Chapter 7
Structuring System Requirements:
Conceptual Data Modeling
Learning Objectives

- Define key data-modeling terms
  - Conceptual data model
  - Entity-Relationship (E-R) diagram
  - Entity type
  - Entity instance
  - Attribute
  - Candidate key
  - Multivalued attributes
  - Relationship
  - Degree
  - Cardinality
  - Associative entity
Learning Objectives (continued)

- Ask the right kinds of questions to determine data requirements for an IS
- Learn to draw Entity-Relationship (ER) Diagrams
- Review the role of conceptual data modeling in overall design and analysis of an information system
- Distinguish between unary, binary and ternary relationships
- Discuss relationships and associative entities
- Discuss relationship between data modeling and process modeling
Conceptual Data Modeling

- Representation of organizational data
- Purpose is to show rules about the meaning and interrelationships among data
- Entity-Relationship (E-R) diagrams are commonly used to show how data are organized
- Main goal of conceptual data modeling is to create accurate E-R diagrams
- Methods such as interviewing, questionnaires, and JAD are used to collect information
- Consistency must be maintained among process flow, decision logic, and data modeling descriptions
The Process of Conceptual Data Modeling

- First step is to develop a data model for the system being replaced
- Next, a new conceptual data model is built that includes all the requirements of the new system
- In the design stage, the conceptual data model is translated into a physical design
- Project repository links all design and data modeling steps performed during SDLC
Deliverables and Outcome

- Primary deliverable is the entity-relationship diagram
- There may be as many as 4 E-R diagrams produced and analyzed during conceptual data modeling
  - Covers just data needed in the project’s application
  - E-R diagram for system being replaced
  - An E-R diagram for the whole database from which the new application’s data are extracted
  - An E-R diagram for the whole database from which data for the application system being replaced are drawn
FIGURE 7-3
Sample conceptual data model diagrams (A) Standard E-R notation.
FIGURE 7-3
Sample conceptual data model diagrams (B) Visio ER notation.
Second deliverable is a set of entries about data objects to be stored in repository or project dictionary

- Data elements that are included in the DFD must appear in the data model and conversely
- Each data store in a process model must relate to business objects represented in the data model
Gathering Information for Conceptual Data Modeling

- Two Perspectives:
  - Top-down
    - Data model is derived from an intimate understanding of the business
  - Bottom-up
    - Data model is derived by reviewing specifications and business documents
Introduction to Entity-Relationship Modeling

- Notation uses three main constructs
  - Data entities
  - Relationships
  - Attributes

- Entity-Relationship (E-R) Diagram
  - A detailed, logical, and graphical representation of the entities, associations and data elements for an organization or business
Entity-Relationship (E-R) Modeling

Key Terms

- **Entity**
  - A person, place, object, event or concept in the user environment about which the organization wishes to maintain data
  - Represented by a rectangle in E-R diagrams

- **Entity Type**
  - A collection of entities that share common properties or characteristics

- **Entity Instance**
  - Single occurrence of an entity type
Key Terms

- **Attribute**
  - A named property or characteristic of an entity that is of interest to an organization

- **Candidate Keys and Identifiers**
  - Each entity type must have an attribute or set of attributes that distinguishes one instance from other instances of the same type
  - **Candidate key**
  - Attribute (or combination of attributes) that uniquely identifies each instance of an entity type
FIGURE 7-5
Entity-Relationship Diagram Notations: Basic Symbols, Relationship Degree, and Relationship Cardinality
Entity-Relationship (E-R) Modeling (continued)

Key Terms

- **Identifier**
  - A candidate key that has been selected as the unique identifying characteristic for an entity type
  - Selection rules for an identifier
    - Choose a candidate key that will not change its value
    - Choose a candidate key that will never be null
    - Avoid using intelligent keys
    - Consider substituting single value surrogate keys for large composite keys
Multivalued Attribute

- An attribute that may take on more than one value for each entity instance
- Represented on E-R diagram in two ways:
  - double-lined ellipse
  - weak entity
Entity-Relationship (E-R) Modeling (continued)

Key Terms

- **Relationship**
  - An association between the instances of one or more entity types that is of interest to the organization
  - Association indicates that an event has occurred or that there is a natural link between entity types
  - Relationships are always labeled with verb phrases
Conceptual Data Modeling and the E-R Diagram

- **Goal**
  - Capture as much of the meaning of the data as possible

- **Result**
  - A better design that is easier to maintain
Degree of Relationship

- **Degree**
  - Number of entity types that participate in a relationship

- **Three Cases:**
  - **Unary**
    - A relationship between the instances of one entity type
  - **Binary**
    - A relationship between the instances of two entity types
  - **Ternary**
    - A simultaneous relationship among the instances of three entity types
    - Not the same as three binary relationships
FIGURE 7-6
Examples of the Three Most Common Relationships in E-R Diagrams: Unary, Binary, and Ternary

Unary Relationships

Person
Is_married_to
Employee
Manages

Binary Relationships

Employee
Is_assigned
Parking Place
One-to-one

Product Line
Contains
Product
One-to-many

Student
Registers_for
Course
Many-to-many

Ternary Relationships

Part
Supplies
Vendor
Unit_Cost
Warehouse
Cardinality

- The number of instances of entity B that can be associated with each instance of entity A

- Minimum Cardinality
  - The minimum number of instances of entity B that may be associated with each instance of entity A

- Maximum Cardinality
  - The maximum number of instances of entity B that may be associated with each instance of entity A
Associative Entity

- An entity type that associates the instances of one or more entity types and contains attributes that are peculiar to the relationship between those entity instances
FIGURE 7-7
Example of an Associative Entity
PVF WebStore: Conceptual Data Modeling

- Conceptual data modeling for Internet applications is no different than the process followed for other types of applications
- Pine Valley Furniture WebStore
  - Four entity types defined
  - Customer
  - Inventory
  - Order
  - Shopping cart
FIGURE 7-13
Entity-relationship diagram for the WebStore system.
Selecting the Best Alternative Design Strategy

- Two basic steps:
  1. Generate a comprehensive set of alternative design strategies
  2. Select the one design strategy that is most likely to result in the desired information system

- Process:
  1. Divide requirements into different sets of capabilities
  2. Enumerate different potential implementation environments that could be used to deliver the different sets of capabilities
  3. Propose different ways to source or acquire the various sets of capabilities for the different implementation environments
Selecting the Best Alternative Design Strategy (continued)

- Deliverables
  1. At least three substantially different system design strategies for building the replacement information system
  2. A design strategy judged most likely to lead to the most desirable information system
Summary

- Process of Conceptual Data Modeling
  - Deliverables
  - Gathering information
- Entity-Relationship Modeling
  - Entities
  - Attributes
  - Candidate keys and identifiers
  - Multivalued attributes
- Degree of Relationship
Summary (continued)

- Cardinality
- Associative Entities
- Conceptual Data Modeling and Internet Development
- Generating Alternative Design Strategies