Database Design: Conceptual Model and ER Diagramming

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IS 257: Database Management
Announcements

- Accounts and MySQL access
- Assignment 1 on web site (more at end of class)
Lecture Outline

• Review
  – Information Systems Planning
    • Information Systems Architecture
    • Information Engineering
  – Database Design
• ER Diagrams
• Developing the Conceptual Model for the Diveshop Database
Lecture Outline

• Review
  – Information Systems Planning
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  – Database Design

• ER Diagrams
• Developing the Conceptual Model for the Diveshop Database
An ISA is a “conceptual blueprint or plan that expresses the desired future structure for information systems in an organization”

It provides a “context within which managers throughout the organization can make consistent decisions concerning their information systems”

– Quotes from McFadden (Modern Database Management, 4th edition), Ch. 3
• Benefits of ISA:
  – “Provides a basis for strategic planning of IS
  – Provides a basis for communicating with top management and a context for budget decisions concerning IS
  – Provides a unifying concept for the various stakeholders in information systems.
  – Communicates the overall direction for information technology and a context for decisions in this area
  – Helps achieve information integration when systems are distributed (increasing important in a global economy)
  – Provides a basis for evaluating technology options (for example, downsizing and distributed processing)”

• Read Chapter 2 in Hoffer…
• Zachman ISA Framework components
  – Data
    • The “what” of the information system
  – Process
    • The “how” of the information system
  – Network
    • The “where” of the information system
  – People
    • Who performs processes and are the source and receiver of data and information.
  – Events and Points in time
    • When processes are performed
  – Reasons
    • For events and rules that govern processing
# Zachman Framework

<table>
<thead>
<tr>
<th>Abstractions</th>
<th>Perspectives</th>
<th>SCOPE: Planner</th>
<th>ENTERPRISE MODEL: Owner</th>
<th>SYSTEM MODEL: Designer</th>
<th>TECHNOLOGY CONSTRAINED MODEL: Builder</th>
<th>DETAILED REPRESENTATIONS: Subcontractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additions</td>
<td></td>
<td>e.g., Semantic Model</td>
<td>e.g., Business Process Model</td>
<td>e.g., Logical Data Model</td>
<td>e.g., Physical Data Model</td>
<td>e.g., Data Definition</td>
</tr>
<tr>
<td>FUNCTION</td>
<td>FUNCTION</td>
<td>List of Processes in the Business</td>
<td>List of Locations in which the Business Operates</td>
<td>Function = Class of Business Resources</td>
<td>i/O = User Viewers</td>
<td>UOC = Interface Specifications</td>
</tr>
<tr>
<td>NETWORK</td>
<td>NETWORK</td>
<td>List of Locations Important to the Business</td>
<td>List of Organizations Significant to the Business</td>
<td>Node = Major Business Location</td>
<td>Node = Business Location</td>
<td>Node = Business Resource</td>
</tr>
<tr>
<td>PEOPLE</td>
<td>PEOPLE</td>
<td>List of Organizations Important to the Business</td>
<td>List of Events Significant to the Business</td>
<td>People = Class of People and Major Organizations</td>
<td>People = Organization Unit</td>
<td>People = User, Work, Service</td>
</tr>
<tr>
<td>MOTIVATION</td>
<td>MOTIVATION</td>
<td>List of Business Goals and Strategies</td>
<td>List of Business Goals and Strategies</td>
<td>Ends/Mean=Major Business Goal/Critical Success Factor</td>
<td>End = Business Objective</td>
<td>End = Condition</td>
</tr>
</tbody>
</table>

**John A. Zachman, Zachman International**

**IS 257 – Fall 2015**
Information Engineering

• A formal methodology that is used to create and maintain information systems
• Starts with the Business Model and works in a Top-Down fashion to build supporting data models and process models for that business model
1. Identify Strategic Planning Factors
   a. Goals
   b. Critical Success Factors
   c. Problem Areas
2. Identify Corporate Planning Objects
   a. Org. Units
   b. Locations
   c. Business Functions
   d. Entity types
3. Develop Enterprise Model
   a. Function decomposition
   b. Entity-Relationship Diagram
   c. Planning Matrices

Design

1. Develop Conceptual Model
   (detailed E-R Diagram)
2. Develop Process Models
   (data flow diagrams)

Analysis

Planning

Implementation

1. Design Databases
   (normalized relations)
2. Design Processes
   a. Action Diagrams
   b. User Interfaces: menus, screens, reports

1. Build database definitions
   (tables, indexes, etc.)
2. Generate Applications
   (program code, control blocks, etc.)
Focus

• In this course we will focus on the design aspects for databases

• We will NOT focus on interaction design or interface design (That is covered in other courses)
Database Design Process

Conceptual Model

Application 1
External Model
Conceptual requirements

Application 2
External Model
Conceptual requirements

Application 3
External Model
Conceptual requirements

Application 4
External Model
Conceptual requirements

Logical Model

Internal Model

Application 1

Application 2

Application 3

Application 4
Database Design Process

• Conceptual Model
  – Merge the collective needs of all applications
  – Determine what **Entities** are being used
    • Some object about which information is to maintained
  – What are the **Attributes** of those entities?
    • Properties or characteristics of the entity
    • What attributes uniquely identify the entity
  – What are the **Relationships** between entities
    • How the entities interact with each other?
Entity

• An Entity is an object in the real world (or even imaginary worlds) about which we want or need to maintain information
  – Persons (e.g.: customers in a business, employees, authors)
  – Things (e.g.: purchase orders, meetings, parts, companies)

Employee
Attributes

- Attributes are the significant properties or characteristics of an entity that help identify it and provide the information needed to interact with it or use it. (This is the Metadata for the entities.)

```
Employee
   `- Name
      `- Last
      `- Middle
      `- First

     `- Birthdate
     `- Age
     `- SSN
     `- Projects
```
• Relationships are the associations between entities. They can involve one or more entities and belong to particular relationship types
Relationships

- Student
- Attends
- Class

- Project

- Supplier
- Supplies project parts
- Part
Types of Relationships

• Concerned only with *cardinality* of relationship

Chen ER notation
Other Notations

“Crow’s Foot”
Many to Many Relationships

- **Employee**
  - SSN
  - Proj#
  - Hours

- **Project**
  - Proj#

- **Project Assignment**
  - Assigned

- **Is Assigned**
Note on drawing diagrams

• You will be asked to draw ER (or UML) diagrams for your personal database
• I prefer diagrams drawn with a drawing tool or DB Design tool
• There are loads of DB Design tools
  – See, e.g., http://www.databaseanswers.org/modelling_tools.htm
• One that integrates well with MySQL is MySQLWorkBench
  – http://www.mysql.com/products/workbench/
Lecture Outline

• Review
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    • Information Systems Architecture
    • Information Engineering
  – Database Design
  – ER Diagrams

• Developing the Conceptual Model for the Diveshop Database
Developing a Conceptual Model

• Overall view of the database that integrates all the needed information discovered during the requirements analysis.

• Elements of the Conceptual Model are represented by diagrams, **Entity-Relationship or ER Diagrams**, that show the meanings and relationships of those elements independent of any particular database systems or implementation details.

• Can also be represented using other modeling tools (such as UML)
Developing a Conceptual Model

• Building the Conceptual Model for the Diveshop database
Developing a Conceptual Model

• We will look at a small business -- a diveshop that offers scuba diving adventure vacations

• Assume that we have already done interviews with the business and found out the **following information** about the forms used and types of information kept in files and used for business operations...
Primary Business Operations

• The shop takes orders from customers for dive vacations.
• It ships information about the dive vacation to the customers.
• It rents diving equipment for the divers going on the trips (these may include additional people other than the customer)
• It bills the customer for the vacation and for equipment rental or sales.
Business Operations (cont.)

• It arranges sub-trips to particular dive sites at the primary location
  – NOTE: *This needs expanding* – *e.g., charter boats, divemasters, local dive companies*

• It provides information about the features of various sites to help customers choose their destinations.
  – Features include sea life found at the location and shipwrecks
Business Operations (cont.)

- Each dive order (or sale or trip) is on an invoice to one customer.
  - Invoices contain:
    - Line items for each type of equipment ordered,
    - Total amount due for the invoice,
    - Customer information:
      - Name, address, phone, credit card info.
    - *Note: could be expanded with particular charter dates and time, dive boats, etc.*

- Information must be kept on inventory of dive equipment.

- There are multiple types of dive equipment:
  - The prices charged for sale or rental are maintained
• Destination information includes:
  – Name of the destination
  – Information about the location (accommodations, nightlife, travel cost, average temperatures for different times of the year
• Destinations have associated dive sites
• Dive Sites have associated features
  – Difficulty rating, depth, etc.
  – Sea life
  – Shipwrecks (as sites or at sites)
  – *Note: could be expanded to include the boats, etc. that go to specific sites*
Business Operations (cont.)

• One record is kept for *each* order by a customer and will include the method of payment, total price, and location information. (I.e. Customers may have multiple orders)

• The company needs to know how an order is to be shipped.

• The shop has to keep track of what equipment is on-hand and when replacements or additional equipment is needed
Entities

- Customer
- Dive Order
- Line item
- Shipping information
- Dive Equipment/Stock/Inventory
- Dive Locations
- Dive Sites
- Sea Life
- Shipwrecks
Diveshop Entities: DIVECUST

- Customer no
- Name
- Street
- City
- State/Prov
- ZIP/Postal Code
- Country
- Phone
- First Contact
- DiveCust
Diveshop Entities: DIVEORDS

- Customer No
- Order no
- Sale Date
- Ship Via
- Vacation Cost
- Destination
- Depart Date
- Return Date
- No of People
- Payment Method
- CCExpDate
- CCNumber
- DiveOrds
Diveshop Entities: SHIPVIA

Ship Via

Ship Cost

ShipVia
Diveshop Entities: SITES

- Site Name
- Site Highlight
- Site Notes
- Distance From Town (M)
- Distance From Town (Km)
- Depth (ft)
- Depth (m)
- Visibility (ft)
- Visibility (m)
- Current
- Skill Level
- Site no
- Destination no
Diveshop Entities: BIOSITE

- Species No
- Site No

BioSite
Diveshop Entities: BIOLIFE

- Species Name
- Common Name
- Category
- Species no
- Length (cm)
- Length (in)
- Notes external
- Graphic external
Functional areas

• Ordering
• Inventory
• Supplies
• Shipping
• Billing
• Location/Site Selection
  – We will concentrate on Ordering and Location/Site Selection (these are joined tasks)
Ordering

Customers place Orders
Each Order needs Customer information
Ordering Normalization

- DiveCust
  - Customer No
  - Orders
    - Order No
    - Customer No
  - Ship
    - Ship Via

- DiveOrds
  - Ship Via
  - Order No
  - Contains
    - DivItem
      - Item No
      - Order No
      - Qty
      - Rental/sale
Details of DiveItem

We’re ignoring this part...

Company#

Supplier  \( \rightarrow \) Supplies  \( \rightarrow \) DiveStok

Item No  \( \rightarrow \) Order No

Has

Item No  \( \rightarrow \) On Hand  \( \rightarrow \) Sale Price
Ordering: Full ER

- **DiveCust**: Customer
- **DiveOrds**: Order
- **Dest**: Destination
- **ShipVia**: Shipping
- **DiveItem**: Item
- **DiveStok**: Stock
Destination/ Sites

- Destination Name
- Customer No
- Destination No
- Site No

1:1 relationship between Dest and Sites
1:n relationship between Sites and DiveOrds
n:1 relationship between DiveOrds and Dest

Sites and Sea Life 1

- Site No
- Destination
- BioLife

Multiple occurrences of sea life...
Diveshop ER diagram: BioSite

Species No

BioSite

Site No
Sites and Shipwrecks

Diagram:
- Sites
  - Site No
  - Destination
    - Site No
  - 1
- ShipWrck
  - Site No
  - 1/n
What must be calculated?

- Total price for equipment rental?
- Total price for equipment sale?
- Total price of an order?
  - Vacation price
  - Equipment (rental or sale)
  - Shipping
What is Missing??

• Not really an “enterprise-wide” database
  – No personnel…
    • Sales people
    • Dive masters
    • Boat captains and crew
    • payroll
  – No Local arrangements…
    • Dive Boats
      – Charter bookings?
    • Hotels?
  – Suppliers/Wholesalers for dive equipment
    • Orders for new/replacement equipment
  – No history (only current or last order)
Diveshop database

• We will take a look at the MySQL version of the DiveShop database using phpMyAdmin
MySQL version of Diveshop

- MySQL version of the database is available for download through the class web site
- phpMyAdmin is a web-based interface for MySQL databases providing simple access and modification functions
  - Not really a full DB environment, but has many useful features
phpMyAdmin

- phpMyAdmin has been set up for iSchool MySQL database accounts
- It can be accessed at https://groups.ischool.berkeley.edu/pma/
  - Need to have I School login/pw and MySQL login and pw
- Quick Demo…
Assignment 1 (also online)

• How many tons was the sunken ship Delaware?
• What is customer Karen Ng’s address?
• At what destinations and sites might you find a Spotted Eagle Ray?
• Where (what destination) is the site Palancar Reef?
• What sites might Lorraine Vega dive on her trip?
• Keith Lucas wants to see a shipwreck on his trip. Is he going to the right place?
• What equipment is Richard Denning getting?
• What is the cost of the equipment rental for Louis Jazdzewski
Assignment 1: cont.

- The Database is available on the course website
- Download your own copy and install from phpMyAdmin (demo)
- For each of the questions create a query in phpMyAdmin (more on this later)
- Create a document (Word, etc.) containing
  - The query being answered
  - The results of your query cut and pasted from phpMyAdmin
- Due date Sept. 17
Next Week

• Tuesday:
  – Workshop on SQL
  – Workshop on Personal/Group DBs