

# Slide Set 3: Entity Relationship Model

## The Entity Relationship Model

- ❖ A detailed, logical representation of the entities, associations, and data elements for an organization or business area.
- ❖ Graphical model of the people, places, objects, things, events, or concepts, their characteristics and relationships, for an organization or business area.
- ❖ A graphical *interpretation* of reality
- ❖ Repeated until the end users and designers agree that the E-R diagram is a fair representation of the organization's activities and functions.

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## Why do Conceptual Modeling?

- ❖ Independent of technology
- ❖ Understandable representation of organizational data
- ❖ Strong foundation for the development process
- ❖ Helps to elicit business rules
- ❖ Communication *tool* between designers and clients/end users
- ❖ Easier to **FIX ERRORS** early in DB development process (during modeling) rather than later (during physical implementation)

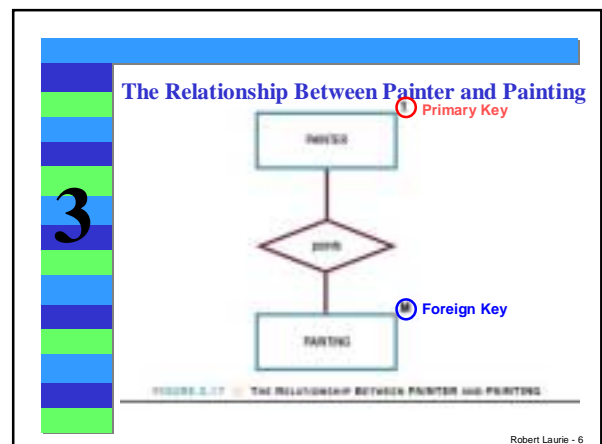
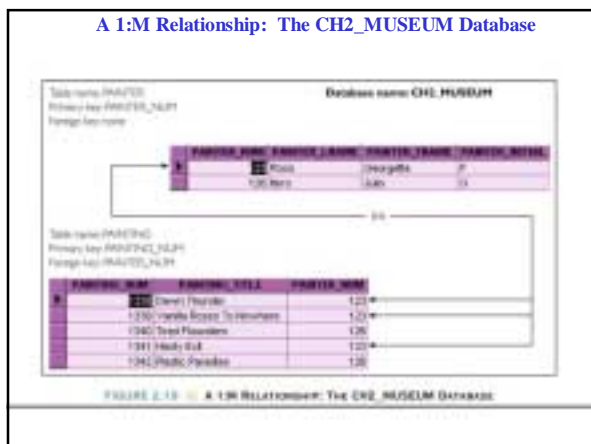
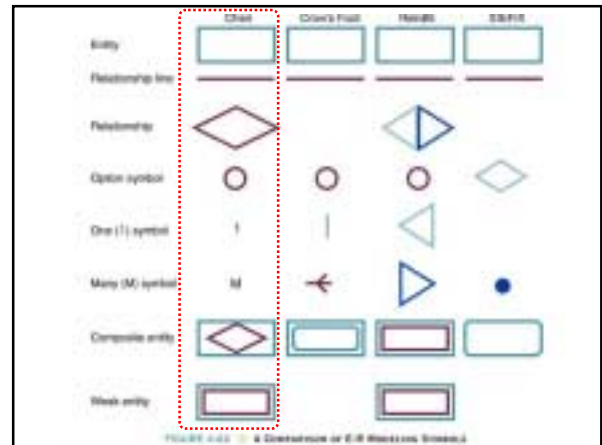
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## Relationships within the Relational Database

### E-R Diagram (ERD)

- ❖ Rectangles are used to represent entities.
- ❖ Entity names are nouns and capitalized.
- ❖ Diamonds are used to represent the relationship(s) between the entities and usually expressed with a verb.
- ❖ The number 1 is used to represent the "1" side of the relationship.
- ❖ The letter M or N is used to represent the "many" sides of the relationship.

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# Slide Set 3: Entity Relationship Model

Database name: CHG\_COLLEGE

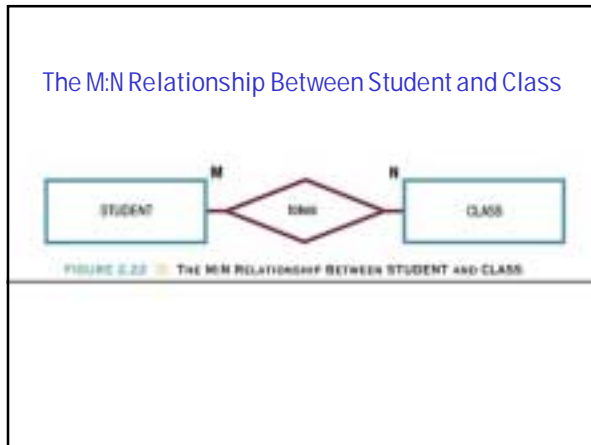
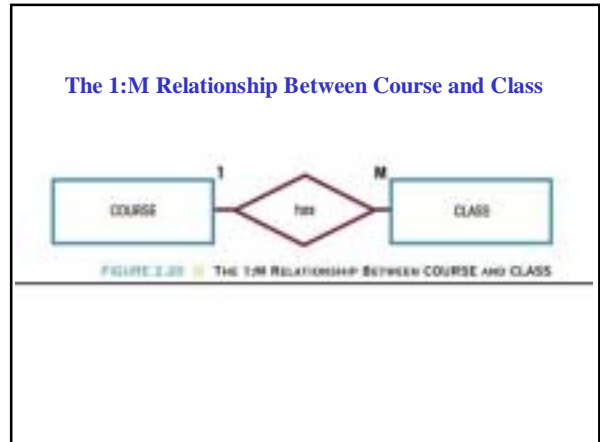
Table name: COURSE

COURSE_CODE	PREQ_CODE	COURSE_SECTION	CLASS_SECTION
ACCT 201	ACCT 101	Accounting I	1
ACCT 202	ACCT 101	Accounting II	2
BLDG 101	BLDG 101	Blvd. In Maintenance	1
BLDG 102	BLDG 101	Database Design and Implementation	2
ENGL 101	ENGL 101	ENGL 101 (Section 1)	1
ENGL 102	ENGL 101	ENGL 101 (Section 2)	2

Table name: CLASS

CLASS_CODE	COURSE_CODE	COURSE_SECTION	CLASS_SECTION	STUDENT_CODE	STUDENT_SECTION
1	ACCT 201	ACCT 201 (Sec 1)	1	101	101
2	ACCT 201	ACCT 201 (Sec 2)	2	102	102
3	ACCT 202	ACCT 202 (Sec 1)	3	103	103
4	ACCT 202	ACCT 202 (Sec 2)	4	104	104
5	BLDG 101	BLDG 101 (Sec 1)	5	105	105
6	BLDG 101	BLDG 101 (Sec 2)	6	106	106
7	BLDG 102	BLDG 102 (Sec 1)	7	107	107
8	BLDG 102	BLDG 102 (Sec 2)	8	108	108
9	ENGL 101	ENGL 101 (Sec 1)	9	109	109
10	ENGL 101	ENGL 101 (Sec 2)	10	110	110
11	ENGL 102	ENGL 102 (Sec 1)	11	111	111
12	ENGL 102	ENGL 102 (Sec 2)	12	112	112

FIGURE 2.21 Analyzing 1:M Relationships: The CHG\_COLLEGE Database

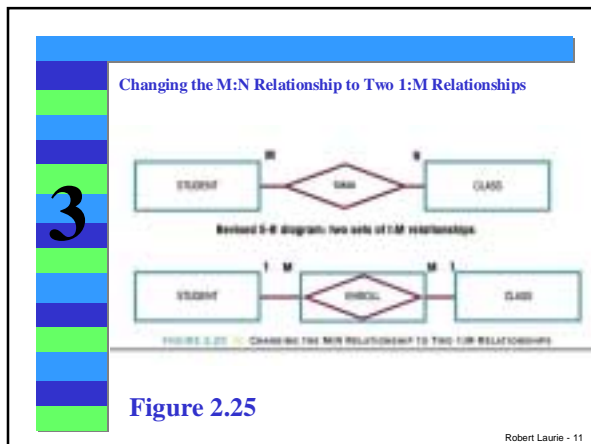


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### M:N Relationships

- ❖ The Curse of M:N Relationships
  - ◆ Entity Integrity does not exist
    - No Primary Key Field
    - Therefore, no Referential Integrity
  - ◆ Many redundancies lead to anomalies
- ❖ The Solution
  - ◆ Create a Composite Entity
  - ◆ Also Known As:
    - Bridge Entity
    - Associative Entity
    - Gerund
  - ◆ Composite Entity is placed between M:N entities and decomposed into two 1:M relationships

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Database name: CHG\_TEST

Table name: STUDENT\_TAKE

STUDENT_CODE	CLASS_CODE
101	1
102	2
103	3
104	4
105	5
106	6
107	7
108	8
109	9
110	10
111	11
112	12

Table name: BRIDGE\_TAKE

BRIDGE_CODE	STUDENT_CODE	CLASS_CODE
101	101	1
102	102	2
103	103	3
104	104	4
105	105	5
106	106	6
107	107	7
108	108	8
109	109	9
110	110	10
111	111	11
112	112	12

Table name: CLASS\_TAKE

CLASS_CODE	COURSE_CODE	COURSE_SECTION	CLASS_SECTION	STUDENT_CODE	STUDENT_SECTION
1	ACCT 201	ACCT 201 (Sec 1)	1	101	101
2	ACCT 201	ACCT 201 (Sec 2)	2	102	102
3	ACCT 202	ACCT 202 (Sec 1)	3	103	103
4	ACCT 202	ACCT 202 (Sec 2)	4	104	104
5	BLDG 101	BLDG 101 (Sec 1)	5	105	105
6	BLDG 101	BLDG 101 (Sec 2)	6	106	106
7	BLDG 102	BLDG 102 (Sec 1)	7	107	107
8	BLDG 102	BLDG 102 (Sec 2)	8	108	108
9	ENGL 101	ENGL 101 (Sec 1)	9	109	109
10	ENGL 101	ENGL 101 (Sec 2)	10	110	110
11	ENGL 102	ENGL 102 (Sec 1)	11	111	111
12	ENGL 102	ENGL 102 (Sec 2)	12	112	112

FIGURE 2.24 CONVERTING THE M:N RELATIONSHIP INTO TWO 1:M RELATIONSHIPS

# Slide Set 3: Entity Relationship Model

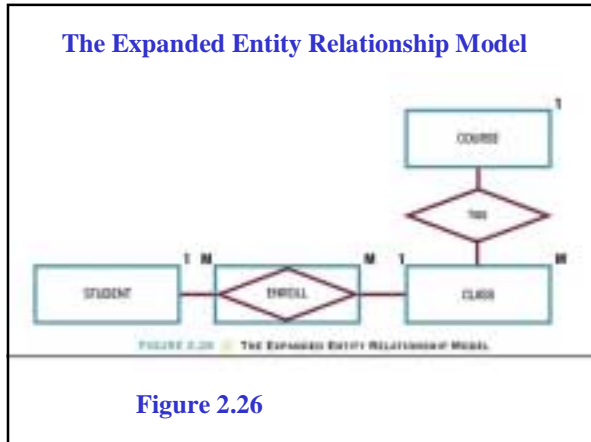


Figure 2.26

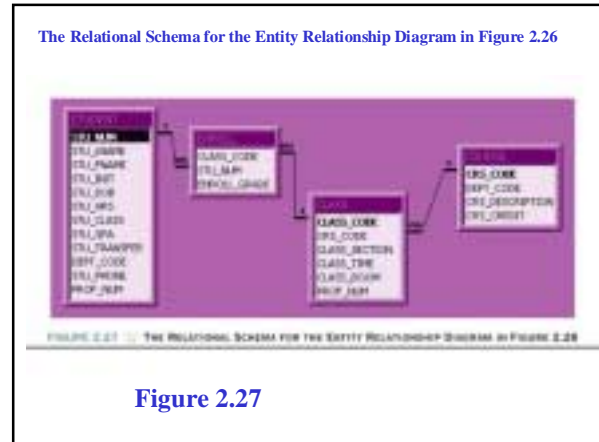


Figure 2.27

### The Entity Relationship (E-R) Model

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❖ **E-R Model Components**

- ◆ **Entities**
  - In E-R models an entity refers to the entity set.
  - An entity is represented by a rectangle containing the entity's name.
- ◆ **Attributes**
  - Attributes are represented by ovals and are connected to the entity with a line.
  - Each oval contains the name of the attribute it represents.
  - Attributes have a domain -- the attribute's set of possible values.
  - Attributes may share a domain.
  - Primary keys are underlined.
- ◆ **Relationships**

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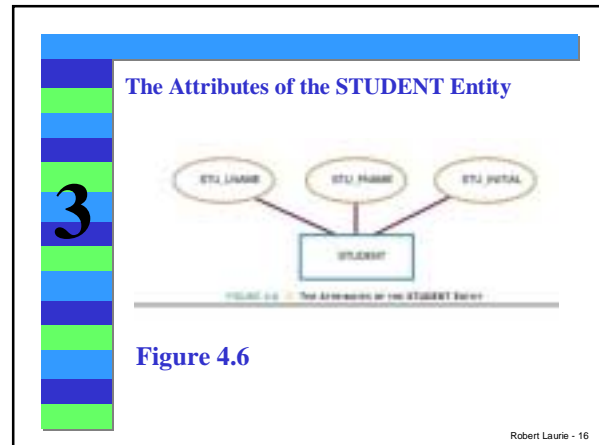


Figure 4.6

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### The Entity Relationship (E-R) Model

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❖ **Classes of Attributes**

- ◆ A **simple attribute** cannot be subdivided.
  - Examples: Age, Sex, and Marital status
- ◆ A **composite attribute** can be further subdivided to yield additional attributes.
  - Examples:
    - ADDRESS ↘ Street, City, State, Zip
    - PHONE NUMBER ↘ Area code, Exchange number

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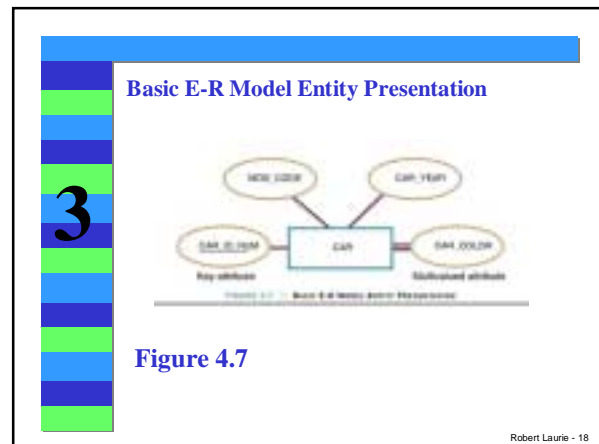


Figure 4.7

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# Slide Set 3: Entity Relationship Model

## The Entity Relationship (E-R) Model

### ❖ Classes of Attributes

- ◆ A **single-valued attribute** can have only a single value.
  - Examples:
    - A person can have only one social security number.
    - A manufactured part can have only one serial number.
- ◆ **Multivalued attributes** can have many values.
  - Examples:
    - A person may have several college degrees.
    - A household may have several phones with different numbers
  - Multivalued attributes are shown by a double line connecting to the entity.

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## The Entity Relationship (E-R) Model

### ❖ Multivalued Attribute in Relational DBMS

- ◆ The relational DBMS cannot implement multivalued attributes.
- ◆ Possible courses of action for the designer
  - Within the original entity, create several new attributes, one for each of the original multivalued attribute's components (Figure 4.9).
  - Create a new entity composed of the original multivalued attribute's components (Figure 4.10).

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## Splitting the Multivalued Attributes into New Attributes

Figure 4.9

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## A New Entity Set Composed of Multivalued Attribute's Components

Figure 4.10

Table 4.1

Component	Color
Top	White
Body	Red
Tire	Green
Interior	Blue

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## The Entity Relationship (E-R) Model

- ◆ A **derived attribute** is not physically stored within the database; instead, it is derived by using an algorithm.
  - Example: AGE can be derived from the data of birth and the current date.

Figure 4.11 A Derived Attribute

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## The Entity Relationship (E-R) Model

### ❖ A relationship's degree indicates the number of associated entities or participants.

- ◆ A **unary (recursive) relationship** exists when an association is maintained within a single entity.
- ◆ A **binary relationship** exists when two entities are associated.
- ◆ A **ternary relationship** exists when three entities are associated.

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Figure 4.25



Figure 4.26



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### The Entity Relationship (E-R) Model

❖ **Connectivity**

- The term **connectivity** is used to describe the relationship classification (e.g., one-to-one, one-to-many, and many-to-many).

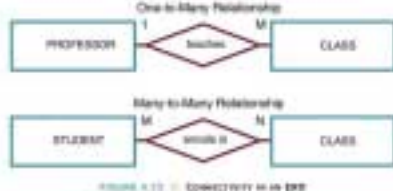


Figure 4.15 Connectivity in an ERD

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### The Entity Relationship (E-R) Model

❖ **Cardinality**

- Cardinality** expresses the specific number of entity occurrences associated with one occurrence of the related entity.

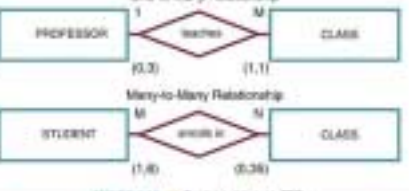


Figure 4.16 Cardinality in an ERD

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❖ **Existence Dependency**

- If an entity's existence depends on the existence of one or more other entities, it is said to be existence-dependent.



Figure 4.18

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### The Entity Relationship (E-R) Model

❖ **Relationship Participation**

- The participation is optional if one entity occurrence does not require a corresponding entity occurrence in a particular relationship.
- An optional entity is shown by a small circle on the side of the optional entity.




Figure 4.19 An ERD With An Optional Entity

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Figure 4.20 CLASS is Optional to COURSE


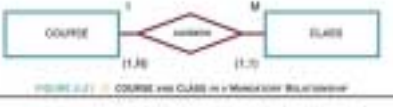


Figure 4.21 COURSE and CLASS in a Mandatory Relationship



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# Slide Set 3: Entity Relationship Model

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## The Entity Relationship (E-R) Model

### ❖ Weak Entities

- ◆ A **weak entity** is an entity that
  - Is existence-dependent and
  - Has a primary key that is partially or totally derived from the parent entity in the relationship.
- ◆ The existence of a weak entity is indicated by a double rectangle. (Figure 4.22)
- ◆ The weak entity inherits all or part of its primary key from its strong counterpart.

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## A Weak Entity in an ERD

FIGURE 4.22 A Weak Entity in an ERD

**Figure 4.22**  
 EMPLOYEE(EMP\_NUM, EMP\_LNAME, EMP\_FNAME, EMP\_INITIAL, EMP\_DOB)  
 DEPENDENT(EMP\_NUM, DEP\_NUM, DEP\_FNAME, DEP\_DOB)

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## An Illustration of the Weak Relationship Between DEPENDENT and EMPLOYEE

FIGURE 4.23 AN ILLUSTRATION OF THE WEAK RELATIONSHIP BETWEEN DEPENDENT AND EMPLOYEE

**Figure 4.23**

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## What do you do with the M:N Relationship Between STUDENT and CLASS?

FIGURE 4.31 The M:N Relationship Between STUDENT and CLASS

**Figure 4.31**

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## A Composite Entity in the ERD

FIGURE 4.32 A Composite Entity in the ERD

**Figure 4.32**

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## Converting the M:N Relationship Into Two 1:M Relationships

FIGURE 4.33 CONVERTING THE M:N RELATIONSHIP INTO TWO 1:M RELATIONSHIPS

**Figure 4.30**

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# Slide Set 3: Entity Relationship Model

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## The Entity Relationship (E-R) Model

❖ **Entity Supertypes and Subtypes**

- ◆ The **generalization hierarchy** depicts the parent-child relationship. (Figure 4.34)
- ◆ The supertype contains the shared attributes, while the subtype contains the unique attributes.
- ◆ A subtype entity inherits its attributes and its relationships from the supertype entity.
- ◆ The supertype entity set is usually related to several unique and disjointed (nonoverlapping) subtype entity sets (G).
- ◆ The supertype and its subtype(s) maintain a 1:1 relationship.

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## A Generalization Hierarchy

Figure 4.34

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## The EMPLOYEE/PILOT Supertype/Subtype Relationship

Figure 4.35

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## Extended Entity Relationship Model

❖ **Entity Supertypes and Subtypes**

- ◆ Sometimes subtypes may contain overlapping subtypes.
  - A Professor could also be an administrator
  - A Person could be both a Employee and Student
- ◆ Overlapping subtypes are symbolized by (Gs)

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## A Generalization Hierarchy With Overlapping Subtypes

Figure 4.36

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Figure 4.37  
ER Component Summary

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### Developing an E-R Diagram

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- ❖ **Converting an E-R Model into a Database Structure**
  - ◆ A painter might paint many paintings. The cardinality is (1,N) in the relationship between PAINTER and PAINTING.
  - ◆ Each painting is painted by one (and only one) painter.
  - ◆ A painting might (or might not) be exhibited in a gallery; i.e., the GALLERY is optional to PAINTING.

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### Developing an E-R Diagram

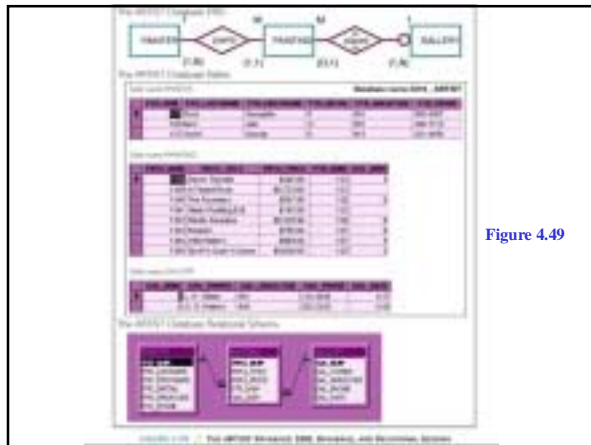
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- ❖ **Summary of Table Structures and Special Requirements for the ARTIST database**

```

PAINTER(PRT_NUM, PRT_LASTNAME,
PRT_FIRSTNAME, PRT_INITIAL,
PTR_AREACODE, PRT_PHONE)
GALLERY(GAL_NUM, GAL_OWNER,
GAL_AREACODE, GAL_PHONE,
GAL_RATE)
PAINTING(PNTG_NUM, PNTG_TITLE,
PNTG_PRICE, PTR_NUM, GAL_NUM)
                
```

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#### A Data Dictionary for the ARTIST Database

TABLE 4.3 - A Data Dictionary for the ARTIST Database

TABLE	FIELD	DATA TYPE	LENGTH	NULL	INDEX	PK	FK
PAINTER	PRT_NUM	NUMBER	5	N		Y	
	PRT_LASTNAME	VARCHAR2	30	Y			
	PRT_FIRSTNAME	VARCHAR2	30	Y			
	PRT_INITIAL	VARCHAR2	3	Y			
	PRT_PHONE	VARCHAR2	15	Y			
GALLERY	GAL_NUM	NUMBER	5	N		Y	
	GAL_OWNER	VARCHAR2	30	Y			
	GAL_AREACODE	VARCHAR2	10	Y			
	GAL_RATE	NUMBER	5	Y			
PAINTING	PNTG_NUM	NUMBER	5	N		Y	
	PNTG_TITLE	VARCHAR2	50	Y			
	PNTG_PRICE	NUMBER	5	Y			
	PTR_NUM	NUMBER	5	Y			Y
	GAL_NUM	NUMBER	5	Y			Y

Table 4.3

### The Moral of the Story

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- ❖ It is very important to have the entities, attributes, and relationships clearly identified and well-defined -- and this is not an easy task!!
- ❖ The more you do -- in terms of thinking and modeling -- in this part of the process, the less money and time are needed later on (for re-work)!!

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### Lets get some practice...

- ❖ MegaBucks - a consulting company, wishes to design a data base to track employees, projects, and clients. For employees, they wish to track name, id, address, date of birth, date of hire, and phone number. For clients, they wish to track name, address, phone, and the contact person's name, phone, and email address. For projects, they wish to track the name, description, start date, and targeted end date.
- ❖ MegaBucks has a number of employees and projects and clients. Each employee may be assigned to one or more projects, or may not be assigned to a project. A project must have at least one employee assigned, and may have several employees assigned. Further, a project will belong to only one client. A client may have one or many projects with MegaBucks, or may not currently have any projects with the firm.
- ❖ Draw the E-R diagram....