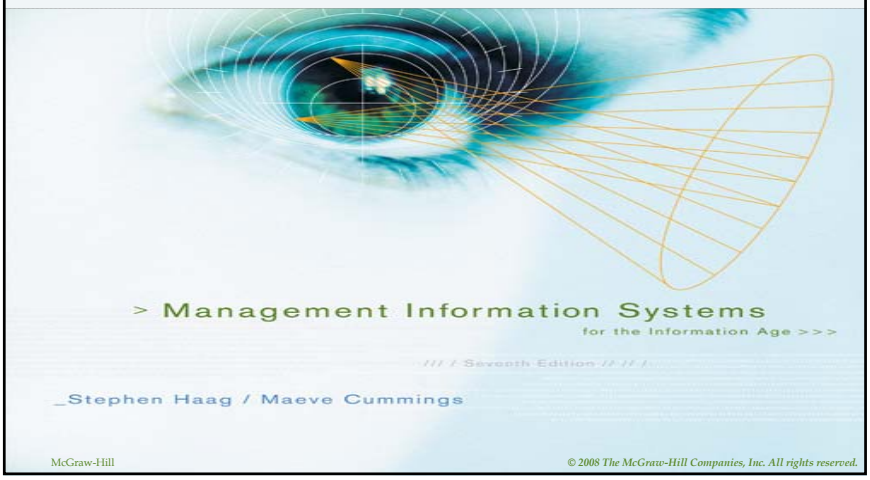
Extended Learning Module C
DESIGNING DATABASES AND ENTITY-RELATIONSHIP DIAGRAMMING



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STUDENT LEARNING OUTCOMES

1. Identify how databases and spreadsheets are both similar and different.
2. List and describe the four steps in designing and building a relational database.
3. Define the concepts of entity class, instance, primary key, and foreign key.

STUDENT LEARNING OUTCOMES

4. Given a small operating environment, build an entity-relationship diagram.
5. List and describe the steps in normalization.
6. Describe the process of creating an intersection relation to remove a many-to-many relationship.

INTRODUCTION

- Chapter 3 discussed why databases are important
- This module teaches you how to design a relational database
- Relational databases are the most popular model

INTRODUCTION

- Databases and spreadsheets are similar and different
- Both have rows and columns of information
  - Spreadsheet – must know physical row and column (e.g., B4)
  - Database – work with information logically

INTRODUCTION

- ***Database*** – collection of information that you organize and access according to the logical structure of that information
- ***Relational database*** – uses a series of logically related two-dimensional tables or files to store information in the form of a database

DESIGNING & BUILDING A RELATIONAL DATABASE

1. Define entity classes & primary keys
2. Define relationships among classes
3. Define information for each relation
   - Relation = table = file
4. Use a data definition language to create database

Remember Solomon Enterprises?

- From Chapter 3
- Provides concrete to commercial builders & home owners
- Chapter 3 – the CRM side of Solomon's database
- Focus now – SCM side of Solomon's database

Remember Solomon Enterprises?

ORDER FILE

Order Number	Order Date	Customer Number	Delivery Address	Concrete Type	Amount	Truck Number	Driver ID
100000	9/1/2004	1234	55 Smith Lane	1	8	111	123456789
100001	9/1/2004	3456	2122 E. Biscayne	1	3	222	785934444
100002	9/2/2004	1234	55 Smith Lane	5	6	222	435296657
100003	9/3/2004	4567	1333 Burr Ridge	2	4	333	435296657
100004	9/4/2004	4567	1333 Burr Ridge	2	8	222	785934444
100005	9/4/2004	5678	1222 Westminster	1	4	222	785934444
100006	9/5/2004	1234	222 East Hampton	1	4	111	123456789
100007	9/6/2004	2345	9 W. Palm Beach	2	5	333	785934444
100008	9/8/2004	6789	4532 Lance Circle	1	8	222	785934444
100009	9/7/2004	1234	987 Furlong	3	8	111	123456789
100010	9/9/2004	6789	4532 Lance Circle	2	7	222	435296657
100011	9/9/2004	4567	3500 Tomahawk	5	6	222	785934444

CUSTOMER FILE

Customer Number	Customer Name	Customer Phone	Customer Primary Contact
1234	Smelding Homes	3333333333	Bill Johnson
2345	Home Builders Superior	3334444444	Marcus Connolly
3456	Mark Akey	3335555555	Mark Akey
4567	Triple A Homes	3336666666	Janielle Smith
5678	Sheryl Williamson	3337777777	Sheryl Williamson
6789	Home Makers	3338888888	John Yu

EMPLOYEE FILE

Employee ID	Employee Last Name	Employee First Name	Date of Hire
123456789	Johnson	Emilio	2/1/1985
435296657	Evaraz	Antonio	3/3/1992
785934444	Robertson	John	6/1/1999
984568756	Smithson	Allison	4/1/1997

CONCRETE TYPE FILE

Concrete Type	Type Description
1	Home foundation and walkways
2	Commercial foundation and infrastructure
3	Premier speckled (concrete with pea-size smooth gravel aggregate)
4	Premier marble (concrete with crushed marble aggregate)
5	Premier shell (concrete with shell aggregate)

TRUCK FILE

Truck Number	Truck Type	Date of Purchase
111	Ford	6/17/1999
222	Ford	12/24/2001
333	Chevy	1/1/2002

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Remember Solomon Enterprises?

- Solomon's database tables
  - *Customer*
  - *Concrete Type*
  - *Order*
  - *Truck*
  - *Employee*

Observations for Solomon

- 5 concrete types
  1. Home foundation and walkways
  2. Commercial foundation and infrastructure
  3. Premier speckled (with gravel)
  4. Premier marble
  5. Premier shell

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Observations for Solomon

SOLOMON ENTERPRISES
Supply Report Ending October 14, 2005

CONCRETE		RAW MATERIAL				SUPPLIER	
Type	Name	ID	Name	Unit	QOH	ID	Name
1	Home	B	Cement paste	1	400	412	Wesley Enterprises
		C	Sand	2	1200	444	Juniper Sand & Gravel
		A	Water	1.5	9999	999	N/A
			TOTAL:	4.5			
2	Comm	B	Cement paste	1	400	412	Wesley Enterprises
		C	Sand	2	1200	444	Juniper Sand & Gravel
		A	Water	1	9999	999	N/A
			TOTAL:	4			
3	Speckled	B	Cement paste	1	400	412	Wesley Enterprises
		C	Sand	2	1200	444	Juniper Sand & Gravel
		A	Water	1.5	9999	999	N/A
		D	Gravel	3	200	444	Juniper Sand & Gravel
			TOTAL:	7.5			
4	Marble	B	Cement paste	1	400	412	Wesley Enterprises
		C	Sand	2	1200	444	Juniper Sand & Gravel
		A	Water	1.5	9999	999	N/A
		E	Marble	2	100	499	A&J Brothers
			TOTAL:	6.5			
5	Shell	B	Cement paste	1	400	412	Wesley Enterprises
		C	Sand	2	1200	444	Juniper Sand & Gravel
		A	Water	1.5	9999	999	N/A
		F	Shell	2.5	25	499	A&J Brothers
			TOTAL:	7			

Observations for Solomon

- 6 raw materials
  A. Water
  B. Cement paste
  C. Sand
  D. Gravel
  E. Marble
  F. Shell
- Mixing instructions are for a cubic yard

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Observations for Solomon

- Some raw materials are in several concrete types
- Concrete types require several raw materials
- Inventory (QOH) is tracked for all raw materials

Observations for Solomon

- Suppliers provide raw materials
- Solomon uses only 1 supplier for a given raw material
- A supplier can provider several raw materials

Observations for Solomon

- Water
  - Supplier not tracked
  - QOH not tracked

Business Rules for Solomon

1. Given concrete type will have many raw materials
2. Given raw material may appear in many concrete types
3. Each raw material has one and only one supplier

Business Rules for Solomon

4. A supplier may provide many raw materials
   - There may be suppliers present not providing any raw materials

- These business rules are very important to remember

STEP 1: DEFINE ENTITY CLASSES & PRIMARY KEYS

- ***Entity class*** – concept – typically, person, place, or thing – about which you wish to store information and that you can identify with a unique key (primary key)
  - *Concrete Type*
  - *Raw Material*
  - *Supplier*

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STEP 1: DEFINE ENTITY CLASSES & PRIMARY KEYS

- ***Primary key*** – a field (or group of fields) that uniquely describe each record
- A record in a database is sometimes called an ***instance*** (of an entity class)

STEP 1: DEFINE ENTITY CLASSES & PRIMARY KEYS

- In general, stay away from names for primary keys (duplicates)
- *Concrete Type – Concrete Type*
- *Raw Material – Raw Material ID*
- *Supplier – Supplier ID*

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STEP 1: DEFINE ENTITY CLASSES & PRIMARY KEYS

SOLOMON ENTERPRISES
Supply Report Ending October 14, 2005

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		F	Shell	2.5	25	499	A&J Brothers
			TOTAL:	7			

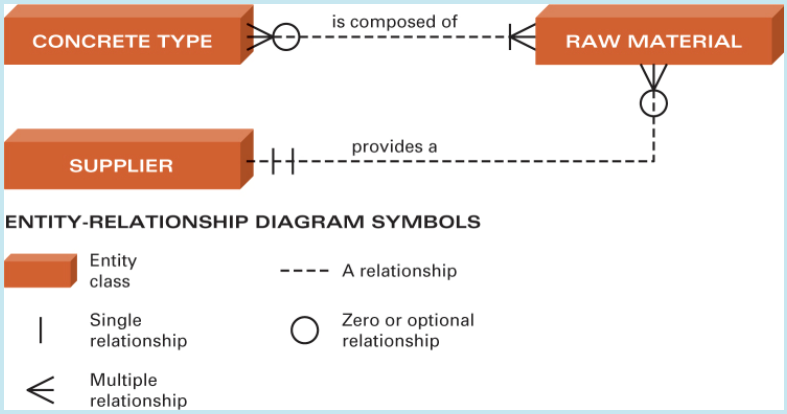
STEP 2: DEFINE RELATIONSHIPS AMONG ENTITY CLASSES

- To define relationships, you create an E-R diagram
- ***Entity-relationship (E-R) diagram*** – a graphic method of representing entity classes and their relationships

E-R Diagrams

- Use 5 symbols
  1. Rectangle – entity class
  2. Dotted line – relationship
  3. | - single relationship
  4. 0 – zero/optional relationship
  5. Crow's foot (←) – multiple relationship

E-R Diagrams



E-R Diagrams

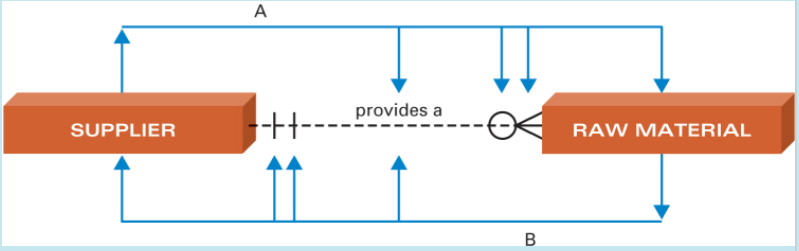
- Figure C.2 on page 147 reads as…
  - A *Concrete Type* is composed of *Raw Material*
  - A *Raw Material* is used to create a *Concrete Type*
  - A *Supplier* provides a *Raw Material*
  - A *Raw Material* is provided by a *Supplier*

E-R Diagrams - Cardinality

- E-R diagrams show relationships
- They also show numerical nature of relationships
- This is called cardinality
  - | - single relationship
  - 0 – zero/optional relationship
  - ← - multiple relationship

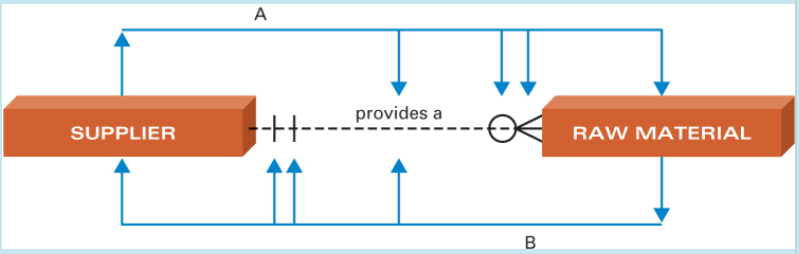
E-R Diagrams - Cardinality

- Following lines marked A:
  - A *Supplier* may not provide any *Raw Material* (0) but may provide more than one *Raw Material* (←)



E-R Diagrams - Cardinality

- Following lines marked B:
  - A *Raw Material* must be provided by a *Supplier* (|) and can only be provided by one *Supplier* (|)



Normalization

- ***Normalization*** – process of assuring that a relational database structure can be implemented as a series of two-dimensional tables
- We will follow three rules of normalization

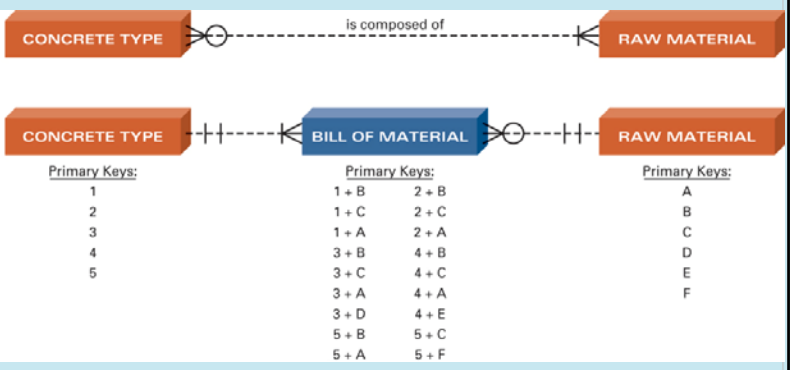
Normalization Rules

1. Eliminate repeating groups or many-to-many relationships
2. Assure that each field in a relation depends only on the primary key for that relation
3. Remove all derived fields from the relations

Eliminating Many-to-Many Relationships

- A many-to-many relationship exists if there is a crow's foot (←) on each end
- You must eliminate these by creating an intersection relation

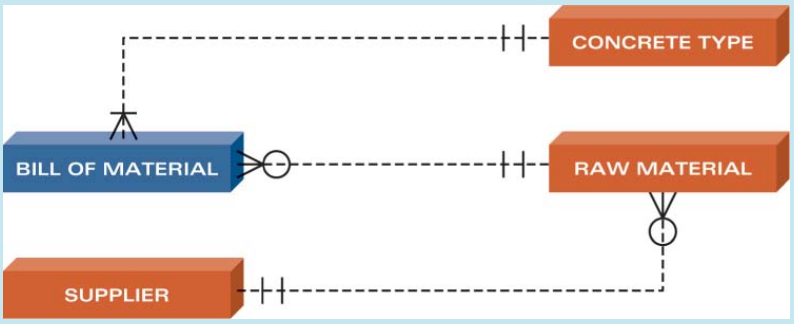
Eliminating Many-to-Many Relationships



Eliminating Many-to-Many Relationships

- ***Intersection (composite) relation*** – a relation you create to eliminate a many-to-many relationship
  - Intersection relation will have a composite primary key
- ***Composite primary key*** – consists of the primary key fields from the two intersecting relations

Solomon's New Database Structure



Steps to Eliminate a Many-to-Many Relationship

1. Draw the part of the E-R diagram with many-to-many relationship
2. Write some primary keys for each relation
3. Create new E-R diagram with intersection relation in the middle
4. Write some composite primary keys for intersection relation

Steps to Eliminate a Many-to-Many Relationship

5. Create a meaningful name for intersection relation
6. Move minimum cardinality next to left relation to the right of intersection relation
7. Move minimum cardinality next to right relation to the left of intersection relation

Steps to Eliminate a Many-to-Many Relationship

8. Maximum cardinality on both sides of intersection relation is always many (←)
9. General rule – new minimum and maximum cardinalities for the 2 original relations will be one (|) and one (|)

STEP 3: DEFINING INFORMATION FOR EACH RELATION

- To ensure that each field is in the right relation, ask the following question:
- "Does this piece of information depend only on the primary key for this relation?"
  - Yes – it's in the correct relation
  - No – It's in the wrong relation

STEP 3: DEFINING INFORMATION FOR EACH RELATION

- See Figure C.6 on page 153
- Look at *Raw Material* relation
- Every field must depend only on *Raw Material ID*
- Raw *Material Name*, *QOH*, and *Supplier ID* do
- *Supplier Name* does not

STEP 3: DEFINING INFORMATION FOR EACH RELATION

- What does *Supplier Name* depend on?
- It depends on *Supplier ID*
- *Supplier ID* is primary key for *Supplier* relation
- Therefore, *Supplier Name* belongs only in *Supplier* relation

STEP 3: DEFINING INFORMATION FOR EACH RELATION

- See Figure C.6 on page 153
- Do you see any derived information?
  - Counts?
  - Sums?
  - Averages?
- If you see them, remove them

STEP 3: DEFINING INFORMATION FOR EACH RELATION

- *Raw Material Total* in the *Concrete Type* relation is derived
- It can be obtained by summing the appropriate fields of the appropriate records in the *Bill of Material* relation
- Therefore, you do not need *Raw Material Total*
- Take it out

STEP 3: DEFINING INFORMATION FOR EACH RELATION

- See Figure C.7 on page 154
- It is the correct and final structure
- No many-to-many relationships
- Each field depends only on relation's primary key
- No derived fields
- Good database design

STEP 4: USE A DATA DEFINITION LANGUAGE TO CREATE YOUR DATABASE

- You're ready to implement Solomon's database with a DBMS
- ***Database management system (DBMS)*** – helps you specify the logical organization for a database and access and use the information within the database

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STEP 4: USE A DATA DEFINITION LANGUAGE TO CREATE YOUR DATABASE

- When creating a database, you must first create the data dictionary
- ***Data dictionary*** – contains the logical structure for the information in a database
- This is the first step in implementing your database
- *Extended Learning Module J* is devoted to using Microsoft Access to create Solomon's database