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This preview shows selected pages that are representative of the entire course book. The pages shown are not consecutive. The page numbers as they appear in the actual course material are shown at the bottom of each page. All table-of-contents pages are included to illustrate all of the topics covered by a course.
TDWI Advanced Data Modeling Techniques
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Module 1

Data Modeling Concepts

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# Data Models in Context

## Zachman Framework Overview

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<th>Source: <a href="http://www.zachmaninternational.com">www.zachmaninternational.com</a></th>
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<tr>
<td><strong>THE ZACHMAN FRAMEWORK FOR ENTERPRISE ARCHITECTURE™</strong></td>
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<td>author: John A. Zachman</td>
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*Note: The items in the framework cells are examples of artifacts that you might produce at the intersection of each row and column. They are not intended as a prescriptive statement of things that you must produce, or as a complete list of architectural deliverables.*
Data Models in Context
Zachman Framework Overview

FRAMEWORK INCEPTION
The Zachman Framework for Enterprise Architecture was developed by observing the way work was planned and performed in disciplines, such as building, that have existed for centuries. He reasoned that the same fundamental concepts exist within the information environment and that applying them can provide systems and other products with the same lasting power and reliability of buildings and quality machinery.

PERSPECTIVES
The framework recognizes people have different roles or “perspectives”, depending on their need for and use of information in the creation of a product. These perspectives need to be developed sequentially.

- PLANNER: This role is concerned with positioning the product in the context of its environment. This provides the contextual view to establish the scope.
- OWNER: This role is interested in the business deliverable and how it will be used. This provides the conceptual (business) view.
- DESIGNER: This role works with the specifications for the product to ensure that it will fulfill the owner’s expectations. This provides the logical (system) view.
- BUILDER: This role manages the assembling and fabricating of the components to create the product. This provides the physical (technology) view.
- SUBCONTRACTOR: This role builds out-of-context (reusable) components to meet the builder’s specifications without specific knowledge of where the component will be placed.

DIMENSIONS
The framework also recognizes that answers to the six interrogatories must be provided to fully describe any perspective. These answers address:

- Entities (what?)
- Activities (how?)
- Places (where?)
- People (who?)
- Timing (when?)
- Motivations (why?)

There is no implied sequence in answering these six questions.
Data Models in Context
Levels of Data Models – Enterprise Perspective

PARTIAL SUBJECT AREA MODEL

- PRODUCTS
- CUSTOMERS
- SALES
- FINANCIALS
- HUMAN RESOURCES
- PROJECTS

PARTIAL BUSINESS DATA MODEL
## Data Models in Context
### Levels of Data Models – Enterprise Perspective

**ENTERPRISE VS. PROJECT PERSPECTIVE**
The enterprise perspective for data provides the foundation for all projects that use data. Regardless of whether or not such a perspective is physically implemented (it rarely is), its existence establishes a consistent set of business rules and definitions for all data used in the enterprise independent of any constraints imposed by the organizational structure, local processes, and system constraints.

**SUBJECT AREA MODEL**
Subject areas are the 10 – 20 broad groupings of data of interest to the enterprise. When these subject areas are defined so that they are mutually exclusive, the subject areas provide a framework for assigning responsibilities for data (e.g., data stewardship, modeling) and for setting the foundation for managing the business data model.

Development of the subject area model is fairly quick, and generic models are available to serve as a starting point. There are many subjects that are common across industries, including customers, products (or offerings), locations, information, facilities, and sales. In addition, specific industries have subject areas that are common across companies. For example, in the insurance industry, subject areas such as claims and incidents exist and (sold) policies may be used instead of “sales”.

**BUSINESS DATA MODEL**
The business data model is an abstraction or representation of the data in an enterprise. The business data model helps manage the data asset just as the chart of accounts helps to manage the money asset and the organizational chart helps to manage the human resources. The model is typically depicted in “third normal form”. Using this modeling technique ensures that it is internally consistent, that there is no redundancy, and that the relationships among data groupings (entities) are properly represented. The model can then be used as the foundation for all systems development projects. When the business model is used to guide development, the resultant data structures should be fairly consistent and integration of data from multiple systems will be much easier.

Development of the business data model can take several months and if one does not exist, most companies don’t sanction an independent effort to create one. Instead, the model is developed incrementally as data is needed for new development efforts. As with the subject area model, generic starting points are available. *The Data Model Resource Book* by Len Silverston is an extremely useful resource.
Module 2
Business Data Model Development

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Model Components

Entities

Attributive Entity

Fundamental Entity

Associative Entity
Model Components

Entities

**DEFINITION**
An entity is a person, place, concept, event, or thing of interest to the enterprise and for which it has the capability of capturing and retaining data. The caveat is not technically part of the definition, but it is included because of the need to approach data modeling from a pragmatic viewpoint. Data modeling is not a theoretical exercise. The data model is built to ultimately drive the design of a physical data structure. If the enterprise has no capability to capture the information, then it does not need a physical structure to store it. Hence, it is not worth spending the time to identify and define it. Each entity must be uniquely identifiable and exists only once within the business data model.

**FUNDAMENTAL**
A fundamental entity (a.k.a. independent entity) is one that does not depend on any other entity for its existence. Examples include:

- Employee
- Department
- Customer

**ATTRIBUTIVE**
An attributive entity (a.k.a. characteristic entity) is one that depends on another entity for its existence. Its primary key is a concatenated key that includes the primary key of the parent entity (entity on which it depends). It is created to resolve repeating groups within an entity. Examples include:

- Employee Address
- Dealer Objective

**ASSOCIATIVE**
An associative entity (a.k.a. intersection entity) is one that depends on at least two other entities for its existence. Its primary key is a concatenated key that includes the primary keys of each of the parent entities. An additional key component may or may not exist. This entity is formed by resolving many-to-many relationships and it contains information that is at the intersection of the parent entities. Examples include:

- Inventory
- Customer Interaction
Model Components
Entities (Continued) - Supertype and Subtype
Model Components
Entities (Continued) – Supertype and Subtype

**DEFINITION**
Supertype and subtype entities enable the model to represent generalizations and specializations. The supertype entity represents the highest level of abstraction that is useful in the model. For example, human resource is a supertype and employee, retiree, applicant, and contractor are subtypes.

**GENERALIZATION**
The supertype entity represents the highest level abstraction that is useful in the model. It includes the relationships and attributes that apply to all the subtype entities. In the above example, the human resource key, first name, middle name, last name, etc. reside in the human resource entity and apply to all of the subtypes.

Each supertype also contains an attribute describing the types of subtype groupings that it has. For example, the human resource entity would have an attribute called human resource type.

**SPECIFICATION**
Specification is achieved through the subtypes. Each subtype contains relationships and attributes that are unique to it. For example there may be a relationship between employee and department, while that relationship would not apply to the other subtypes. Similarly, a retiree would have a retirement date, but the other subtypes would not.
Model Components

Entities (Continued) – Supertype and Subtype
Model Components

Entities (Continued) – Supertype and Subtype

OVERVIEW

Within business intelligence, supertypes and subtypes often get transformed into dimensions within the star schema. Care must be taken to ensure that the relationships are structured to provide correct results. This requires distinguishing between two types of subtypes – classifications and roles.

CLASSIFICATIONS

Classifications are mutually exclusive subtypes. For example, a Customer may have subtypes of Residential Customer and Commercial Customer. If the business rule is that the same customer cannot be both a residential and commercial customer, these subtypes are classifications.

For classifications, the sum of the number of occurrences of each of the subtypes is the same as the number of occurrences of the supertype.

ROLES

Roles are subtypes that are not mutually exclusive. In the human resource example, if a retiree can simultaneously also be a contractor, the subtypes are roles.

For roles, the sum of the number of occurrences of each of the subtypes is greater than or equal to the number of occurrences of the supertype. In building data marts, one must be very careful with dimensions that are roles to avoid duplicate counts.

PARTY

A modeling generalization approach is to use the concept of “Party”, which is defined as a person or organization. With this approach, the role of the party (e.g., supplier, customer, employee) is a separate (associative) entity which relates two parties. The advantage of this approach is that information about the party is shown only once regardless of the role. The major disadvantage is that the level of generalization is sometimes too high to effectively communicate the rules indicated by the model.

A compromise that is sometimes made is to represent parties explicitly within the business model and to transform these into the party concept for the system or technology models.
Module 3
System and Physical Data Model Development

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## Data Modeling Roles

**Data Analyst / Data Modeler**

| WHO: | IT person responsible for developing and maintaining data models |
| ROLE: | Lead data model development |
|      | Understand data in scope and business access expectations |
|      | Transform business data model into system model |
| TRAITS: | Recognition of data as an asset |
|        | Data modeling expertise (including tools) |
|        | Analysis capabilities |
| CHALLENGES: | Determining the type of model and degree of denormalization |
|           | Knowing when to stop |
Data Modeling Roles
Data Analyst / Data Modeler

WHO ARE THESE
The data analyst / data modeler is the person who transforms the business data model into the systems model and supports the database administrator in creating the technology model.

MODEL DEVELOPMENT ROLE
The data analyst works with the development team to understand the scope of the effort. For business intelligence projects, the emphasis is on understanding the data within scope and how the business user expects to access or use the data. Armed with this information, the data analyst can create the starting point for the system data model and then proceed to fully develop it for the scope of the initiative.

HOW TO ENCOURAGE INVOLVEMENT
The data analyst’s involvement typically does not need to be encouraged. This is the person’s job.

HOW TO OVERCOME ABSENCE
Sometimes other priorities preclude involvement by the data analyst. When this happens, the project leader should try to emphasize the importance of the data analyst’s involvement. There may be opportunities to shift project activities to accommodate the data analyst’s priorities and still complete the project on time.

Failing that, the project leader should try to enlist someone else with the requisite skills. Often database administrators can also create the system data model.
Denormalization

Overview

**DENORMALIZATION ACTIVITIES**

- Inclusion of reference data in transactions
  - Customer name within sales transaction

- Inclusion of same element in multiple tables
  - Product name in tables that refer to product

- Creation of aggregations and summaries
  - To help migrate data to data marts

- Compression of hierarchies into a single table
  - To create star schema

- Creation of tables with data commonly used together
  - To minimize joins upon retrieval

**DENORMALIZATION TRADE-OFFS**

- Development Time
  - Data structure design
  - Design, coding, and testing to reliably replicate data

- Processing
  - Extra processing needed to place same data in multiple places
  - Reduction in joins and full table scans

- Storage
  - Duplicate storage consumes disk space

- Consistency
  - Vigilance needed to ensure synchronization
Denormalization

Overview

**DESCRIPTION**

Denormalization is the process of including redundant data within a database to improve performance and usability. Within traditional systems, data is denormalized to improve transaction processing performance. Within the business intelligence environment, denormalization is performed to improve query performance and data navigation. Examples of denormalization include:

- Inclusion of reference data (e.g., customer name) within transaction tables
- Inclusion of the same data element in multiple tables
- Creation of aggregations and summaries
- Compression of hierarchies into a single table
- Creation of tables with data that is commonly used together

**COST**

Denormalization improves query performance by reducing the data joins and full-table scans needed to retrieve the data. This improvement requires costs during both development and operation of a system. Typical costs include:

- Development – the denormalization steps need to be designed and the code to reliably replicate the data needs to be built and tested
- Processing – it requires extra processing to place the same data element in multiple places
- Storage – duplicate storage consumes disk space
- Consistency – duplicating data requires careful vigilance to ensure that all copies of the data are updated simultaneously

**DESIGN CONSIDERATIONS**

In the business intelligence environment, the primary consideration for denormalization is the data access requirement and the design of the information delivery layer. That layer typically includes dimensional models, and these structures are inherently denormalized. Each dimension contains a hierarchy, with the hierarchy compressed into a single table. In addition, the fact table is sometimes at an aggregated level.

In a hub and spoke environment, aggregation tables, within the data warehouse, are often built to facilitate building the data marts.
## Module 4
### Additional Concepts

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Complementary Models
State Transition Model

- **start**
  - **Proposed Project**
    - Project conceived
    - Project approved and funded
  - **Cancelled Project**
    - Project not approved
    - Project cancelled
  - **Active Project**
    - Project initiated
  - **Approved Project**
    - Project goals met
  - **Completed Project**
Complementary Models
State Transition Model

DESCRIPTION
The state transition model is a way of depicting a single entity throughout its lifecycle. It provides information about the entity at each state and also describes the actions needed for it to change from one state to another. For example, a sale has several states, including proposal, order, fulfillment, delivery, and payment. The state transition model would depict each of these states and indicate what is necessary for the sale to move from one state to the next, recognizing that there may be options. For example in the lifecycle of a loan, after the application state, the loan may proceed to an approved state or a rejected state.

COMPONENTS
The model consists of the following major components:
- States – the unique set of business circumstances in which an occurrence of an entity may exist
- Actions – the events that must take place for the entity to move from one state to the next
In addition, terminators to indicate the start and end points of the lifecycle and descriptions of each state (including any preconditions and postconditions) should be included to complete the model.

PERSPECTIVE
The state transition model is focused on a single entity and should represent its states and the business rules governing the transitions from an enterprise perspective. Restricting the view to a single business area defeats the purpose of this model since the transitions would not be fully represented.

PROCESS
Development of this model requires the following major activities:
- Determine the entity to be modeled.
- Identify the states of interest (both linear and tangential). Name and describe each of these.
- Identify the actions that cause changes in the state.
- Identify preconditions and postconditions for each state.
- Verify correctness (and adjust if needed).

DATA MODEL SIGNIFICANCE
This model is extremely useful for traditional application development, since the actions from migrating from state to state are often within the scope of the systems and this provides a comprehensive view of what needs to be accomplished. If a state transition exists, it can be used to help validate the business data model and the way in which the supertypes and subtypes for the entity are represented.