Chapter 2:
The Database Development Process

Modern Database Management
9th Edition

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Objectives

- Definition of terms
- Describe system development life cycle
- Explain prototyping approach
- Explain agile software development approach
- Explain roles of individuals
- Explain three-schema approach
- Explain role of packaged data models
- Explain three-tiered architectures
- Explain scope of database design projects
- Draw simple data models
Enterprise Data Model

- First step in database development
- Specifies scope and general content
- Overall picture of organizational data at high level of abstraction
- Entity-relationship diagram
- Descriptions of entity types
- Relationships between entities
- Business rules
Enterprise data model describes the high-level entities in an organization and the relationship between these entities.
Information Systems Architecture (ISA)

- Conceptual blueprint for organization’s desired information systems structure
- Consists of:
  - Data (e.g. Enterprise Data Model-simplified ER Diagram)
  - Processes-data flow diagrams, process decomposition, etc.
  - Data Network-topology diagram (like Fig 1-7)
  - People—people management using project management tools (Gantt charts, etc.)
  - Events and points in time (when processes are performed)
  - Reasons for events and rules (e.g., decision tables)
Information Engineering

- A data-oriented methodology to create and maintain information systems
- Top-down planning—a generic IS planning methodology for obtaining a broad understanding of the IS needed by the entire organization
- Four steps to Top-Down planning:
  - Planning
  - Analysis
  - Design
  - Implementation
<table>
<thead>
<tr>
<th>STEP</th>
<th>EXPLANATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Identify strategic planning factors</td>
</tr>
<tr>
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<td>a. Goals</td>
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<td></td>
<td>b. Critical success factors</td>
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<td></td>
<td>c. Problem areas</td>
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<tr>
<td>2.</td>
<td>Identify corporate planning objects</td>
</tr>
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<td>a. Organizational units</td>
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<td>b. Locations</td>
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<td>c. Business functions</td>
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<tr>
<td></td>
<td>d. Entity types</td>
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<tr>
<td>3.</td>
<td>Develop an enterprise model</td>
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<tr>
<td></td>
<td>a. Functional decomposition</td>
</tr>
<tr>
<td></td>
<td>b. Entity-relationship diagram</td>
</tr>
<tr>
<td></td>
<td>c. Planning matrixes</td>
</tr>
</tbody>
</table>

**Table 2-1**

Information Engineering Planning Phase
Identify Strategic Planning Factors (Table 2-2)

- Organization goals—what we hope to accomplish
- Critical success factors—what MUST work in order for us to survive
- Problem areas—weaknesses we now have
Identify Corporate Planning Objects (Table 2-3)

- Organizational units—departments
- Organizational locations
- Business functions—groups of business processes
- Entity types—the things we are trying to model for the database
- Information systems—application programs
Develop Enterprise Model

- Functional decomposition
  - Iterative process breaking system description into finer and finer detail
- Enterprise data model
- Planning matrixes
  - Describe interrelationships between planning objects
Figure 2-2  Example process decomposition of an order fulfillment function (Pine Valley Furniture Company)
Planning Matrixes

- Describe relationships between planning objects in the organization

- Types of matrixes:
  - Location-to-function
  - Unit-to-function
  - IS-to-data entity
  - Supporting function-to-data entity
  - IS-to-business objective
## Example Business Function-to-Data Entity Matrix (Fig. 2-3)

<table>
<thead>
<tr>
<th>Business Functions</th>
<th>Customer</th>
<th>Product</th>
<th>Raw Material</th>
<th>Order</th>
<th>Work Center</th>
<th>Work Order</th>
<th>Invoice</th>
<th>Equipment</th>
<th>Employee</th>
</tr>
</thead>
<tbody>
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<td></td>
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<td></td>
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<tr>
<td>Materials Management</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td>Order Fulfillment</td>
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<td>X</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Order Shipment</td>
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<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sales Summarization</td>
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<td>X</td>
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<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
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<td>Production Operations</td>
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<td>X</td>
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<td></td>
</tr>
<tr>
<td>Finance and Accounting</td>
<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

* X = data entity (column) is used within business function (row)
Two Approaches to Database and IS Development

- **SDLC**
  - System Development Life Cycle
  - Detailed, well-planned development process
  - Time-consuming, but comprehensive
  - Long development cycle

- **Prototyping**
  - Rapid application development (RAD)
  - Cursory attempt at conceptual data modeling
  - Define database during development of initial prototype
  - Repeat implementation and maintenance activities with new prototype versions
Systems Development Life Cycle
(see also Figures 2.4, 2.5)
Systems Development Life Cycle
(see also Figures 2.4, 2.5) (cont.)

Planning

Purpose—preliminary understanding
Deliverable—request for study

Analysis

Logical Design

Physical Design

Implementation

Maintenance

Database activity—enterprise modeling and early conceptual data modeling
Purpose—thorough requirements analysis and structuring
Deliverable—functional system specifications

Database activity—thorough and integrated conceptual data modeling
Purpose—information requirements elicitation and structure
Deliverable—detailed design specifications

Database activity—logical database design
(transactions, forms, displays, views, data integrity and security)
Systems Development Life Cycle
(see also Figures 2.4, 2.5) (cont.)

Purpose—develop technology and organizational specifications
Deliverable—program/data structures, technology purchases, organization red designs

Database activity—physical database design (define database to DBMS, physical data organization, database processing programs)

Purpose—programming, testing, training, installation, documenting
Deliverable—operational programs, documentation, training materials

Database activity—database implementation, including coded programs, documentation, installation and conversion
Systems Development Life Cycle
(see also Figures 2.4, 2.5) (cont.)

Planning

Purpose–monitor, repair, enhance
Deliverable–periodic audits

Analysis

Logical Design

Physical Design

Implementation

Maintenance

Database activity–
database maintenance,
performance analysis
and tuning, error
corrections
Prototyping Database Methodology
(Figure 2.6)
Prototyping Database Methodology

(Figure 2.6) (cont.)

Conceptual data modeling
- Analyze requirements
- Develop preliminary data model

Identify problem
Initial requirements

Develop initial prototype
Working prototype
New requirements

Convert to operational system

If prototype is inefficient

Implement and use prototype
Problems
Next version

Revise and enhance prototype
Prototyping Database Methodology

(Figure 2.6) (cont.)

Conceptual data modeling
- Analyze requirements
- Develop preliminary data model

Identify problem

Initial requirements

Develop initial prototype

Logical database design
- Analyze requirements in detail
- Integrate database views into conceptual data model

Physical database design and definition
- Define new database contents to DBMS
- Decide on physical organization for new data
- Design database processing programs

Database implementation
- Code database processing
- Install new database contents, usually from existing data sources

Database maintenance
- Analyze database to ensure it meets application needs
- Fix errors in database

Convert to operational system

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CASE

- Computer-Aided Software Engineering (CASE) - software tools providing automated support for systems development

- Three database features:
  - Data modeling - drawing entity-relationship diagrams
  - Code generation - SQL code for table creation
  - Repositories - knowledge base of enterprise information
Packaged Data Models

- Model components that can be purchased, customized, and assembled into full-scale data models

- Advantages
  - Reduced development time
  - Higher model quality and reliability

- Two types:
  - Universal data models
  - Industry-specific data models
Managing Projects

- Project—a planned undertaking of related activities to reach an objective that has a beginning and an end
- Involves use of review points for:
  - Validation of satisfactory progress
  - Step back from detail to overall view
  - Renew commitment of stakeholders
- Incremental commitment—review of systems development project after each development phase with rejustification after each phase
Managing Projects: People Involved

- Business analysts
- Systems analysts
- Database analysts and data modelers
- Users
- Programmers
- Database architects
- Data administrators
- Project managers
- Other technical experts
Database Schema

- External Schema
  - User Views
  - Subsets of Conceptual Schema
  - Can be determined from business-function/data entity matrices
  - DBA determines schema for different users
- Conceptual Schema
  - E-R models—covered in Chapters 3 and 4
- Internal Schema
  - Logical structures—covered in Chapter 5
  - Physical structures—covered in Chapter 6
Different people have different views of the database...these are the external schema.

The internal schema is the underlying design and implementation.
Figure 2-8  Process of developing three-schema architecture for a database project

Start here

Enterprise data model

Conceptual schema

Develop conceptual schema

User views

When conceptual and external databases are fully defined

User views

Develop user views (external schemas) and logical database specifications

Understanding of transactions, reports, screen displays, database use

New user requirements

Develop physical schema

Performance expectations

Hardware and software features, physical characteristics of data

General understanding of project's database requirements
Figure 2-9  Three-tiered client/server database architecture

**Client tier**
- Accounts payable processing
  - Browser
  - Database of vendors, purchase orders, vendor invoices

**Application/Web tier**
- Cash flow analyst
  - Browser
  - Database of customer receipts and our payments to vendors
  - Application/Web server
  - A/P, A/R, order processing, inventory control, and so forth; access and connectivity to DBMS. Dynamic Web pages; management of session

**Enterprise tier**
- Customer service representative
  - Browser
  - No local database

- Enterprise server with DBMS
  - Transaction databases containing all organizational data or summaries of data on department servers
Pine Valley Furniture

Segment of project data model  (Figure 2-11)
Figure 2-12 Four relations (Pine Valley Furniture)

(a) Order and Order Line tables

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<thead>
<tr>
<th>Order ID</th>
<th>Order_Date</th>
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<td>10/22/2006</td>
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Figure 2-12 Four relations (Pine Valley Furniture) (cont.)