Previews of TDWI course books are provided as an opportunity to see the quality of our material and help you to select the courses that best fit your needs. The previews can not be printed.

TDWI strives to provide course books that are content-rich and that serve as useful reference documents after a class has ended.

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 Data Modeling

Data Analysis and Design for BI and Data Warehousing Systems

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Module 1

Data Modeling Concepts

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Kinds of Data Systems	1-6
Data Characteristics	1-8
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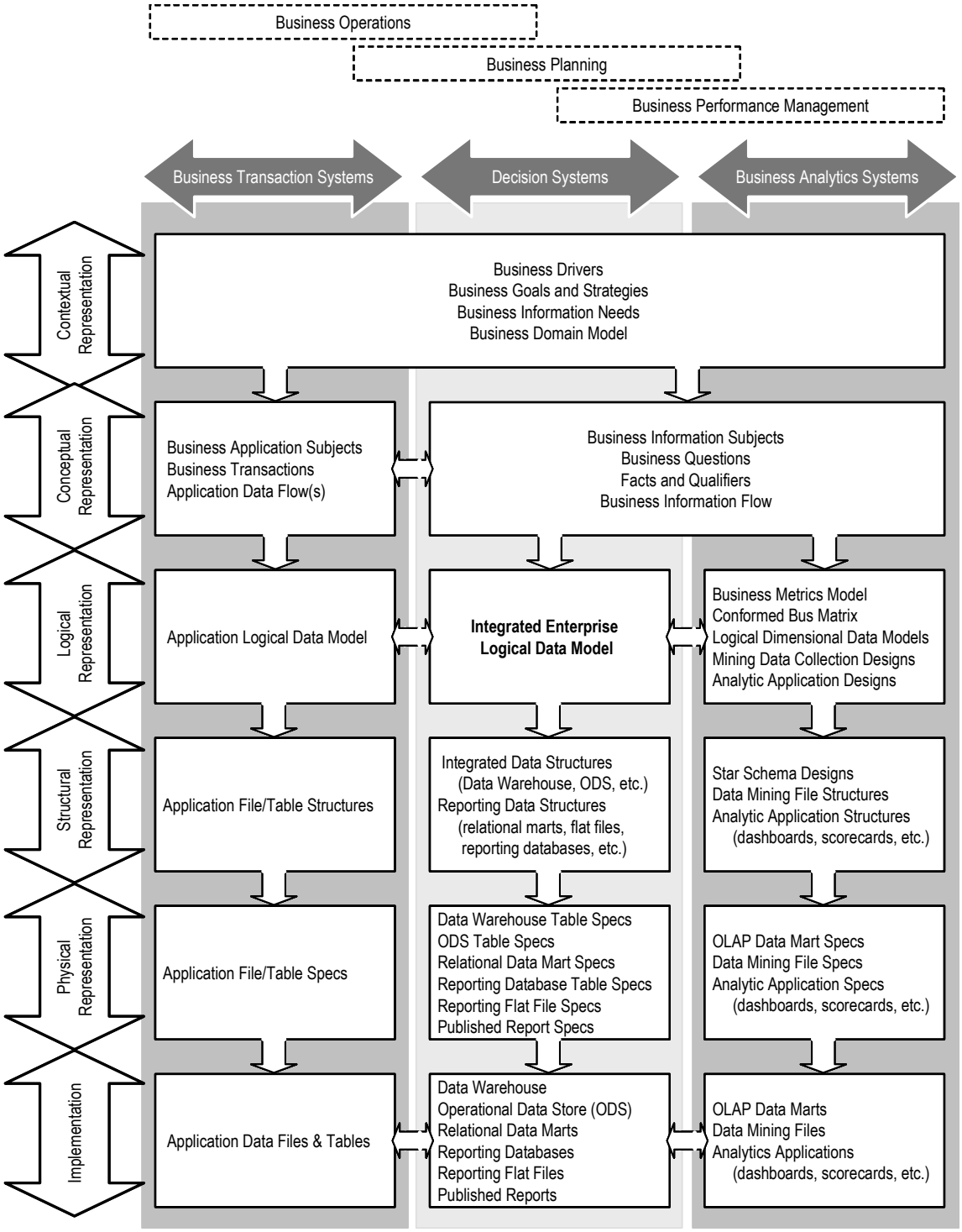
Data Modeling Framework for BI

Where and What to Model



Data Modeling Framework for BI

Where and What to Model

SCOPE OF DATA ANALYSIS AND DESIGN

The diagram on the facing page illustrates the full scope of data analysis and design as covered in this course. Looking through the diagram you'll find:

- *Business perspectives* of business operations, business planning, and performance management – each dependent on data and information services. Business operations depend primarily on transaction systems with some value received from decision support systems. Business planning is dependent on decision support with some assistance from transaction systems and business analytics. Performance management is primarily an analytics-dependent activity with some application of decision support systems.
- *Six layers of abstraction* from contextual representation of data to implementation of data. The top two layers – contextual and conceptual – represent analysis activities. The third and fourth layers – logical and structural – are design activities. The bottom two layers are directly related to implementation of data systems.
- *Three parallel columns of data analysis and design results* that are based on three distinct kinds of data and information systems – business transaction systems, decision systems, and business analytics systems.

  At the contextual level the results are identical for all three columns. It would make little sense if the three kinds of systems were each built using unrelated business context.

  At the conceptual level decision support and business analytics systems share common deliverables because they are both founded on enterprise perspective and integrated data. Business transaction systems are likely to be conceptually narrower resulting in non-integrated data and operational systems stovepipes.

  Below context and concept levels each type of information system has unique analysis and design deliverables and specialized data models.
- At the center of the model the *Integrated Enterprise Logical Data Model* is highlighted. This model, whether physically created or not, provides an essential business-oriented and application-independent view of the entire scope of data.

Module 2

Contextual Modeling

Topic	Page
Business Drivers, Goals, and Strategies	2-2
Modeling Business Domains	2-8
Collecting Information Needs	2-14

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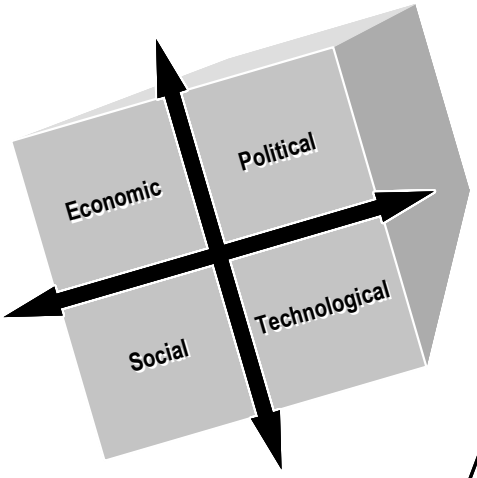
Business Drivers, Goals, and Strategies

External Context



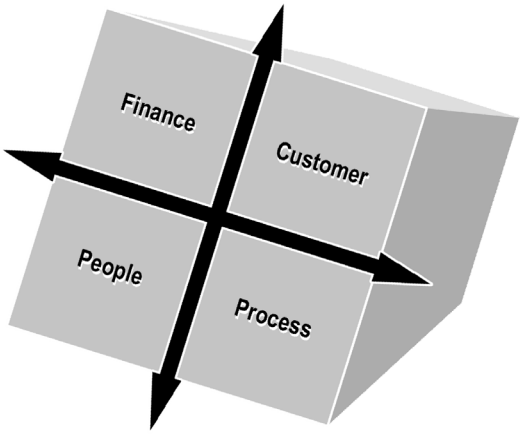
forces that cause a need to act:
- increased competition
- changing regulations
- changing economy
- merger or acquisition
- changing marketplace
- changing workforce
- changing technology
- etc.

Business Drivers
forces that cause a need to act

Business Goals
desired outcomes of actions

Business Strategies

desired outcomes of actions:
- increased market share
- increased customer share
- improved customer retention
- cost reduction
- increased revenue
- improved profit margins
- reduced cycle time
- etc.



planned means to achieve goals:
- competitive pricing
- innovative product packaging
- customer loyalty programs
- outsourcing and partnerships
- new sales channels
- supply chain optimization
- new delivery channels
- etc.

Business Drivers, Goals, and Strategies

External Context

THE MODELING FRAMEWORK

WHY MODEL

Business context determines the nature of data and information services – the business processes to be affected, the kinds of applications to be implemented, and the information services to provide. Business context provides the means to align data with business goals.

BUSINESS DRIVERS

Business drivers are those things that are strategically important in positioning the business to achieve its short- and long-term goals. They are the external forces that have significant influence on operation and performance of a business. Drivers create need to take action, but they don't dictate the actions to be taken. Common business driver examples include changing economy, changing marketplace, and changing regulations.

BUSINESS GOALS

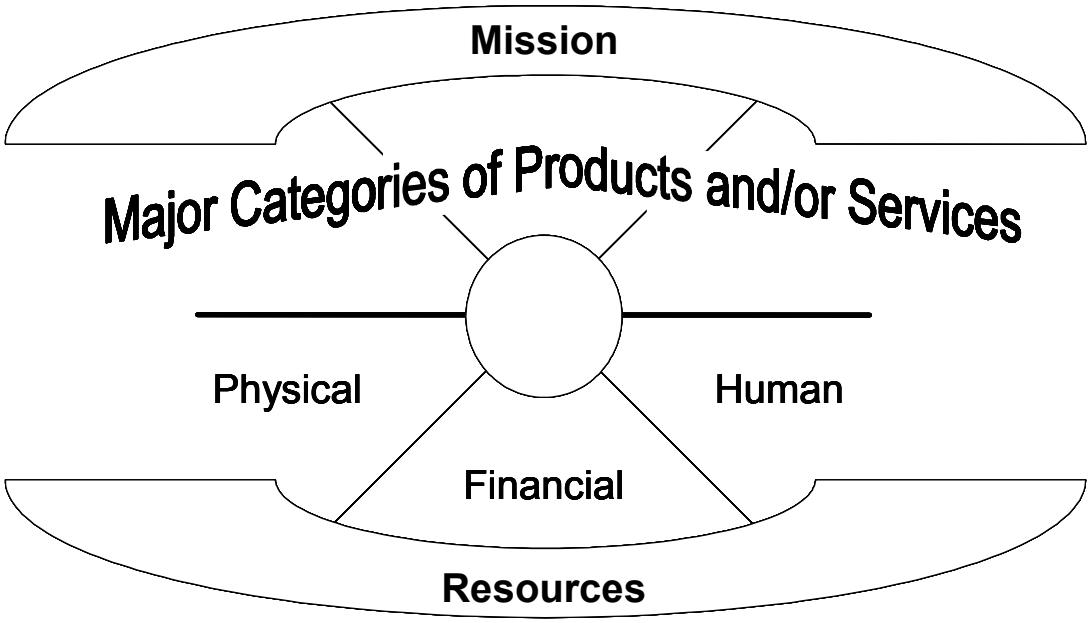
Business goals are the things that the business wants to accomplish to respond to business drivers. Drivers create the need to act. Goals describe the desired outcomes of taking action. Goals are commonly related to financial or operational performance (i.e., cost reduction, generation of revenue, increased market share, etc.) Goals are most effective in setting data management priorities and directions when they are: (1) described by clear, concise, understandable statement, (2) specific enough that level of achievement can be measured, and (3) of high business priority.

BUSINESS STRATEGIES

Business strategies are action plans for the business. They describe how the business plans to accomplish its goals. The range of strategies is broad – introducing new products, exploiting new sales channels, pricing competitively, optimizing business processes, etc. Strategies help to determine which business processes and organizations most need to be information enabled.

Modeling Business Domains

Internal Context



Modeling Business Domains

Internal Context

THE MODELING FRAMEWORK

WHY MODEL

A business domain is a sphere of business activity or function – a broad classification of resource and activity that is planned, managed, executed, and monitored by the business. Domain is the top-tier of business data classification (even more broad than subject, for those familiar with subject modeling). Modeling business domains extends the understanding of business context that is established by modeling drivers, goals, and strategies. It is particularly useful as a starting place to model subjects and metrics that align well with the business; and it is valuable throughout the modeling process to prevent losing sight of the "big picture."

WHAT TO MODEL

A typical enterprise has five to seven domains, each related to the mission of the enterprise, the resources used to fulfill the mission, or the allocation of resources to mission objectives.

The illustration on the facing page shows a nonspecific domain model. The arc across the top represents mission-related domains, each of which is a major category of products or services that the enterprise provides to its customers. The lower arc represents resource-related domains. Resource domains are commonly segmented as human, financial, and physical resources, although the particular names may be different and some enterprises may have unique resource domains (i.e., intellectual).

Module 3

Conceptual Modeling

Topic	Page
Modeling Business Subjects	3-2
Gathering Business Questions	3-12
Modeling Facts and Qualifiers	3-20
Modeling Information Flow	3-38

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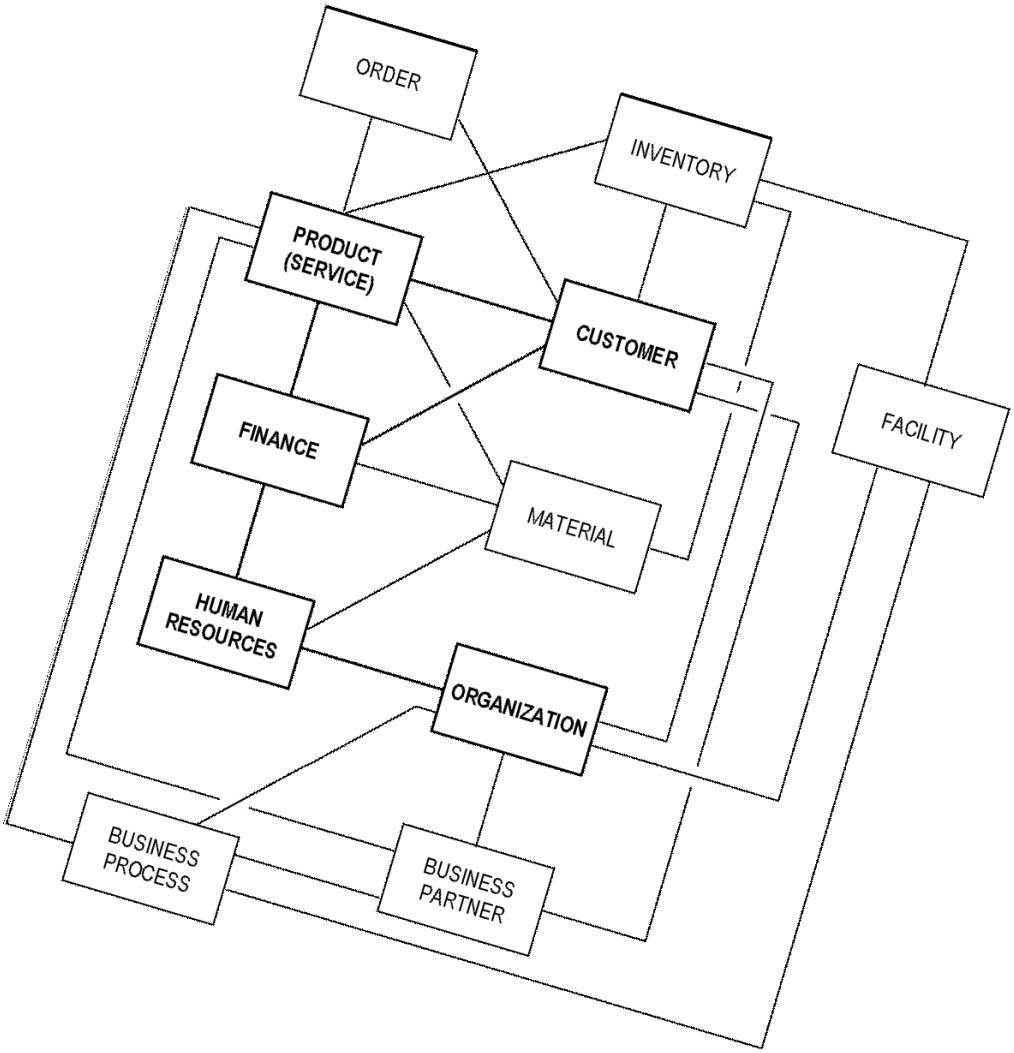
Modeling Business Subjects

The Key to a Subject-Oriented Data Warehouse

Major Business Subject Areas

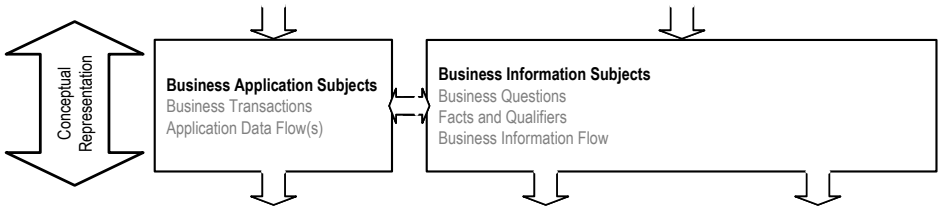


and the Relationships Among Them

Modeling Business Subjects

The Key to a Subject-Oriented Data Warehouse

THE MODELING FRAMEWORK



WHY MODEL

A subject data model represents business data subjects and the major associations among them. A subject is a broad category of things that are of business interest – a classification of a group of things about which data is needed. A data warehouse is by definition subject-oriented. Subject modeling develops the foundation for a data warehouse to take on this fundamental property. Ideally there is a logical correspondence between subject in the warehouse subject model and those found in business transaction systems.

WHAT TO MODEL

A business subject model is an illustration of the high-level subjects of information that are of business interest and the important business associations among those subjects. Ideally, a subject model has these characteristics:

- Information and data are classified into broad categories.
- The subjects are unique and non-overlapping.
- Each subject is of broad interest across the entire business.
- Each subject is described by examples of the kinds of information that it contains.

Modeling Facts and Qualifiers

Refining Data System Requirements

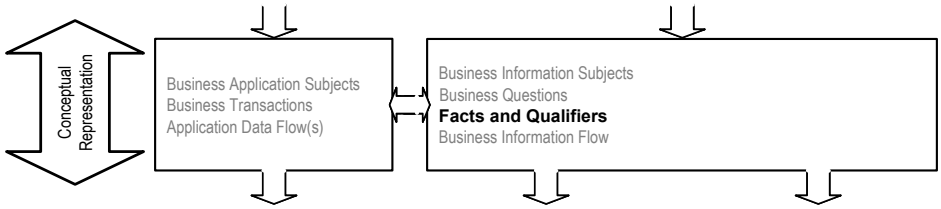
Facts → / *Qualifiers* ↓	customer count	percent of market	customer-id	customer-name	household count	lost customer-id	lost-policy-id	lost-policy-value	claim count	claim settlement lag time	lag time
region	✓	✓	✓	✓							
district	✓	✓	✓	✓							
zone	1,5,7,11	✓	✓	✓		✓					
employee											
location											
customer			✓	✓		17,18	17,18	17,18			
line of business	1,5,7,11, 16	2,8	13,14,15	13,14,15	16	17,18	17,18	17,18	19	20	
product line	✓	✓				✓	✓	✓			
product	✓	2,8				✓	✓	✓			
policy						17,18	17,18	17,18			
cause of claim									19	✓	
year	1,3,5,7,9 ,11	2,8									
quarter	✓	✓									
month	1,3,5,7,9 ,11	2,8									
day											
demographics	3,9	4,10									
policy features	5,11										
coverage group	6,12										
size of claim											
custom...											

Business questions decomposed into constituent parts.
Data items identified by role and usage.

Modeling Facts and Qualifiers

Refining Data System Requirements

THE MODELING FRAMEWORK



WHY MODEL

Fact/qualifier modeling marks the transition from modeling information structures (needs, questions, etc.) to modeling data structures. This model begins to look beyond business questions to the underlying data structures and to translate those questions into implementation-neutral data structures.

WHAT TO MODEL

As business questions are translated into data structures, the modeler seeks to identify:

- Which data is metric (implementing a business measure)?
- In what roles (as facts and/or qualifiers) is each data item used? Note that a single data item may be used in both roles.
- What are the common facts and qualifiers across multiple business questions? This provides the basis for conformed facts and dimensions that are discussed later – those facts and dimensions to which a standard is applied. They share common definitions, and structures across multiple data marts.

Module 4

Logical Modeling and Data Integration

Topic	Page
Enterprise Logical Data Model	4-2
Logical Models of Transaction Systems	4-12
Logical Models of Integrated Data Stores	4-22
Logical Models of Decision Systems	4-28
Data Integration and Master Data Management	4-34

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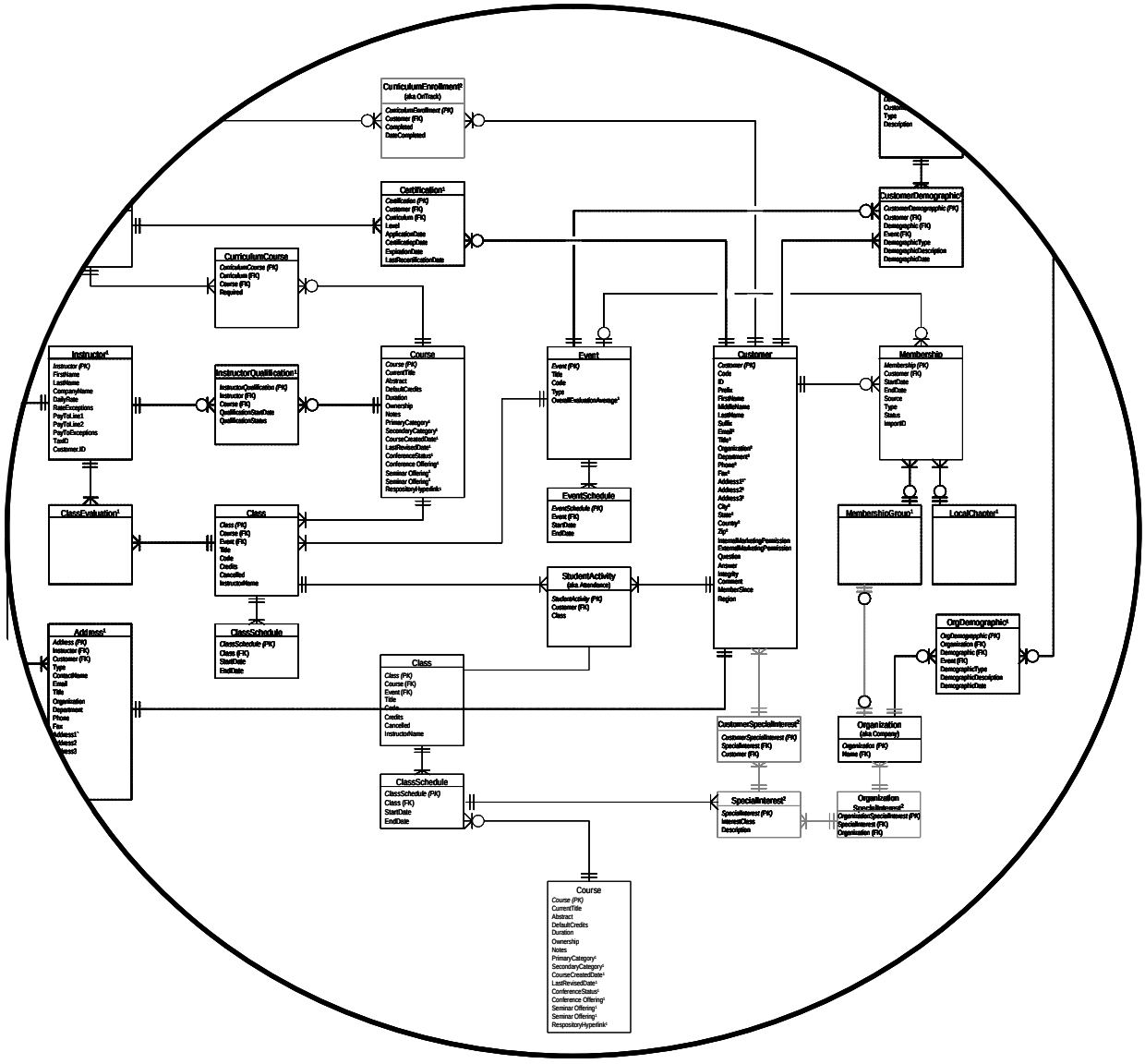
Enterprise Logical Data Model

An Enterprise-Wide Business View



Fully Normalized

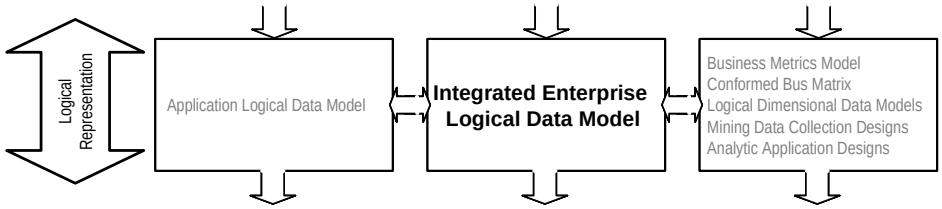
Fully Attributed

360 Degree View of the Business

Enterprise Logical Data Model

An Enterprise-Wide Business View

THE MODELING FRAMEWORK



WHY MODEL

Peter Chen, the creator of entity-relationship modeling, built the technique on a fundamental concept of separating data from process – both business processes and computer system processes. It is this principle of data separation that defines logical data modeling. The logical data model is a business view of data, but not a business process view. At the enterprise level a logical data model provides and enterprise-wide view of all data free of any dependencies. Business process dependency, computer system dependency, application system dependency, and DBMS dependency are all eliminated from this view of the data. The value of an enterprise logical data model for data integration is obvious and immeasurable. An enterprise-wide, business-based view is the ultimate objective of data integration – the concept frequently expressed as "a single version of the truth."

WHAT TO MODEL

This modeling activity produces an entity-relationship model that is:

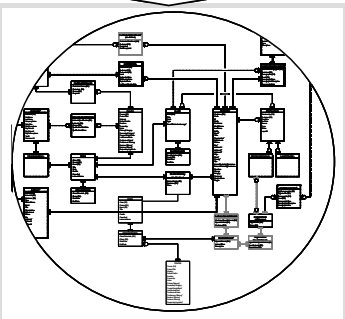
- fully attributed (all attributes are identified for all entities),
- fully normalized (to the 5^{th} normal form without redundancy of attributes and relationships), and
- a three-hundred-sixty degree view of the business (accounting for all business perspectives and stakeholders).

SO WHY DON'T WE MODEL?

If the integration value of an enterprise logical model is so immense, and the drive for integration is so strong throughout business, then why are these models so infrequently found? The difficulty lies in our application and database development history. For most enterprises, both public and private sector, the bulk of the enterprise data is already implemented in transaction systems – implemented redundantly, without consistency, frequently with conflicting business rules, and typically without any logical modeling whatsoever. The magnitude of effort required to resolve this data chaos into a true logical model is the barrier.

Enterprise Logical Data Model

All-at-Once vs. Incremental

All-at-Once		Incremental
Scope is the Enterprise	Define the Scope of Modeling	Scope is determined by project needs
Must involve many people to get the full enterprise view	Identify, Name, and Describe Entities	Must have strong data administration and data governance to ensure enterprise compatibility
Takes a long time to produce results	Identify, Name & Describe Relationships	Multiple, simultaneous projects are challenging
Value to projects is limited and unclear … often too late to meet project needs	Identify, Name, and Describe Attributes	Easily distorted and error-prone with bias to project-specific needs
	Identify, Name, and Describe Specialization/Generalization	
Needs enterprise-wide data definitions with business consensus	Fully Normalize the Data Model	Full normalization is critical
Difficult to keep current		Never complete
Not synchronized with or mapped to the data implemented by projects		Can't fully achieve a 360 degree view of the business

Enterprise Logical Data Model

All-at-Once vs. Incremental

TO MODEL OR NOT TO MODEL?

The diagram on the facing page contrasts all-at-once and incremental approaches to building an enterprise logical data model. Clearly neither approach is perfect. Yet they are the only alternatives available, except that of continuing without an enterprise logical model. It is a difficult choice. Integration is challenging without this model, but creating the model may prove to be equally demanding.

TOP-DOWN vs. BOTTOM-UP

Another consideration in the "to model or not to model" decision is that of top-down and bottom-up approaches. Top-down modeling works independently of existing data and applications to develop the model from a pure business perspective. Bottom-up modeling examines implemented data to reverse-engineer a best-guess business view. Both of these techniques can work well with the incremental approach.

Any project that is developing a new business application from scratch must perform data analysis and design activities. During the analysis phase developing a process-independent view is a useful activity and not a particular burden to the project. A top-down approach here is effective to produce an increment of the enterprise logical data model.

Any project that must examine data already implemented to meet its objectives – data warehousing projects, data conversion projects, etc. – must perform most of the hard work of bottom-up modeling. They may provide opportunity to incrementally add to the enterprise model with a small amount of additional effort.

UNIVERSAL DATA MODELS

Universal data models – those that apply to a specific industry or that apply across multiple industries – are valuable when performing bottom-up modeling. They remove some of the guesswork from creating the "best guess" representation. Two books are recommended here:

- *The Data Model Resource Book, Vol. 1: A Library of Universal Data Models for All Enterprises* by Len Silverston
- *The Data Model Resource Book, Vol. 2: A Library of Universal Data Models for Specific Industries* by Len Silverston

Also helpful (but more abstract and less "ready-to-wear") is *Data Model Patterns: Conventions of Thought* by David C. Hay.

Module 5

Logical Modeling and Business Analytics

Topic	Page
Modeling Business Metrics	5-2
Conforming Business Dimensions	5-12
Logical Dimensional Modeling	5-14
Data Design for Analytic Systems	5-32
Analytic Systems and Master Data Management	5-34

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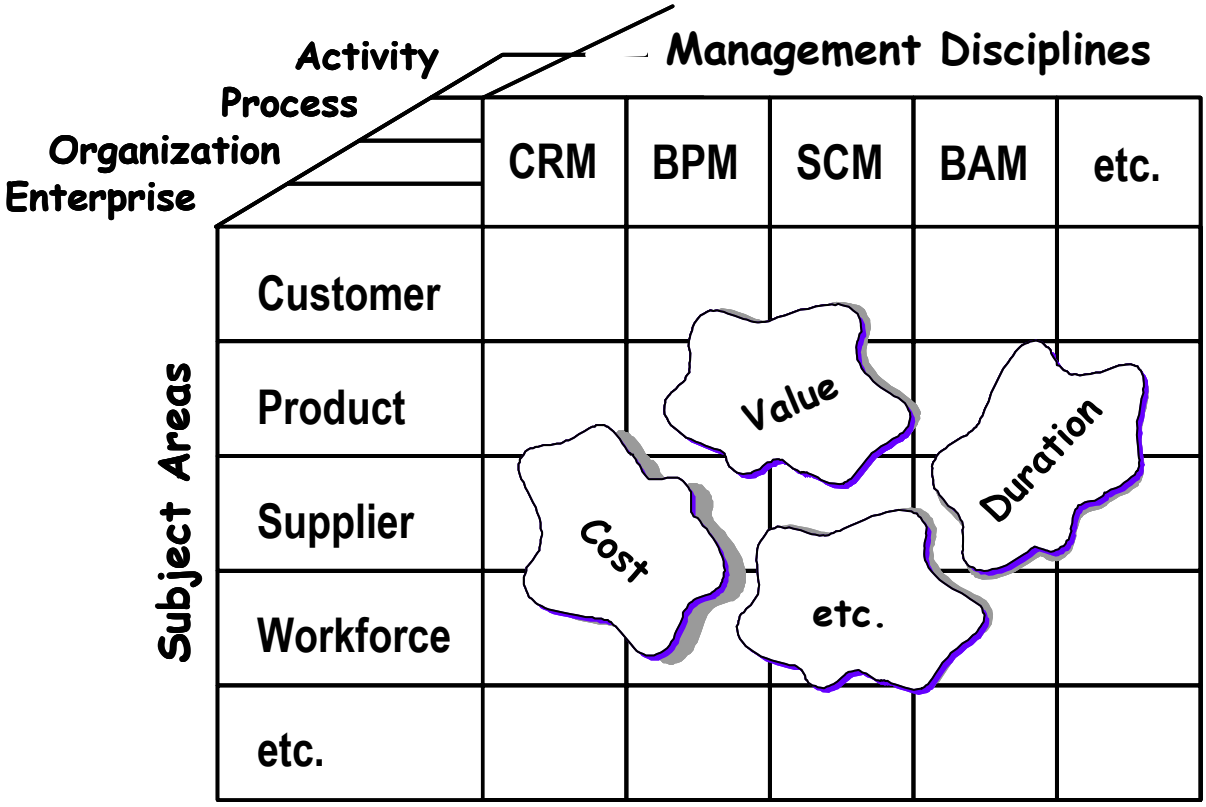
Modeling Business Metrics

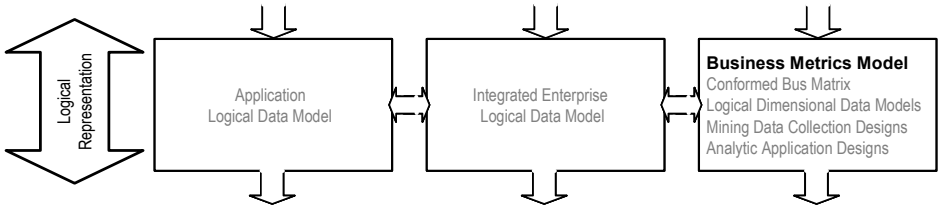
Business Measures



Modeling Business Metrics

Business Measures

THE MODELING FRAMEWORK



WHY MODEL

Measurement-based disciplines have become central to management of business. BPM, SCM, CRM and more take business-by-the-numbers to a new level. Technology enables the trend with performance scorecards and dashboards. But with these technologies comes the risk of new integration problems – disintegration of business analytics. How do we prevent the customer measures of CRM from conflicting with those of SCM? How do we achieve consistency, cohesion, and integration among metrics?

If we've learned anything from the past we will start with a business view and enterprise perspective. But what really happens when we model business measures? Most of us start with a star-schema goal – not because we don't want a better way, but because it is the only thing that is widely known and accepted. Go to the internet and Google the phrase "business metrics model." As of this writing, very few hits contain all three words; and those are simply coincidental use of the terms, not information about modeling of business metrics.

This section of the course is new modeling discipline. The need exists yet remains unfulfilled. So with this course TDWI puts forth the industry's first enterprise business metrics modeling technique. Is it complete? Probably not. Is it perfect? Certainly not. Will it change? Absolutely! We expect it to grow and evolve with practice. So let's get started. Learn it. Practice it. Evolve it. Integrate metrics from the beginning and avoid building today's analytic systems as tomorrow's legacy problems.

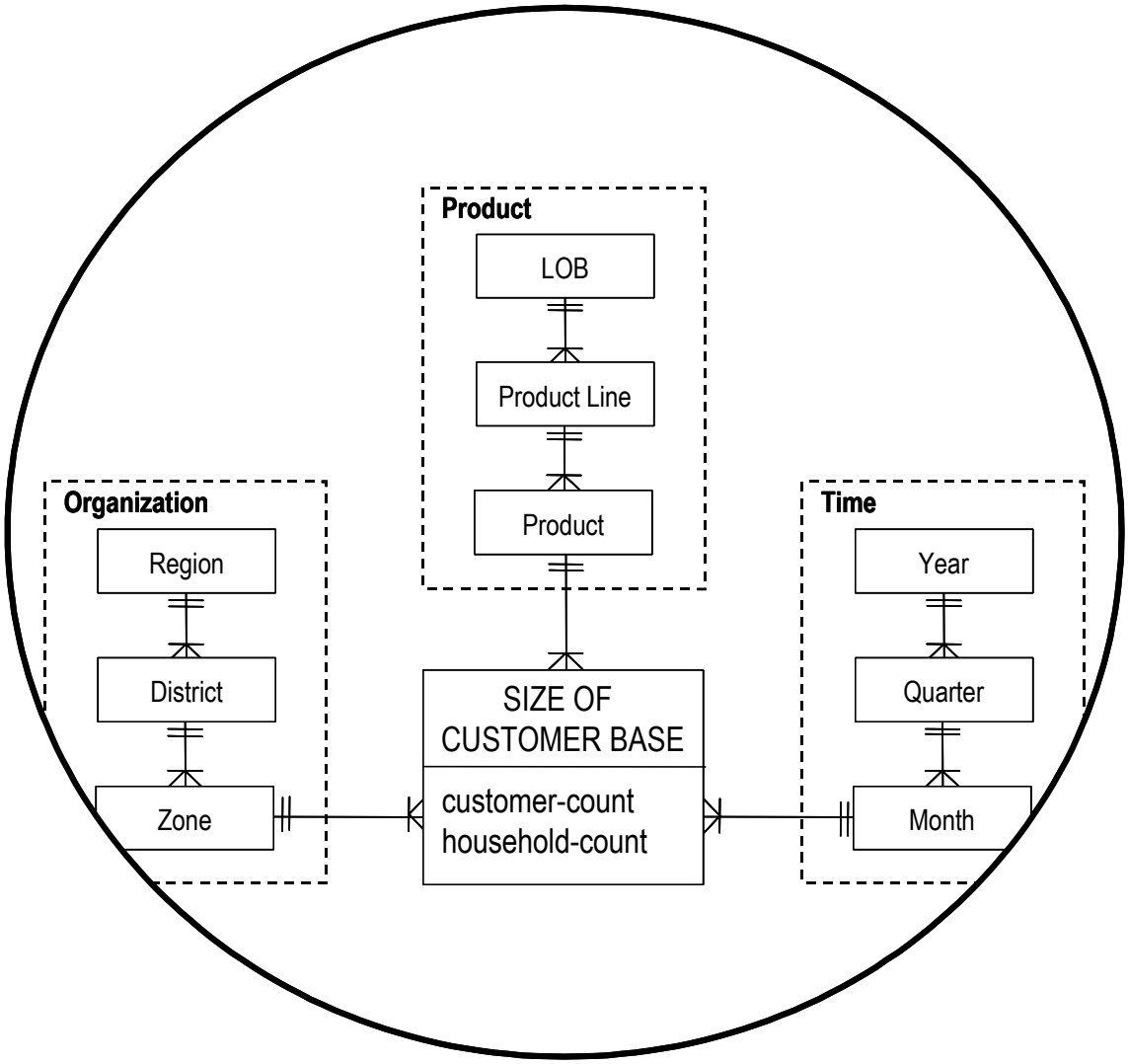
WHAT TO MODEL

This modeling activity produces a catalog of implemented and desired business metrics with consistency of description and classification for all metrics. The catalog supports multiple dimensions to organize metrics by

- community of interest (enterprise, organization, process, etc.)
- business domain (mission or resource domain)
- external drivers (economic, social, political, technological)
- internal perspectives (finance, customer, process, people)
- management discipline (BPM, CRM, SCM, etc.)
- subject of measurement (customer, product, supplier, etc.)

Logical Dimensional Modeling

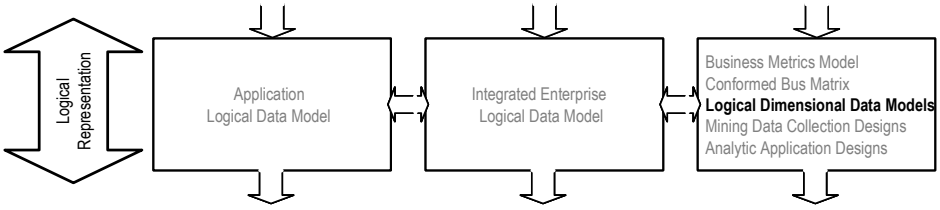
Data Structure of Business Metrics



Logical Dimensional Modeling

Data Structure of Business Metrics

THE MODELING FRAMEWORK



WHY MODEL

Logical dimensional modeling organizes business metrics as data structures. The logical model is a process-independent business view of metrics that identifies the measures needed to support a metric and the dimensions necessary to give context and meaning to the measures. Logical dimensional modeling is the predecessor to star-schema design.

WHAT TO MODEL

This modeling activity produces logical dimensional data model that includes:

- A **Meter** that contains related **measures** of business interest. Each logical dimensional model has only one meter.
- **Dimensions** that provide the means to select, sort, filter and summarize business measures.
- **Dimension Levels** to describe the business subjects or entities that exist within dimensions.
- **Dimension Attributes**, which include identifiers and descriptive data about dimension levels.
- **Associations within a dimension**, which describe the dimension hierarchy and are represented as one-to-many relationships from one dimension level to.
- **Dimension to meter associations** that are represented as one-to-many relationships from the lowest level of each dimension to the meter.

Module 6

Structural Modeling

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Data Structure in Transaction Systems	6-2
Structural Modeling and Data Integration	6-4
Normalization	6-6
Time-Variant Data Structures	6-12
Access, Navigation, Security, and Distribution	6-20
Structural Modeling and Business Analytics	6-26
Star-Schema Design	6-28
Analytic Application Data Structures	6-44
Data Mining Data Structures	6-46

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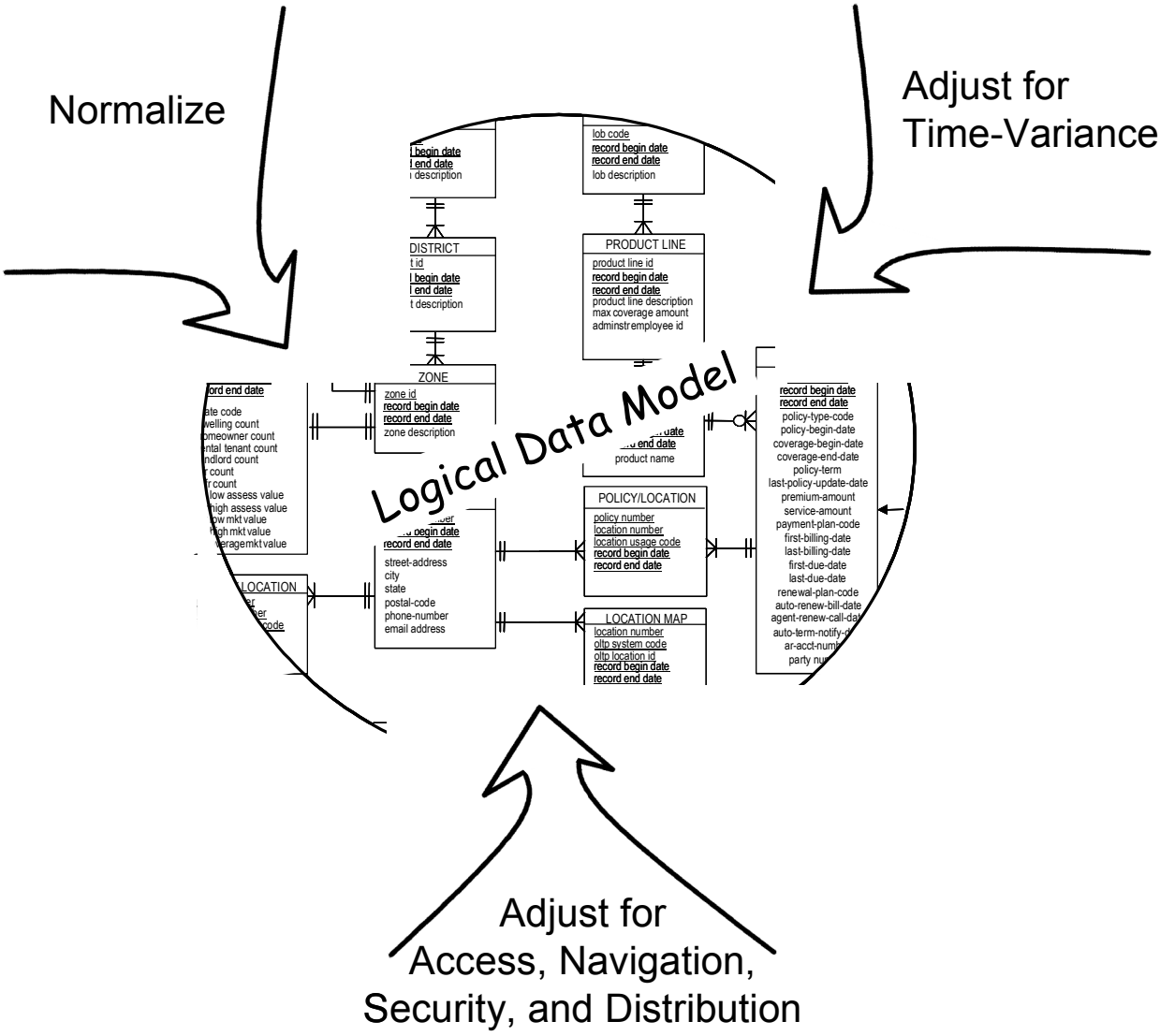
Structural Modeling and Data Integration

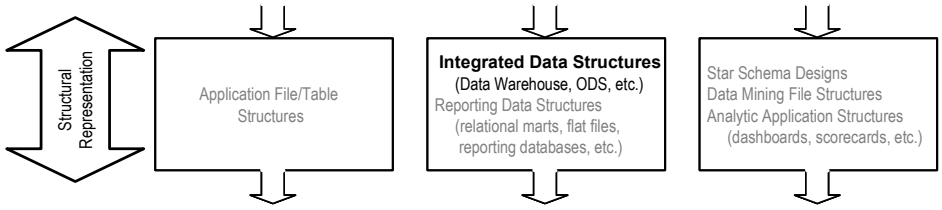
From Business Models to Technology Models



Structural Modeling and Data Integration

From Business Models to Technology Models

MODELING FRAMEWORK



WHY MODEL

The logical data model for the data warehouse or ODS is a business-oriented model. It is a business system design that is free of data system dependencies. Those dependencies, however, must be recognized and resolved before physical design and implementation occur. That is the role of structural modeling.

WHAT TO MODEL

Information systems dependencies occur in warehouse and ODS data for a two primary reasons:

- Time-variance is a defining characteristic of both the data warehouse and the ODS.
- Access, navigation, and security requirements are significant influences on warehouse and ODS implementation.

Both reasons are cause to compromise the rules of normalization when moving from logical design toward physical design and implementation. Although best-practice logical models are normalized to a defined level, normalization is also a structural design issue for several reasons. It is important to ensure that the logical model is in the desired form. It is equally important to understand where and why that model deviates from the third normal form. This understanding is essential foundation before further compromises of normalization rules can be made with confidence.

WHEN TO MODEL

Develop structural models following logical modeling and prior to physical design. Many modelers consider structural modeling to be the first step of physical design.

HOW TO MODEL

Who: This is a job for data modelers and the development team.
Inputs: The logical data model is the primary input. Knowledge of how the data warehouse or ODS will be used is also important.
Outputs: This process produces an entity-relationship model that is adapted to the requirements of time-variance, access, navigation, and security. It is frequently considered to be the first-cut physical model.
Activities: The activities of adjusting form time, access, navigation, and security are discussed in greater detail on the following pages.

Module 7

Physical Modeling and Implementation

Topic	Page
Physical Design Overview	7-2
Some Optimization Techniques	7-4
Physical Design and Implementation	7-16

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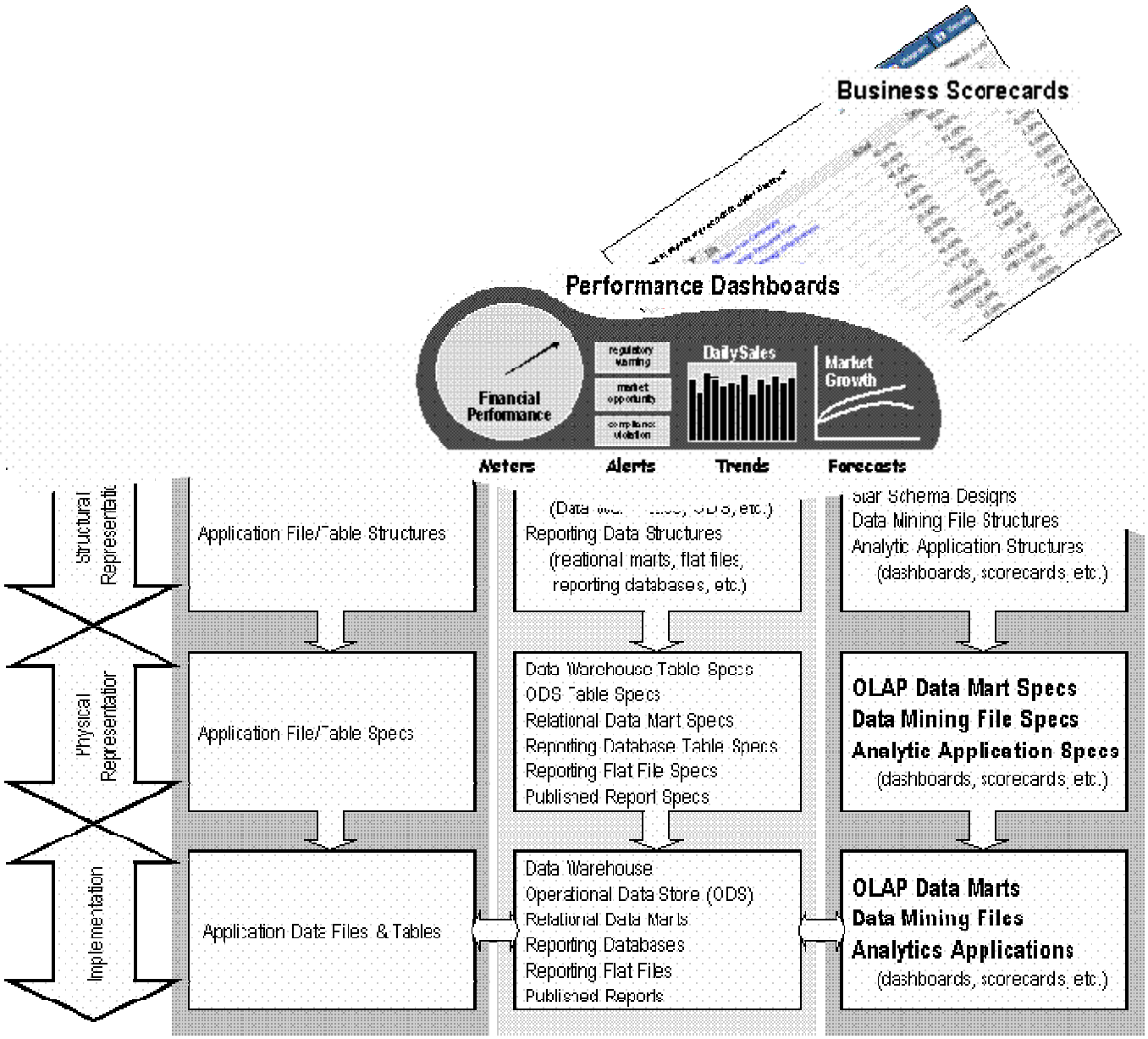
Physical Design and Implementation

Implementing Business Analytics



Physical Design and Implementation

Implementing Business Analytics

PHYSICAL DESIGN FOR ANALYTICS

As with logical and structural design, physical design of dashboards, scorecards, and analytic applications is not yet a mature discipline. Deployment of analytics is highly dependent upon selected technology, so the physical design must align with that technology. Optimization issues and techniques vary widely depending on the vendor and tools being used. Following tool vendor guidance for physical design is advised.

DEPLOYING DASHBOARDS

Some BI technology vendors offer dashboards that can be purchased and customized to the specific goals and KPIs of a business. Alternatively, the dashboard can be a custom product developed by the IT department using metric data management and visualization technologies.

Where multiple analytic tools and applications have been deployed in a non-integrated form, a dashboard may prove to be a useful portal to a variety of analytic information and metrics. A portal of this type may drive standardization of business metrics and consistency of analytic applications across the organization.

DEPLOYING SCORECARDS

Several product vendors offer scorecard products[1] but technology does not make a scorecard culture. Business-driven, top-down development that addresses training, standards, strategies, goals, metrics, targets, systems, and data collection is essential to successful scorecard deployment. Sustained effort, patience, and leadership are necessary to adopt the disciplines of scorecard management and to become a scorecard culture. Deployment of scorecards is relatively simple. Value from scorecards depends on the higher levels of design and analysis as well as the organizational culture in which they are implemented.

[1] At this writing scorecard vendors include Cognos, Hyperion, Peoplesoft, SAP, and SAS.

DEPLOYING ANALYTIC APPS

Analytic applications can be delivered in any of there ways: (1) purchase an application, (2) build from a vendor-supplied template, or (3) build from scratch. At this writing, the range of purchased applications is limited, they may not meet business needs, and the underlying data warehouse must be populated. Some vendors offer greater range and adaptability with templates to build applications customized to the domains, metrics, and data sources of your business. Building from scratch offers the greatest flexibility, but the technology is relatively new and cost and effort to custom build may be prohibitive.

Appendix A

Entity-Relationship Modeling Basics

Topic	Page
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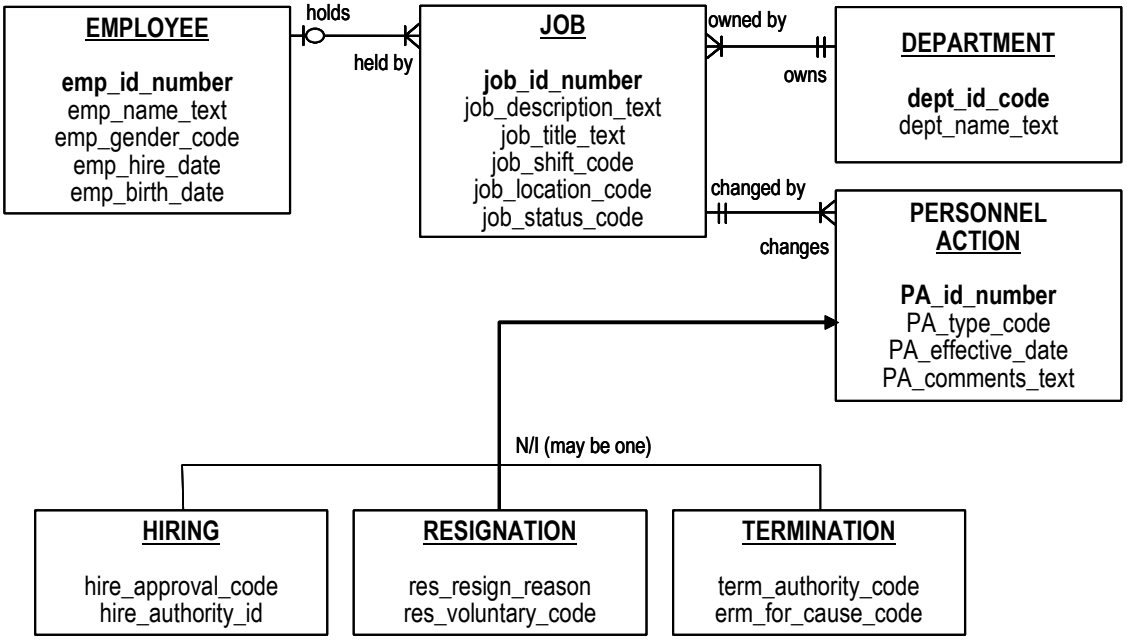
Reading E/R Models

E/R Models for Communication



what the model says

about the entities

- EMPLOYEE, JOB, DEPARTMENT and PERSONNEL ACTION are the entities of interest in this data modeling domain.
- PERSONNEL ACTIONs include HIRING, RESIGNATION, and TERMINATION, each of which has some unique data characteristics.

about the relationships

- One EMPLOYEE performs one or more JOBs.
- One JOB is held by zero or one EMPLOYEEs.
- One JOB is owned by one and only one DEPARTMENT.
- One DEPARTMENT owns many JOBs.
- One JOB is changed by one or more PERSONNEL ACTIONs.
- One PERSONNEL ACTION changes exactly one JOB.

about the attributes

- EMPLOYEES are identified by emp-id-number.
- JOBs are identified by job_id_number.
- DEPARTMENTs are identified by dept_id_code.
- PERSONNEL ACTIONs are identified by PA_id_number.
- Each entity type has several other attributes of interest.

about the attributes

- HIRING, RESIGNATION, and TERMINATION are mutually exclusive kinds of PERSONNEL ACTIONs.
- Each has attributes different from the other sub-types.
- Other kinds of PERSONNEL ACTIONs may exist.

Reading E/R Models

E/R Models for Communication

READING THE MODEL

One purpose of an E/R model is communication. The essence of the model can be expressed as two simple sentences for each relationship, including cardinality, along with the associated entities. For example, from the model on the facing page:

- One *Employee* holds one or more *Jobs*.
- One *Job* is held by zero or one *Employee*(s).

Minimum model validation requires that each of these statements be affirmed by the business as correct business rules.

As shown at the bottom of the facing page, there is much information about data and business rules contained in a relatively small data model.

Appendix B

State Transition Modeling

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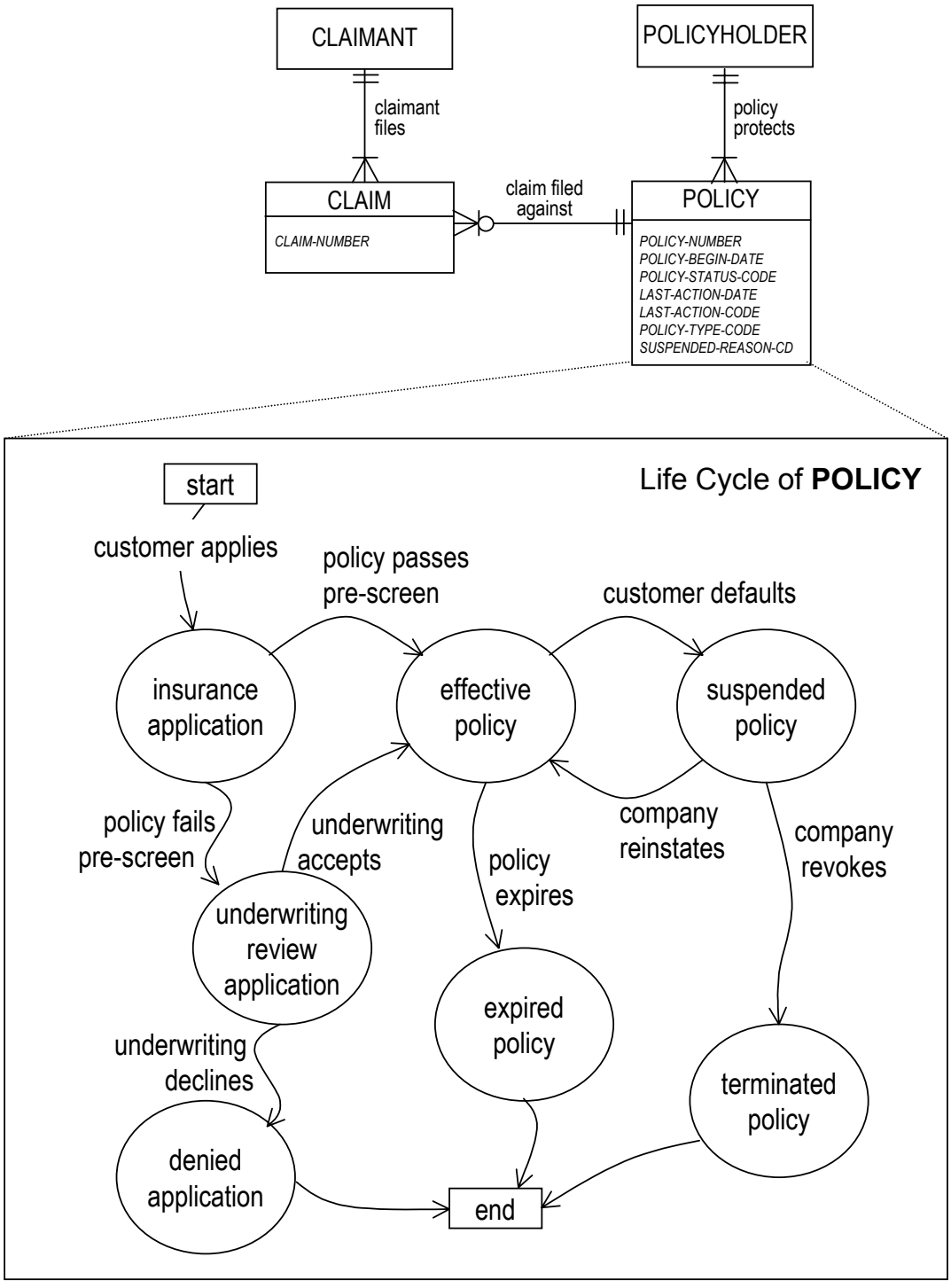
Introduction to State Transition Modeling

Model Example



Introduction to State Transition Modeling

Model Example

LIFE OF A POLICY

The facing page shows an example of a state transition diagram that illustrates the business life cycle of a policy. Note that the POLICY entity in the E-R diagram has several indicators that it may be a state-dependent entity:

- Status codes, dates, and reasons may indicate state-dependency.
- Action codes, dates, and reasons may indicate state-dependency.
- Attributes with 'verb form' names (e.g., "suspended") may indicate state-dependency.

The state transition diagram illustrates the following:

- A policy first becomes of interest to the business as an *insurance application.*
- Policies (or applications) may exist in any of seven states throughout their business life cycle.
- *Denied applications*, *expired policies*, and *terminated policies* have reached the end of their life cycle.

Appendix C

TDWICo Case Study - Basis of Course Examples

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TDWICo (Thomann, Duncan, & Wells Insurance Co.)

Case Study

Company Overview

TDWICo is a mutual insurance company that does business in the western USA. The company has divided its area into 2 regions, the Northwest and the Southwest. The company sells three separate lines of insurance: automobile, residential and life. It has been very successful through the years when competing with the large national firms, because it has specialized in customizing products to each of the regions and the states within those regions where it does business. Localization and customization have provided TDWICo with a distinct advantage. The laws were similar across the states, but each state had local variations. TDWICo, with its local focus, understood the regulatory environment in the regions better than the national firms.

TDWICo got its start selling automobile insurance. As it grew, it added residential insurance. Life insurance was added when the TDWICo acquired another company in its regions specializing in life insurance. It has kept each of the product lines separate and distinct. Some of the separation was due to the structure of the state laws in the regions, and some was due to the way that new lines of business were started.

Until recently, the company only had a very small sales force of its own. The main outlet for its products has been independent agencies.

Current Situation

Over the past five years, the competitive environment in the regions has changed rapidly and dramatically. The large national companies are gaining market share and TDWICo is losing its advantageous position. As the regional economies have grown, the insurance industry has experienced a corresponding change in customer needs. There have been demands for new and integrated products, price discounts for customers with multiple policies, and more. The national companies are better positioned to respond to these changes.

Restructuring of banking and insurance laws at the national level is also changing the nature of the insurance business throughout the regions where TDWICo operates. Congress has nationalized the regulations, blurred the distinctions between banks and insurance companies, and forced changes to insurance regulations at the state level. This has not only taken away one of TDWICo's prior advantages, but has introduced banks as new competitors in the marketplace. The large money center banks have been the leaders both in creating customer demand for one-stop-shopping for all financial products and services, and in providing a set of products and services to meet that demand.

Technology is also changing the way that successful insurance companies do business. The growth of electronic commerce and the World Wide Web is opening up new possibilities, and TDWICo is losing market share to companies that are using these technologies to improve customer care services.

Appendix D

Exercises

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Exercise Two

Modeling Business Subjects