Chapter 2:
The Database Development Process

Modern Database Management

8th Edition

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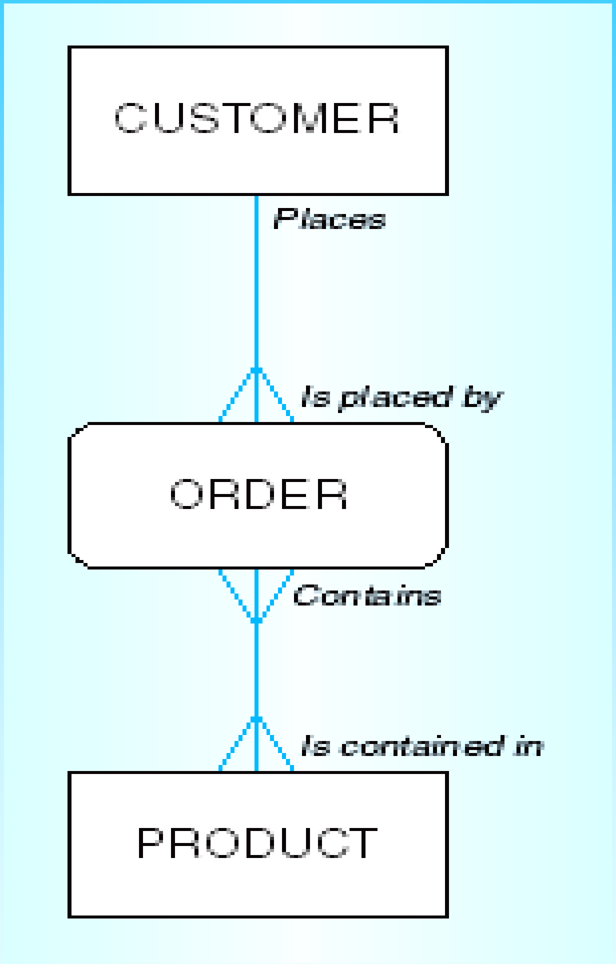
Objectives

- Definition of terms
- Describe system development life cycle
- Explain prototyping 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

Figure 2-1 Segment from enterprise data model



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) the important one
  - Processes – data flow diagrams DFD, process decomposition, etc.
  - Data Network–topology diagram (like Fig 1-9)
  - People–people management using project management tools (Gantt charts, etc.)
  - Events and points in time (when processes are performed, e.g. state transition diagram)
  - Reasons for events and rules (e.g., decision tables)

Information Engineering

start with data in this type of models

- 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***

Information Systems Planning (Table 2-1)

1. Purpose –align information technology with organization's business strategies
2. Three steps:
   1. Identify strategic planning factors
   2. Identify corporate planning objects
   3. Develop enterprise model

Identify Strategic Planning Factors (Table 2-2)

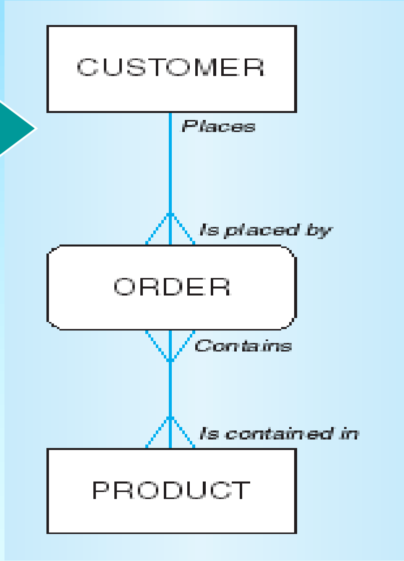
- Organization goals –what we hope to accomplish (10% per year growth)
- Critical success factors –what MUST work in order for us to survive (high quality product, on-time delivery, raise productivity of employees)
- Problem areas –weaknesses we now have (inaccurate sales forecasts, competitions)

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

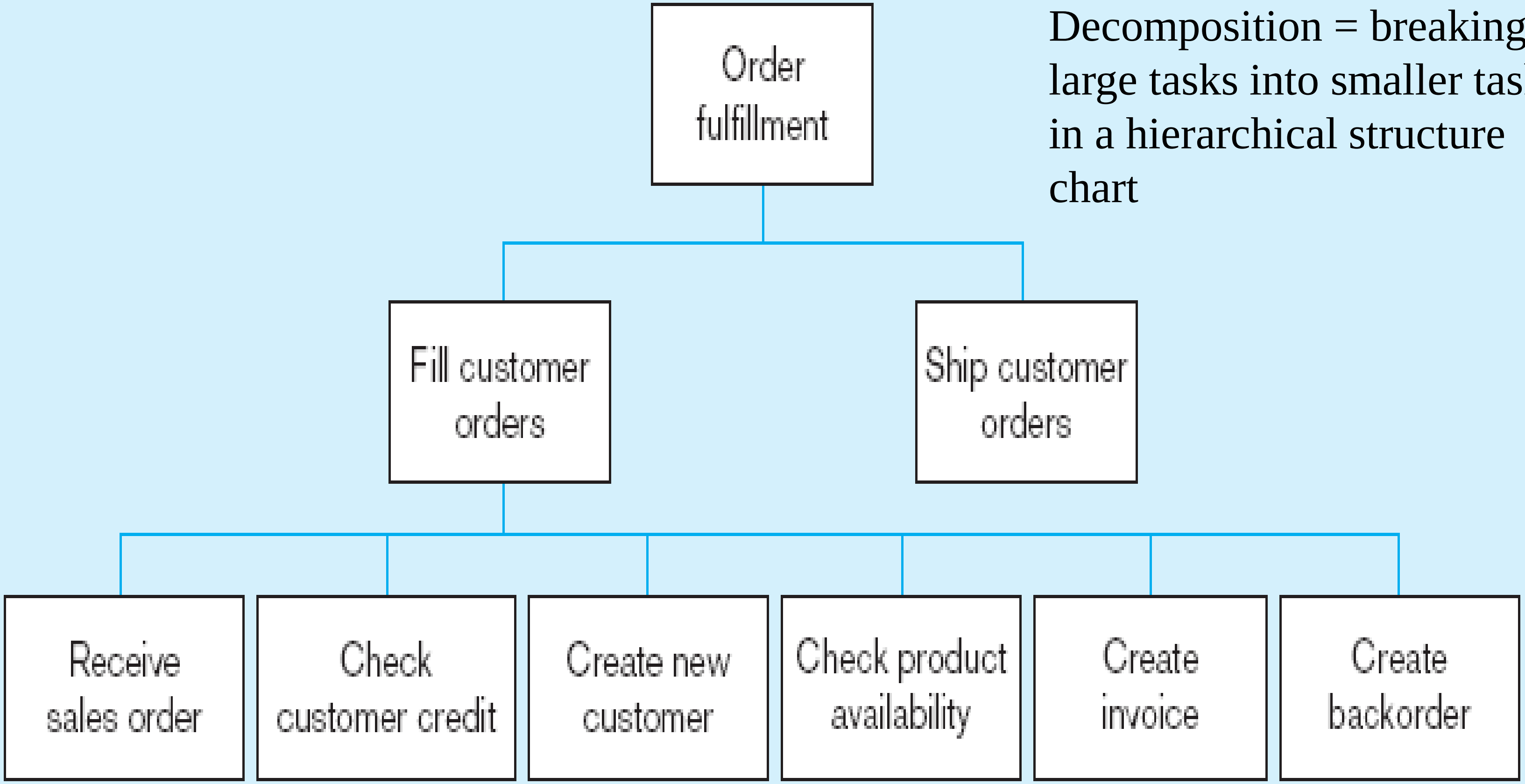
Develop Enterprise Model

- 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 of process decomposition of an order fulfillment function (Pine Valley Furniture)



Decomposition = breaking large tasks into smaller tasks in a hierarchical structure chart

Planning Matrixes

- Describe relationships between planning objects in the organization
- Types of matrixes:
  - Function-to-data entity the only important one
  - 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)

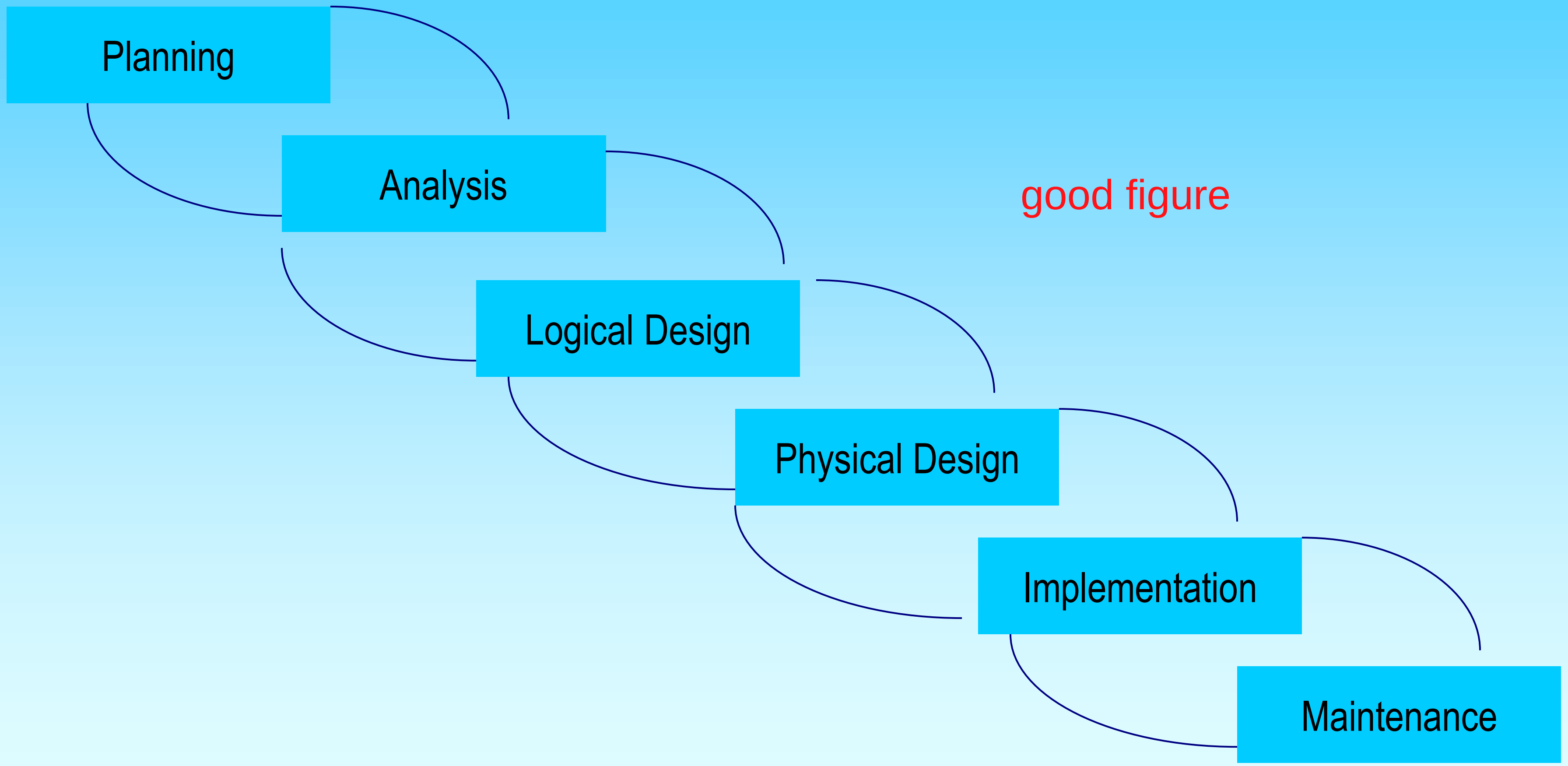
Business Functions \ Data Entity Types	Customer	Product	Raw Material	Order	Work Center	Work Order	Invoice	Equipment	Employee
Business Planning	X	X						X	X
Product Development		X	X		X			X	
Materials Management		X	X	X	X	X		X	
Order Fulfillment	X	X	X	X	X	X	X	X	X
Order Shipment	X	X		X	X		X		X
Sales Summarization	X	X		X			X		X
Production Operations		X	X	X	X	X		X	X
Finance and Accounting	X	X	X	X	X		X	X	X

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)



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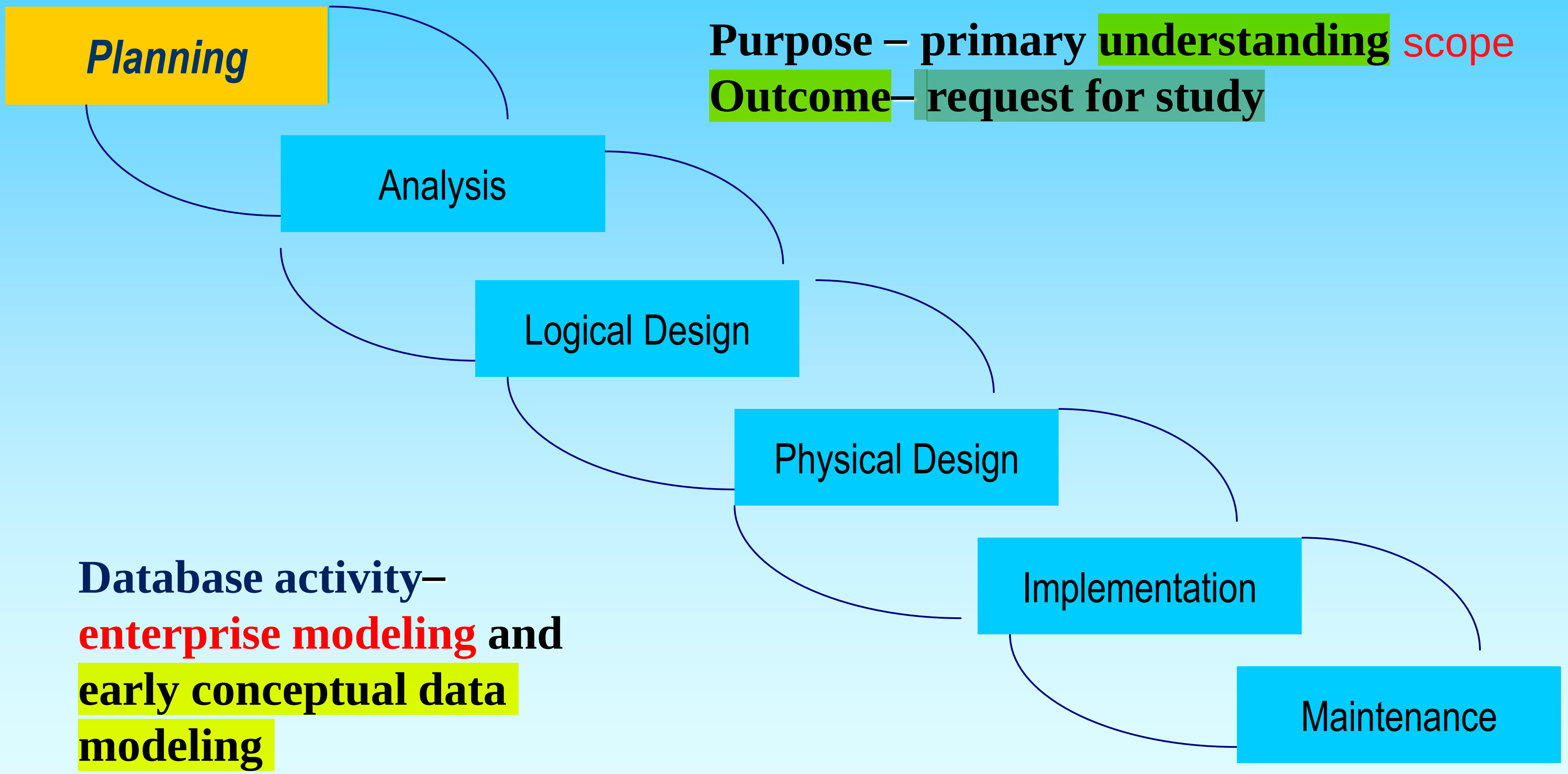
Systems Development Life Cycle (see also Figures 2.4, 2.5) (cont.)



Purpose – primary understanding scope

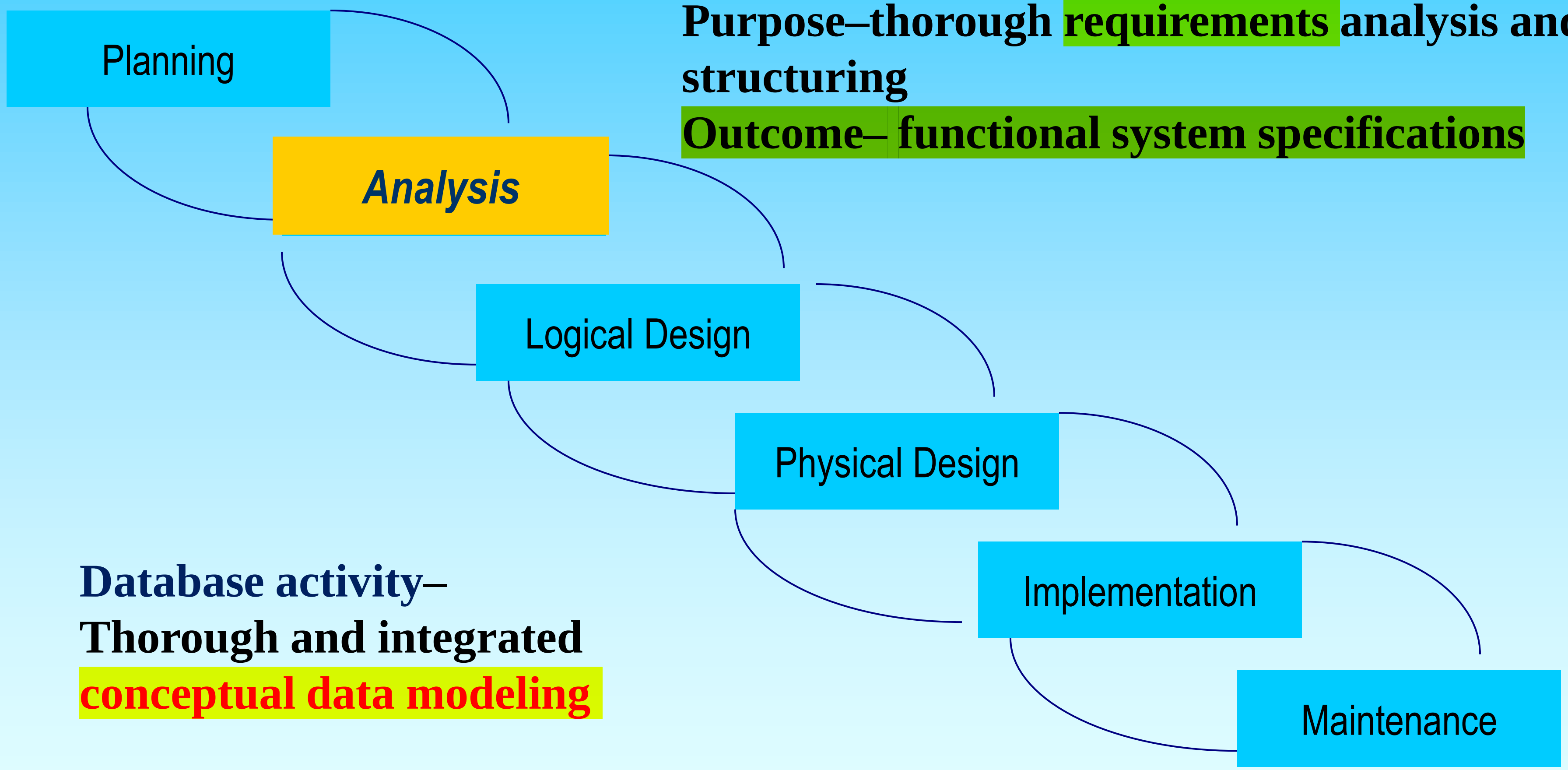
Outcome– request for study

Database activity– enterprise modeling and early conceptual data modeling

Systems Development Life Cycle (see also Figures 2.4, 2.5) (cont.)

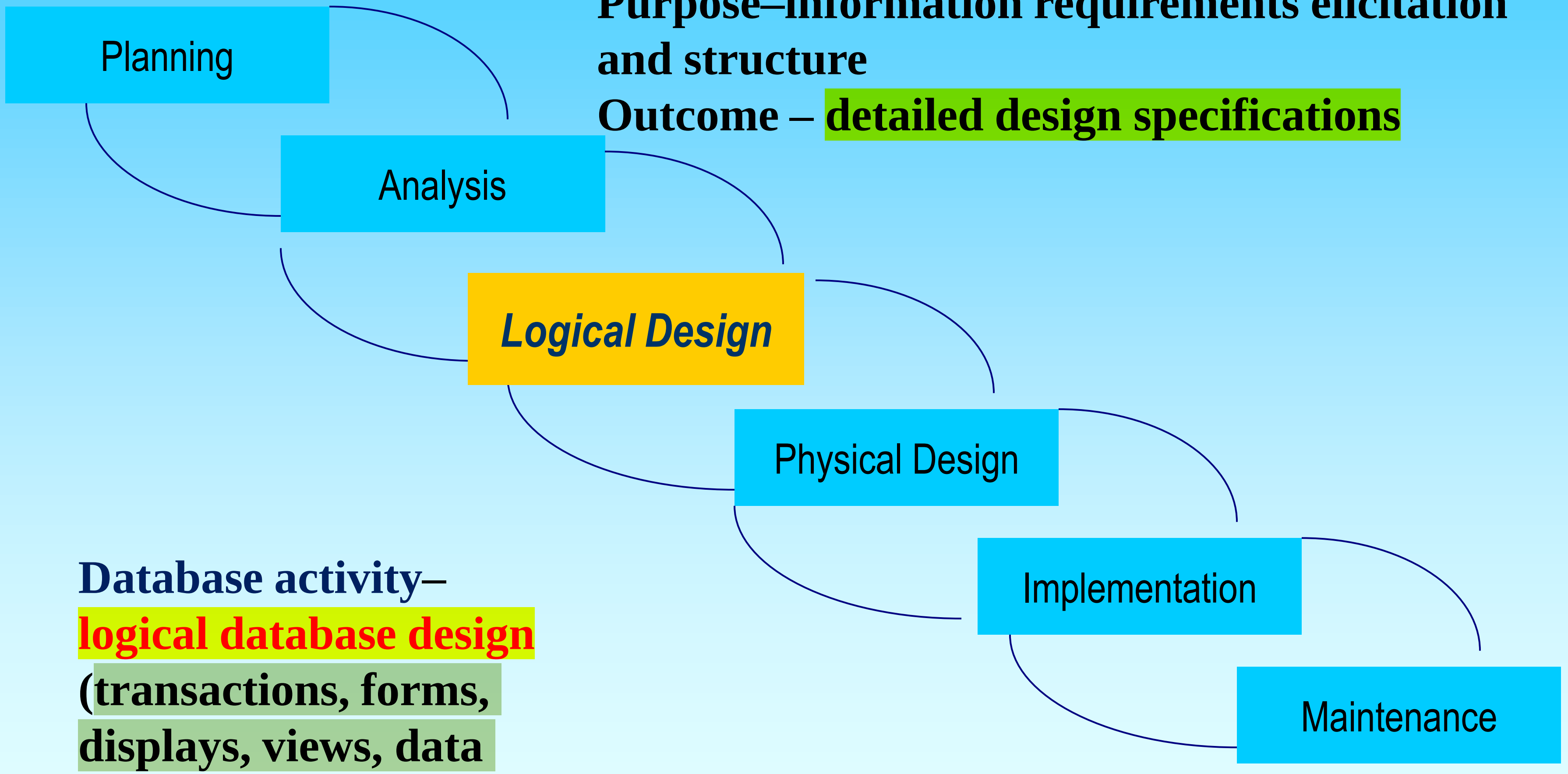
Purpose–thorough requirements analysis and structuring

Outcome– functional system specifications



Database activity–
Thorough and integrated conceptual data modeling

Systems Development Life Cycle (see also Figures 2.4, 2.5) (cont.)

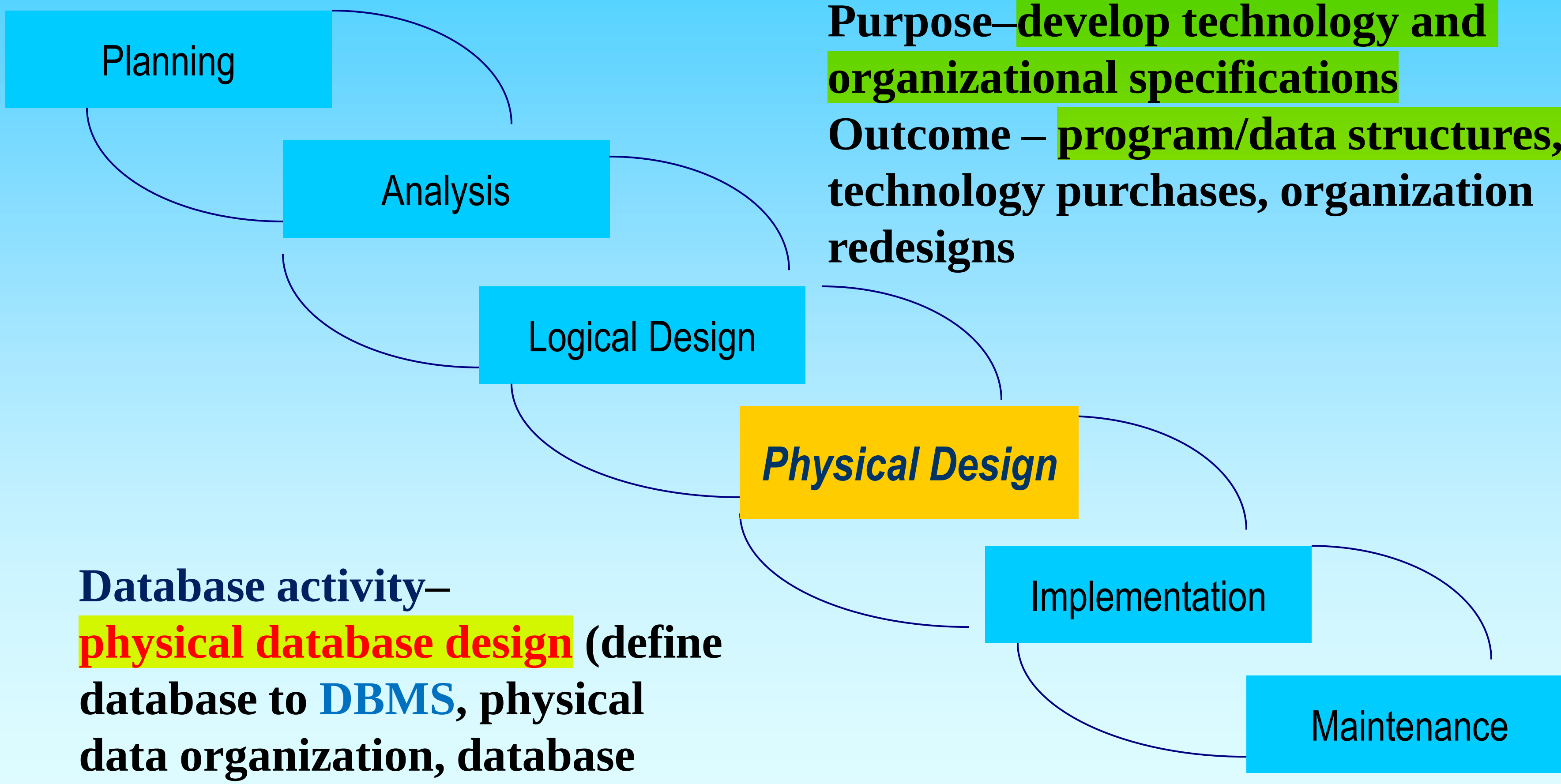


Purpose–information requirements elicitation and structure

Outcome – 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.)

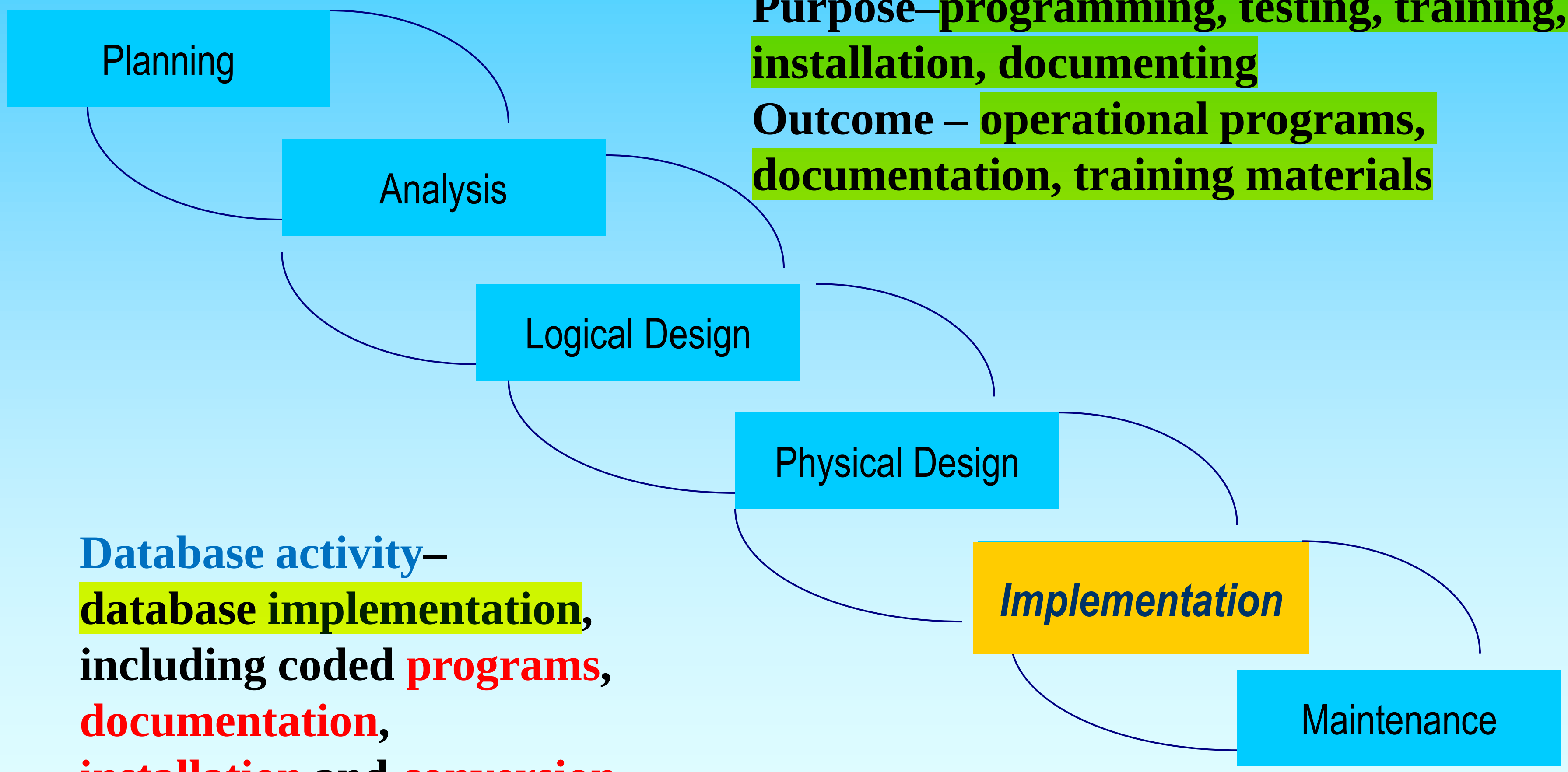


Purpose–develop technology and organizational specifications

Outcome – program/data structures, technology purchases, organization redesigns

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

Systems Development Life Cycle (see also Figures 2.4, 2.5) (cont.)

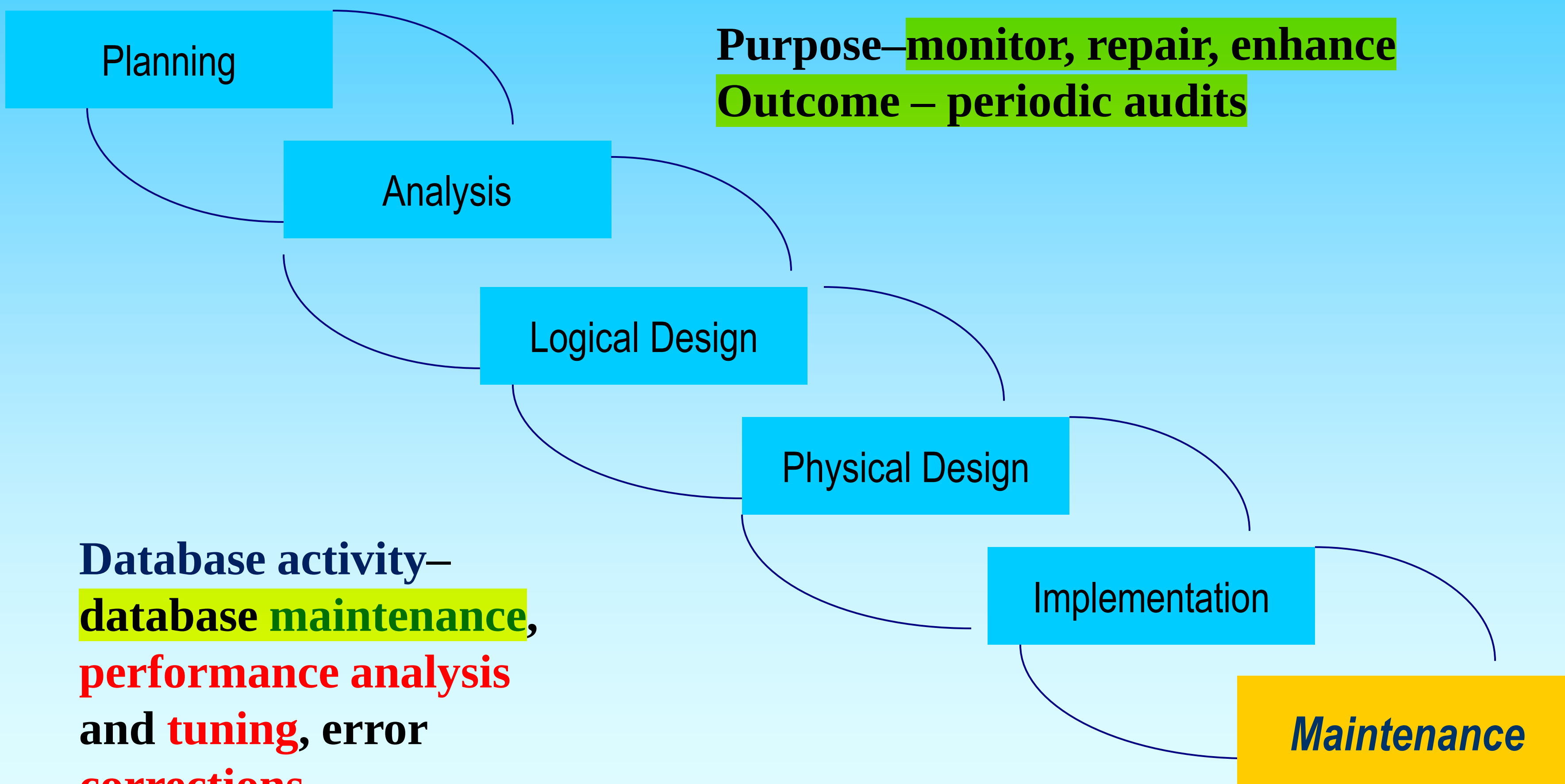


Purpose–programming, testing, training, installation, documenting

Outcome – 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.)

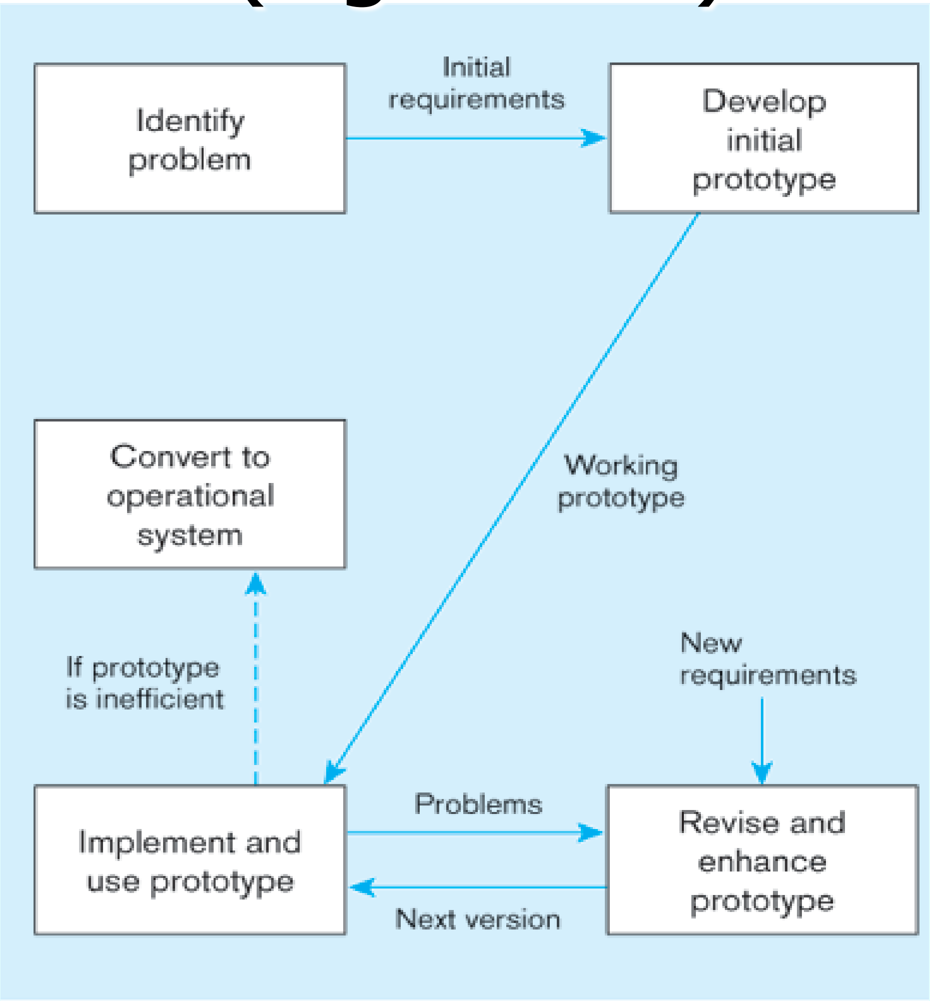


Purpose–monitor, repair, enhance

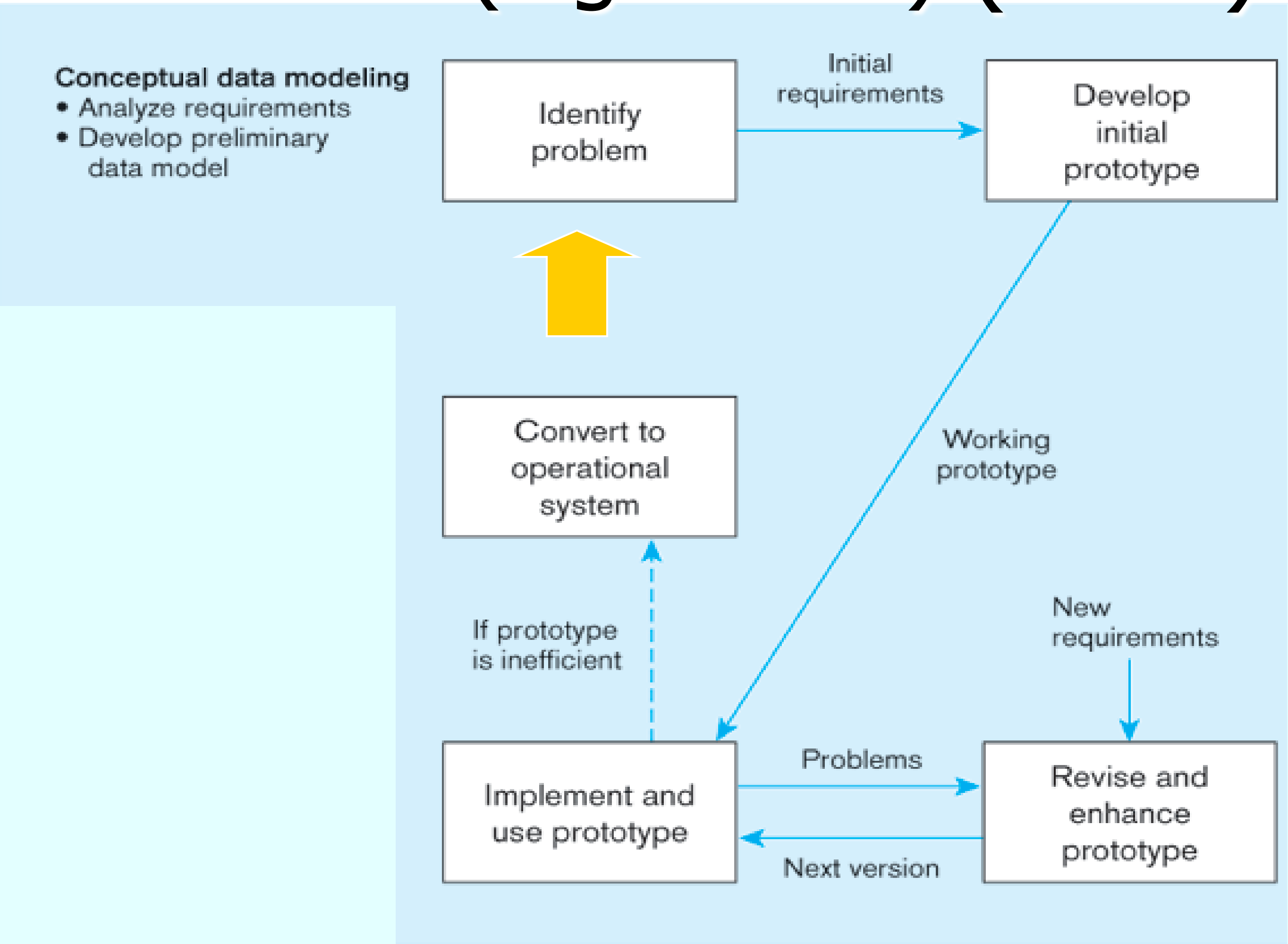
Outcome – periodic audits

Database activity–
database maintenance, performance analysis and tuning, error corrections

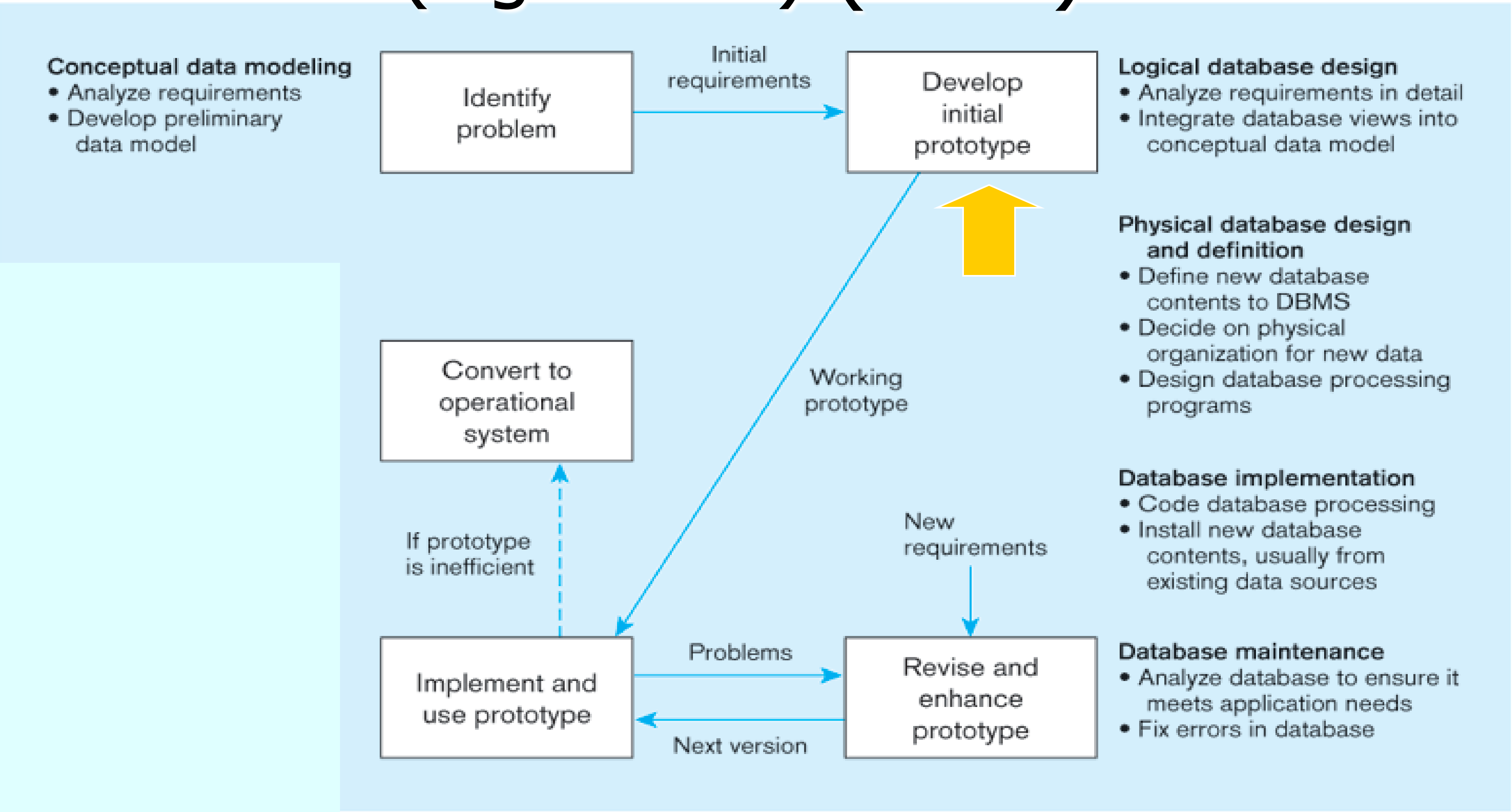
Prototyping Database Methodology (Figure 2.6)



Prototyping Database Methodology (Figure 2.6) (cont.)



Prototyping Database Methodology (Figure 2.6) (cont.)



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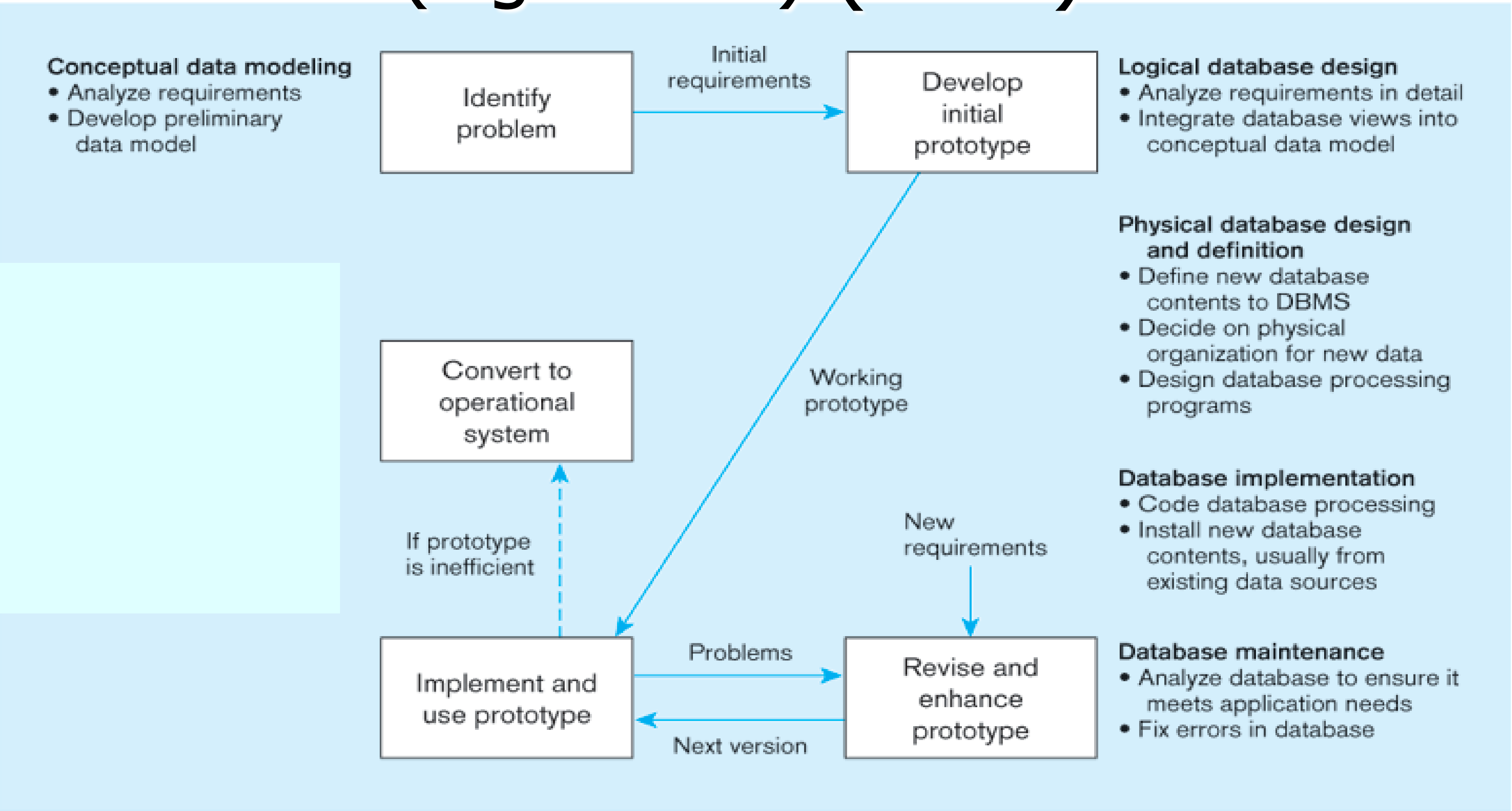
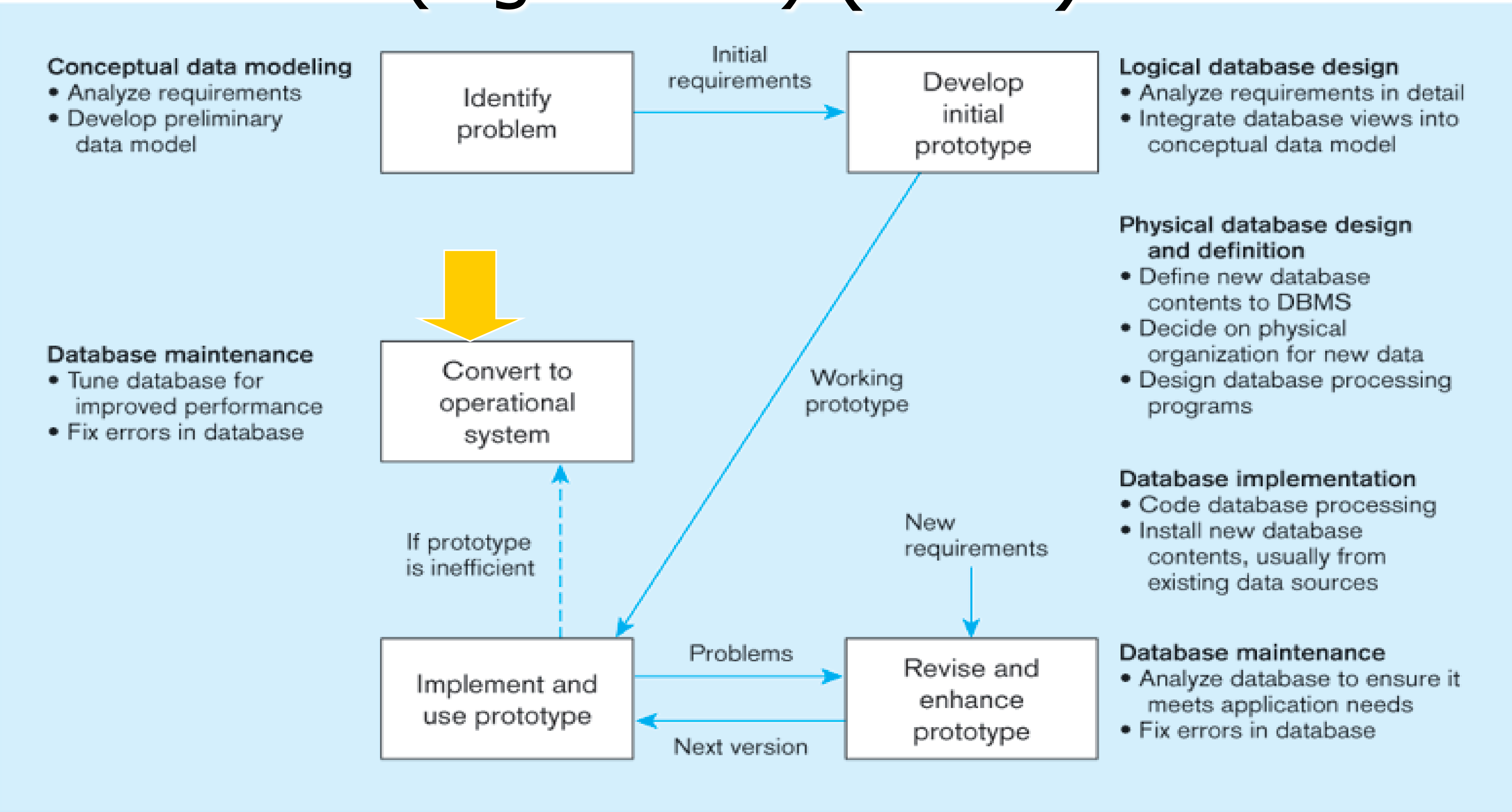


Prototyping Database Methodology (Figure 2.6) (cont.)



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

ask

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 تعهد of stakeholders
- Incremental commitment–review of systems development project after each development phase with rejustification after each phase

ask

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

- Physical Schema
  - Physical structures–covered in Chapters 5 and 6
- Conceptual Schema
  - E-R models–covered in Chapters 3 and 4
- External Schema
  - User Views
  - Subsets of Conceptual Schema
  - Can be determined from business-function/data entity matrices
  - DBA determines schema for different users

Figure 2-7 Three-schema architecture

Different people have different views of the database…these are the external schema

The internal schema is the underlying design and implementation

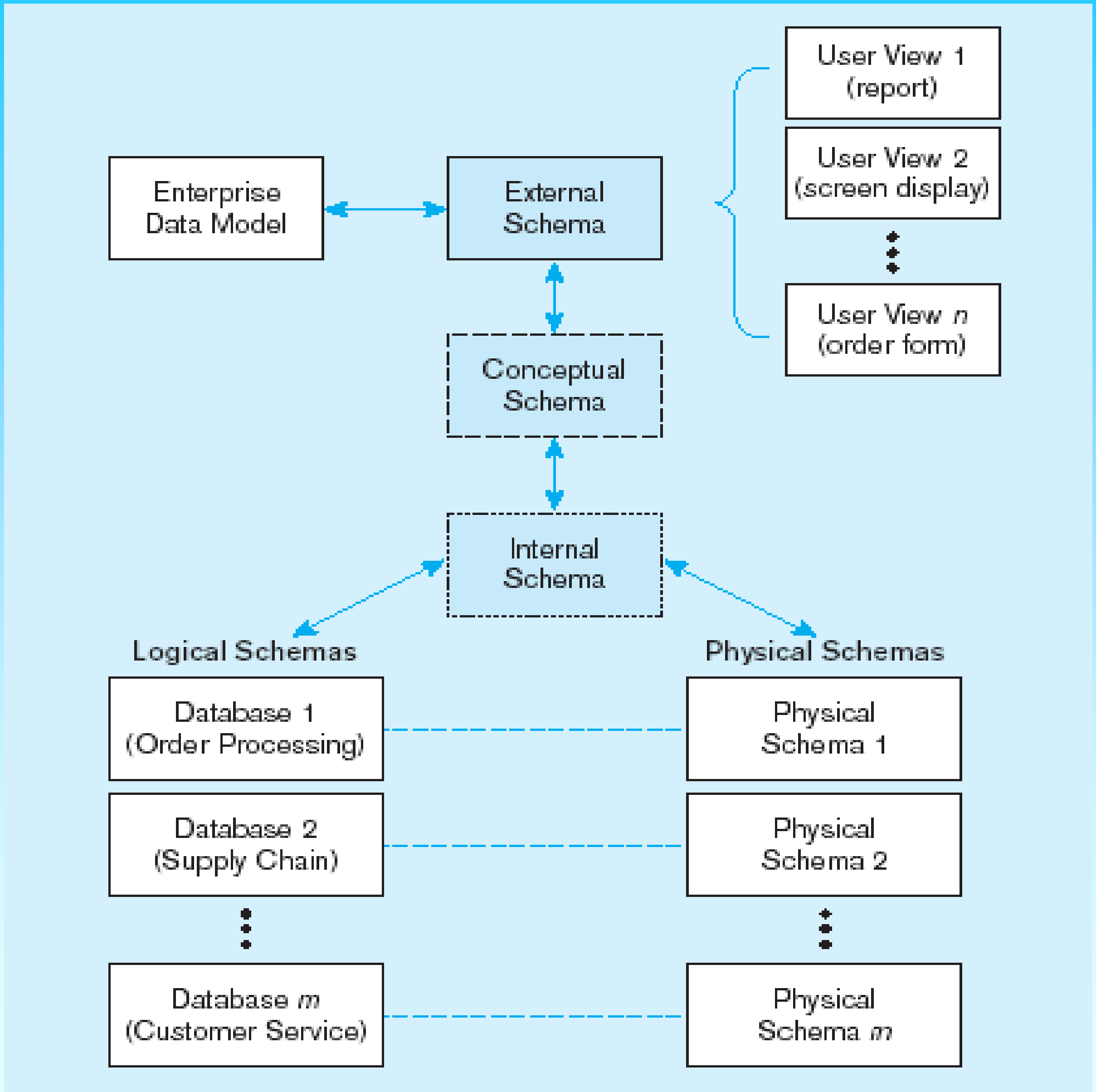


Figure 2-8 Developing the three-tiered architecture

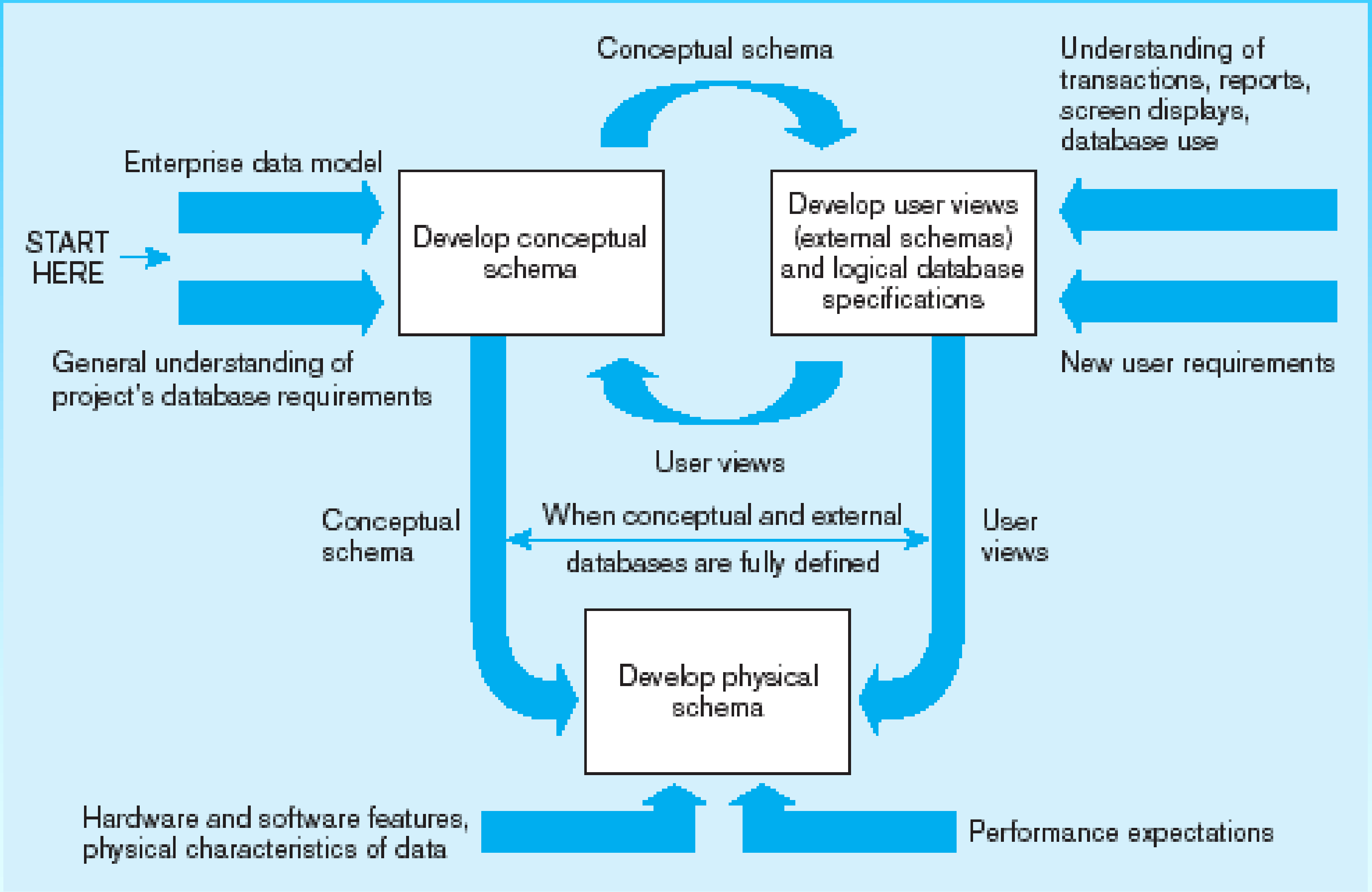
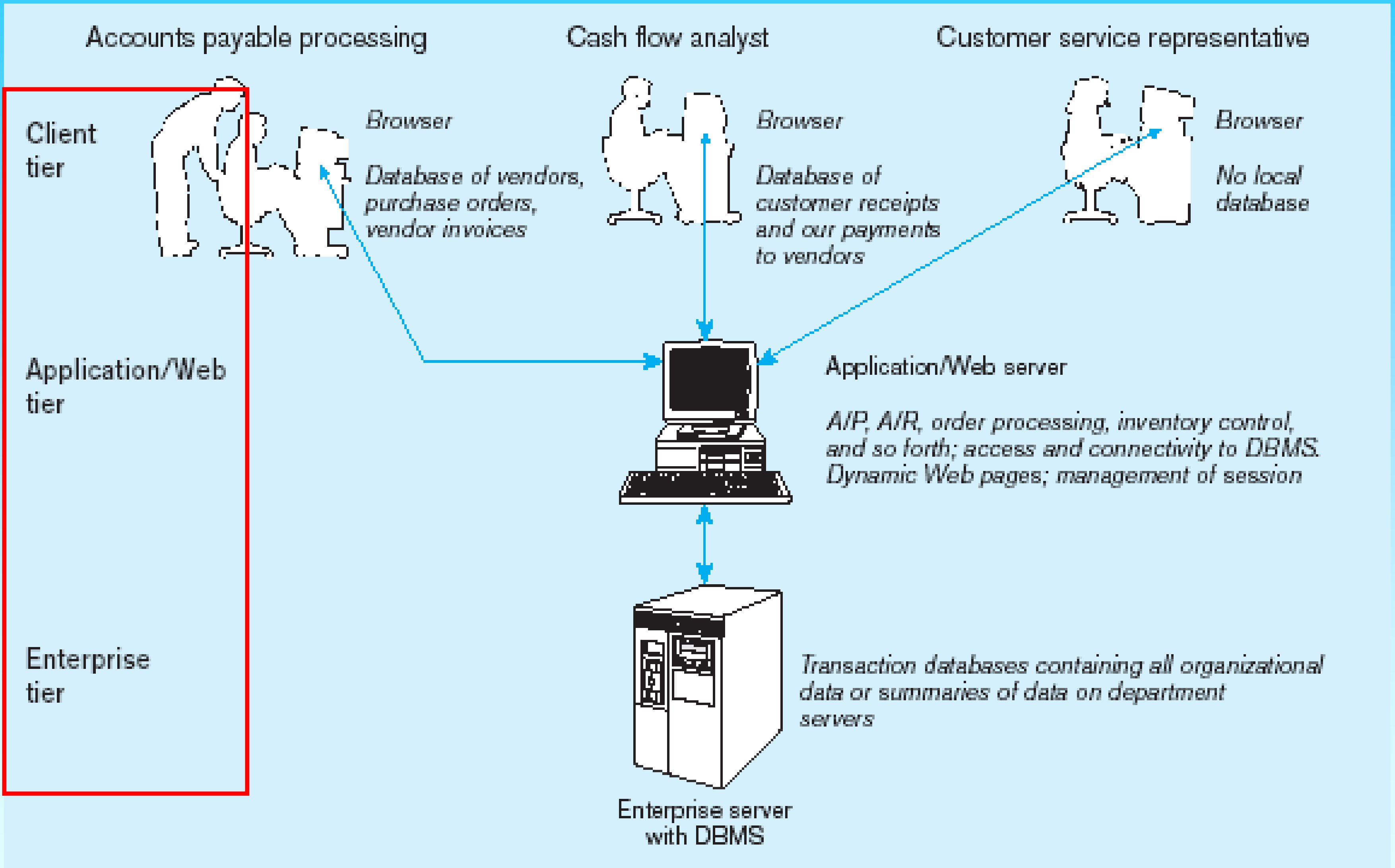


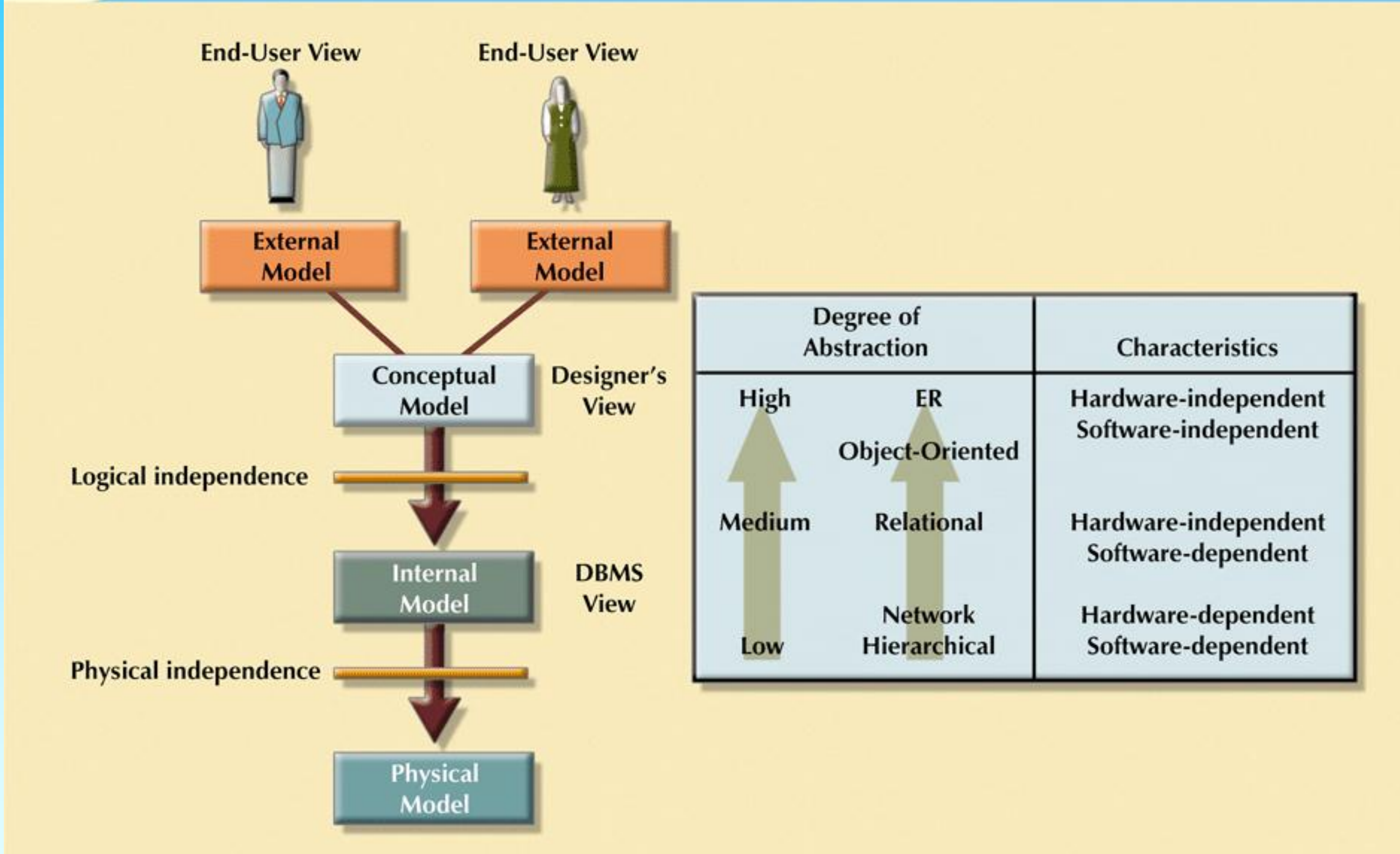
Figure 2-9 Three-tiered client/server database architecture



Degrees of Data Abstraction

- Database designer starts with abstracted view, then adds details
- ANSI Standards Planning and Requirements Committee (SPARC)
  - Defined a framework for data modeling based on degrees of data abstraction (1970s):
    - External
    - Conceptual
    - Internal

FIGURE 2.6 Data abstraction levels



The External Model

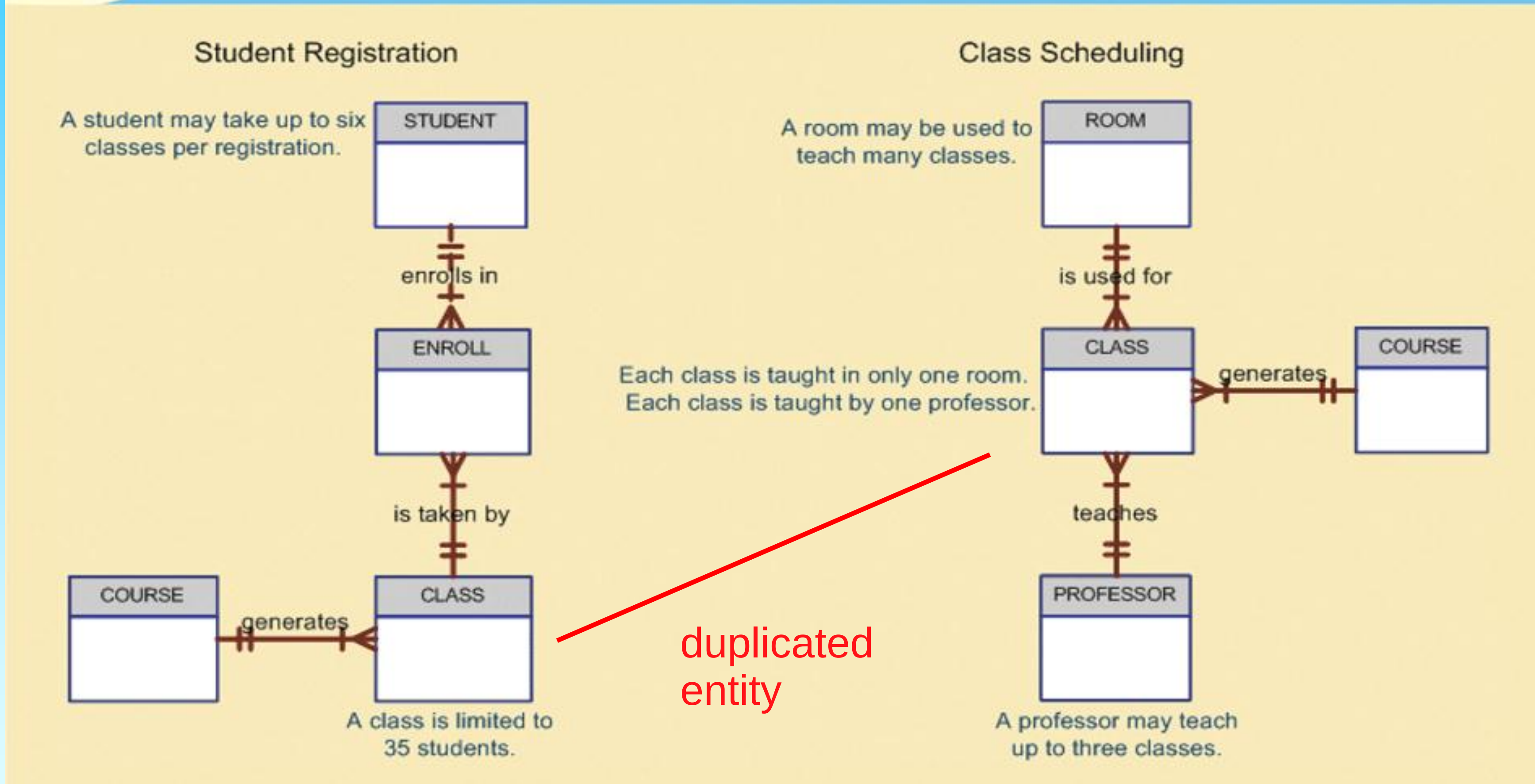
- End users' view of the data environment
- ER diagrams represent external views
- External schema: specific representation of an external view
  - Entities
  - Relationships
  - Processes
  - Constraints

The External Model (cont'd.)

- Easy to identify specific data required to support each business unit's operations
- Facilitates designer's job by providing feedback about the model's adequacy
- Ensures security constraints in database design
- Simplifies application program development

example for entriprise data base

FIGURE 2.7 External models for Tiny College



The Conceptual Model

- Represents global view of the entire database
- All external views integrated into single global view: conceptual schema
- ER model most widely used
- ERD graphically represents the conceptual schema

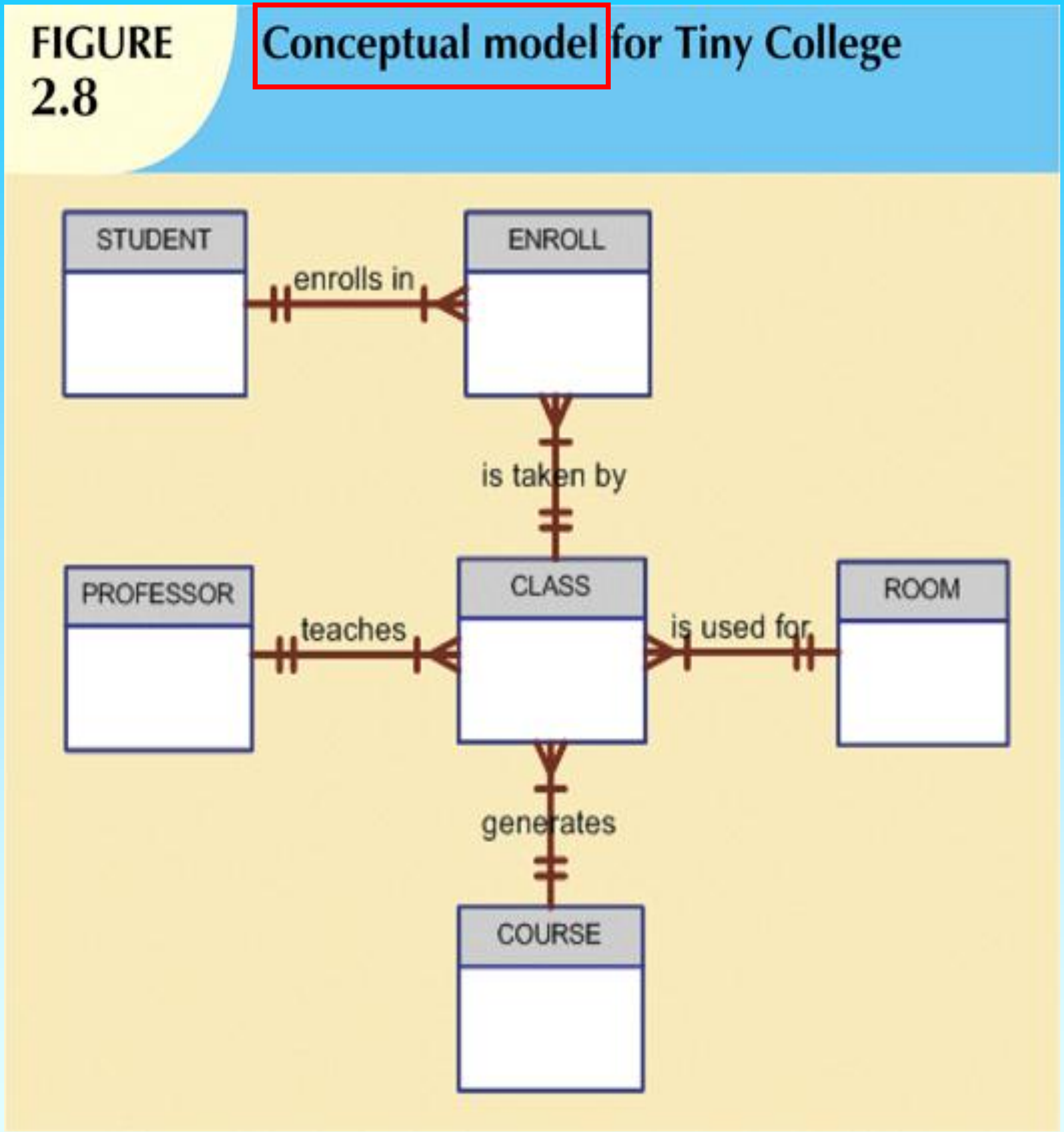


FIGURE
2.8
Conceptual model for Tiny College
STUDENT
enrolls in
ENROLL
is taken by
PROFESSOR
teaches
CLASS
is used for
ROOM
generates
COURSE

The Conceptual Model (cont'd.)

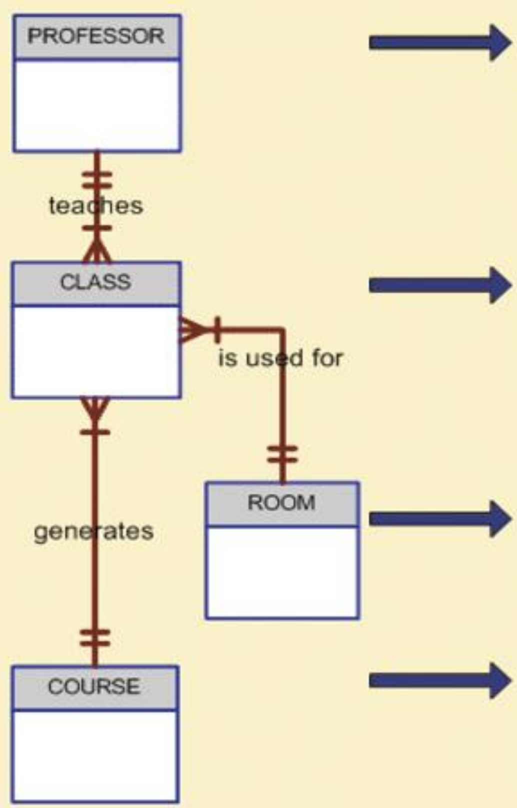
- Provides a relatively easily understood macro level view of data environment
- Independent of both software and hardware
  - Does not depend on the DBMS software used to implement the model
  - Does not depend on the hardware used in the implementation of the model
  - Changes in hardware or software do not affect database design at the conceptual level

The Internal Model

- Representation of the database as “seen” by the DBMS
  - Maps the conceptual model to the DBMS
- Internal schema depicts a specific representation of an internal model
- Depends on specific database software
  - Change in DBMS software requires internal model be changed
- Logical independence: change internal model without affecting conceptual model

FIGURE 2.9 **Internal model for Tiny College**

CONCEPTUAL MODEL



INTERNAL MODEL

```
Create Table PROFESSOR(
 PROF_ID        NUMBER PRIMARY KEY,
 PROF_LNAME     CHAR(15),
 PROF_INITIAL   CHAR(1),
 PROF_FNAME     CHAR(15),
 .........);

Create Table CLASS(
 CLASS_ID       NUMBER PRIMARY KEY,
 CRS_ID         CHAR(8)  REFERENCES COURSE,
 PROF_ID        NUMBER REFERENCES PROFESSOR,
 ROOM_ID        CHAR(8)  REFERENCES ROOM,
 .........);

Create Table ROOM(
 ROOM_ID        CHAR(8) PRIMARY KEY,
 ROOM_TYPE      CHAR(3),
 .........);

Create Table COURSE(
 CRS_ID         CHAR(8) PRIMARY KEY,
 CRS_NAME       CHAR(25),
 CRS_CREDITS    NUMBER,
 .........);
```

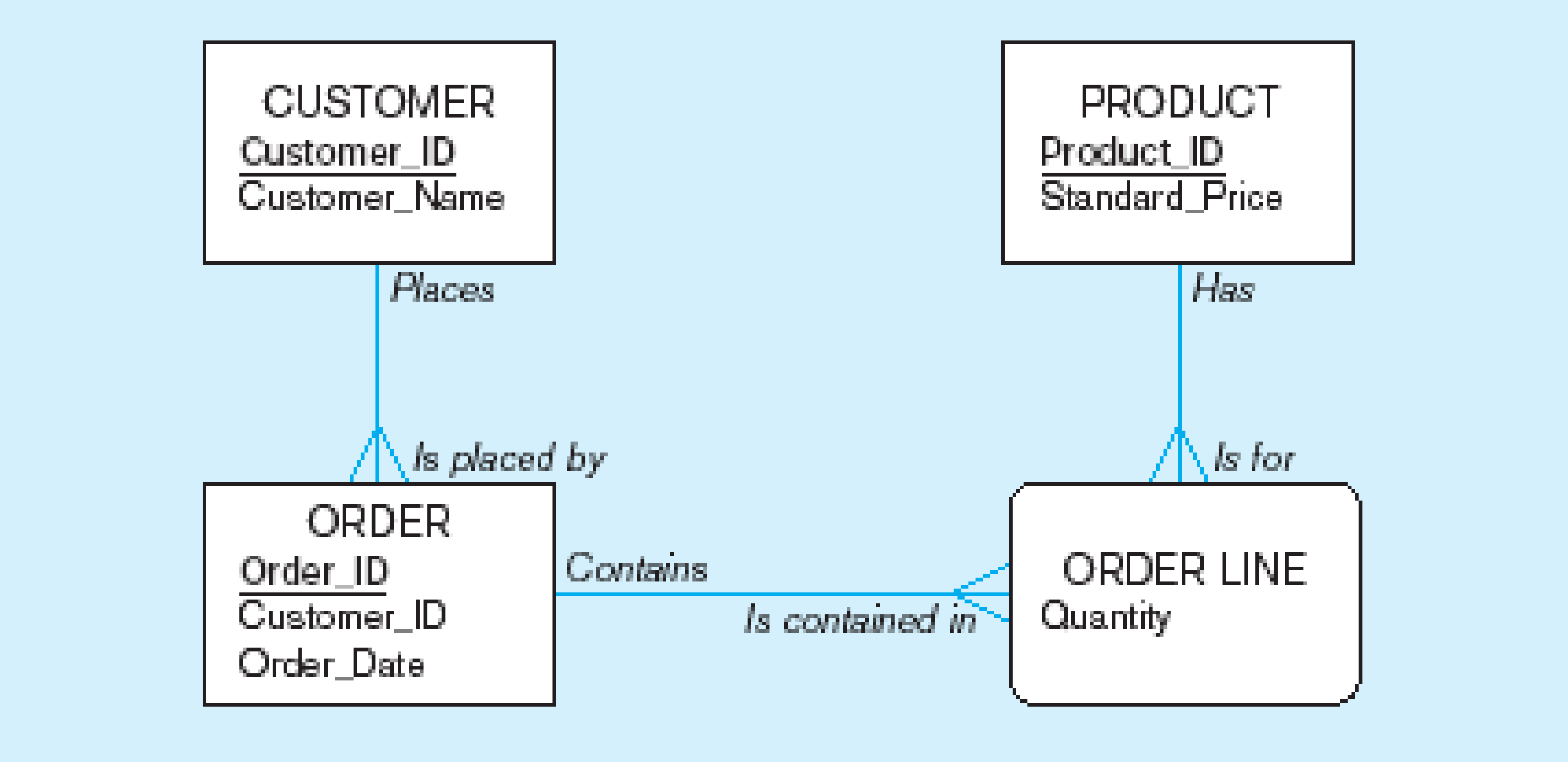
The Physical Model

- Operates at lowest level of abstraction
  - Describes the way data are saved on storage media such as disks or tapes
- Requires the definition of physical storage and data access methods
- Relational model aimed at logical level
  - Does not require physical-level details
- Physical independence: changes in physical model do not affect internal model

TABLE 2.4 Levels of Data Abstraction

MODEL	DEGREE OF ABSTRACTION	FOCUS	INDEPENDENT OF
External	High	End-user views	Hardware and software
Conceptual	↕	Global view of data (database model–independent)	Hardware and software
Internal		Specific database model	Hardware
Physical	Low	Storage and access methods	Neither hardware nor software

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

Order : Table

Order_ID	Order_Date	Customer_ID
1001	10/21/2006	4
1002	10/21/2006	3
1003	10/22/2006	1
1004	10/22/2006	6
1005	10/24/2006	4
1006	10/24/2006	2
1007	10/27/2006	11
1008	10/30/2006	12
1009	11/5/2006	4
1010	11/5/2006	1
0		0

Record: 1 of 10

Order Line : Table

Order_ID	Product_ID	Quantity
1001	1	2
1001	2	2
1001	4	1
1002	3	5
1003	3	3
1004	5	2
1004	8	2
1005	4	4
1006	4	1
1006	7	2
1007	1	3
1007	2	2
1008	3	3
1008	8	3
1009	4	1
1009	7	3
1010	8	10
0	0	0

Record: 18 of 18

Figure 2-12 Four relations (Pine Valley Furniture) (cont.)

(b) Customer table

Customer : Table

Customer_ID	Customer_Name
1	Contemporary Casuals
2	Value Furniture
3	Home Furnishings
4	Eastern Furniture
5	Impressions
6	Furniture Gallery
7	Period Furniture
8	California Classics
9	M and H Casual Furniture
10	Seminole Interiors
11	American Euro Lifestyles
12	Battle Creek Furniture
13	Heritage Furnishings
14	Kaneohe Homes
15	Mountain Scenes
0	

Record: 16 of 16

(c) Product table

Product : Table

Product_ID	Standard_Price
1	$175.00
2	$200.00
3	$375.00
4	$650.00
5	$325.00
6	$750.00
7	$150.00
8	$250.00
0	$0.00

Record: 9