



# Chapter 6

## **Foundations of Business Intelligence: Databases and Information Management**



# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

### Student Learning Objectives

- **What is a database and how does a relational database organize data?**
- **What are the principles of a database management system?**



# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

### Student Learning Objectives

- **What are the principal tools and technologies for accessing information from databases to improve business performance and decision making?**
- **Why are information policy, data administration, and data quality assurance essential for managing the firm's data resources?**



# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

### Student Learning Objectives

## Learning Tracks

1. Database Design, Normalization, and Entity-Relationship Diagramming
2. Introduction to SQL
3. Hierarchical and Network Data Models

## Video Cases

**Case 1:** Dubuque Uses Cloud Computing and Sensors to Build a Smarter City

**Case 2:** Brooks Brothers Closes In on OmniChannel Retail

**Case 3:** Maruti Suzuki Business Intelligence and Enterprise Databases



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

### BAE Systems

- **Problem:**
  - Legacy information systems impeding aircraft part of business
  - Distributed nature of BAE's design and manufacturing make storing and analyzing accurate sets of data challenging
  - Accessing data from many systems a complex task
- **Solution:**
  - Single repository for CAD/CAM data



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

### BAE Systems

- **Siemen's Teamcenter and Dassault Systemes' CATIA** together have given BAE powerful integrated data management tools
- **Demonstrates IT's role in successful data management**
- **Illustrates digital technology's ability to lower costs while improving performance**

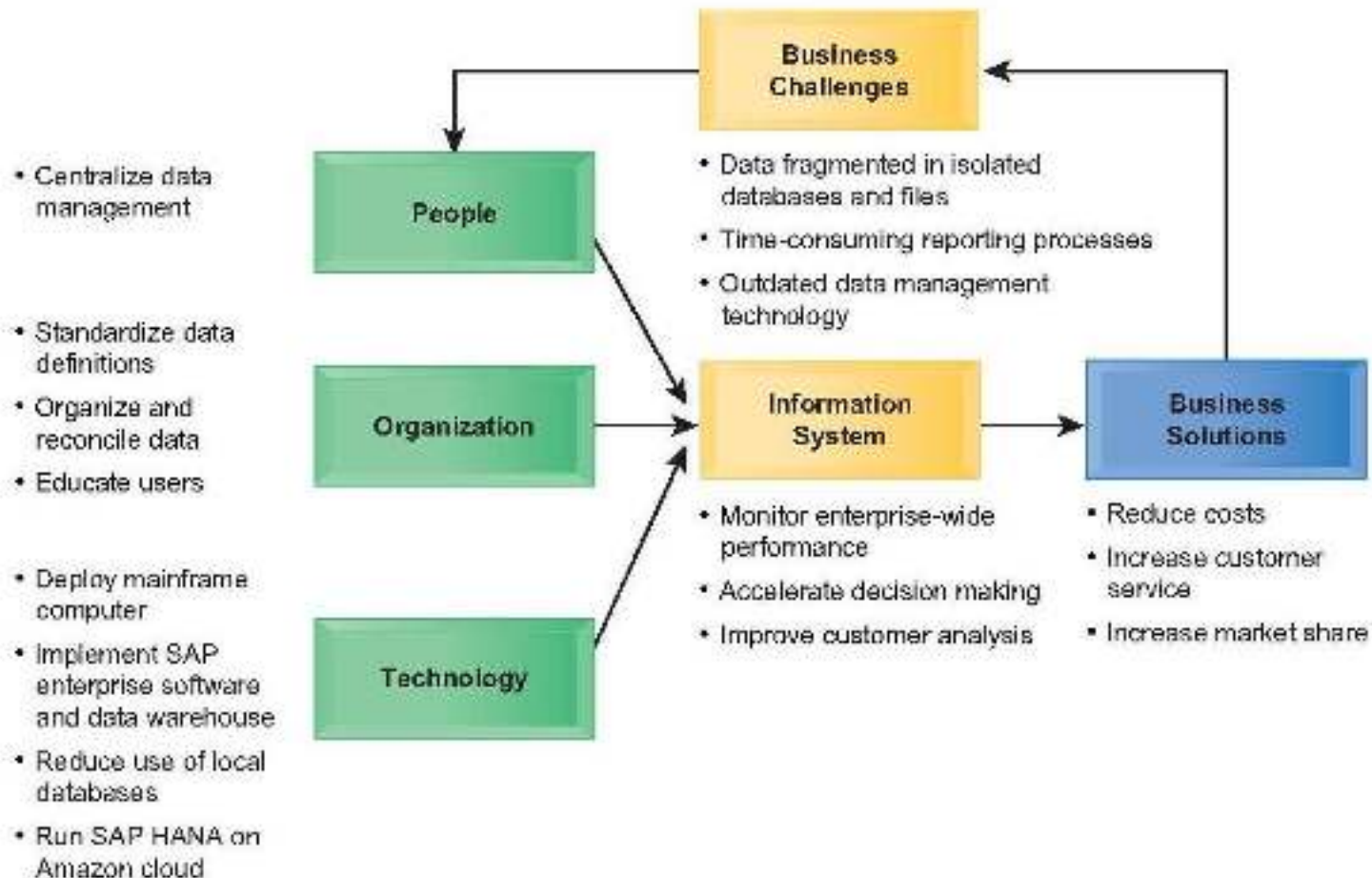




# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

### BAE Systems





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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What is a database and how does a relational database organize data?

- **Database:**
  - Collection of related files containing records on people, places, or things.
  - Prior to digital databases, business used file cabinets with paper files.
- **Entity:**
  - Generalized category representing person, place, thing on which we store and maintain information
  - E.g., SUPPLIER, PART
- **Attributes:**
  - Specific characteristics of each entity:
    - SUPPLIER name, address
    - PART description, unit price, supplier





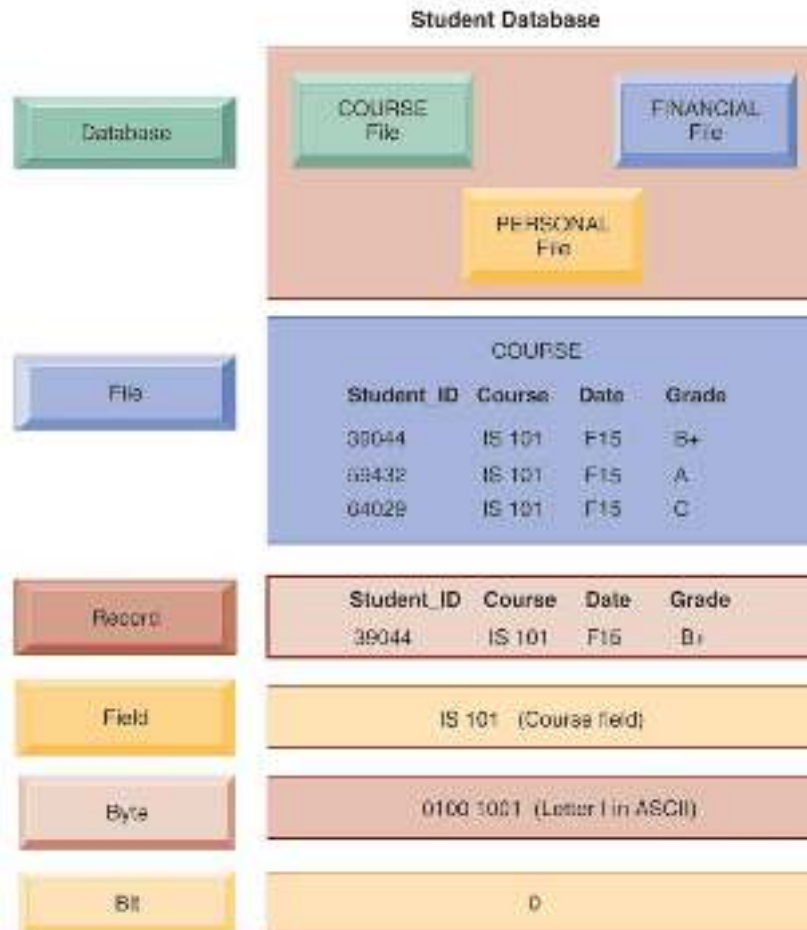
# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What is a database and how does a relational database organize data?

### The Data Hierarchy

A computer system organizes data in a hierarchy that starts with the bit, which represents either a 0 or a 1. Bits can be grouped to form a byte to represent one character, number, or symbol. Bytes can be grouped to form a field, and related fields can be grouped to form a record. Related records can be collected to form a file, and related files can be organized into a database.



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# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What is a database and how does a relational database organize data?

- **Relational database:**
  - Organize data into two-dimensional tables (relations) with columns and rows.
  - One table for each entity:
    - E.g., (CUSTOMER, SUPPLIER, PART, SALES)
  - **Fields** (columns) store data representing an attribute.
  - Rows store data for separate **records**, or tuples.
  - **Key field:** uniquely identifies each record.
  - **Primary key:**
    - One field in each table
    - Cannot be duplicated
    - Provides unique identifier for all information in any row



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What is a database and how does a relational database organize data?

### A Relational Database Table

**SUPPLIER**

Columns (Attributes, Fields)

Supplier_Number	Supplier_Name	Supplier_Street	Supplier_City	Supplier_State	Supplier_Zip
8259	CBM Inc.	74 5 <sup>th</sup> Avenue	Dayton	OH	45220
8261	B. R. Molds	1277 Gandolly Street	Cleveland	OH	49345
8263	Jackson Composites	8233 Micklin Street	Lexington	KY	56723
8444	Bryant Corporation	4315 Mill Drive	Rochester	NY	11344

Rows (Records, Tuples)

Key Field (Primary Key)

A relational database organizes data in the form of two-dimensional tables. Illustrated here is a table for the entity SUPPLIER showing how it represents the entity and its attributes. Supplier\_Number is the key field.

Figure 6.2



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What is a database and how does a relational database organize data?

### PART **The PART Table**

Data for the entity PART have their own separate table. Part\_Number is the primary key and Supplier\_Number is the foreign key, enabling users to find related information from the SUPPLIER table about the supplier for each part.

Part_Number	Part_Name	Unit_Price	Supplier_Number
137	Door latch	22.00	8259
145	Side mirror	12.00	8444
150	Door molding	6.00	8263
152	Door lock	31.00	8259
155	Compressor	54.00	8261
178	Door handle	10.00	8259

Primary Key

Foreign Key

Figure 6.3





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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

### The Database Approach to Data Management

- **Establishing relationships**
  - **Entity-relationship diagram**
    - Used to clarify table relationships in a relational database
  - **Relational database tables may have:**
    - **One-to-one relationship**
    - **One-to-many relationship**
    - **Many-to-many relationship**
      - Requires “join table” or intersection relation that links the two tables to join information



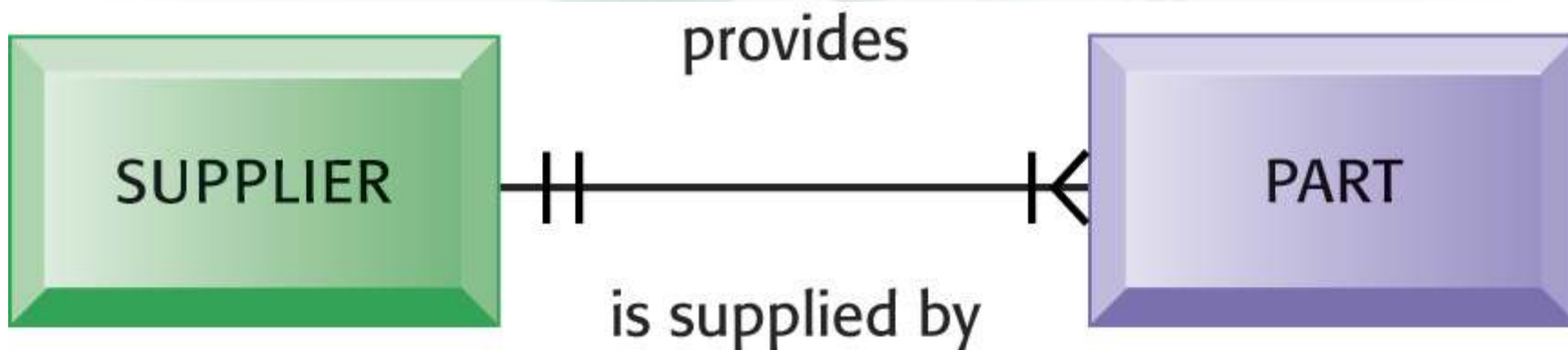


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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What is a database and how does a relational database organize data?

### A Simple Entity-Relationship Diagram



This diagram shows the relationship between the entities SUPPLIER and PART.

Figure 6.4



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

### The Database Approach to Data Management

- **Normalization**

- Process of streamlining complex groups of data to:
  - Minimize redundant data elements.
  - Minimize awkward many-to-many relationships.
  - Increase stability and flexibility.

- **Referential integrity rules**

- Used by relational databases to ensure that relationships between coupled tables remain consistent.
- E.g., when one table has a foreign key that points to another table, you may not add a record to the table with foreign key unless there is a corresponding record in the linked table.



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What is a database and how does a relational database organize data?

### Sample Order Report

Order Number: 3502  
Order Date: 1/15/2014

Supplier Number: 8259  
Supplier Name: CBM Inc.  
Supplier Address: 74 5th Avenue, Dayton, OH 45220

Order_Number	Part_Number	Part_Quantity	Part_Name	Unit_Price	Extended Price
3502	137	10	Door latch	22.00	\$220.00
3502	152	20	Door lock	31.00	620.00
3502	178	5	Door handle	10.00	50.00
Order Total:					\$890.00

Figure 6.5

The shaded areas show which data came from the SUPPLIER, LINE\_ITEM, and ORDER tables. The database does not maintain data on Extended Price or Order Total because they can be derived from other data in the tables.



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What is a database and how does a relational database organize data?

### The Final Database Design with Sample Records

PART

Part_Number	Part_Name	Unit_Price	Supplier_Number
137	Door latch	22.00	8259
145	Side mirror	12.00	8444
150	Door molding	6.00	8263
152	Door lock	31.00	8259
155	Compressor	54.00	8281
178	Door handle	10.00	8259

LINE\_ITEM

Order_Number	Part_Number	Part_Quantity
3502	137	10
3502	152	20
3502	178	5

ORDER

Order_Number	Order_Date
3502	1/15/2014
3503	1/16/2014
3504	1/17/2014

SUPPLIER

Supplier_Number	Supplier_Name	Supplier_Street	Supplier_City	Supplier_State	Supplier_Zip
8259	CBM Inc.	74 5 <sup>th</sup> Avenue	Dayton	OH	45220
8281	B. R. Molds	1277 Gandolly Street	Cleveland	OH	49345
8263	Jackson Components	8233 Micklin Street	Lexington	KY	56723
8444	Bryant Corporation	4315 Mill Drive	Rochester	NY	11344

Figure 6.6

The final design of the database for suppliers, parts, and orders has four tables. The LINE\_ITEM table is a join table that eliminates the many-to-many relationship between ORDER and PART.



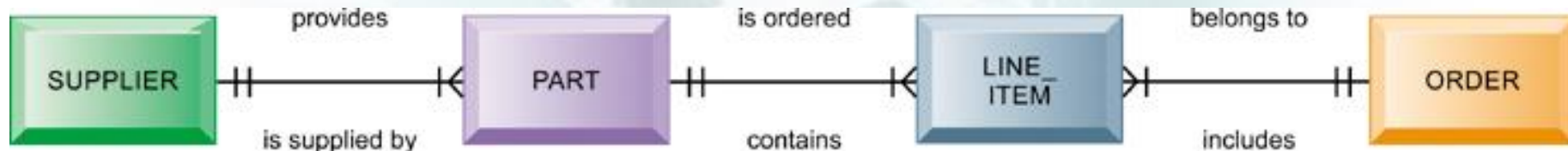


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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What is a database and how does a relational database organize data?

### Entity-Relationship Diagram for the Database with Four Tables



This diagram shows the relationship between the entities SUPPLIER, PART, LINE\_ITEM, and ORDER.

Figure 6.7





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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What are the principles of a database management system?

### DBMS

- **Specific type of software for creating, storing, organizing, and accessing data from a database**
- **Separates the logical and physical views of the data**
- **Logical view:** how end users view data
- **Physical view:** how data are actually structured and organized
- **Examples of DBMS:** Microsoft Access, DB2, Oracle Database, Microsoft SQL Server, MySQL,



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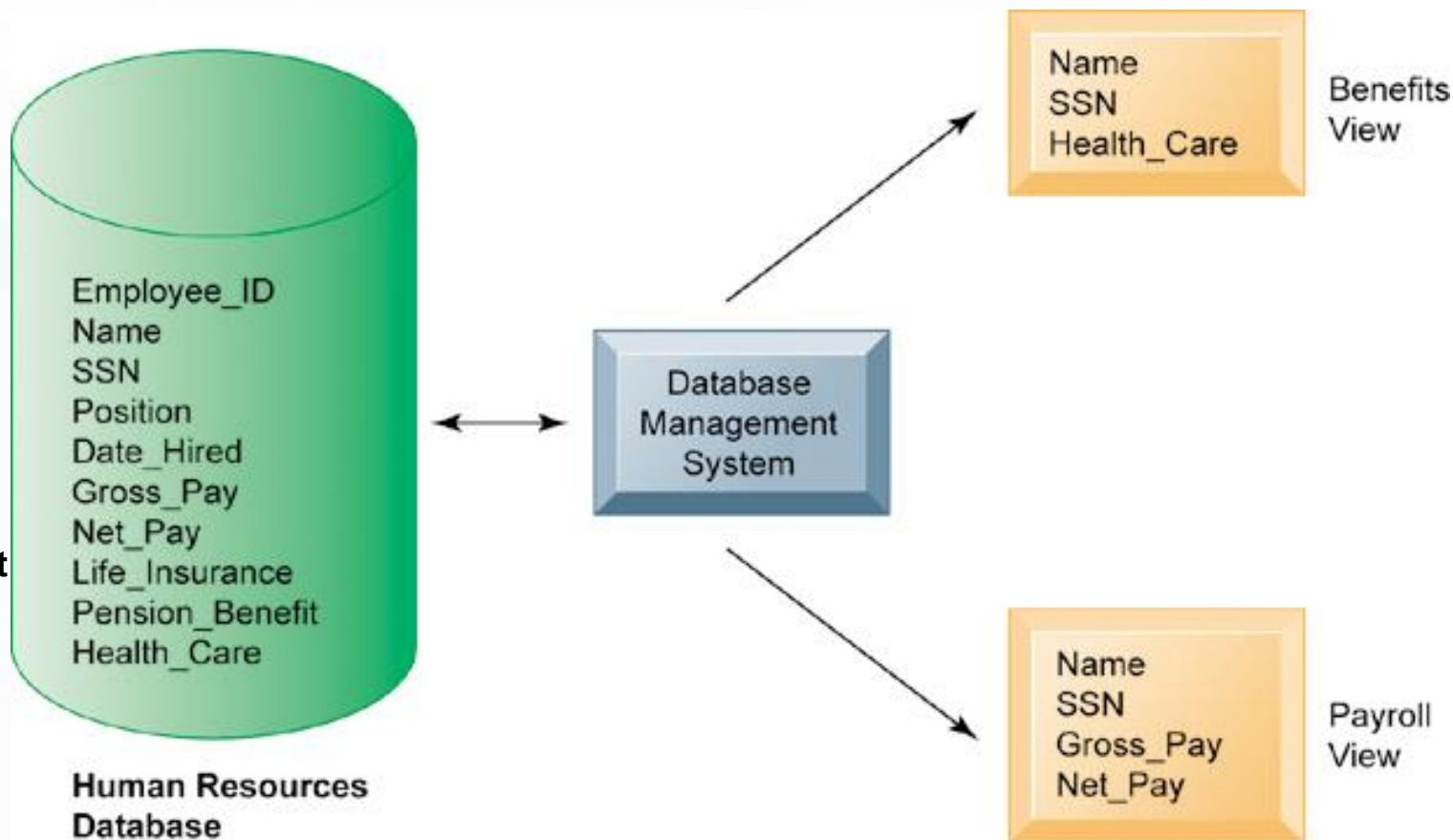
## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What are the principles of a database management system?

### Human Resources Database with Multiple Views

Figure 6.8

A single human resources database provides many different views of data, depending on the information requirements of the user. Illustrated here are two possible views, one of interest to a benefits specialist and one of interest to a member of the company's payroll department.





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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What are the principles of a database management system?

### Operations of a Relational DBMS

- **Select:**
  - Creates a subset of all records meeting stated criteria
- **Join:**
  - Combines relational tables to present the server with more information than is available from individual tables
- **Project:**
  - Creates a subset consisting of columns in a table
  - Permits user to create new tables containing only desired information

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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What are the principles of a database management system?

### The Three Basic Operations of a Relational DBMS

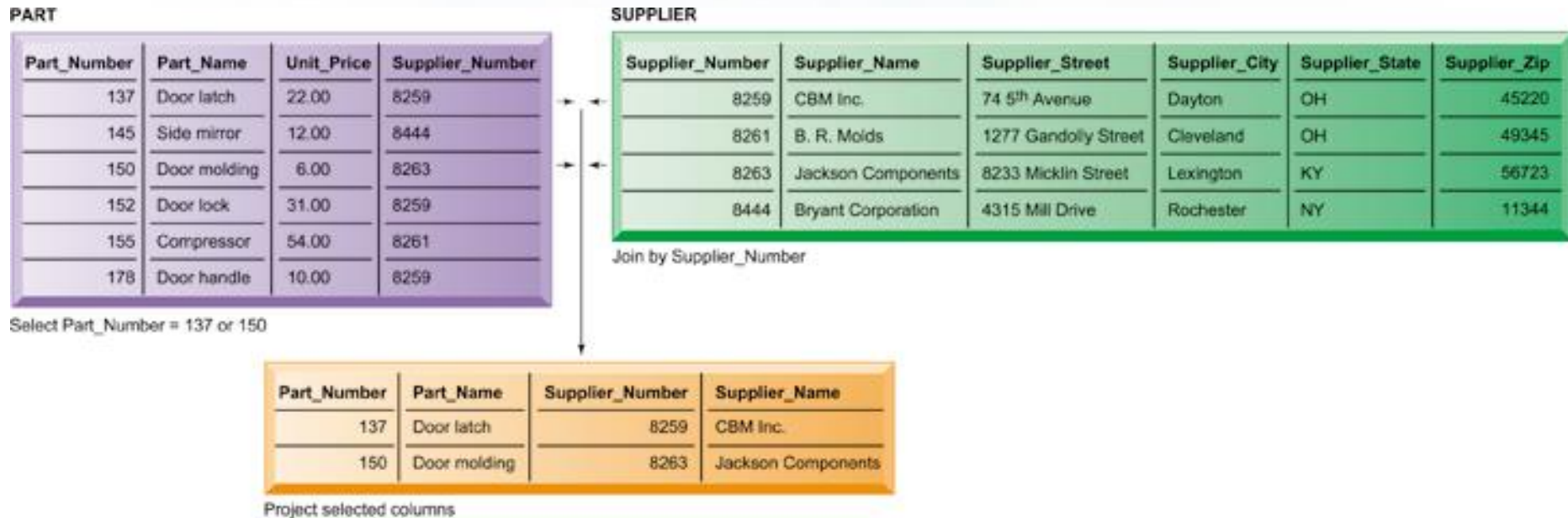


Figure 6.9

The select, project, and join operations enable data from two different tables to be combined and only selected attributes to be displayed.





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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What are the principles of a database management system?

### Capabilities of Database Management Systems

- **Data definition capabilities:**
  - Specify structure of content of database.
- **Data dictionary:**
  - Automated or manual file storing definitions of data elements and their characteristics.
- **Querying and reporting:**
  - **Data manipulation language**
    - Structured query language (SQL)
    - Microsoft Access query-building tools
  - **Report generation, e.g., Crystal Reports**





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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What are the principles of a database management system?

## Access Data Dictionary Features

Microsoft Access has a rudimentary data dictionary capability that displays information about the size, format, and other characteristics of each field in a database. Displayed here is the information maintained in the SUPPLIER table. The small key icon to the left of Supplier\_Number indicates that it is a key field.

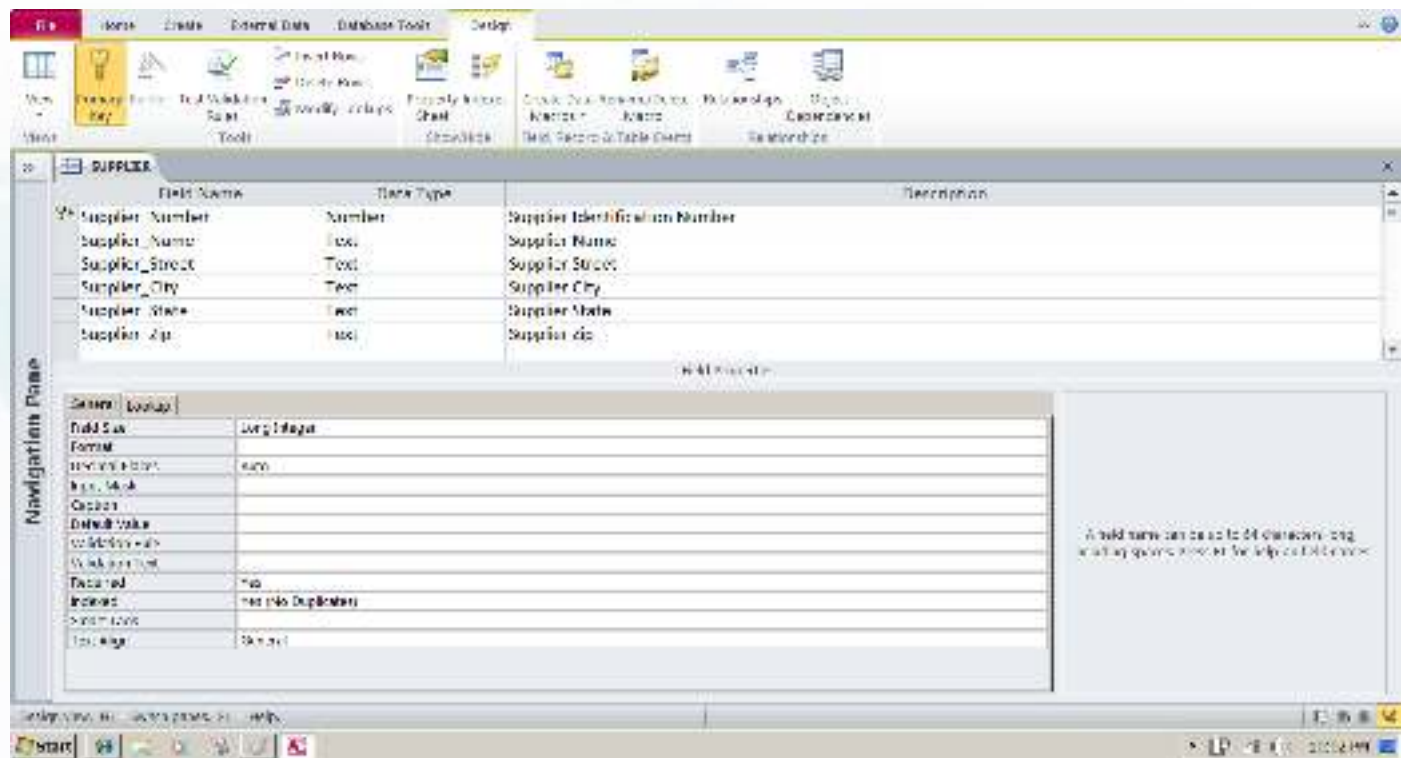


Figure 6.10



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What are the principles of a database management system?

### Example of an SQL Query

```
SELECT PART.Part_Number, PART.Part_Name, SUPPLIER.Supplier_Number,  
SUPPLIER.Supplier_Name  
FROM PART, SUPPLIER  
WHERE PART.Supplier_Number = SUPPLIER.Supplier_Number AND  
Part_Number = 137 OR Part_Number = 150;
```

Illustrated here are the SQL statements for a query to select suppliers for parts 137 or 150. They produce a list with the same results as Figure 6.9.

Figure 6.11

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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What are the principles of a database management system?

### An Access Query

Illustrated here is how the query in Figure 6-10 would be constructed using Microsoft Access query-building tools. It shows the tables, fields, and selection criteria used for the query.

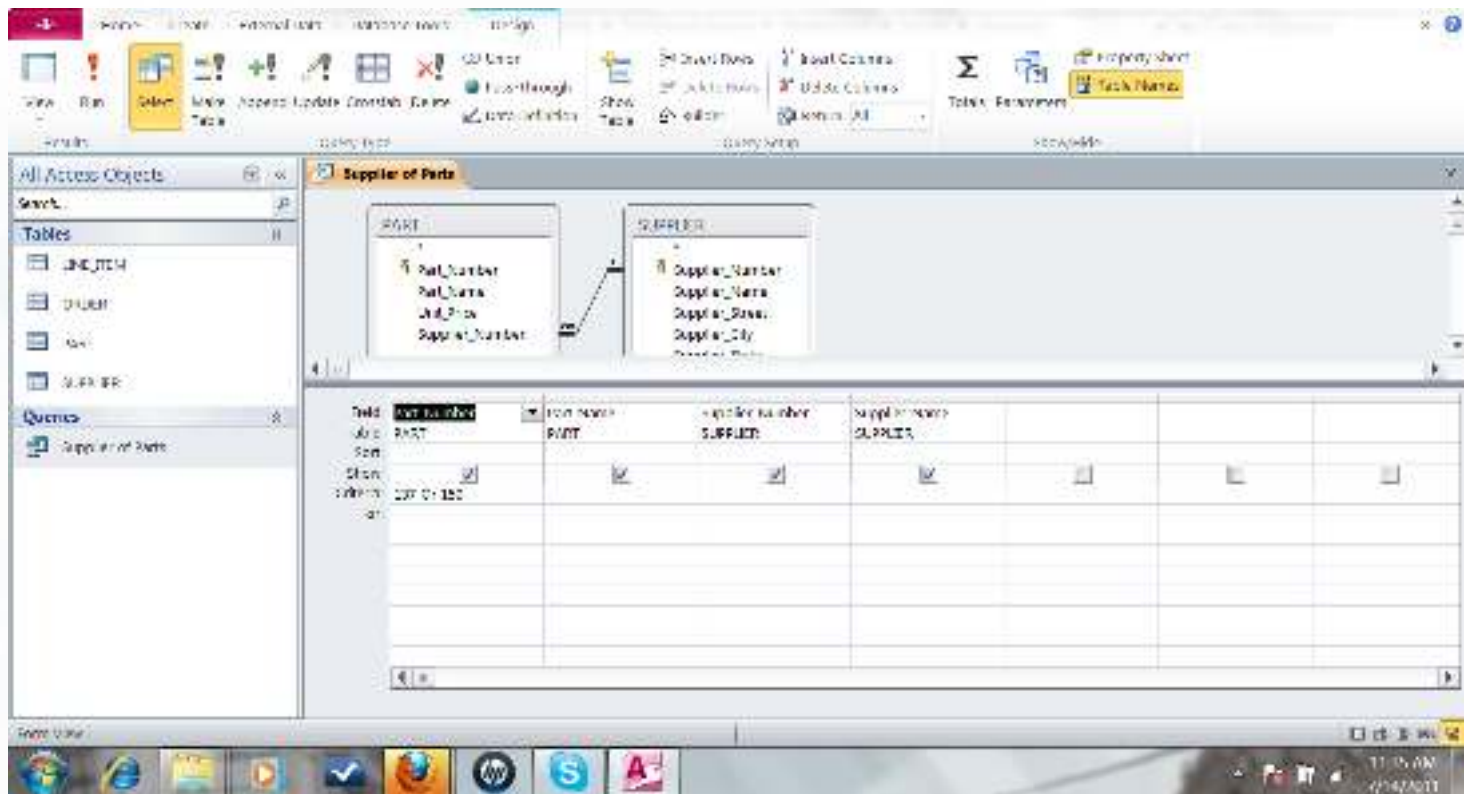


Figure 6.12



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What are the principles of a database management system?

### Non-Relational Databases

- Developed to handle large data sets of data that is not easily organized into tables, columns, and rows
- “NoSQL”: Non-relational database technologies
- Non-relational DBMS
  - Use more flexible data model
  - Don't require extensive structuring
  - Can manage unstructured data, such as social media and graphics
  - E.g. Amazon's SimpleDB





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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

What are the principles of a database management system?

### Cloud Databases

- **Relational database engines provided by cloud computing services, such as Amazon**
- **Pricing based on usage**
- **Appeal to Web-focused businesses, small or medium-sized businesses seeking lower costs than developing and hosting in-house databases**
- **E.g. Amazon Relational Database Service**
  - Offers MySQL, Microsoft SQL Server, Oracle Database engines
- **Private clouds**





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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### **The Challenge of Big Data**

- **Massive quantities of unstructured and semi-structured data from Internet and networked services and applications**
- **Big datasets provide opportunity more patterns and insights than smaller datasets, e.g.**
  - Customer behavior
  - Weather patterns
- **Requires new technologies and tools**



# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### **Business Intelligence Infrastructure**

- **Array of tools for obtaining useful information from internal and external systems and big data**
  - **Data warehouses**
  - **Data marts**
  - **Hadoop**
  - **In-memory computing**
  - **Analytical platforms**



# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### Data Warehouses

- **Data warehouse:**
  - Database that stores current and historical data that may be of interest to decision makers
  - Consolidates and standardizes data from many systems, operational and transactional databases
  - Data can be accessed but not altered
- **Data mart:**
  - Subset of data warehouses that is highly focused and isolated for a specific population of users



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### Hadoop

- **Open-source software framework from Apache**
- **Designed for big data**
- **Breaks data task into sub-problems and distributes the processing to many inexpensive computer processing nodes**
- **Combines result into smaller data set that is easier to analyze**
- **Key services**
  - Hadoop Distributed File System (HDFS)
  - MapReduce



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### **In-Memory Computing**

- **Relies on computer's main memory (RAM) for data storage**
- **Eliminates bottlenecks in retrieving and reading data from hard-disk based databases**
- **Dramatically shortens query response times**
- **Enabled by**
  - High-speed processors
  - Multicore processing
  - Falling computer memory prices
- **Lowers processing costs**





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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### **Analytic Platforms**

- **Preconfigured hardware-software systems**
- **Designed for query processing and analytics**
- **Use both relational and non-relational technology to analyze large data sets**
- **Include in-memory systems, NoSQL DBMS**
- **E.g. IBM Netezza**
  - **Integrated database, server, storage components**

# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### Contemporary Business Intelligence Infrastructure

A contemporary business intelligence infrastructure features capabilities and tools to manage and analyze large quantities and different types of data from multiple sources. Easy-to-use query and reporting tools for casual business users and more sophisticated analytical toolsets for power users are included.

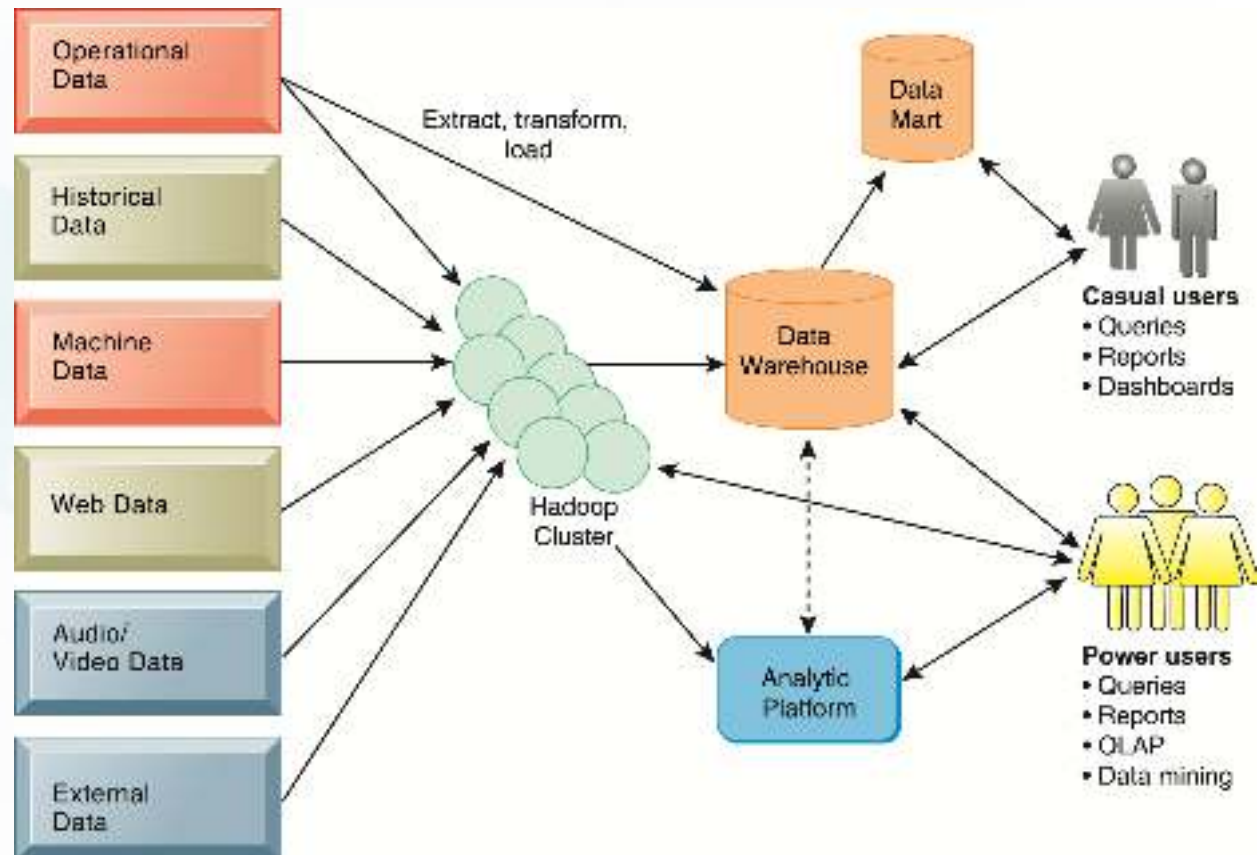


Figure 6-13



# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### **Analytical Tools: Relationships, Patterns, Trends**

- **Once data gathered, tools are required for consolidating, analyzing, and insight to improve decision making**
  - **Software for database querying and reporting**
  - **Multidimensional data analysis (OLAP)**
  - **Data mining**



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### Online Analytical Processing (OLAP)

- **Supports multidimensional data analysis, enabling users to view the same data in different ways using multiple dimensions**
  - Each aspect of information—product, pricing, cost, region, or time period—represents a different dimension
  - E.g., comparing sales in East in June versus May and July
- **Enables users to obtain online answers to ad hoc questions such as these in a fairly rapid amount of time**





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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### Multidimensional Data Model

The view that is showing is product versus region. If you rotate the cube 90 degrees, the face that will show is product versus actual and projected sales. If you rotate the cube 90 degrees again, you will see region versus actual and projected sales. Other views are possible.

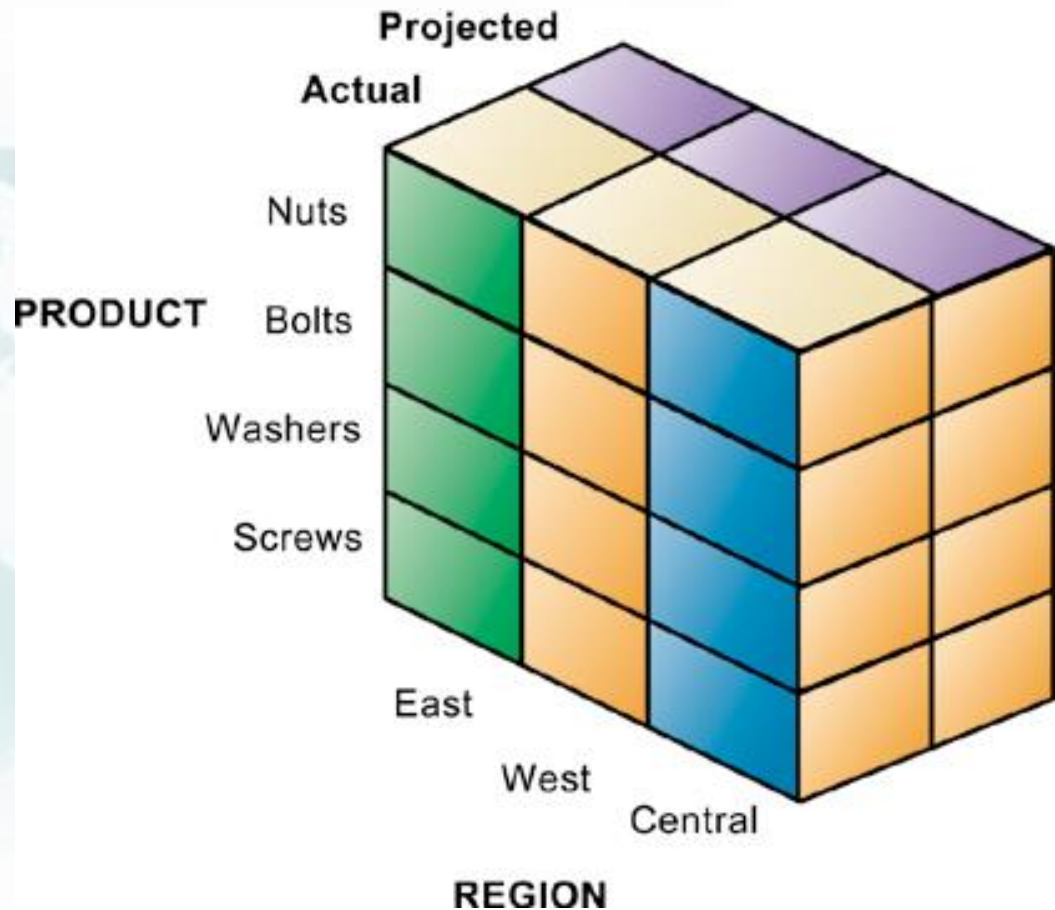


Figure 6.14



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### Data Mining

- Finds hidden patterns and relationships in large databases and infers rules from them to predict future behavior
- Types of information obtainable from data mining
  - **Associations:** occurrences linked to single event
  - **Sequences:** events linked over time
  - **Classifications:** patterns describing a group an item belongs to
  - **Clustering:** discovering as yet unclassified groupings
  - **Forecasting:** uses series of values to forecast future values



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### Interactive Session: People American Water Keeps Data Flowing

- **Read the Interactive Session and then discuss the following questions:**
  1. Discuss the role of information policy, data administration, and efforts to ensure data quality in improving data management at American Water.
  2. Describe roles played by information systems specialists and end users in American Water's systems transformation project.
  3. Why was the participation of business users so important? If they didn't play this role, what would have happened?
  4. How did implementing a data warehouse help American Water moved toward a more centralized organization?
  5. Give some examples of problems that would have occurred at American Water if its data were not "clean"?
  6. How would American Water's data warehouse improve operations and management decision making?



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

### Using Databases to Improve Business Performance and Decision Making

- **Text Mining**

- Unstructured data (mostly text files) accounts for 80 percent of an organization's useful information.
- Text mining allows businesses to extract key elements from, discover patterns in, and summarize large unstructured data sets.
- Sentiment analysis
  - Mines online text comments online or in e-mail to measure customer sentiment





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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

### Using Databases to Improve Business Performance and Decision Making

- **Web Mining**

- Discovery and analysis of useful patterns and information from the Web
  - E.g. to understand customer behavior, evaluate Web site, quantify success of marketing
- **Content mining** – mines content of Web sites
- **Structure mining** – mines Web site structural elements, such as links
- **Usage mining** – mines user interaction data gathered by Web servers



# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### Databases and the Web

- **Firms use the Web to make information from their internal databases available to customers and partners.**
- **Middleware and other software make this possible**
  - Web server
  - Application servers or CGI
  - Database server
- **Web interfaces provide familiarity to users and savings over redesigning legacy systems.**

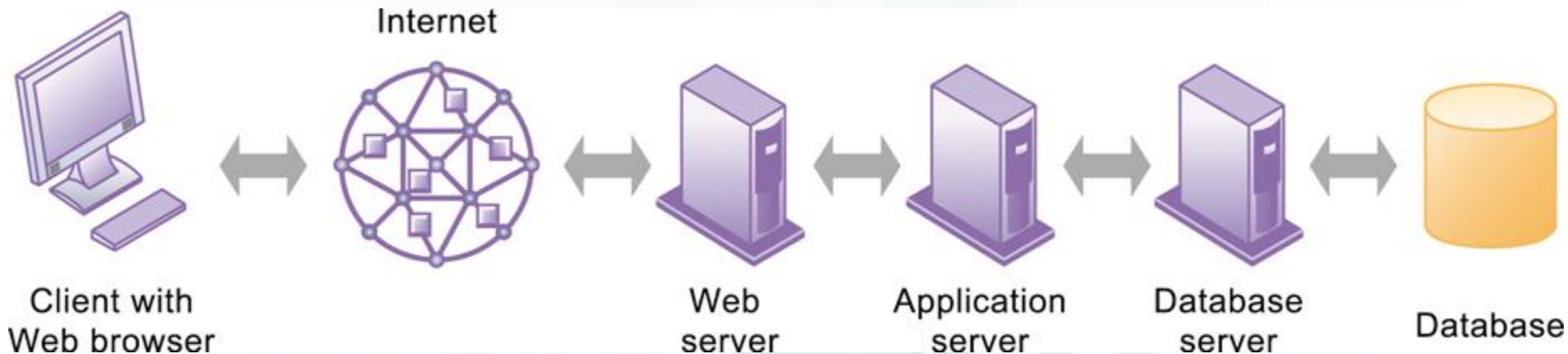


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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Using Databases to Improve Business Performance and Decision Making

### Linking Internal Databases to the Web



Users access an organization's internal database through the Web using their desktop PCs and Web browser software.

Figure 6.15



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## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

Why are information policy, data administration, and data quality assurance essential for managing the firm's data resources?

### Establishing an Information Policy

- **Information policy**
  - States organization's rules for organizing, managing, storing, sharing information
- **Data administration**
  - Responsible for specific policies and procedures through which data can be managed as a resource
- **Database administration**
  - Database design and management group responsible for defining and organizing the structure and content of the database, and maintaining the database.





# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

### Managing Data Resources

## Ensuring Data Quality

- **Poor data quality:** major obstacle to successful customer relationship management
- **Data quality problems:** caused by
  - Redundant and inconsistent data produced by multiple systems
  - Data input errors
- **Data quality audit:** structured survey of the accuracy and completeness of data
- **Data cleansing:** detects and corrects incorrect, incomplete, improperly formatted, and redundant data



# Essentials of Management Information Systems

## Chapter 6 Foundations of Business Intelligence: Databases and Information Management

### Managing Data Resources

## **Interactive Session: People Driving ARI Fleet Management With Real-Time Analytics**

- **Read the Interactive Session and then discuss the following questions:**
  1. Why was data management so problematic at ARI?
  2. Describe ARI's earlier capabilities for data analysis and reporting and their impact on the business.
  3. Was SAP HANA a good solution for ARI? Why or why not?
  4. Describe the changes in how ARI and its customers ran their businesses as a result of adopting HANA.
  5. Describe two decisions that were improved by adopting HANA.