example of a procedural business rule is described in lesson 2 of section 4: Initial contact with the client must be made by the project manager. How could you incorporate this constraint in your ERD? Can you think of other examples of procedural business rules?

Step 5 – Resolving many-to-many relationships

This step may be undertaken following Section 5 Lesson 3.

You already saw how to solve the M:M relationship between the PARTNER and EVENT entities through the JOB ASSIGNMENT intersection entity. Incorporate this in your ERD.

How would you solve a M:M relationship between SONG and CD? What about the one between SONG and EVENT? What would be a good name for the intersection entities and what attributes would they have? Incorporate this step in your ERD.

Step 6 – Understanding CRUD requirements

This step may be undertaken following Section 5 Lesson 4.

Performing a CRUD analysis on the model you created so far for the DJs on Demand project is important. A CRUD analysis helps you to check the completeness and accuracy of the data model. Use the business rules presented in the Case Study section and create a table following the example below.

Look for words and phrases that impact CRUD (we want to track data, we need to enter data). Is there an entity or attribute or relationship that allows a user of the DJs on Demand to create, retrieve, update, or delete?

Hint: All entities need to have one create and retrieve function. This means you need to have the business rules that points to entering data in the entity and viewing the data once it is in the database.

Table 3 CRUD requirements example worksheet

Entity	Business Rules	CRUD Function?
EVENT	Since several partners can work on an event, and an event can be assigned to several partners, We like to keep track of who is working on which event.	CREATE RETRIEVE
ENTITY NAME	Specific business rule	

	relating to the entity	

Table 4 CRUD examples

"Whenever we get a new customer, we take down basic information (name, address, email) and assign an ID."	Create
"We'd like to print out a list of songs to be played at each event."	Retrieve
"The event manager reserves the location and may do a site visit. Then she notes down the status and date of each job."	Update
"A number of our customers were small companies that were hit hard by the recession. They went out of business. We removed them from our current records."	Delete

Step 7 – Mutually exclusive relationships

This step may be undertaken following Section 7 Lesson 1.

You have learned that you can represent mutually exclusive relationships through arcs. Incorporate the exclusive OR relationship between EVENT and PRIVATE HOME and PUBLIC SPACE in your ERD.

Can you think of another example using the same method of mutually exclusive relationship?

Step 8 – Supertypes and subtypes

This step may be undertaken following Section 7 Lesson 2.

In lessons 1 and 2 of section 7, you learned about the two ways to represent supertypes and subtypes: as arcs or through recursive relationships. Think about the advantages and drawbacks of each model. Which way would you choose to incorporate the supertype PARTNER, followed by the subtypes EVENT PLANNER, DJ, MANAGER, and OTHER in your ERD?

Hint: Take into account the procedural business rule about the manager described above.

Step 9 – Presenting the design to the instructor

This step can be undertaken at the end of Section 15 Lesson 4.

Create a presentation for the DJs on Demand Director, whose role will be played by your instructor. Organize your presentation, by including:

- Statement of the problem
- Information requirements of the business clearly stated

- Assumptions and constraints you took into account
- The ERD

You will present this to your instructor, and you will be given the opportunity to present the ERD as a communication tool, along with the business rules, to show the client that you understand their needs and that these needs are being met by your design.

A suggested order for the presentation is a follows:

1. Introduce the group members
2. State the business issue that you addressed
3. Present and explain the ERD (large enough for all to see)
4. Summarize how your solution will meet the client's needs
5. Present written documentation
6. State assumptions that you made in creating your solution
7. Thank the clients for their time
8. Exit gracefully

Remember: When you have a very large diagram, it may also help to break it up into smaller diagrams of functionally related entities. You could use the smaller sub-diagrams when presenting to different groups within the customer's company.

Hint: Review Section 11 Lesson 1 for drawing conventions for readability.

Step 10 – Making modifications and new requirements

This step can be undertaken at the end of Section 15 Lesson 5.

Modify your ERD based on the feedback received from the presentation to the DJs on Demand Director. Produce a Design Revision Document outlining the changes made since the presentation was given. Include the modified ERD with the Design Revision Document and submit the package to your instructor for review.

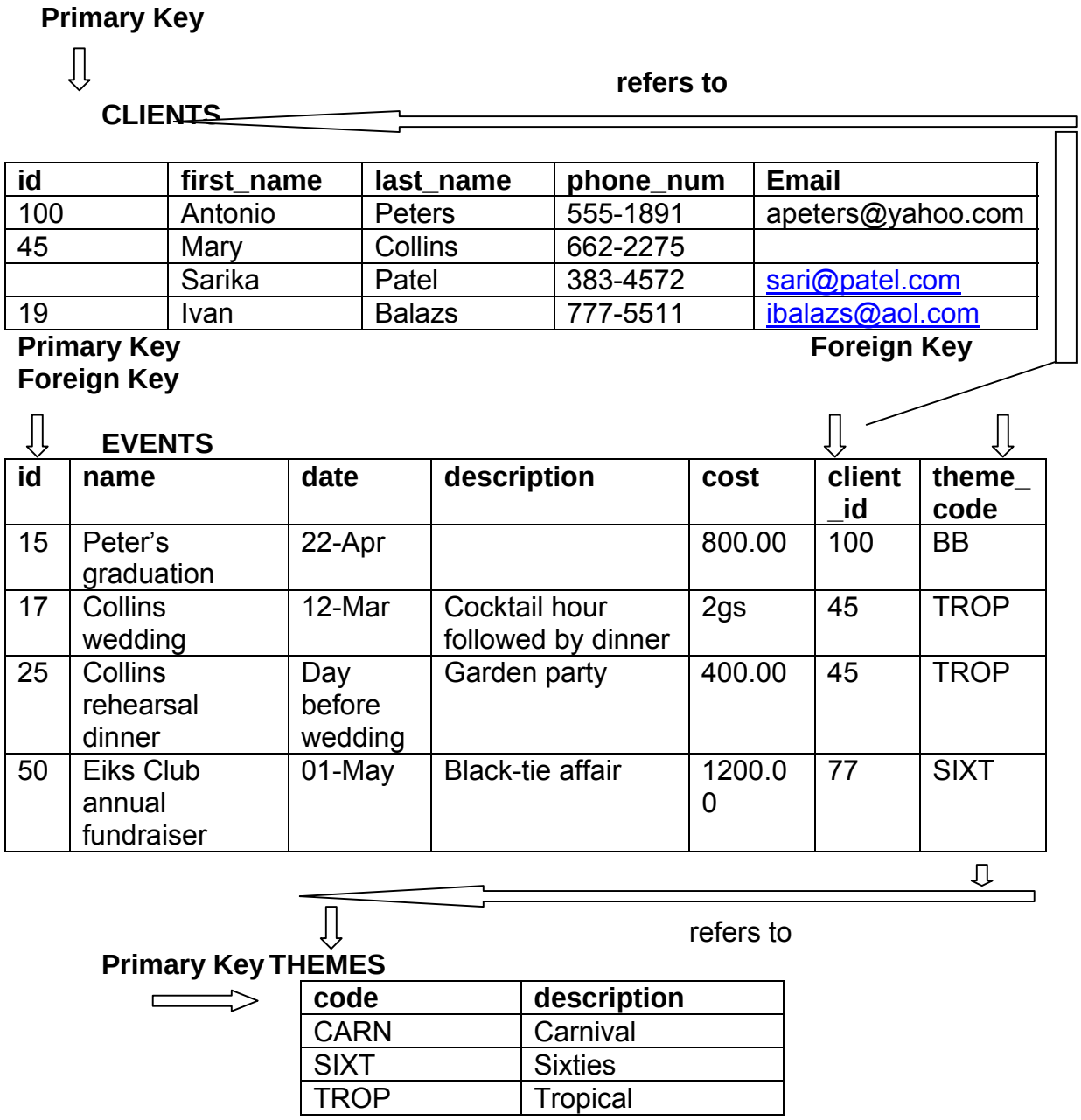
Think of reports that can be generated from the future system, which includes the modifications you just made. Document how you imagine these reports could be used in the business.

For example, the staffing manager could run an "Events Report" that lists the names of the partners who worked on different projects. If it looks like some of the partners are busier and perform better, then, the manager can promote them.

Step 11 – Checking data integrity in the DJ database

Examine the sample data for these tables in the DJs on Demand database. Check for entity, referential, and column integrity. Identify any data integrity violations. Assume that all date columns should have a date format and all cost columns should have a number format.

Figure 1 Sample data for DJs on Demand database



id	first_name	last_name	phone_num	Email
100	Antonio	Peters	555-1891	apeters@yahoo.com
45	Mary	Collins	662-2275	
	Sarika	Patel	383-4572	sari@patel.com
19	Ivan	Balazs	777-5511	ibalazs@aol.com

id	name	date	description	cost	client_id	theme_code
15	Peter's graduation	22-Apr		800.00	100	BB
17	Collins wedding	12-Mar	Cocktail hour followed by dinner	2gs	45	TROP
25	Collins rehearsal dinner	Day before wedding	Garden party	400.00	45	TROP
50	Eiks Club annual fundraiser	01-May	Black-tie affair	1200.00	77	SIXT

code	description
CARN	Carnival
SIXT	Sixties
TROP	Tropical

Step 12 – The PARTNER supertype

Transform the PARTNER supertype in the DJ model, using the supertype or single-table implementation.

1.4. Solutions

Solution Step 1 – Recognizing attributes for an entity

Answer: See Table 5 Entity and attribute assignment

Table 5 Entity and attribute assignment

SONG	EVENT	CUSTOMER	Attributes
√			Title
√	√		Description
	√		Venue
		√	First Name
		√	Phone Number
√			Release date
		√	Last Name
√	√		Type
		√	Email address

Solution Step 2 – Understanding relationship between SONG and TYPE

- Must every SONG have a TYPE?

Answer: Yes. The relationship between SONG and TYPE is mandatory.

- Can you have a SONG that doesn't fall under any one TYPE? What would you do in this case?

Answer: Yes, it is possible. In this case, you would create another type, because chances are there are going to be more songs classified under that type.

- Must every TYPE describe or classify a SONG? Why would we want to have a TYPE with no songs under it?

Answer: No, it is not necessary. But it is helpful in case other songs will be included in the database that will have this type.

- How many songs can fall under one type?

Answer: The diagram and business scenario indicate that a TYPE may be used to classify several songs, or as many as needed for the database.

- Think about attributes for both of these entities.

Answer: Answers will vary, but for SONG, some attributes (actually used in the ERD) are id, title, duration, and artist. For TYPE, attributes: code and description.

Examples of playlists:

- 90's music
- My top rated
- Recently added
- Recently played

- Party shuffle
- Rock (might include indie, alternative, hard rock)

Students should now categorize the songs belonging to these playlists or others.

Solution Step 3 – Understanding relationship between clients, events, and types

Answer: Other entities for the DJs on Demand project include: PARTNER, CLIENT, EVENT, JOB ASSIGNMENT, PRIVATE HOME, PUBLIC SPACE, THEME, TYPE, PLAY LIST ITEM, SONG, PACKAGE, TRACK LISTING, CD

Solution Step 4 – Procedural business rules

Answer: This is a rule that will have to be implemented by a computer program. Visualize a system where the partners can look up events and update them. The program could allow only the project manager to enter a new event and then assign the partners who will be working on it. Once the assignment is made, the system could send out an email notification to the event manager and the DJ, giving them details about the event, the customer contact information, etc.

Other procedural business rules:

- Only the project manager can make changes regarding the details of an event, after the client has requested them.
- Only the event manager can make arrangements for the venue of an event.
- All the advertisements for the business have to be approved by the manager.

Solution Step 5 – Resolving many-to-many relationships

Answer: The intersection entity for SONG and CD would be TRACK LISTING and could have an attribute called "* track".

The intersection entity for PARTNER and EVENT would be JOB ASSIGNMENT and could have the following attributes: status and #date.

Students should now incorporate these new entities in their preliminary ERD.

Solution Step 6 – Understanding CRUD requirements

Answer: Examples include:

- "The project manager makes the first contact with the client to discuss the event." – CREATE
- "Once that's decided, the event planner gets in touch with the client about specific locations, catering, decorations, and other specific details. The DJ talks with the client about the kind of music wanted." – RETRIEVE

- "Of course, a client can request other songs as well" – UPDATE
- "Since several partners can work on an event, and an event can be assigned to several partners, we like to keep track of who is working on which event. We keep a log of what each event planner and DJ has done on an event, and when they did it." – RETRIEVE
- "We can add new types as the need arises – in fact, we recently added a new type for rap music." – UPDATE
- "We keep adding event themes as we go" – UPDATE

Solution Step 7 – Mutually exclusive relationships

Answer: Students should now incorporate these new relationships in their preliminary ERD. Check to see they understood why they are needed.

When they are asked if they can think of another example using the same method of mutually exclusive relationships, answers will vary, but it would be good to introduce them to the different entities related to the PARTNER one, such as EVENT PLANNER, DJ, MANAGER and OTHER.

Solution Step 8 – Supertypes and subtypes

Answer: An advantage of the recursive relationships is that they can represent hierarchy in an ERD.

Usually, supertypes/subtypes are used to represent classifications or types of things. Arcs are used when you want to represent mutually exclusive relationships between entities. An M:1 relationship would not be suited to a supertype/subtype construct.

Also, arcs should be used when the exclusive relationships between the entities are more important to the business. The arc tells the reader of the diagram that only one of the "features" of the main entity will have the relationship with the main entity for each instance.

The entities EVENT PLANNER, DJ, and MANAGER have distinct sets of attributes, so there exists a strong need to model them as distinct entities. When supertype/subtype is redrawn as an arc, the relationships in the arc are mandatory 1:1 relationships.

PRO Hierarchical: Hierarchical structures are more explicit and are easier for most people to understand because they are very similar to an organizational chart. Each entity can have its own mandatory attributes and relationships, if the business requires this (instead of all optional attributes and relationships, as you would have in a recursive). In this way, your data model truly reflects the business rules.

PRO Recursive: Recursive relationships tend to be simpler because you are using only one entity. Your diagram will be less "busy". However, they are less specific – you cannot have mandatory attributes or relationships unless they are mandatory in all instances of the entity.

More: If the structure of the types of relationships changes often, a recursive relationship is easier to maintain. If the structure is fixed, then the more explicit hierarchy can be better.

A structure that doesn't change very much would be a building with suites and floors and rooms. This is a good case for using an explicit hierarchy. On the other hand, a company that reorganizes frequently (going from a fairly flat organizational structure to one with many levels and vice versa) would probably be better modeled with a recursive relationship.

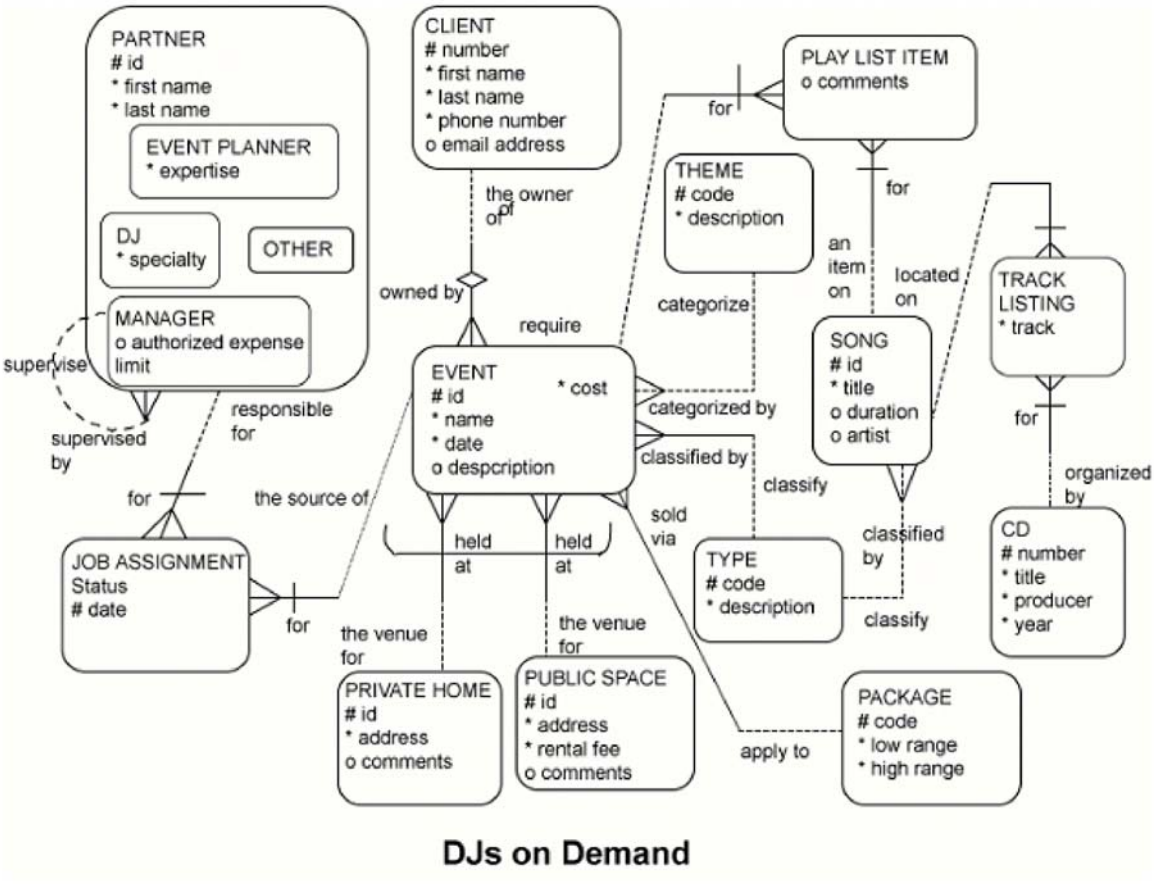
Taking into account the procedural business rule that "Initial contact with the client must be made by the project manager, and that managers, thus, should supervise the other PARTNERS", the use of subtypes and the recursive relationship is preferred. The ERD makes it possible for managers to manage other managers.

Solution Step 9 – Presenting the design to the instructor

Answer: Each presentation must contain the following:

- Statement of the Problem
- Statement of the Proposed Solution
- The information requirements of the business/organization clearly stated
- The business rules as they apply to the information requirements of the company/organization stated as single sentences
- The assumptions and constraints that had to be considered clearly stated
- ERD

Figure 2 DJs on Demand entity relationship diagram



Solution Step 10 – Making modifications and new requirements

Answer: Examples of reports:

- List of the locations of the private homes used for parties so that the business knows where to advertise more
- List of the most interested clients, so that they can receive discounts
- List of the most played songs so that the DJs can make better recommendations/improve their play lists

Solution Step 11 – Checking data integrity in the DJ database

Table 6 Data integrity check

CLIENTS table	Entity integrity: ID for Sarika Patel should not be null.

EVENTS table	Column integrity: Cost for Collins wedding (event id = 17) is not numeric.
	Column integrity: Date for Collins rehearsal dinner (event id = 25) is not a valid date format.
	Referential integrity: There is no client 77 in the CLIENTS table (event id = 50).
	Referential integrity: There is no theme corresponding to "BB" in the THEMES table (event id =15).

Solution Step 12 – The PARTNER supertype

Answer: After going through the activity, you may want to conduct the following discussion to check for understanding:

- Remind students that they need a discriminator column. What would this column be named? (***Answer:*** pnr_type.) What are the allowable values for this column? (***Answer:*** EPR, DJ, MNR.)
- Remind students that they need a check constraint. What would it check for? (***Answer:*** (pnr_type = 'EPR' and expertise is not null and specialty is null and authorized_expense_limit is null) or (pnr_type = 'DJ' and expertise is null and specialty is not null and authorized_expense_limit is null) or (pnr_type = 'MNR' and expertise is null and specialty is null and authorized_expense_limit is not null).)
- What does the foreign-key column pnr_id refer to? (***Answer:*** the PARTNERS table.)
- What relationship was it mapped from? (***Answer:*** the recursive relationship in PARTNER.)
- What does it represent? (***Answer:*** the id of the partner's manager.)

Project 2: Global Fast Foods

2.1. Introduction

The Global Fast Foods project describes the business scenario of a small fast-food restaurant. The business need for the database is that the director wants to better keep track of the staff and the shifts, the orders and the food items. The director wants to see reports stating the busiest times of the day, the hardest worker, who takes the most orders, the most popular items, the customers who frequent the Global Fast Foods restaurant the most.

Difficulty Scale: 2

Project Use: Apply basic concepts of the Database Design course

Application: Start this project following Section 3 Lesson 3.

Like the other projects, this project consists of a series of practice steps with each step building on the results of the previous step. Each step should be completed at the end of a specific lesson in the course. Similar to the DJs on Demand project, Global Fast Foods also has the business rules already defined.

At the end of this project, students will have revised ERDs highlighting important concepts in data modeling, such as supertypes/subtypes, relationship types, 1NF, arcs, hierarchies & recursive relationships, solving many-to-many relationships, and normalization. An important feature of the DJs on Demand project is Step 9 – Modeling historical data. This step allows students to test their knowledge about the UIDs of intersection entities and barred relationships. This project will also allow students to develop their skills regarding drawing conventions for readability in an ERD, since an easy reading of the diagram is essential for a successful presentation.

The project ends with steps requiring the students to develop a presentation of their data modeling solution and then modify this in compliance with the Global Fast Foods' director's feedback, whose role will be played by the instructor.

The lessons practices that reference this project are:

- Section 3 Lesson 3
- Section 4 Lesson 1
- Section 5 Lessons 1, 2 and 3
- Section 6 Lessons 2 and 4
- Section 7 Lessons 1, 2 and 3

Note: If lessons are skipped, students may not be able to successfully complete the corresponding practice step, or any later steps in the project.

On a scale of 1 to 5, the difficulty of this project is 2.5. Instructors should choose to complete this project in class when students would benefit from more practice regarding the application of basic concepts in data modeling, such as

supertypes/subtypes, relationship types, 1NF, arcs, hierarchies & recursive relationships. The final ERD can be found in the solutions section at the end of this document.

2.2. Case Study

The Global Fast Foods project has the following business scenarios.

"I own a small fast-food restaurant. We feature food items from all around the world – hence the name, Global Fast Foods. Some of our employees work at the counters and take orders. An order can consist of one or more food items.

"I'd like to track which of my employees work the hardest – who takes the most orders? I want to know what the busiest times of the day are, and what the busiest days of the week are. I also want to find out which food items are the most popular. I have different kinds of employees on staff, but for all of them I need to know their first name, last name, age, and phone number.

"I mentioned that we have different kinds of employees and how for all of them I need to know basic contact information. Oh yes, every employee gets a salary. In addition to that, I need to know other things depending on what the employee responsibility is:

- A cook normally has some kind of training – vocational school, self-taught, apprentice work, etc. I like to record that.
- The order taker is paid overtime on top of the standard salary. So I record how much we pay by the hour for every extra hour worked.
- The manager is responsible for supervising all employees and has a budget for expenses and a target revenue for the restaurant that he/she is in charge of.

"That's it for now. As we expand, I may hire other types of employees, but I'm not sure what they would be at this time.

"When a customer places an order with one of our staff, that order taker is responsible for seeing that order through – for making sure the chef gets it, for assembling it, and for collecting payment. If the customer has changes or questions about that order, he/she must go through the person the order was placed with. The order taker cannot ask another staff member to take care of it.

"You were asking about the items that can appear on an order? Well, mostly it's food items, but sometimes a customer can also purchase a frequent-diner card. This card entitles a customer to discounts at our restaurant. Also, if a customer buys this card, we can get information such as name and address. This way we can send the customer coupons and other promotional materials. The other benefit to us is that we can now track which items the customer likes to order regularly. When a customer comes in and

uses the card, we now have a record of the orders placed with that particular card.

"A customer can have one frequent-diner card, and each card is for only one customer. Only one frequent-diner card can be used to place an order.

"We have a variety of food items on our menu. Each order can be for multiple food items. And, of course, a food item (a hamburger, for example) can appear on many orders.

"All employees on our staff are assigned to shifts. We currently maintain a morning and an afternoon shift, but we are considering adding an early evening shift. Currently, we just have a sign-in sheet for each shift. It keeps getting lost, and then it's hard for me to allocate the workload properly. Several employees work on a single shift, and we do have employees who work consecutive shifts. It helps me to know which of my staff are overworked and which are underutilized, so I'd like to keep track of who is working double shifts, who is not working enough shifts, etc. Also, if there's a problem on a shift, I like to know immediately which employees were working during that time.

"We just started introducing a promotional menu. This menu features food items that are not available on the regular menu. It's a way for us to test new items and to take advantage of seasonal events (holidays, etc.) and commercial offerings (for example, when the movie "King Kong" was out, we offered oversized Kong burgers). Sometimes we have a little gift associated with a promotional item. For the Chinese New Year, we featured a mooncake on the promotional menu, and everyone who ordered it got a free toy dragon, because it was the year of the dragon. Each promotional menu has a name, such as Back to School or Summer Barbecue, and it has a start and end date. There is only one promotion in effect at any given time.

"Our regular menus contain those items that customers expect when they come to Global Fast Foods. Right now we have two types: a breakfast menu, available from 6 a.m. to 11 a.m., and a lunch menu, available from 11:01 a.m. until closing time. We're still considering a separate dinner menu, but we'll have to test that first.

"The manager is responsible for supervising all employees and has a budget for expenses and a target revenue for the restaurant that he/she is in charge of."

2.3. Steps, Exercises, and Examples

Step 1 – Speaking ERDish and drawing relationships

This step can be undertaken at the end of Section 3 Lesson 3.

Read the following business rules for the Global Fast Foods project and think about entities and relationships:

"I own a small fast-food restaurant. We feature food items from all around the world - hence the name, Global Fast Foods. Some of our employees work at the counters and take orders. An order can consist of one or more food items.

"I'd like to track which of my employees work the hardest - who takes the most orders? I want to know what the busiest times of the day are, and what the busiest days of the week are. I also want to find out which food items are the most popular. I have different kinds of employees on staff, but for all of them I need to know their first name, last name, age, and phone number."

It might be helpful to take a review slides in Section 3 Lesson 1 in order to better understand the relationship between customer and order.

Step 2 – Supertypes and subtypes

This step can be undertaken at the end of Section 4 Lesson 1.

Read the additional interview notes for Global Fast Foods listed below. Revise the ERD to reflect this information.

"I mentioned that we have different kinds of employees and how for all of them I need to know first name, last name, age, and phone number. Oh yes, every employee gets a salary. In addition to that, I need to know other things depending on what the employee responsibility is:

- A cook normally has some kind of training - vocational school, self-taught, apprentice work, etc. I like to record that.
- The order taker is paid overtime on top of the standard salary. So I record how much we pay by the hour for every extra hour worked.
- The manager is responsible for supervising all employees and has a budget for expenses and a target revenue for the restaurant that he/she is in charge of.

"That's it for now. As we expand, I may hire other types of employees, but I'm not sure what they would be at this time."

Step 3 – Relationship transferability

This step can be undertaken at the end of Section 5 Lesson 1.

Read the interview with the owner of Global Fast Foods and revise the ERD as necessary.

"When a CUSTOMER places an order with one of our STAFF, that ORDER TAKER is responsible for seeing that ORDER through - for making sure the chef gets it, for assembling it, and for collecting payment. If the CUSTOMER has changes or questions about that ORDER, he/she must go through the person the ORDER was placed with. The ORDER TAKER cannot ask another STAFF member to take care of it."

Step 4 – Relationship types

This step can be undertaken at the end of Section 5 Lesson 2.

Read the following additional notes from a conversation with the Global Fast Foods owner and modify the ERD as needed:

> "You were asking about the items that can appear on an order? Well, mostly it's food items, but sometimes a customer can also purchase a frequent-diner card. This card entitles a customer to discounts at our restaurant. Also, if a customer buys this card, we can get information such as name and address. This way we can send the customer coupons and other promotional materials. The other benefit to us is that we can now track which items the customer likes to order regularly. When a customer comes in and uses the card, we now have a record of the orders placed with that particular card.
>
> "Each customer may have one frequent-diner card, and each card is for only one customer. Only one frequent-diner card can be used to place an order.
>
> "We have a variety of food items on our menu. Each order can be for multiple food items. And, of course, a food item (a hamburger, for example) can appear on many orders."

Step 5 – Resolving many-to-many relationships

This step can be undertaken at the end of Section 5 Lesson 3.

Resolve the many-to-many relationship between ORDER and FOOD ITEM.

How do you track the quantity of each food item ordered?

Step 6 – Normalization and first normal form

This step can be undertaken at the end of Section 6 Lesson 2.

Read the following notes from a subsequent interview with the owner of Global Fast Foods:

> "All employees on our staff are assigned to shifts. We currently maintain a morning and an afternoon shift, but we are considering adding an early evening shift. Currently we just have a sign-in sheet for each shift. It keeps getting lost, and then it's hard for me to allocate the workload properly. Several employees work on a single shift, and we do have employees who work consecutive shifts. It helps me to know which of my staff are overworked and which are underutilized, so I'd like to keep track of who is working double shifts, who is not working enough shifts, etc. Also, if there's a problem on a shift, I like to know immediately which employees were working during that time."

Modify the ERD to include these new requirements.

Go through each entity in your revised ERD and check that it is in first normal form. If not, modify the ERD so that it conforms to 1NF.

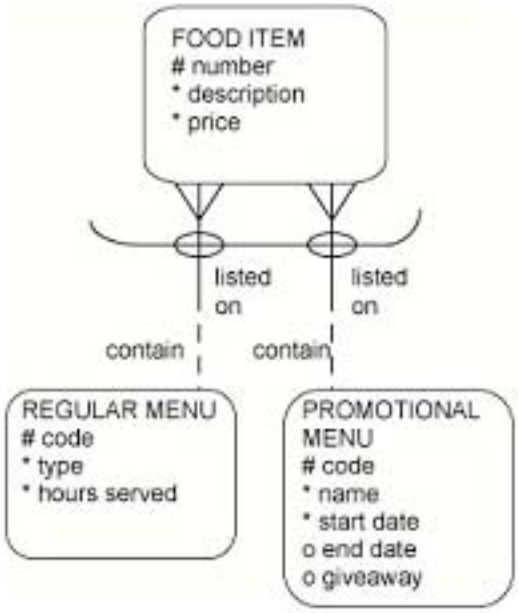
Step 7 – Arcs

This step can be undertaken at the end of Section 7 Lesson 1.

Read the following interview notes with the Global Fast Foods owner. Refine the ERD accordingly.

"We just started introducing a promotional menu. This menu features food items that are not available on the regular menu. It's a way for us to test new items and to take advantage of seasonal events (holidays, etc.) and commercial offerings (for example, when the movie "King Kong" was out, we offered oversized Kong burgers). Sometimes we have a little gift associated with a promotional item. For the Chinese New Year, we featured a mooncake on the promotional menu, and everyone who ordered it got a free toy dragon, because it was the year of the dragon. Each promotional menu has a name, such as Back to School or Summer Barbecue, and it has a start and end date. There is only one promotion in effect at any given time.

Figure 3 Menu arcs



"Our regular menus contain those items that customers expect when they come to Global Fast Foods. Right now we have two types: a breakfast menu, available from 6 a.m. to 11 a.m., and a lunch menu, available from 11:01 a.m. until closing time. We're still considering a separate dinner menu, but we'll have to test that first."

Redraw the REGULAR and PROMOTIONAL MENU entities as a supertype, and include the relationship to FOOD ITEM, based on the previously given scenario.

Step 8 – Hierarchies and recursive relationships

This step can be undertaken at the end of Section 7 Lesson 2.

The following was noted in an earlier interview with the owner of Global Fast Foods:

> "The manager is responsible for supervising all employees and has a budget for expenses and a target revenue for the restaurant that he/she is in charge of."

Modify the ERD to include a recursive relationship on STAFF showing the manager's supervisory role.

Step 9 – Modeling historical data

This step can be undertaken at the end of Section 7 Lesson 3.

Revisit the SHIFT ASSIGNMENT entity in the Global Fast Foods ERD, and recall an earlier interview from Step 6:

> "All employees on our staff are assigned to shifts. We currently maintain a morning and an afternoon shift, but we are considering adding an early evening shift. Currently we just have a sign- in sheet for each shift. It keeps getting lost, and then it's hard for me to allocate the workload properly. Several employees work on a single shift, and we do have employees who work consecutive shifts. It helps me to know which of my staff are overworked and which are underutilized, so I'd like to keep track of who is working double shifts, who is not working enough shifts, etc. Also, if there's a problem on a shift, I like to know immediately which employees were working during that time."

Notice that "consecutive shifts" means that an employee can work two shifts on the same date.

Answer the following questions:

1. What is the UID of this entity? How is it represented on the diagram?
2. Explain what would happen if the UID of SHIFT ASSIGNMENT included only the barred relationships to STAFF and SHIFT, and not the date.
3. Explain what would happen if the UID of SHIFT ASSIGNMENT included a barred relationship to STAFF, and the date?
4. Explain what would happen if the UID of SHIFT ASSIGNMENT included a barred relationship to SHIFT, and the date.

Step 10 – Drawing conventions for readability

This step can be undertaken at the end of Section 11 Lesson 1.

Review your Global Fast Foods data model so far.

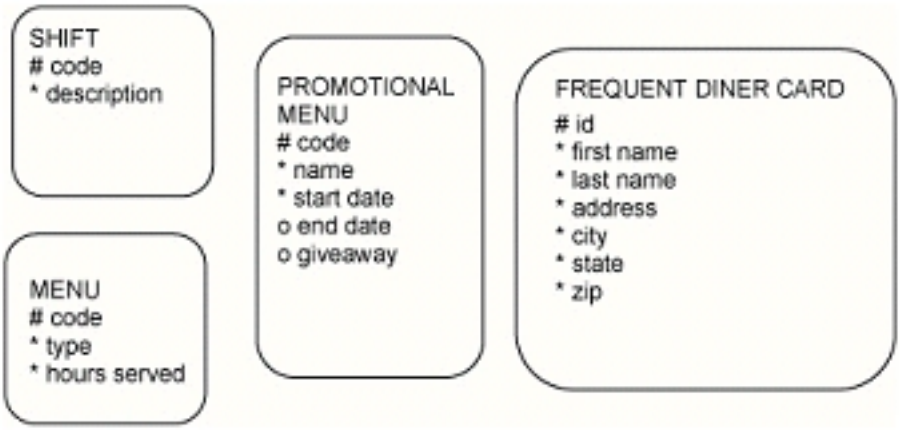
1. Identify the high-volume entities and redraw your ERD to use the "crows fly south and east" convention as far as possible. Try to avoid criss-crossing lines, and make good use of white space.
2. Create a smaller diagram that contains all the entities that would be of interest to the order taker.

Step 11 – Basic mapping: the transformation process

This step can be undertaken at the end of Section 12 Lesson 2.

Transform the following entities in Global Fast Foods into table diagrams. Use suitable naming conventions.

Figure 4 Entities to table diagrams



Refer to the completed Global Fast Foods model and map the following: entities:

- FOOD ITEM
- ORDER
- ORDER LINE

Transform relationships into foreign-key columns. Use as many rows as necessary in the following table diagram.

Table 7 Primary, foreign, and unique key mapping

Key Type (pk,fk,uk)	Optionality (“*” or “o”)	Column Name

Transform the STAFF supertype in the Global Fast Foods model, using the subtype or two-table implementation.

Step 12 – Presenting the design to the instructor

This step can be undertaken at the end of Section 15 Lesson 4.

Create a presentation for the Global Fast Foods client, whose role will be played by your instructor. Organize your presentation, by including:

- Statement of the problem
- Information requirements of the business clearly stated
- Assumptions and constraints you took into account
- ERD

One example of an assumption is that there is only one Global Fast Foods restaurant. The current model does not consider a chain of restaurants.

You will present this to your instructor, and you will be given the opportunity to present the ERD as a communication tool, along with the business rules, to show the client that you understand their needs and that these needs are being met by your design.

A suggested order for the presentation is a follows:

1. Introduce the group members
2. State the business issue that you addressed
3. Present and explain the ERD (large enough for all to see)
4. Summarize how your solution will meet the client's needs
5. Present written documentation
6. State assumptions that you made in creating your solution
7. Thank the clients for their time
8. Exit gracefully

Step 13 – Modifications and new requirements

This step can be undertaken at the end of Section 15 Lesson 5.

Modify your ERD based on the feedback received from the presentation to the Global Fast Foods client. Produce a Design Revision Document outlining the changes made since the presentation was given. Include the modified ERD with the Design Revision Document and submit the package to your instructor for review.

Think of reports that can be generated from the future system, which includes the modifications you just made. Document how you imagine these reports could be used in the business.

2.4. Solutions

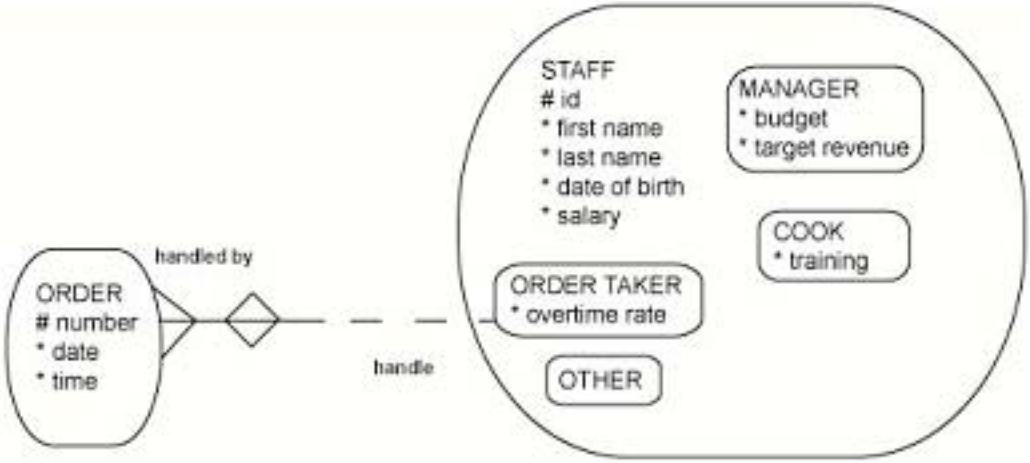
Solution Step 1 – Speaking ERDish and drawing relationships

Answer: Read the interview notes for Global Fast Foods and watch the video clips. Construct the ERD. Then present it to the class.

Solution Step 2 – Supertypes and subtypes

Answer: See example below. Do not try to model "manager supervising all employees" yet. This is a hierarchical or recursive relationship (between an entity and itself) and will be covered in a later step.

Figure 5 ORDER and ORDER TAKER relationship



Solution Step 3 – Relationship transferability

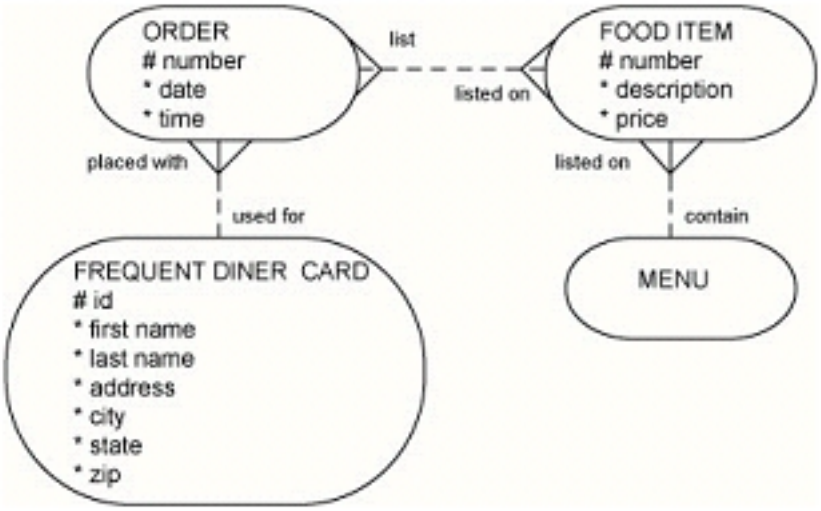
Answer: An order may be only taken by an order taker. Therefore, the diamond goes on the ORDER side of the relationship with the ORDER TAKER.

Solution Step 4 – Relationship types

Answer: Point out how the scenario clarifies the M:M relationship between FOOD ITEM and ORDER. We also add a new entity called FREQUENT DINER CARD. There is no need to model CUSTOMER because we record customer information on the card. Someone may also ask, "What if one customer places an order for a group of people, but each person in the group has a frequent-diner card?" In this case, the discount applies to the total order, and the order gets tracked under the one frequent-diner card.

Some students may not model a MENU entity, and some may decide that it is necessary. Both are valid. It is not clear right now that there is more than one menu. When we discuss arcs, they will get additional information that there are two menus.

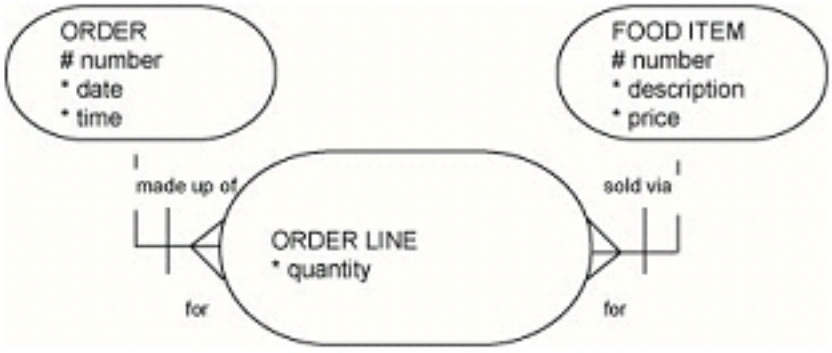
Figure 6 Frequent diner card and menu entities



Solution Step 5 – Resolving many-to-many relationships

Answer: See figure below.

Figure 7 ORDER and FOOD ITEM relationship



Solution Step 6 – Normalization and first normal form

Answer: Go through each entity in your revised ERD and check that it is in first normal form. If not, modify the ERD so that it conforms to 1NF.

The SHIFT ASSIGNMENT entity will result from the resolution of the M:M relationship between SHIFT and EMPLOYEE. There needs to be a date attribute in SHIFT ASSIGNMENT. The UID should include barred relationships from the two originating entities, plus the date. However, we have not learned to model change over time yet. Point out the UID but no need to emphasize this yet. If some students have trouble understanding it, tell them that we will talk about modeling time later.

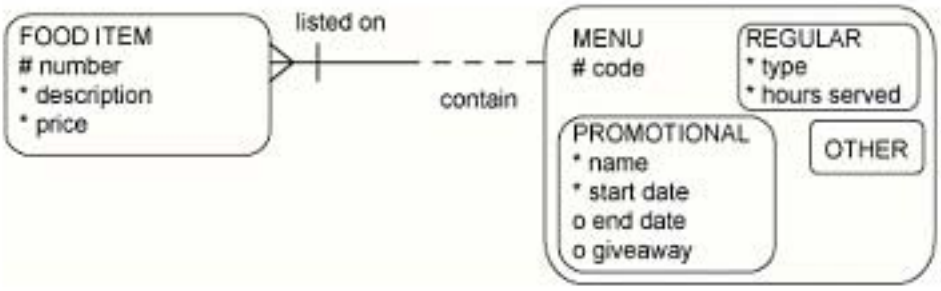
Figure 8 Shift assignment entity

Solution Step 7 – Arcs

Answer: See figure below.

One acceptable solution would be to have three entities in the arc:

- PROMOTIONAL MENU
- BREAKFAST MENU
- LUNCH MENU



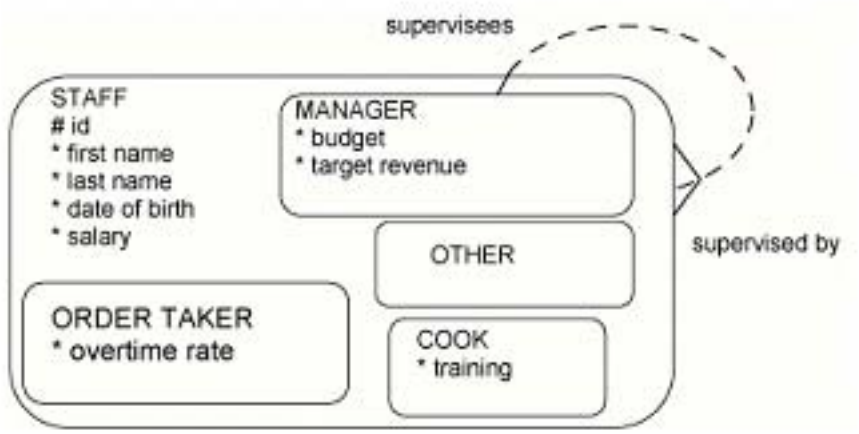
BREAKFAST MENU and LUNCH MENU would have the same attributes - code and hours served.

One acceptable solution would be to have four subtypes of MENU (BREAKFAST, LUNCH, PROMOTIONAL, OTHER). The type attribute would not be needed in the BREAKFAST and LUNCH subtypes.

Solution Step 8 – Hierarchies and recursive relationships

Answer: Point out that the relationship is from MANAGER to STAFF, not STAFF to itself. This is because only a STAFF member who is a manager can supervise other employees. Also note that this ERD does not prevent a manager from supervising other managers. A hierarchical relationship (with MANAGER as a separate entity) would make this clear.

Figure 9 STAFF recursive relationship



Solution Step 9 – Modeling historical data

1. What is the UID of this entity? How is it represented on the diagram?

Answer: The UID of SHIFT ASSIGNMENT is a combination of STAFF id, SHIFT code, and SHIFT ASSIGNMENT date. This is represented by the barred relationships to STAFF and SHIFT, and the # before date.

2. Explain what would happen if the UID of SHIFT ASSIGNMENT included only the barred relationships to STAFF and SHIFT, and not the date.

Answer: Using just the barred relationships, without the date as part of the UID, an employee could never work the same shift again, even on a later date.

3. Explain what would happen if the UID of SHIFT ASSIGNMENT included a barred relationship to STAFF, and the date?

Answer: Creating a barred relationship between SHIFT ASSIGNMENT and STAFF, and including the date in the UID, would mean that an employee could not work more than one shift on a given date. This would prevent an employee from working consecutive shifts.

4. Explain what would happen if the UID of SHIFT ASSIGNMENT included a barred relationship to SHIFT, and the date.

Answer: Creating a barred relationship between SHIFT ASSIGNMENT and SHIFT, and including the date in the UID, would mean that only one employee could work on a particular shift on a given date.

Solution Step 10 – Drawing conventions for readability

Answer: The Global Foods ERD can be drawn in several ways that are clear and readable. Look for adherence to basic conventions such as no crossing relationship lines, relationship names on either side of the relationship line, no overlapping relationship names, enough white space, etc.

Entities that would be of interest to the order taker: FREQUENT DINER CARD, ORDER, ORDER LINE, FOOD ITEM, REGULAR MENU, PROMOTIONAL MENU.

Solution Step 11 – Basic mapping: the transformation process

Answer: The following table shows the table diagram for the entities.

Table 8 Primary, foreign, and unique key mapping

Key Type (pk,fk,uk)	Optionality (“*” or “o”)	Column Name
SHIFT		
Pk	*	Code
	*	Description
MENU		
PK	*	Code
	*	Type
	*	Hours_served
PROMOTIONAL MENU		
PK	*	Code
	*	Name
	*	Start_date
	O	End_date
	O	Giveaway
FREQUENT DINER CARD		
PK	*	Id
	*	First_name
	*	Last_name
	*	Address
	*	City
	*	State
	*	Zip

Explain that we are not creating tables; we are creating definitions of tables.

The physical implementation of the tables will be done in a later lesson using Application Express.

Table 9 Entity to table mapping

Key Type (pk,fk,uk)	Optionality ("*" or "o")	Column Name
FOOD ITEM		
PK	*	Number
	*	Description
	*	Price
ORDER		
PK	*	Number
	*	Date
	*	Time
ORDER LINE		
PK	*	FoodItem.Number & Order.Number
	*	Quantity

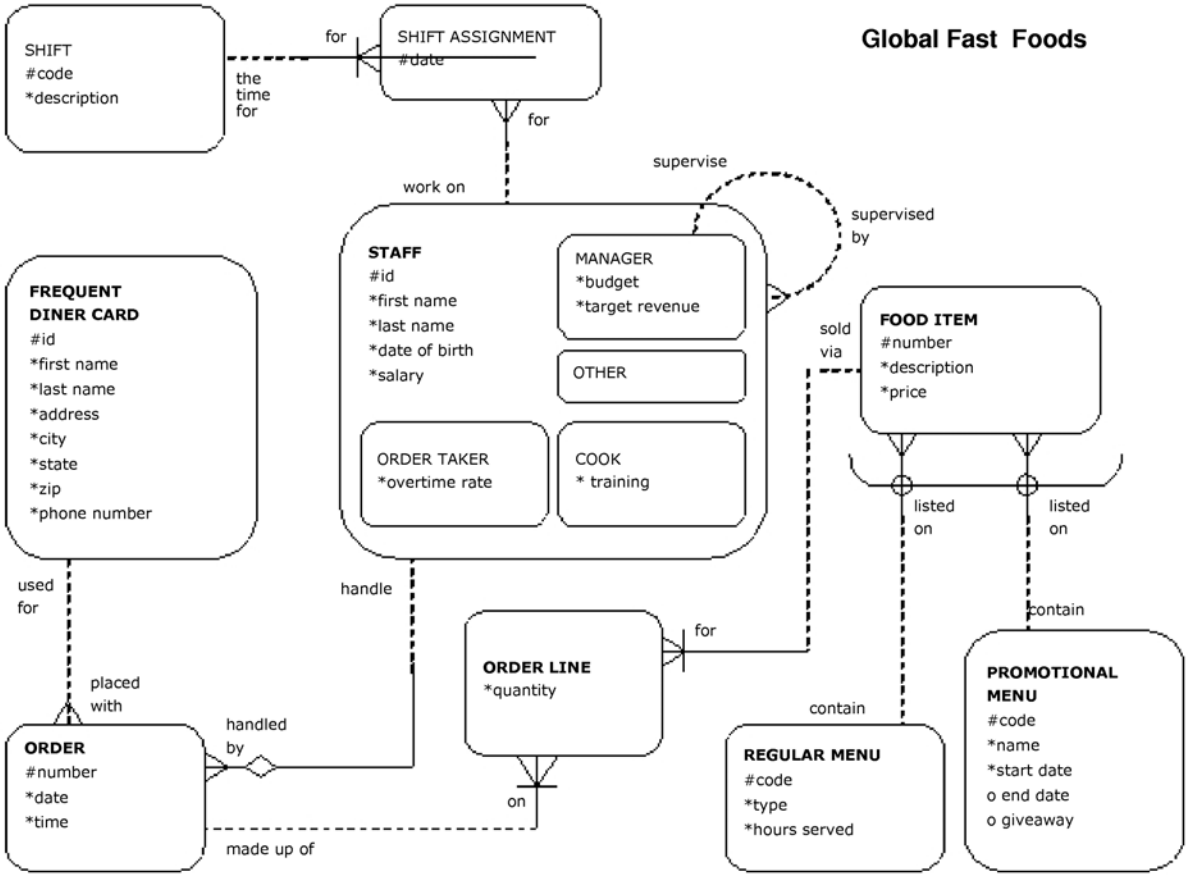
Solution Step 12 – Presenting the design to the instructor

Each presentation must contain the following:

1. Statement of the Problem
2. Statement of the Proposed Solution
3. The information requirements of the business/organization clearly stated
4. The business rules as they apply to the information requirements of the company/organization stated as single sentences
5. The assumptions and constraints that had to be considered clearly stated
6. ERD

Solution Step 13 – Modifications and new requirements

Answers will vary.



Project 3: Animal Shelter

3.1. Introduction

Difficulty Scale: 3.5

Project Use: Research business needs using interview techniques

Application: Start this project following Section 4 Lesson 2.

For this project, students will play the role of a consulting company whose mission is to model a database for an animal shelter. They will have to perform interviews with the animal shelter client, whose role will be played by their instructor, then document the business rules and eventually come up with the best solution for an Animal Shelter business database and present this to the client. The need for a database for this business has risen as the director wants to keep better track of the staff and the adopters, the animals which are/have been in the shelter, their adoption record and the cage occupancy. All of this data is important for the Animal Shelter database because it allows the director to make appropriate accommodations for the clients.

Like the other projects, the Animal Shelter project consists of a series of practice steps, each step building on the results of the previous one. Each step is designed for completion at the end of a specific lesson in the course. These lessons are identified at the beginning of each practice step. The steps themselves are referenced in the corresponding lesson practices.

This project is different in that it allows students to research similar businesses in order to have a sense of the business before the interview and then compare their notes from the interview and the ones from the Internet research. The project allows for enough flexibility for students to find the best way to implement the client's requirements, because there are no business rules already defined. Although they can derive some business rules from the interview notes, the students will have to guess at some based on their own reasoning and experience.

An important feature of the project is the step that requires a CRUD analysis because it allows students to understand the project and its specifics in depth. Another important feature, the interviews, gives the students a good start for the international competition.

The presentation, the most important part of the Animal Shelter project, constitutes excellent practice for both the international contest and the students' presentation skills. The modifications and new requirements also prepare the students for the challenges they will meet when preparing the presentation for the topic in the international competition. This project also permits students to work in groups to construct the business rules and then prepare the presentation. This is important as students can observe with whom they work best.

The lessons practices that reference this project are:

- Section 4 Lessons 1 and 2
- Section 5 Lesson 4
- Section 7 Lessons 1 and 2
- Section 15 Lessons 4 and 5

Note: If you choose not to teach a lesson at all, then students will not be able to complete the corresponding practice step, or any later steps in the same project.

On a scale of 1 to 5, this project is ranked 3.5 in terms of difficulty. Instructors have hints for the business rules in the solutions part of the project.

The final ERD can be found in the solutions section at Solution Step 6 – New requirements.

3.2. Case Study

An animal shelter is a place where the main business is housing and finding permanent homes for animals, mainly dogs and cats, that are brought to the facility. Many activities occur, including recordkeeping, adoption, and financial transactions. Your consulting company, through research of other shelters and interviews, will create the database design for this animal shelter.

Examples of questions to ask the interviewee:

- What's the business goal?
- What do you generally want to keep track of?
- What do you want to record for each animal in the record?
- Any special information if it's a dog/cat/other animal?
- What do you want to keep track of for the animal adopter?
- What about the non-adopters?
- What sort of information would you record for the cages?
- What type of lists/reports are you interested in compiling from the database?
- What other special requests/suggestions do you have?

3.3. Steps, Exercises and Examples

Step 1 – Determining business needs

This step may be undertaken following Section 4 Lesson 1.

Your group will play the role of the consulting company. Your teacher will act as the director of a city animal shelter who needs a database.

Choose a meaningful name for your consulting company.

Spend about 15 minutes getting ready for the interview. The process can be broken down into the following steps:

1. Prepare for the interview
   a) Prepare a question list
   b) Set goals
   c) Determine and gather materials needed

2. Conduct the interview
   a) Take notes
   b) Ask for clarification

3. End the interview
   a) Summarize key points
   b) Thank the interviewee

4. Follow up.
   a) Review notes
   b) Look for missing information

Check out the following links for examples of real animal shelter websites.

- PetsLifeLine in Sonoma Valley, California at http://www.petslifeline.org
- Animal Care and Control of New York City at http://www.nycacc.org
- Wood Green Animal Shelters' Godmanchester Shelter in the UK at http://www.woodgreen.org.uk

Conduct an interview between the director and the consulting company to determine the business needs of the organization. At the end of the interview, you should be able to list the data and information requirements of the business.

Step 2 – Documenting business requirements

This step may be undertaken following Section 4, Lesson 2.

Using notes taken from the interview with the director of the animal shelter (Step 1), construct the business rules for this project. Document at least two structural rules and two procedural rules.

Structural business rules indicate the types of information to be stored and how the information elements are interrelated. Example: Each animal must have a unique identification number.

Process rules are related to workflow or business process. Example: Each animal must undergo a medical examination when it arrives at the shelter.

If you make assumptions, document them as well. You can confirm or clarify them with the director in a follow-up interview. If there is time, begin to identify entities, attributes, and relationships.

Step 3 – Understanding CRUD requirements

This step may be undertaken following Section 5, Lesson 4.

Create your Animal Shelter ERD models. Do a CRUD analysis on the model. Capture the information from your CRUD analysis in a worksheet similar to the one below. Use your interview notes and business rules during your CRUD analysis. Look for words and phrases that impact CRUD (we want to track data, we need to enter data, etc.). Is there an entity or attribute or relationship that allows a user of the animal shelter to create, retrieve, update, or delete?

Hint: All entities need to have one create and retrieve function. This means that you need to have interview notes or a business rule that points to entering data in the entity and viewing the data once it's in the database.

Use the worksheet below. One example has been created for you.

Table 10 CRUD requirements example worksheet

Entity	Interview Notes or Business Rules	CRUD Function
ANIMAL	When an animal comes into the shelter, we assign it an id and collect information We need to track animals in our shelters	CREATE RETRIEVE

Step 4 – Presenting requirements

This step can be undertaken at the end of Section 15 Lesson 4.

Create a presentation for the animal shelter director. Organize your presentation. Each presentation must contain the following:

- Statement of the problem
- Statement of the proposed solution
- The information requirements of the business/organization clearly stated (you should have this from your interview notes)
- The business rules as they apply to the information requirements of the company/organization stated as single sentences (you should have this from the previous step)
- The assumptions and constraints that are to be considered clearly stated. Assumptions can be relationships or rules for the data model that you do not have time to verify. They can also be conditions that need to be true in order for the proposed solution to be successful. These may not be directly reflected in the ERD.
- Entity relationship model

Your teacher will decide how much time you have to present to the "client." Remember: This is a "meeting" between the client and your consulting company. You will present your ERD to the "director." The ERD should serve as a communication tool, along with the business rules, to show the client that you understand their needs and that these needs are being met by the design. If a time limit is set for the meetings, be careful not to allow additional questioning after it is over.

A suggested order for the presentation is a follows:

1. Introduce the group members
2. State the business issue that you addressed
3. Present and explain the ERD (large enough for all to see)
4. Summarize how your solution will meet the client's needs
5. Present written documentation
6. State assumptions that you made in creating your solution
7. Thank the clients for their time
8. Exit gracefully

Step 5 – Modifications

This step can be undertaken at the end of Section 15 Lesson 5.

Modify the Animal Shelter ERD based on the input received from the presentation to the director of the animal shelter. Produce a Design Revision Document outlining the changes made since the presentation was given. Include the modified ERD with the Design Revision Document and submit the package to your teacher for review.

The Design Revision Document may have the following contents:

- Project Name
- Presentation Date
- Consultant Name
- Presentation Attendees
- Business Requirements Identified
- New Business Requirements Impact Statement
- Request for Approval – Signature line

Step 6 – New requirements

This step may be undertaken following Section 15 Lesson 5.

Make modifications to your Animal Shelter ERD based on these additional requirements:

- "Even though we did not require employees of the shelter to be part of the design, we do need to know which employee received the animal at the shelter. No need to tie it to our employee system - we just want to capture the name."

- “We also need to know the date and time the animal was taken in at the shelter.”
- “We also need to know special information about the date the animal is adopted (was the date a holiday?) and special notes about the date. For special notes, we'd like to know things such as, "general weather conditions" or "schools finish this week for summer."
- “We're trying to find trends that affect animal adoption. We need this information so that we can give good reports to our staffing manager about the number of employees needed for each shift and on special days of the year. You don't need to design information about "shifts" (we already have that in the other system)."

Think of at least one report or statistic that can be generated from the future system that includes the modifications you just made. Document how you imagine these reports could be used in the business.

For example, the staffing manager could run a "Receiving Report" that lists names of employees who received the animals and the dates received. If it looks as though some days of the week are a lot busier, and there are less employees working on those days, then more employees could be scheduled to work.

Step 7 – Adding the time element to the Animal Shelter ERD

This step may be undertaken following Section 15, Lesson 5.

Read the following extra requirement and modify the ERD.

"We'd also like to capture data on the days that animals are brought to the shelter. Does it happen more after holidays? On rainy days? This will help us staff the shelter more appropriately if we anticipate a large number of animals being dropped off."

3.4. Solutions

Solution Step 1 – Determining business needs

Answer: Answers will vary. Examples:

- The animal shelter would like to track animals in their shelters.
- Keep track of who has adopted their animals.
- For all animals, track name, approximate age, health, whether they're vaccinated, spayed or neutered, reason being given up, whether good with children, trained, person giving it up or a rescue.
- For cats, identify long-haired or short-haired.
- For dogs, identify the breed and the size: small, medium, or large
- For animal adopters, track name, address, phone number, email, dog/cat preference, animal adopted, and number of children in their house.

- For non-adopters who would like to receive the newsletter, track name, address, email, and phone number.
- Track in which cage an animal is.
- Obtain a list of all unadopted cats and dogs.
- Send only dog information to people who like dogs and cat information to people who like cats.

Solution Step 2 – Documenting business requirements

Answer: Answers will vary.

Explain to the class that although they can derive some business rules from the interview notes, they will have to guess at some based on their own reasoning and experience. This is where a consultant's previous experience becomes helpful. Of course, remind them that all business rules will have to be confirmed by the client. The business rules formulated here will be part of their presentation. Some business rules that can be formulated:

Structural business processes include:

- Each shelter contains dogs, cats, and the occasional other type of animal (bird, snake).
- Basic information taken for all animals: name, age, vaccinations, neuter status, health, reason being given up, and person giving up. If it is a dog, breed and size are noted. If it is a cat, it is classified as long- or short-haired.
- Persons who come into the shelter are classified as adopters or non-adopters (volunteers or newsletter only). Adopters must provide name, address, phone number, email, animal preference, and number of children in the house.
- Dog-related mailings must be sent only to dog lovers; and cat-related mailings must be sent only to cat lovers.

Procedural business rules include:

- When an animal comes into the shelter, it is assigned an ID and a temporary collar. After the required information is noted, the animal is assigned to a cage.
- A non-adopter who comes into the shelter can fill out a card to receive the newsletter.
- Each week, a list of all cats and dogs that are not adopted are posted online in the respective “Cat Lovers” and “Dog Lovers” pages of the website.

Solution Step 3 – Understanding CRUD requirements

Answer: Answers will vary.

The answers in the Interview Notes/Business Rule column will vary depending on what they asked during their interview with the client. The key thing is to check for completeness – do they have all the entities? If they are missing some, remind them of the interview and the data requirements the client provided at that time. Remind the students that a client often describes business functions as part of the scenario. For example:

- "Whenever we get a new adopter, we take down basic information (name, address, email) and assign an ID." (CREATE)
- “Each week, a list of all cats and dogs that are not adopted are posted online in the respective “Cat Lovers” and “Dog Lovers” pages of the website.” (RETRIEVE)
- "Once an animal is adopted, we update its status and the associated information for the adopter." (UPDATE)
- "We remove records of unadopters for whom newsletters were returned." (DELETE)

Remind students that ERDs are modified over and over until the project is ready to move on to creating the physical database. It's an iterative process in that each time the ERD is reviewed and revised, it more closely approaches the desired result. The ERD is a conversation piece between the client and consultant. It's a guideline for the DBA (database administrator) who will likely implement the consultant's design. It may never be perfect, but hopefully the consultants will take the design a long way toward this goal!

Solution Step 4 – Presenting requirements

Answer: Remind the class that each group will be presenting to the "client" during the next meeting. They should start assigning roles and responsibilities for their presentation. If they took good notes during the interview and documented business rules and assumptions, they should have most of the written materials. Check with each team to see what they're missing. Each presentation must contain the following:

- Statement of the problem
- Statement of the proposed solution
- The information requirements of the business/organization clearly stated (you should have this from your interview notes)
- The business rules as they apply to the information requirements of the company/organization stated as single sentences (you should have this from the previous lesson)
- The assumptions and constraints that had to be considered clearly stated (you should have this from the previous lesson)
- Entity relationship model

Spend a few minutes giving the class advice on how to organize their presentations. Write the order in which the companies will meet with the client on the board. You can ask for volunteers or write the groups in alphabetical order.

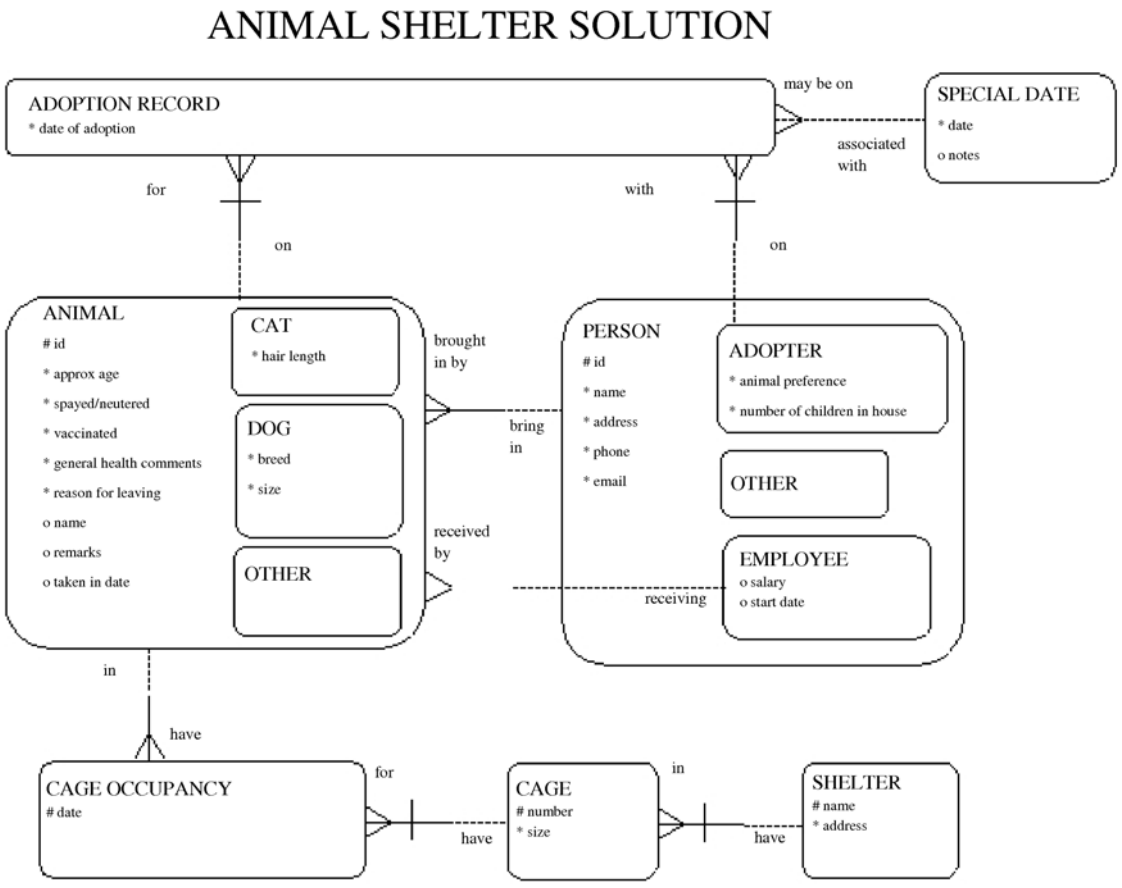
Solution Step 5 – Modifications

Answer: Answers will vary.

Solution Step 6 – New requirements

Answer: ERD diagram Figure 10 Animal Shelter entity relationship diagram

Figure 10 Animal Shelter entity relationship diagram



Possible reports include:

- Report on average time between an animal being received and adopted. The director to plan for animal housing and care while it is at the shelter could use this information.

- Report on the busiest employees - who receives the most animals.
- Report on what time of day is the busiest or least busy for receiving animals.
- Report on what time of day is the busiest or least busy for people bringing animals to the shelter.

Solution Step 7 – Adding the time element to the Animal Shelter ERD

Answer: This is tricky. They need to create a new relationship from the previously created DAY entity to the ANIMAL entity. If they are not comfortable with multiple relationships, they may want to create another DAY entity.

Another challenge is the fact that this will assume that an animal may be dropped off only once (each ANIMAL can be received on one and only one DAY). This is not necessarily true. An animal can be dropped off and returned more than once. Do you assign the animal a unique ID each time it is dropped off? That's not practical because you would not have the history of the animal.

A quick solution would be to "bar" the relationship from DAY to ANIMAL so that the drop-off date would be part of the UID of ANIMAL (along with animal ID). However, this hides the real M:M nature between DAY and ANIMAL. Probably a better way would be to recognize that there is an M:M relationship between ANIMAL and drop-off DAY, and resolve it with an intersection entity such as ANIMAL RECEIVING HISTORY.

You can discuss these issues in class to demonstrate that sometimes there are no easy answers in data modeling. There are many options and the good modeler evaluates them and their implications.

Project 4: Natural Science Lab

4.1. Introduction

To fully appreciate science, you must enter a laboratory and perform experiments, because in natural sciences observation means understanding. Experiments should produce quantitative and qualitative data, which should be recorded in the students' lab notebook and in a lab-recording book. A proper way of recording all lab activity information (what is taking place in a lab) ensures that no hazards occur and enhances the quality of data analysis. A successful science department for a high school needs good laboratories, practice, and order.

Difficulty Scale: 4

Project Use: Integrate interviewing skills of a science teacher into creative data modeling.

Application: Start this project following Section 4 Lesson 1.

The Natural Science Lab project will begin with a focus on interviewing skills to determine business requirements. Once business needs for the natural science lab are uncovered, the focus of the project will be on accurate and creative data modeling. The project completion will be demonstrated by a final presentation to the instructor.

Note: Students are encouraged to choose to do the data model for whichever natural science they want, but the solution is given for a chemistry lab.

The project allows for enough flexibility for students to find the best way to implement the client's requirements, because there are no business rules already defined. Although they can derive some business rules from the interview notes, the students will have to guess at some based on their own reasoning and experience.

An important feature of the project is the step that requires a CRUD analysis because it allows students to understand the project and its specifics in depth. Another important feature, the interviews, gives the students a good start for the international competition.

The presentation, the most important part of the Natural Science Lab project, constitutes excellent practice for both the international contest and the students' presentation skills. The modifications and new requirements also prepare the students for the challenges they will meet when preparing the presentation for the topic in the international competition. This project also permits students to work in groups to construct the business rules and then prepare the presentation. This is important as students can observe with whom they work best.

The lessons practices that reference this project are:

- Section 4 Lessons 1 and 2
- Section 5 Lesson 4
- Section 7 Lessons 1 and 2
- Section 15 Lessons 4 and 5

Note: If you choose not to teach a lesson at all, then students will not be able to complete the corresponding practice step, or any later steps in the same project.

On a scale of 1 to 5, this project is ranked 4 in terms of difficulty. Instructors have hints for the business rules in the solutions part of the project.

The final ERD can be found in the solutions section at Solution Step 6 – New requirements.

4.2. Case Study

As a consulting company specializing in high school science labs, your contract is to create a conceptual data model to support the database needs of the lab. The lab manager or other people affiliated should be able to enter and query data. The data should focus on the information relevant to the experiments performed, the chemical solutions used and the students. The data should be specific for the students and the staff/scientists, meaning that the names, IDs, grades, specialization and other special notes. Other information such as hazards, lab occupancy, shifts and the different suppliers for the chemical solutions are also of importance. One other detail that should be accounted for is the class a student is enrolled: standard/AP/Honors.

Through an interview with a science teacher, you will acquire the information needed to create a data model. Not only do you have the physical lab space, but the students, lab manager, and teachers that interact with many different aspects of a science lab and its experiments. Examples of questions to consider as you gather information are:

- What's the general goal of the database?
- Who are the users? What do they need to know from the database?
- How many laboratories are there? How do they differ from one another?
- What information are you interested in for the students?
- What information do you need about the class(es) students are enrolled in?
- What would you want to keep track of for the experiments?
- What materials are used during experimentation?
- Other than the students, do you want to keep track of other teachers/staff involved in the laboratory?
- What special requests/suggestions do you have regarding the data model?

4.3. Steps, Exercises and Examples

Step 1 – Determining business needs

This step may be undertaken following Section 4 Lesson 1.

Your group will play the role of the consulting company. Choose a meaningful name for your consulting company. Then, schedule an interview with a science/chemistry teacher at your high school.

Take your time in getting ready for the interview. The process can be broken down into the following steps:

1. Prepare for the interview.
   c) Prepare a list of questions
   d) Set goals
   e) Determine and gather materials needed

2. Conduct the interview
   a) Take notes
   b) Ask for clarification

3. End the interview
   a) Summarize key points
   b) Thank your interviewee

Although there are no formal business needs for a chemistry lab, because this is not in itself a business, you must always ask yourself (and your interviewee!) if you understand the way the lab works. At the end of the interview, you should be able to list the data and information requirements for such a lab.

Step 2 – Documenting business requirements

This step may be undertaken following Section 4, Lesson 2.

Using notes taken from the interview with your science teacher (Step 1), work in your respective groups to construct the business rules.

Structural business rules indicate the types of information to be stored and how the information elements are interrelated. Example: Each solution must have a unique identification number.

Process rules are related to workflow or business processes. Example: Each solution should be tested by the lab manager before being used by students.

If you make assumptions, document them as well, and make sure to ask for the opinion of either your lab science teacher or your Database Design Instructor. If there is time, begin to identify entities, attributes, and relationships.

Step 3 – Understanding CRUD requirements

This step may be undertaken following Section 5 Lesson 4.

Create your Natural Science Lab ERD model. Do a CRUD analysis on the model. Capture the information from your CRUD analysis in a worksheet similar to the one below. Use your interview notes and business rules during your CRUD analysis. Look for words and phrases that impact CRUD (we want to track data,

we need to enter data, etc.). Is there an entity or attribute or relationship that allows a user of the Natural Science Lab database to create, retrieve, update, or delete?

Hint: All entities need to have one create and retrieve function. This means that you need to have interview notes or a business rule that points to entering data in the entity and viewing the data once it's in the database.

Use the worksheet below. One example has been created for you.

Table 11 CRUD Requirements Example Worksheet

Entity	Interview Notes or Business Rules	CRUD Function
EXPERIMENT	We assign an ID to each experiment we perform. We want to track all the experiments performed in a day.	CREATE RETRIEVE

Step 4 – Presenting requirements

This step can be undertaken at the end of Section 15 Lesson 4.

Create a presentation for the science teacher/client. Organize your presentation. Each presentation must contain the following:

- Statement of the problem
- Statement of the proposed solution
- The information requirements of the business/organization clearly stated (you should have this from your interview notes)
- The business rules as they apply to the information requirements of the company/organization stated as single sentences (you should have this from the previous step)
- The assumptions and constraints that are to be considered clearly stated. Assumptions can be relationships or rules for the data model that you do not have time to verify. They can also be conditions that need to be true in order for the proposed solution to be successful. These may not be directly reflected in the ERD.
- Entity relationship model

Your teacher will decide how much time you have to present to the "client." Remember: This is a "meeting" between the client/science teacher and your consulting company. This is your chance to present your ERD. The ERD should serve as a communication tool, along with the business rules, to show the client that you understand their needs and that these needs are being met by the design. If a time limit is set for the meetings, be careful not to allow additional questioning after it is over.

A suggested order for the presentation is a follows:

1. Introduce the group members
2. State the business issue that you addressed
3. Present and explain the ERD (large enough for all to see)
4. Summarize how your solution will meet the client's needs
5. Present written documentation
6. State assumptions that you made in creating your solution
7. Thank the clients for their time
8. Exit gracefully

Step 5 – Modifications

This step can be undertaken at the end of Section 15 Lesson 5.

Modify the Science Lab ERD based on the input received from the presentation to the client/ science teacher. Produce a Design Revision Document outlining the changes made since the presentation was given. Include the modified ERD with the Design Revision Document and submit the package to your teacher for review.

Step 6 – New requirements

This step may be undertaken following Section 15 Lesson 5.

Make modifications to your Science Lab ERD based on these additional requirements:

- Test questions are posted through the database for students to answer. The questions are related to experiments that students undertake. Students enter responses to the questions for the teacher to review.
- Administrators want to be able to see if a student is enrolled in a standard or AP or Honors class.
- The lab manager and teachers want to introduce an online forum feature in the database. This should include virtual science projects and discussions. This will provide the database users with a means of instantly accessing information and being in touch with each other regarding their research projects or similar interests.
- The teachers want to keep track of the science contests or Olympiads held locally, regionally, nationally or internationally in order to better prepare the students for them. Teachers are interested in recording relevant information regarding the subjects given at each contest they are tracking, the results, practice exams, preparatory books, online notes, preparation times, helpful software, and special or advanced experiments for contests.

Think of as many reports or statistics that can be generated from the future system that includes the modifications you just made. Document how you

imagine these reports could be used in the business. Create examples of the reports with sample data. For example, the lab manager may want to see which experiments produced the most incidents.

Step 7 – Accomplishments

This step may be undertaken following Section 15 Lesson 5.

Sometimes, due to time constraints, you may limit parts of your ERD. Or, when you find something too difficult to model, you will create a business rule or an assumption.

First, identify why incorporating that part in your ERD was difficult and think about how your model would have benefited more if you managed to find a solution to that.

Second, choose one part to extend upon. For this, you can work closely with your instructor or share opinions with other students in the class.

At the end of a project, it is sometimes useful to check again the initial business needs and special needs of the client and then look at your solution. This is a great way to revise your project and provides good practice for the next projects you will take on.

When you are done, create a table with 2 columns: Initial Business Needs and Your Solution.

4.4. Solutions

Solution Step 1 – Determining business needs

Answer: The chemistry lab data model clients want to keep track of all the experiments performed in a school's labs. Since there are multiple lab classrooms, they assign each one an ID and they want to know if that particular lab is used for special or themed experiments.

They want to know the following data about the students involved in each experiment: ID, name, and grade. The class each student is enrolled in is also of importance. They want to keep track of the ID, date, title, and syllabus. It should also be kept track if it is a standard chemistry class, or an AP/honors class.

They want to know the exact list of the students who took part in a given experiment.

For each experiment they perform, they assign an ID. For the experiment they want to know the title, date, instructions, outcome, and hazard warnings.

They also want to track the incidents that took place during each experiment, in an experiment logbook. For each incident, they want to record the description and special notes.

The chemical solutions used for an experiment are also very important to keep track off. For each one, the ID, producer, purity, concentration, date of preparation, safety issues. They also want to know details regarding the materials used/waste.

The supplier/producer is also one of the elements of great importance in a chemistry lab database. For each, they assign an ID, and want to know the name, specialization, contact person, and a short description.

They also want to know about the people associated with the chemistry lab. They want to track the ID, name, and specialization of the lab manager, teacher and others. The shifts are also important to the database; they want to track the date and time and a description for each.

Solution Step 2 – Documenting business requirements

Answer: Variable.

Explain to the class that although they can derive some business rules from the interview notes, they will have to guess at some based on their own reasoning and experience. This is where a consultant's previous experience becomes helpful. Of course, remind them that all business rules will have to be confirmed by the client. The business rules formulated here will be part of their presentation. Some business rules that can be formulated:

Structural business rule examples include:

- Each student is assigned a unique id including information about the class taken, and date and time of experiments undertaken.
- All experiments are identified with a title, date, instructions, and any hazard warnings. Any materials required for the experiment are documented.

Procedural business rule examples include:

- Each student is assigned to a lab station for that experiment.
- Following an experiment, the waste generated from that experiment is properly disposal of and logged.
- Any incidents that occur outside the normal experiment outcomes are to be logged in an incident report.
- All unused chemical solutions must be returned to the lab manager for proper check in.

Solution Step 3 – Understanding CRUD requirements

Answer: The answers in the Interview Notes/Business Rule column will vary depending on what they asked during their interview with the client. The key thing is to check for completeness – do they have all the entities? If they are missing some, remind them of the interview and the data requirements the client provided

at that time. Remind the students that a client often describes business functions as part of the scenario.

Remind students: ERDs get modified over and over until the project is ready to move on to creating the physical database. It's an iterative process in that each time the ERD is reviewed and revised, it more closely approaches the desired result. The ERD is a conversation piece between the client and consultant. It's a guideline for the DBA (database administrator) who will likely implement the consultant's design. It may never be perfect, but hopefully the consultants will take the design a long way toward this goal!

Solution Step 4 – Presenting requirements

Answer: Remind the class that each group will be presenting to the "client" during the next meeting. They should start assigning roles and responsibilities for their presentation. If they took good notes during the interview and documented business rules and assumptions, they should have most of the written materials. Check with each team to see what they're missing.

Each presentation must contain the following:

- Statement of the problem
- Statement of the proposed solution
- The information requirements of the business/organization clearly stated (you should have this from your interview notes)
- The business rules as they apply to the information requirements of the company/organization stated as single sentences (you should have this from the previous lesson)
- The assumptions and constraints that had to be considered clearly stated (you should have this from the previous lesson)
- Entity relationship model

Spend a few minutes giving the class advice on how to organize their presentations. Write the order in which the companies will meet with the client on the board. You can ask for volunteers or write the groups in alphabetical order.

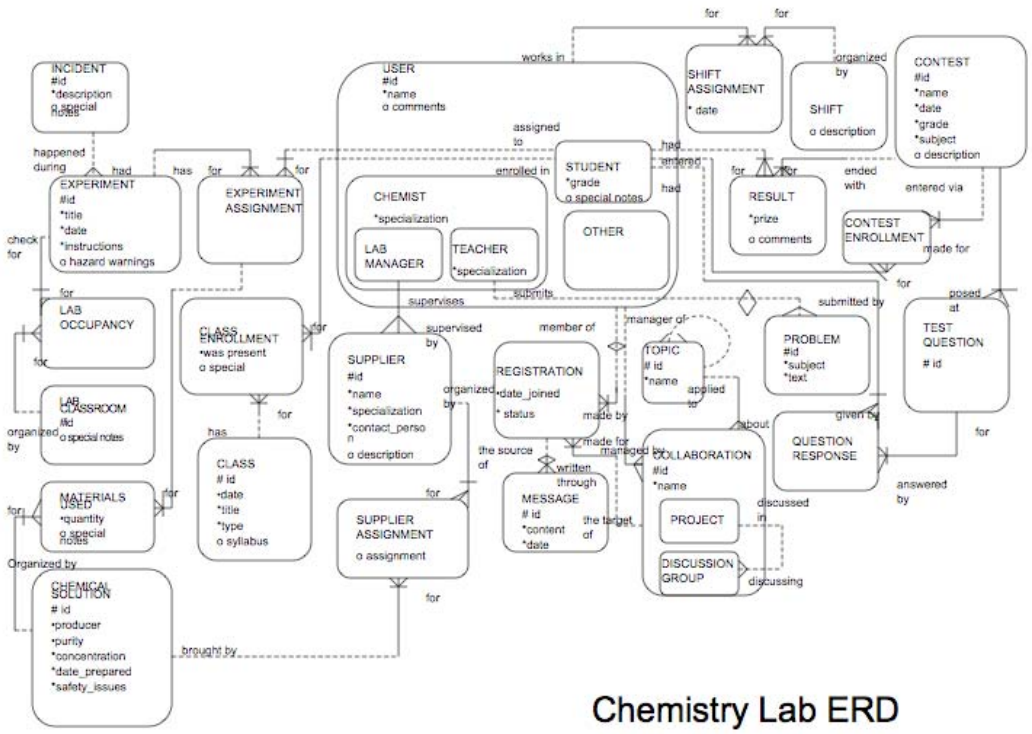
Solution Step 5 – Modifications

Answer: Answers will vary.

Solution Step 6 – New requirements

Answer: See Figure 11 Chemistry Lab entity relationship diagram.

Figure 11 Chemistry Lab entity relationship diagram



Possible reports:

- Class enrollment and lab assignments.
- Upcoming experiments for the quarter and associated chemical solutions required.
- Students participating in specific contests.

You can discuss these issues in class to demonstrate that sometimes there are no easy answers in data modeling. There are many options and the good modeler evaluates them and their implications.

Solution Step 7 – Accomplishments

Answer: Variable.

Project 5: Recycling Center

5.1. Introduction

Difficulty Scale: 4

Project Use: Integrate interviewing skills of a recycling center manager into creative data modeling.

Application: Start this project following Section 4 Lesson 1.

Today there is an important emphasis on recycling and its advantages. Beyond complying with the mandate, recycling is beneficial because it conserves valuable natural resources, reduces energy consumption in the manufacturing of goods, stimulates business development, extends the life of landfills, and reduces disposal costs.

For this project, students will play the role of a consulting company whose mission is to model a database for a recycling center. The Recycling Center project has students develop the business scenario by conducting one or more interviews to construct the business rules and obtain the background to create the database design. They will interview a recycling professional at the recycling center or the database administrator. Assume that the need for a database for this has risen since the president wants to make improve the business and have better control over it.

Like the other projects, the Recycling Center project consists of a series of practice steps, each step building on the results of the previous one. Each step is designed for completion at the end of a specific lesson in the course. These lessons are identified at the beginning of each practice step. The steps themselves are referenced in the corresponding lesson practices.

This project is different in that it allows students to research similar businesses in order to have a sense of the business before the interview and then compare their notes from the interview and the ones from the Internet research. The project allows for enough flexibility for students to find the best way to implement the client's requirements, because there are no business rules already defined. Although they can derive some business rules from the interview notes, the students will have to guess at some based on their own reasoning and experience.

An important feature of the project is the step that requires a CRUD analysis, because it allows students to understand the project and its specifics in depth. Another important feature, the interviews, gives the students a good start for the international competition.

The presentation, the most important part of the Recycling Center project, constitutes excellent practice for both the international contest and the students' presentation skills. The modifications and new requirements also prepare the students for the challenges they will meet when preparing the presentation for the topic in the international competition. This project also permits students to work in groups to construct the business rules and then prepare the presentation. This is important as students can observe with whom they work best.

The lessons practices that reference this project are:

- Section 4 Lessons 1 and 2
- Section 5 Lesson 4
- Section 7 Lessons 1 and 2
- Section 15 Lessons 4 and 5

Note: If you choose not to teach a lesson at all, then students will not be able to complete the corresponding practice step, or any later steps in the same project.

On a scale of 1 to 5, this project is ranked 4 in terms of difficulty. Instructors have hints for the business rules in the solutions part of the project.

The final ERD can be found in the solutions section at Solution Step 6 – New requirements.

5.2. Case Study

As a database consulting company specializing in databases for recycling centers, you recently got the contract to develop a data model for a local recycling center. They work with residential homes, businesses, and homeowner associations. The recyclables they collect are paper, cardboard, plastic and metal. The managers need to be able to enter and query data in order to improve the efficiency of the center – for example, the trucks should have a well-defined and well-managed itinerary so that they consume fuel efficiently. It would also be ideal for the database to provide a way for recording how the commingled materials are sorted in the most efficient way. It is also important for the database to capture all relevant information about the staff, and most importantly, the managers.

Through an interview with staff at a recycling center, you will acquire the information needed to create a data model. Remember, recycling center is a place where multiple types of activities occur ranging from collection, sorting, and payments. Since materials are collected and shipped, financial transactions are made, and many different staff is employed, the types of questions you need to ask are quite varied.

Things to consider are:

- What is the business goal?
- What types of info/data does a recycling center need?
- Where does the material come from and where does it go?
- Why would there be a need for this type of database (this shows understanding of the problem and the key objectives to be solved by the database
- What are the methods of advertising?
- Research recycling centers online
- Develop a proposed list of business needs based on the scenario, your research and objectives

- Perhaps enter the interview with an initial ERD
- Write documentation that clarifies unclear parts of your diagram
- Write ERD explanations
- Identify reports that can be issued from your data model
- Create a table with 2 columns: Initial needs and solutions
- Does historical data need to be modeled

5.3. Steps, Exercises and Examples

Step 1 – Determining business needs

This step may be undertaken following Section 4 Lesson 1.

Your group will play the role of the consulting company. Choose a meaningful name for your consulting company.

Schedule an interview with a person at a recycling center. Your instructor can also play the role of a database administrator at a recycling center if no recycling center is nearby.

Take your time in getting ready for the interview. The process can be broken down into the following steps:

1. Prepare for the interview.
   a) Prepare a question list.
   b) Set goals.
   c) Determine and gather materials needed.

2. Conduct the Interview.
   a) Take notes.
   b) Ask for clarification.

3. End the interview.
   a) Summarize key points.
   b) Thank the interviewee.

Refer to the following links for examples of a few recycling centers websites. These may be helpful in creating your list of questions.

- Waste Management at http://www.wm.com/ (US)
- Sprint Recycling at http://sprintrecycling.com/ (New York)
- City of Portland at http://www.portlandonline.com/osd/index.cfm?c=44752 (Oregon)
- Trashco at http://trashco.com/ (US)
- Eco-Cycle at http://www.ecocycle.org/ (Colorado)
- RecycleNow at http://www.recyclenow.com (UK)

- Cambridge Environment and Recycling at http://www.cambridge.gov.uk/ccm/navigation/environment-and-recycling/ (UK)

At the end of the interview and your individual research, you should be able to list the data and information requirements for such a business.

Step 2 – Documenting business requirements

This step may be undertaken following Section 4 Lesson 2.

Using notes taken from the interview with your instructor/DBA (Step 1), work in your respective groups to construct the business rules.

Structural business rules indicate the types of information to be stored and how the information elements are interrelated. Example: Each business/client we work with must have a UID.

Process rules are related to workflow or business process. Example: The manager must check all contracts.

If you make assumptions, document them as well, and make sure to ask for the opinion of either your contact person at the recycling center or your Database Design Instructor. If there is time, begin to identify entities, attributes, and relationships.

Step 3 – Understanding CRUD requirements

This step may be undertaken following Section 5 Lesson 4.

Create your Recycling Center ERD model. Do a CRUD analysis on the model. Capture the information from your CRUD analysis in a worksheet similar to the one below. Use your interview notes and business rules during your CRUD analysis. Look for words and phrases that impact CRUD (we want to track data, we need to enter data, etc.). Is there an entity or attribute or relationship that allows a user of the Recycling Center database to create, retrieve, update, or delete?

Hint: All entities need to have one create and retrieve function. This means that you need to have interview notes or a business rule that points to entering data in the entity and viewing the data once it's in the database.

Use the worksheet below. One example has been created for you.

Table 12 CRUD requirements example worksheet

Entity	Interview Notes or Business Rules	CRUD Function
STAFF	We assign an UID to each member of our staff. We want to track all the staff members working	CREATE RETRIEVE

	on a certain day.	

Step 4 – Presenting requirements

This step can be undertaken at the end of Section 15 Lesson 4.

Create a presentation for the Recycling Center client. Organize your presentation. Each presentation must contain the following:

- Statement of the Problem
- Statement of the Proposed Solution
- The information requirements of the business/organization clearly stated (you should have this from your interview notes)
- The business rules as they apply to the information requirements of the company/organization stated as single sentences (you should have this from the previous step)
- The assumptions and constraints that are to be considered clearly stated. Assumptions can be relationships or rules for the data model that you do not have time to verify. They can also be conditions that need to be true in order for the proposed solution to be successful. These may not be directly reflected in the ERD.
- Entity relationship model

Your teacher will decide how much time you have to present to the "client." Remember: This is a "meeting" between the client and your consulting company. This is your chance to present your ERD. The ERD should serve as a communication tool, along with the business rules, to show the client that you understand their needs and that these needs are being met by the design. If a time limit is set for the meetings, be careful not to allow additional questioning after it is over.

A suggested order for the presentation is a follows:

1. Introduce the group members
2. State the business issue that you addressed
3. Present and explain the ERD (large enough for all to see)
4. Summarize how your solution will meet the client's needs
5. Present written documentation
6. State assumptions that you made in creating your solution
7. Thank the clients for their time
8. Exit gracefully

Step 5 – Modifications

This step can be undertaken at the end of Section 15 Lesson 5.

Modify the Recycling Center ERD based on the input received from the presentation to the client/teacher. Produce a Design Revision Document outlining the changes made since the presentation was given. Include the modified ERD

with the Design Revision Document and submit the package to your teacher for review.

Step 6 – New requirements

This step may be undertaken following Section 15 Lesson 5.

Make modifications to your Recycling Center ERD based on these additional requirements:

- A web site is created to help answer many questions that customers have.
- The recycling center will provide a calculation of its regional carbon footprint, taking into account the client's location, the use of cars or other transportation, the current level of recycling, house energy information, and plane trips.
- Regional centers want to create a network that will allow them to raise awareness regarding the recycling process, such as through brochures about composting, recycling suggestions, and other general environmental tips.

Think of at least one report or statistic that can be generated from the future system that includes the modifications you just made. Document how you imagine these reports could be used in the business. For example, the manager could want to investigate which sections of the city have the most customers.

Step 7 – Accomplishments

This step may be undertaken following Section 15 Lesson 5.

Sometimes, due to time constraints, you may limit parts of your ERD. Or, when you find something too difficult to model, you will create a business rule or an assumption.

First, identify why incorporating that part in your ERD was difficult and think about how your model would have benefited more if you managed to find a solution to that.

Second, choose one part to extend upon. For this, you can work closely with your instructor or share opinions with other students in the class.

At the end of a project, it is sometimes useful to check again the initial business needs and special needs of the client and then look at your solution. This is a great way to revise your project and provides good practice for the next projects you will take on.

When you are done, create a table with 2 columns: Initial Business Needs and Your Solution.

5.4. Solutions

Solution Step 1 – Determining business needs

Answer: Variable.

The recycling center is a place where trucks collect recyclable materials for sorting at the center, which in turn sells the processed recyclables to a manufacturer for recycling the materials into new products. Most of the business is conducted through collection at homes and businesses, although a drop-off center is also available.

The recycling center collects paper, offers a shredding service, and collects other recyclable materials, such as aluminum, glass, plastic, electronics. The materials are stored in collection containers at the business or home provided by the recycling center. These materials are sorted by types, bailed, and prepared for collection by the hauler.

The staff includes drivers, recycling center staff, shredding team, and business administration. Each group of staff has a manager.

Logs are kept about the shredding service, the materials collected, and the collection containers.

Solution Step 2 – Documenting business requirements

Answer: Variable.

Explain to the class that although they can derive some business rules from the interview notes, they will have to guess at some based on their own reasoning and experience. This is where a consultant's previous experience becomes helpful. Of course, remind them that all business rules will have to be confirmed by the client. The business rules formulated here will be part of their presentation. Some example business rules are listed below.

Structural business rule examples include:

- Each customer is assigned a unique id.
- All customers have containers for their recyclables to be collected by the trucks.
- Collection trucks are assigned a route.
- Basic billing information is collected about each home or business including name, address, phone, and a billing rate is assigned to that customer.

Procedural business rule examples include:

- Once a collection truck arrives, it deposits the materials for sorting and categorizing at the recycling center.
- Certificates of shredding are available to verify that paper was shredded from a specified business.

Solution Step 3 – Understanding CRUD requirements

Answer: The answers in the Interview Notes/Business Rule column will vary depending on what they asked during their interview with the client. The key thing is to check for completeness – do they have all the entities? If they are missing some, remind them of the interview and the data requirements the client provided at that time. Remind the students that a client often describes business functions as part of the scenario. For example:

Remind students that ERDs are modified over and over until the project is ready to move on to creating the physical database. It's an iterative process in that each time the ERD is reviewed and revised, it more closely approaches the desired result. The ERD is a conversation piece between the client and consultant. It's a guideline for the DBA (database administrator) who will likely implement the consultant's design. It may never be perfect, but hopefully the consultants will take the design a long way toward this goal!

Solution Step 4 – Presenting requirements

Answer: Remind the class that each group will be presenting to the "client" during the next meeting. They should start assigning roles and responsibilities for their presentation. If they took good notes during the interview and documented business rules and assumptions, they should have most of the written materials. Check with each team to see what they're missing.

Each presentation must contain the following:

- Statement of the problem
- Statement of the proposed solution
- The information requirements of the business/organization clearly stated (you should have this from your interview notes)
- The business rules as they apply to the information requirements of the company/organization stated as single sentences (you should have this from the previous lesson)
- The assumptions and constraints that had to be considered clearly stated (you should have this from the previous lesson)
- Entity relationship model

Spend a few minutes giving the class advice on how to organize their presentations. Write the order in which the companies will meet with the client on the board. You can ask for volunteers or write the groups in alphabetical order.

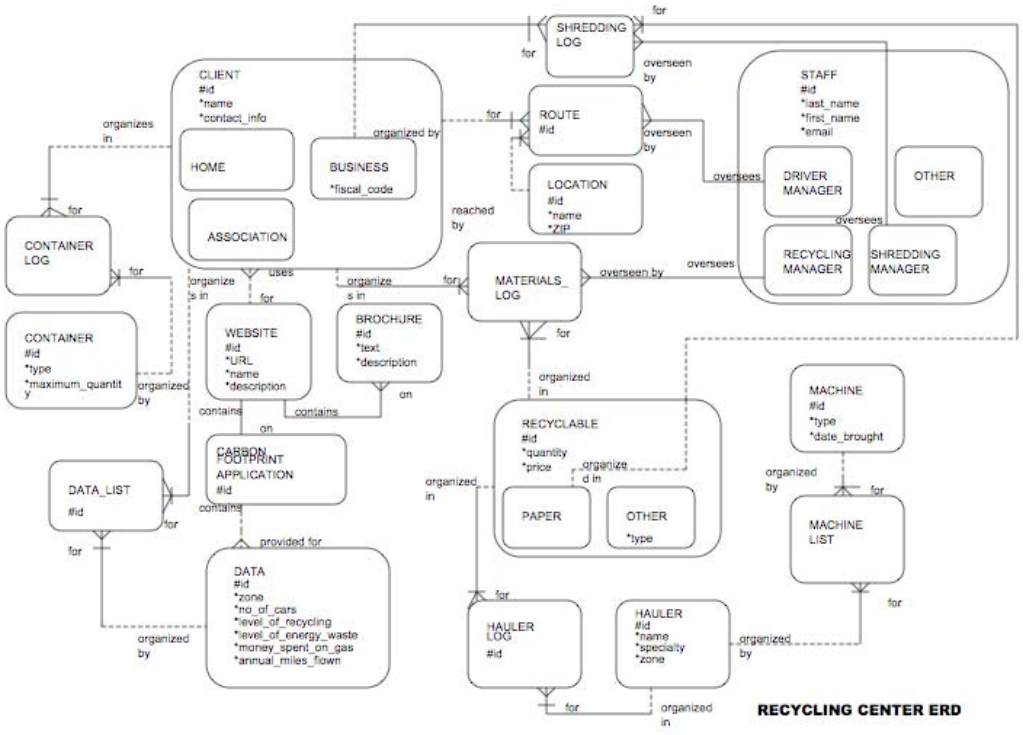
Solution Step 5 – Modifications

Answer: Variable.

Solution Step 6 – New requirements

Answer: See the figure below.

Figure 12 Recycling Center entity relationship diagram



Possible reports:

- Amount of recyclable material received and shipped.
- Driving routes for collection trucks.
- Staff changes during the year.
- Monthly carbon footprint evaluations by region.
- Revenue from sale of sorted recyclable materials.
- Large customer lists.
- Advertising efforts and effectiveness in increasing recycling collection.
- Businesses that use the shredding service and their container sizes.

You can discuss these issues in class to demonstrate that sometimes there are no easy answers in data modeling. There are many options and the good modeler evaluates them and their implications.

Solution Step 7 – Accomplishments

Answer: Variable.