Supporting Decision Making

Chapter 11

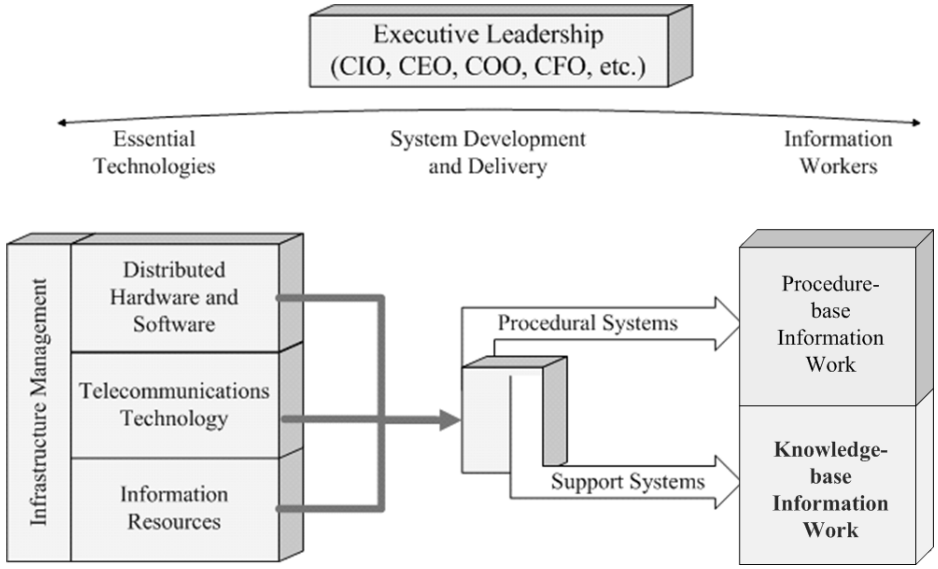
Outline

- Framework for IS Management
- Technologies for supporting decision making:
  - Decision Support Systems (DSS)
  - Data Mining
  - Executive Information Systems (EIS), and
  - Expert Systems
  - Agent-based Modelling
- IT issues related to creating the real-time enterprise

Introduction

- Most computer systems support decision making because all software programs involve automating decision steps that people would take
- Decision making is a process that involves a variety of activities, most of which handle information
- A wide variety of computer-based tools and approaches can be used to confront the problem at hand and work through its solution

A Framework for IS Management



Technologies that Support Decision Making

- The purpose of tractors, engines, machines is to enhance humans' physical capabilities
- The purpose of computers has been to enhance our mental capabilities
- A major use of IT is to relieve humans of some decision making or help us make more informed decisions

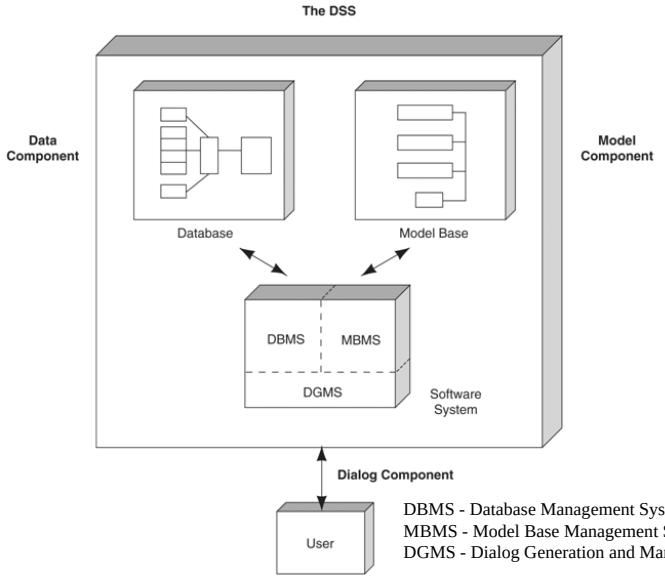
Computer Technologies that Support Decision Making

- Decision Support System (DSS)
- Data Mining
- Executive Information Systems (EIS)
- Expert Systems (ES)
- Agent-based Modeling

What is Decision Support Systems?

- Decision Support Systems (DSS) aims to use IT to relieve humans of some decision making or help us make more informed decisions
  - Systems that support, not replace, managers in their decision-making activities
- DSS are defined as:
  - Computer-based systems
  - That help decision makers
  - Confront ill-structured problems
  - Through direct interaction
  - With data and analysis models

The Architecture for DSS



DBMS - Database Management System
MBMS - Model Base Management System
DGMS - Dialog Generation and Management System

The Architecture for DSS

- The Dialog Component
  - Linking the user to the system
- The Data Component
  - Data sources – use all the important data sources within and outside the organization in the form of summarized data (Date Warehouse & Data Mining)
- The Model Component
  - Models provide the analysis capabilities for a DSS
    - Using a mathematical representation of the problem, algorithmic processes are employed to generate information to support decision making

Types of DSS

- The size and complexity of DSS range from large complex systems that have many of the attributes of major applications down to simple ad hoc analyses that might be called end user computing tasks
- **Institutional DSS** tend to be fairly well defined
  - They are based on predefined data sources
    - Heavily internal with perhaps some external data
  - Use well established models in a prescheduled way
- **Quick-hit DSS** are developed quickly to help a manager make either a onetime decision or a recurring one
  - Can be every bit as useful for a small or large company
    - Example: Excel spreadsheets

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A Taxonomy of DSS

- Model-driven DSS.
- Communication-driven DSS
- Data-driven DSS (Data-oriented DSS)
- Document-driven DSS
- Knowledge-driven DSS

A Taxonomy of DSS

- Model-driven DSS
  - Emphasizes access to and manipulation of a statistical, financial, optimization, or simulation model. Model-driven DSS use data and parameters provided by users to assist decision makers in analyzing a situation; they are not necessarily data intensive.

A Taxonomy of DSS

- Communication-driven DSS
  - Supports more than one person working on a shared task; examples include integrated tools like NetMeeting

A Taxonomy of DSS

- Data-driven DSS (Data-oriented DSS)
  - Emphasizes access to and manipulation of a time series of internal company data and, sometimes, external data.

A Taxonomy of DSS

- Document-driven DSS
  - Manages, retrieves and manipulates unstructured information in a variety of electronic formats.

A Taxonomy of DSS

- Knowledge-driven DSS
  - Provides specialized problem solving expertise stored as facts, rules, procedures, or in similar structures

Motivations of Data Mining

- A promising use of data warehouses is to let the computer uncover unknown correlations by searching for interesting patterns, anomalies, or clusters of data that people are unaware exist
- Its purpose is to give people new insights into data
- Most frequent type of data mined is customer data

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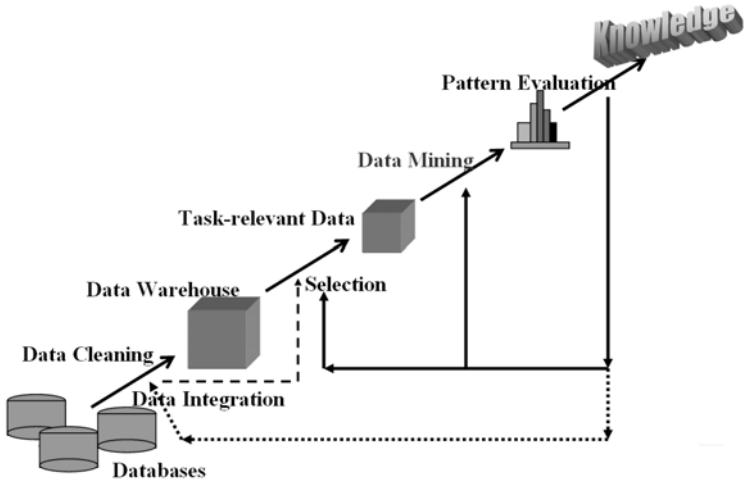
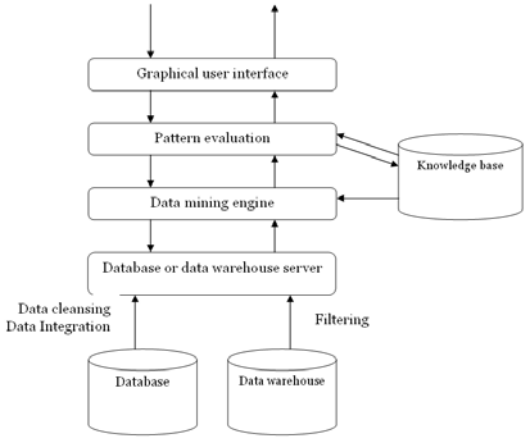
Knowledge Discovery Process

- Data mining is the core of knowledge discovery process



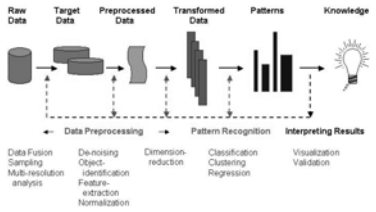
Data Mining

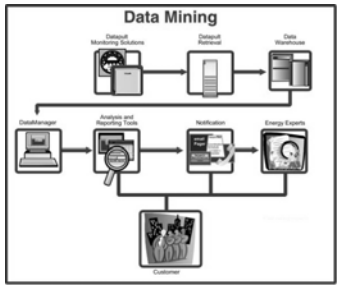
- **Data Mining** attempt to identify relationships between variables in data warehouses in order to assist decision making



Data Mining Techniques:

- **Identifying Associations** – a shopping basket analysis
- **Identifying Sequences** – show the sequence in which actions occurs
- **Forecasting** – using sales histories to forecast future sales.
- **Clustering** – finding groups of facts that were previous unknown
- **Classifications** – patterns





Why Not Traditional Data Analysis?

- Tremendous amount of data (Volume)
- High-dimensionality of data (Dimension)
- High complexity of data (Structure)
- New and sophisticated applications (Application)

Why Not Traditional Data Analysis?

- Tremendous amount of data
  - Algorithms must be highly scalable to handle TB of data

Why Not Traditional Data Analysis?

- High-dimensionality of data
  - Micro-array may have tens of thousands of dimensions

Why Not Traditional Data Analysis?

- High complexity of data
  - Data streams and sensor data
  - Time-series data, temporal data, sequence data
  - Structure data, graphs, social networks and multi-linked data
  - Heterogeneous databases and legacy databases
  - Spatial, spatiotemporal, multimedia, text and Web data
  - Software programs, scientific simulations

Why Not Traditional Data Analysis?

- New and sophisticated applications

Multi-Dimensional View of Data Mining

- Data to be mined
- Knowledge to be mined
- Techniques utilized
- Applications adapted

Multi-Dimensional View of Data Mining

- Data to be mined
  - Relational, data warehouse, transactional, stream, object-oriented/relational, active, spatial, time-series, text, multi-media, heterogeneous, legacy, WWW

Multi-Dimensional View of Data Mining

- Knowledge to be mined
  - Characterization, discrimination, association, classification, clustering, trend/deviation, outlier analysis, etc.
  - Multiple/integrated functions and mining at multiple levels

Multi-Dimensional View of Data Mining

- Techniques utilized
  - Database-oriented, data warehouse (OLAP), machine learning, statistics, visualization, etc.

Multi-Dimensional View of Data Mining

- Applications adapted
  - Retail, telecommunication, banking, fraud analysis, bio-data mining, stock market analysis, text mining, Web mining, etc

Major Issues in Data Mining

- Mining methodology
- User interaction
- Applications and social impacts

Major Issues in Data Mining

- Mining methodology
  - Mining different kinds of knowledge from diverse data types, e.g., bio, stream, Web
  - Performance: efficiency, effectiveness, and scalability
  - Pattern evaluation: the interestingness problem
  - Incorporation of background knowledge
  - Handling noise and incomplete data
  - Parallel, distributed and incremental mining methods
  - Integration of the discovered knowledge with existing one: knowledge fusion

Major Issues in Data Mining

- User interaction
  - Data mining query languages and ad-hoc mining
  - Expression and visualization of data mining results
  - Interactive mining of knowledge at multiple levels of abstraction

Major Issues in Data Mining

- Applications and social impacts
  - Domain-specific data mining & invisible data mining
  - Protection of data security, integrity, and privacy

Executive Information Systems

- The emphasis of Executive Information Systems (EIS) is on graphical displays and easy-to-use user interfaces
- EIS aim to provide both internal and external information relevant to meeting the strategic goals of the organization
  - **Gauge Company Performance**: sales, production, earnings, budgets, and forecasts
  - **Scan The Environmental**: for news on government regulations, competition, financial and economics developments, and scientific subjects

Executive Information Systems

- EIS can be viewed as a DSS that:
  - Provides access to summary performance data
  - Uses graphics to display and visualize the data in an easy-to-use fashion, and
  - Has a minimum of analysis for modeling beyond the capability to **drill down** in summary data to examine components
- EIS and data warehousing technologies are converging in the marketplace
- In many companies, the EIS is called a **Dashboard** and may look like a dashboard of a car
- The term EIS has lost popularity in favor of **Business Intelligence**

Read Case Example P.473

Pitfalls in EIS Development

- Lack of executive support
- Undefined system objectives
- Poorly defined information requirements
- Inadequate support staff
- Poorly planned evolution

Pitfalls in EIS Development

- Lack of executive support
  - Executives must provide the funding, but are the principal users and supply the needed continuity

Pitfalls in EIS Development

- Undefined system objectives
  - The technology, the convenience, and the power of EIS are impressive, but the underlying objectives and business values of an EIS must be carefully thought through

Pitfalls in EIS Development

- Poorly defined information requirements
  - EIS typically need non traditional information sources such as judgments, opinion, external text-based documents, in addition to traditional financial and operating data

Pitfalls in EIS Development

- Inadequate support staff:
  - Support staff must:
    - Have technical competence
    - Understand the business, and
    - Have the ability to relate to the varied responsibilities and work patterns of executives

Pitfalls in EIS Development

- Poorly planned evolution
  - Highly competent system professionals using the wrong development process will fail with EIS
  - EIS are not developed, delivered, and then maintained
    - They should evolve over a period of time under the leadership of a team that includes:
      - The executive sponsor
      - The operating sponsor
      - Executive users
      - The EIS support staff manager, and
      - The IS technical staff

Why Install an EIS?

- Attack a critical business need
  - EIS can be viewed as an aid to dealing with important needs that involve the future health of the organization
- A strong personal desire by the executive
  - The executive sponsoring the project may
    - Want to get information faster than he is now getting it
    - Have a quicker access to a broader range of information
    - Have the ability to select and display only desired information and to probe for supporting detail
    - To see information in graphical form

A Weak Reason to Install an EIS

- The thing to do:
  - An EIS is seen as something that modern management must have, in order to be current in management practices
- The rationale given is that the EIS will increase executive performance and reduce time that is wasted looking for information and by such things as telephone tag

What Should the EIS Do?

- A Status Access System: Filter, extract, and compress a broad range of up-to-date internal and external information
  - It should call attention to variances from plan.
  - It should also monitor and highlight the critical success factors of the individual executive user
  - EIS is a structured reporting system for executive management, providing the executive with the data and information of choice and desired form

Read Case Example P.476

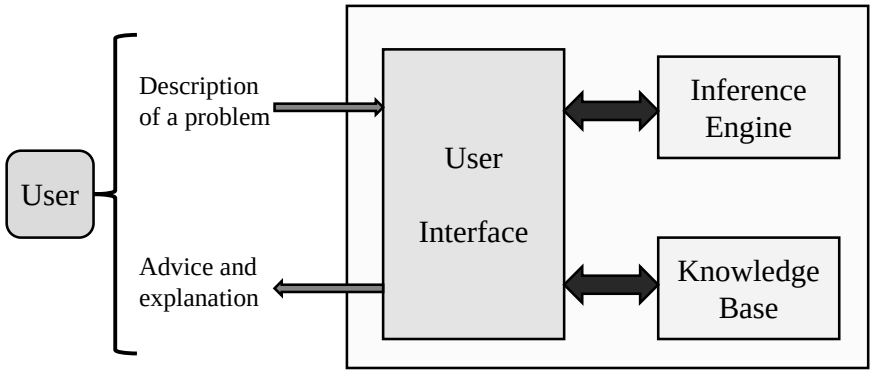
Artificial Intelligence (AI)

- A real-world use of artificial intelligence
  - AI is a group of technologies that attempts to mimic our senses and emulate certain aspects of human behavior such as reasoning and communication
  - Promising for over 40 years.
- Artificial intelligence was adopted throughout the technology industry, providing the heavy lifting for data mining, logistics, medical diagnosis, etc.

Expert System

- An expert system is an automated type of analysis or problem-solving model that deals with a problem the way an "expert" does
  - The process involves consulting a base of knowledge or expertise to reason out an answer based on the characteristics of the problem
- Expert System is a computer-based system composed of:
  - A user interface
  - An inference engine, and
  - Stored expertise (in the form of a knowledge base)
- The inference engine is that portion of the software that contains the reasoning methods used to search the knowledge base and solve the problem

Architecture of an Expert System



Read Case Example P.480-482

Knowledge Representation

- Knowledge can be represented in a number of ways:
  - One is as cases; **case-based reasoning** expert systems using this approach draw inferences by comparing a current problem (or case) to hundreds or thousands of similar past cases
  - A second form is **neural networks**, which store knowledge as nodes in a network and are more intelligent than the other forms of knowledge representation because they can learn
  - Third, knowledge can be **stored as rules** (the most common form of knowledge representation), which are obtained from experts drawing on their own expertise, experience, common sense, ways of doing business, regulations, and laws

Knowledge Representation: Case-based Reasoning

- The process of solving new problems based on the solutions of similar past problems
- A case consists of a problem, its solution, and, typically, annotations about how the solution was derived

Knowledge Representation: Case-based Reasoning

- Case-based reasoning as a four-step process
  - **Retrieve**: given a target problem, retrieve cases from memory that are relevant to solving it
  - **Reuse**: map the solution from the previous case to the target problem
  - **Revise**: test the new solution, if necessary, revise it.
  - **Retain**: After the solution has been successfully adapted to the target problem, store the resulting experience as a new case in memory

Knowledge Representation: Artificial Neural Network

- An interconnected group of artificial neurons
  - Using a mathematical or computational model for information processing based on a connectionistic approach to computation.
  - An adaptive system that changes its structure based on external or internal information that flows through the network.
- Artificial Neural Network can be used to model complex relationships between inputs and outputs or to find patterns in data
  - Non-linear statistical data modeling or decision making tools

Knowledge Representation: Artificial Neural Network

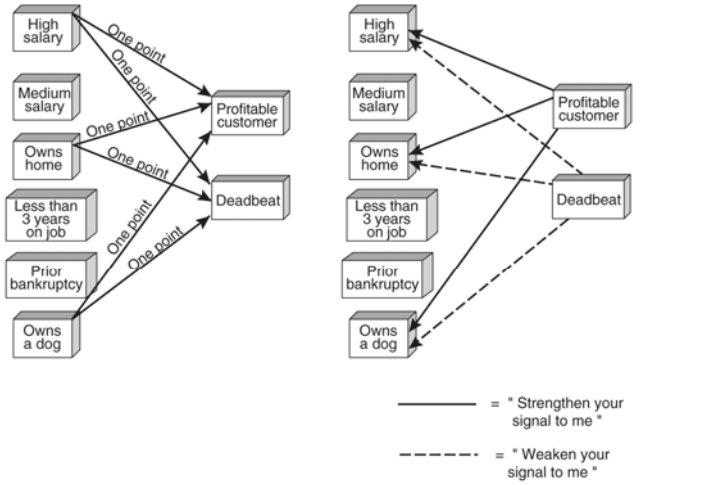


FIGURE 11-2 Training a Neural Network

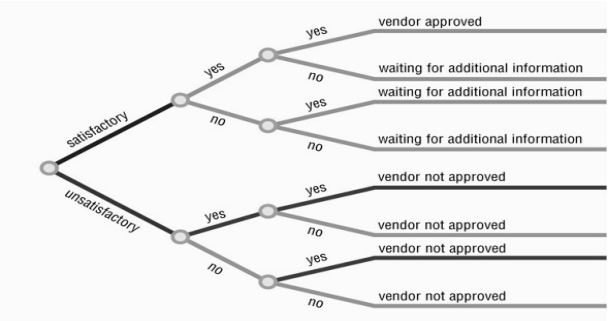
Source: Brian O'Reilly, "Computers That Think Like People," *Fortune*, February 27, 1989, pp. 90–93.

Knowledge Representation: Rule-based Systems

- Knowledge stored as rules
  - The most commonly used form of rules is the if-then statement
  - e.g. IF *condition* THEN *action*

Knowledge Representation: Rule-based Systems

- A rule-based inference model: Decision Tree
  - Each internal node (non-leaf node) denotes a test on an attribute
  - Each branch represents an outcome of the test
  - Each leaf node holds a class label



Degree of Expertise

- As an **assistant**, the lowest level of expertise, the expert system can help a person perform routine analysis and point out those portions of the work where the expertise of the human is required
- As a **colleague**, the second level of expertise, the system and the human can "talk over" the problem until a "joint decision" has been reached
- As an **expert**, the highest level of expertise, the system gives answers that the user accepts, perhaps without question

Agent-based Modelling

- A simulation technology for studying emergent behaviour (e.g. traffic jam) that emerges from the decisions of a large number of distinct individuals (drivers)
  - Simulation contains computer generated agents, each making decisions typical of the decisions an individual would make in the real world
    - Trying to understand the mysteries of why businesses, markets, consumers, and other complex systems behave as they do
- Some examples:
  - Retailer redesign its incentive program
  - Southwest Airlines revamp its cargo operations
  - Company changing its recruiting practices

Toward the Real-Time Enterprise

- Through IT, organizations have been able to see the status of operations more and more toward real time
- The Internet is giving companies a way to disseminate closer-to-real-time information about events
- The essence of the phrase **real-time enterprise** is that organizations can know how they are doing at the moment, rather than have to wait days, weeks, or months for analysis results

Real-time Reporting

- Real-time reporting is occurring on a whole host of fronts:
  - Enterprise nervous systems
    - A network that connects people, applications and devices
    - To coordinate company operations
  - Straight-through processing
    - To reduce distortion in supply chains
  - Real-time CRM
    - To automate decision making relating to customers
  - Communicating objects
    - To gain real-time data about the physical world
    - E.g. radio frequency identification device (RFID)

Enterprise Nervous Systems

- These are the technical means to a real-time enterprise
  - **Message based** – because sending messages is efficient and effective in dispersing information among parties simultaneously
  - **Event driven** – when an event occurs, it is recorded and made available
  - Use a **publish and subscribe** approach – the event is "published" to an electronic address and any system, person, or device authorized to see that information can "subscribe" to that address's information feed, and
  - Use **common data formats** – data formats from disparate systems are reduced to common denominators that can be understood by other systems and hence shared

Read Case Example P.485

Straight-Through Processing

- The notion of a real-time enterprise has generated two “buzzwords”
- One is **zero latency**, which means reacting quickly to new information (with no wait time)
- The second is **straight-through processing**, which means that transaction data are entered just once in a process or a supply chain (like at Delta)
- The goal is to reduce lags and latency in supply chains

Real-Time CRM

- Another view of a real-time response might occur between a company and a potential customer
  - Perhaps via a customer call center or a Website

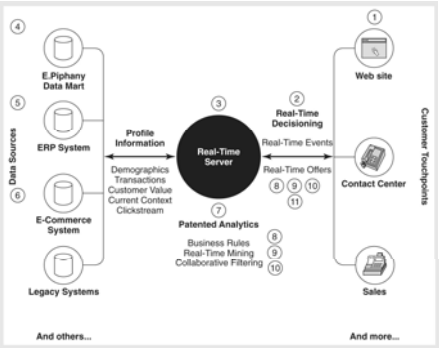


FIGURE 11-3 A Real-Time Interaction on a Web Site

Source: Reprinted with permission of E.piphany, Inc., www.epiphany.com.

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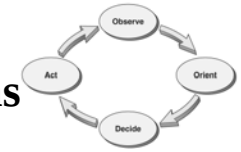
Communicating Objects

- These are sensors and tags that provide information about the physical world via real-time data
- A communicating object can tell you:
  - What it is attached to
  - Where it is located
  - Where it belongs, and
  - A lot more information about itself
- It is a Radio Frequency Identification Device (RFID), also called “smart tags”

Example of Real-time Traffic Control

- In Singapore, cars carry smart tags, and drivers are charged variable prices for where they drive in the city and when
  - The prices are set to encourage or discourage driving at different places at different times
  - Also proposed for Sydney’s new toll ways
- It’s an example of real-time traffic control
- Smart tags will transform industries because they will talk to one another (Object-to-Object Communication), changing how work is handled

Vigilant Information Systems



- The premise of the real-time enterprise is not only that it can capture data in real time, but that it has the means to act on that data quickly
- US Air Force pilot bet he could win any dogfight
  - Never lost a bet, even to superior aircraft
  - Called his theory OODA
    - **Observe** where his challenger's plane is
    - **Orient** himself and size up his own vulnerabilities and opportunities
    - **Decide** which manoeuvre to take
    - **Act** to perform it before the challenger could go through the same four steps

Read Case Example P.491-494

The Dark Side of Real Time

- Object-to-object communication could compromise privacy, since knowing the exact location of a company truck every minute of the day and night can be construed as invading the driver's privacy
  - That's a political issue, not a technical issue, and many CEO are going to face this question in the future
- In the era of speed, a situation can become very bad very fast, so people must be constantly watching for signals that something negative is likely to happen