Decision Support Systems
Semi-structured Decision Modeling

Analyzing Semistructured Decisions

Building Decision Support Systems

Merrill Warkentin
Mississippi State University

Major Topics

- decision-making style
- analytic and heuristic decision making
- decision support systems
- DM process - intelligence, choice, and design
- structured vs. semi-structured decisions
- examples of decisions and DSS
- DSS construction

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Assumption: Rational Decision Making

- based on logical reasoning
- require info about alternatives
- rational choice - "economic man"
- optimization (maximization, minimization)
- exhaustive enumeration (too complex)

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Reality = Bounded Rationality

- limits of human abilities
  - data, processing
  - quickly overloaded, "combinatorial explosion"
- humans "satisfice" (not "optimize")
  - human choices are "good enough"
  - we use "heuristics" (rules of thumb)
  - we "muddle through" (small steps)
- impact on DSS design

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Managers

- make fast decisions with limited data
- prefer verbal media over written
- acquire info informally
- do not think linearly (flexible)
- want to know source of info
- like info filtered and summarized
- value involvement

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Effective Decision Making

decisions are better when we...

- maximize the number of relevant facts
- deal with many influences
- consider long and short-term effects
- test sensitivity of assumptions
- consider the impact of uncertainty

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Decision Making in Business

- information reduces uncertainty
  - related to the openness or closedness of organizational systems
- decision support systems improve decision-making by:
  - adding structure & clarity
  - analyzing data & producing useful information
  - comparing options

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Decision Making

TABLE 1.2 Aids in Decision Making

Phase	Description	Examples of Tools
Early	Compute "crunch numbers," summarize, and organize.	Calculators, early computer programs, statistical models, simple management science models.
Intermediate	Find, organize, and display decision-relevant information.	Database management systems, MIS, filing systems, management science models.
Current	Perform decision-relevant computations on decision-relevant information; organize and display the results; query-based and user-friendly approach; what-if analysis; interact with decision makers to facilitate formulation and execution of the intellectual steps in the process of decision making.	Financial models, spreadsheets, trend exploration, operations research models, computer-assisted design (CAD) systems, decision support systems. Expert systems, executive information systems.
Just beginning	Complex and fuzzy decision situations, expanding to collaborative decision making and machine learning. Using ERP software, the Web, and electronic commerce.	Second-generation expert systems, group support systems, neural computing, knowledge management, Fuzzy logic, intelligent agents, SAP.

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Decision Making Conditions

- certainty
  - decision makers know everything in advance of making the decision
- uncertainty
  - decision makers know nothing about the probabilities or the consequences of decisions
- risk
  - conditions which lie between certainty and uncertainty

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Decision-Making Styles

- analytic
  - information systematically acquired & evaluated
  - methodical, step-by-step procedures
  - quantitative information and models
  - optimal rather than completely satisfying solutions
- heuristic
  - guidelines, "rules of thumb", not necessarily applied consistently or systematically
  - experienced-based
  - learning by acting, using trial and error
  - relying on common sense

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Analytic vs. Heuristic Decision Making

Analytic Decision Maker	Heuristic Decision Maker
Learns by analyzing	Learns by acting
Uses step-by-step procedure	Uses trial and error
Values quantitative information and models	Values experience
Builds mathematical models and algorithms	Relies on common sense
Seeks optimal solution	Seeks completely satisfying solution

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Decision ***S***upport ***S***ystems are

- computer-based systems
- that help decision makers
  - (not replace them)
- confront poorly-structured problems
  - not appropriate for structured problems
- through direct interaction
- with data and analysis models

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Decision Support Systems
Semi-structured Decision Modeling

Decision Support Systems

A class of information systems that emphasize the process of decision making and changing users through their interaction with the system.

(Source: Kendall)

DIRECT INTERACTION

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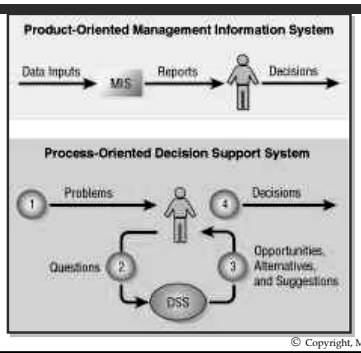
DSS as Process



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Evolution of Systems

Time Sequence

- **mid-1950s** — **Transaction Processing Systems (TPS)**
- **1960s** — **MIS**
- **1970s** — **Office Automation Systems**, **DSS**
- **1980s** — **DSS Expanded**, **Expert Systems**, **Executive Information Systems**
- **1990s** — **Group Support Systems**, **Neural Computing**, **Integrated, hybrid computer systems**

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DSS Components

1. data management module
   - integrated, relational database functions
   - internal and external data
2. model management module
   - applications models, data manipulation
3. dialog (input/output) module
   - report generating capabilities
   - quality graphics features
   - 4th generation, user friendly interface

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1. Data Management Module

- access to data
  - databases & data warehouses
- current & historical data
- internal & external data
  - internal: from business functional areas
  - external: economic conditions, competitors' prices, market trends, etc.

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2. Model Management Module

- set of analytical tools & models
  - statistical, graphical, financial, EOQ models
  - OLAP applications, forecasting techniques, scheduling models, statistical models (e.g., linear regression analysis), etc.
- performs data analysis
- raw data ➔ useful information
- identify trends, test impacts, "what-if"

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3. Dialog Module (User Interface)

- enables user to interact with DSS
  - select data based on certain criteria
  - select models
  - change assumptions, parameters
- user becomes familiar with data
- displays results
  - reports, tables, graphs

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DSS Support

TABLE 1.3 The Support Provided by DSS*

DSS Provides	Answers to Questions
Raw data and status access	What is . . . ?
↓	
General analysis capabilities	What is/why . . . ?
↓ ↑	
Representation models (financial statements), causal models (forecasting, diagnosis)	What will be . . . ? Why . . . ?
↓	
Solution suggestions, evaluation	What if . . . ? Why . . . ?
↓	
Solution selection	What is best/what is good enough . . . ?

*DSS may provide several types of support. The structure above is based on Alter (1980). Each level of support contains and adds to the previous level (but may also contribute to the previous level).

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Types of DSS Support

- explores multiple perspectives of a decision
- generates multiple and higher quality alternatives
- explores multiple strategies
- facilitates brainstorming
- provides guidance and reduction of bias
- increases ability to tackle complex problems
- improves response time
- discourages premature decision-making
- provides control over multiple sources of data

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How Difficult is the Decision?

- structure
  - the more structure, the less info is needed
- cognitive limitations
  - humans can only keep 7 +/- 2 things in head at once
- uncertainty
  - how complete and accurate is the information?
- alternatives and multiple objectives (goals)
  - one choice might be good for some (not all) goals

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Models

What is a model?

Types of Models:

<u>physical</u>
- iconic
- analog

<u>logical</u>
- narrative
- graphical
- mathematical

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Why Use Models?

- to represent & simplify reality
  - understand relationships between factors
- to predict / forecast an outcome
  - based on assumptions (parameters)
  - If we take this course of action, what will happen?

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Why Use Models?

- facilitate understanding
  - simplify
  - show main relationships
  - "assume..."
- predict / forecast
  - an approximation

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Characteristics and Benefits of Mathematical Models

- can do "what-if" analysis
- can express relationships in multiple dimensions
- the symbolic language of mathematics is universal and precise
- computes the same outputs given the same inputs

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Characteristics of a GOOD Model

- simple
- robust
- easy to control
- adaptive / flexible
- complete (in important issues)
- easy to communicate with

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DSS Features & Benefits

- well suited for addressing semi-structured problems
  - add structure to decisions
- organize data/information for decision situations
  - present information for decision-maker understanding
- interact directly with data and business models
  - consider consequences of alternative courses of action
  - use multiple-criteria decision-making models
  - expand the decision maker's horizons
  - informal, ad hoc
- using powerful, easy interface
- see new patterns, relationships, potential actions

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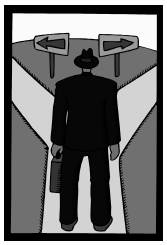
Decision-Making Process Phases

- intelligence
  - decision maker looks for indications that problem exists
- choice
  - alternatives are formulated and analyzed
- design
  - one alternative is selected and implemented



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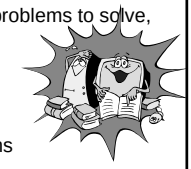
Intelligence Phase

- awareness of problem or opportunity
- involves the decision maker
  - searching the external and internal business environment
  - checking for decisions to make, problems to solve, opportunities to examine
- can be supported by DSS in
  - recognizing problems
  - defining problems
  - determining the scope of problems
  - assigning priorities to problems



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Decision Support Systems
Semi-structured Decision Modeling

Choice Phase

- decision maker chooses a solution to the problem or opportunity
- DSS can help by
  - reminding the decision maker what methods of choice are appropriate for the problem
  - helping to organize and present the information

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Design Phase

- decision maker
  - formulates the problem
  - generates alternatives
  - analyzes the alternatives
- DSS can support by
  - generating alternatives that might not occur to the decision maker
  - quantifying or describing data
  - retrieving data
  - collecting new data
  - manipulating data

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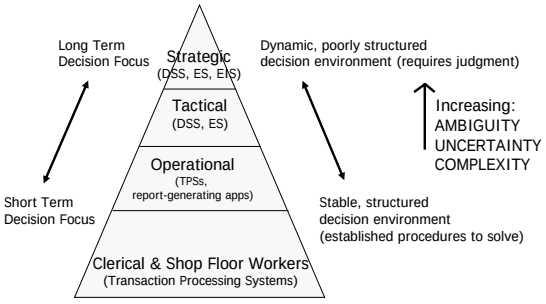
Managerial Hierarchy and MIS



Decisions Structure

- structured decisions
  - all or nearly all the variables are known and can be totally programmed
- semistructured (poorly structured) decisions
  - partially programmable
  - requires human judgment
- unstructured decisions
  - might as well guess

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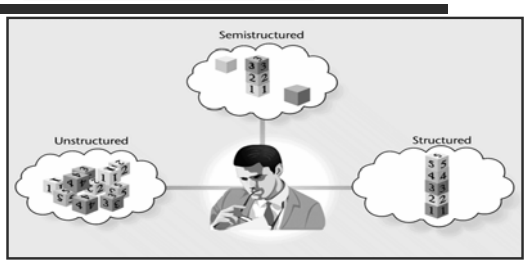
Types of Problems



Source: Oz, Figure 12.2

Unstructured ⟷ Poorly or Semi-structured Structured

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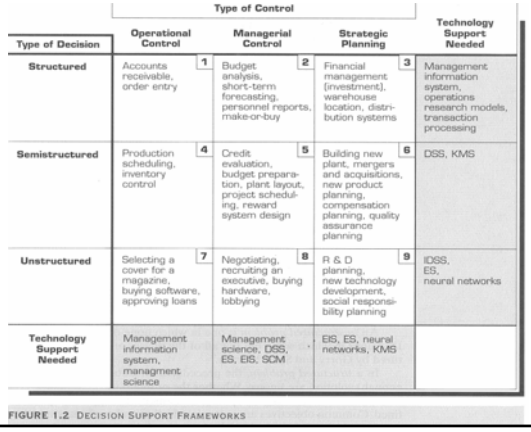

Type of Decision	Type of Control: Operational Control	Managerial Control	Strategic Planning	Technology Support Needed
Structured	1 Accounts receivable, order entry	2 Budget analysis, short-term forecasting, personnel reports, make-or-buy	3 Financial management (investment), warehouse location, distribution systems	Management information system, operations research models, transaction processing
Semistructured	4 Production scheduling, inventory control	5 Credit evaluation, budget preparation, plant layout, project scheduling, reward system design	6 Building new plant, mergers and acquisitions, new product planning, compensation planning, quality assurance planning	DSS, KMS
Unstructured	7 Selecting a cover for a magazine, buying software, approving loans	8 Negotiating, recruiting an executive, buying hardware, lobbying	9 R & D planning, new technology development, social responsibility planning	IDSS, ES, neural networks
Technology Support Needed	Management information system, managment science	Management science, DSS, ES, EIS, SCM	EIS, ES, neural networks, KMS	

FIGURE 1.2 DECISION SUPPORT FRAMEWORKS

Structured Problems

- commonly encountered by operational managers
- repetitive, routine
- can be solved with established, known procedures
- modeled well by Structured English

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Structured Problems

- same parameters ➔ same solution
  - algorithmic, programmable
- operational information systems can be programmed to make operational decisions automatically
  - reduces/eliminates human involvement
  - increases efficiency
- **algorithmic**

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Examples – Structured Problems

- How many workers are needed to staff Line A to meet our delivery deadlines?
- What's the optimal order quantity of Raw Material X, based on our current production?
  - what if production increases by 10%?

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Examples – Structured Problems

- How should we allocate personnel to the various tasks required to complete this project?
- When should we re-stock our inventory of Nike Air Max running shoes?

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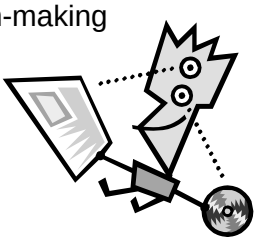
Dimensions of Semi-structured Decisions

- degree of decision-making skill required
- degree of problem complexity
- number of criteria considered



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Poorly Structured Problems

- commonly encountered by tactical and strategic managers
- high degree of uncertainty & ambiguity
  - many factors to consider
  - lots of tradeoffs
  - more than one reasonable alternative
  - optimal course of action is unclear

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Semistructured Decisions in Intelligence, Design, Choice

Intelligence	Design	Choice
Unable to identify the problem	Unable to generate alternatives	Unable to identify a choice method
Unable to define the problem	Unable to quantify or describe alternatives	Unable to organize and present information
Unable to prioritize the problem	Unable to assign criteria, values, weights, and rankings	Unable to select alternatives

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Poorly Structured Problems

- no definitive procedure for solving the problem
  - some analogous history to guide decision maker, but not enough to determine the optimal solution
- difficult to decide!
- need help to analyze
- need judgment, insight

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Examples – Poorly Structured Problems

- which stock portfolio will yield the highest returns over the next 3 years?
- hiring decisions, "lease vs. buy"?
- optimum production level?
- loan application evaluations
- what's the best advertising campaign to launch a new product?

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Unstructured Problems

- decision factors are extremely ambiguous and complex
- novel – no history to guide decision maker
- extremely high degree of uncertainty
- no way to determine the optimal course of action
- might as well guess!

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Poorly Structured Problem – Buying a Car

Multiple-criteria decision-making environment
What are the criteria for buying a car?

- safety
- fuel efficiency
- purchase price
- maintenance costs
- reliability
- function
- power
- handling
- styling
- comfort, ergonomics
- capacity, utility

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Building a DSS for the Car Buying Decision

- can use any software tools that enable you to build models & access data
- spreadsheet is a common tool

Let's build a DSS!

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Sensitivity Analysis

- tests degree to which an outcome is affected by changes in parameters
- What if . . . ?
- which parameters have the biggest impact on the outcome?

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Example – How is the sales forecast impacted?

- original assumptions:
  - $100,000 total advertising budget
  - 20% print, 30% radio, 50% TV
  - open 15 stores in 10 different cities with population of at least 150,000
- model forecasts $6.5M sales in first year

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Example – How do changes in the parameters affect sales?

- What if we increase total advertising budget to $120,000, same media mix?
- What if we spend more on TV commercials & less on radio spots?
- What if we open more than 15 stores?
- What if Dallas instead of Minneapolis?

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High Sensitivity

If a relatively small change in a parameter has a big impact on the outcome

the outcome is **very sensitive** to changes in that parameter

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Low Sensitivity

If a relatively large change in a parameter has a small impact on the outcome

the outcome is **not very sensitive** to changes in that parameter ("insensitive")

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Practice – sensitive?

- Double radio spots
  ➔ sales improve only slightly
- Increase TV budget by 10%
  ➔ sales grow by 65%

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When to Build a DSS

- poorly structured problem
- decision is important
- decision factors are quantifiable
- relevant data are available

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When to Build a DSS

- decision must be made frequently (but each decision is different & cannot be programmed)
  - cost of development must be justified
- significant number of users
- users have time to contribute to the development process

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Review: DSS Components

1. **data management module**
   - integrated, relational database functions
   - internal and external data
2. **model management module**
   - applications models, data manipulation
3. **dialog (input/output) module**
   - report generating capabilities
   - quality graphics features
   - 4th generation, user friendly interface

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Summary

- decision making is not a precise process
- decision makers require information
  - internal, external, reports, queries, etc.
- decision making requires analysis
  - models, graphics, finding trends, etc.
- DSS provide tools
- DSS can change actual decision process

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