Model-Driven Decision Support Systems

Models help us understand business problems

Analysis and Modeling in DSS

- When the model component dominates the DSS design, the system is best referred as a Model-Driven DSS
- Models produce results
- Manipulated directly by managers
- Software used for creating models needs to be linked to any data needed and the user interface

DSS Analysis and Modeling Tools

- Statistical packages
- Forecasting packages
- Modeling and Quantitative Analysis packages
- End-User tools like spreadsheets

Modeling Process

- Identify the problem and analysis of the situation
- Identify the variables and relationships
- Is a model appropriate?
  - What needs to be specified?
  - What solution method is most suitable?
- Is model valid?

Model Assumptions

- Untested beliefs/assumptions
- Static or Dynamic?
  - Static is based on “Single Snapshot”
    - Everything occurs in a single interval
    - Ex: Quarterly or annual income statement
  - Dynamic is used for elapsed time situations
    - Time dependant – when something occurs
    - Ex: Five-year profit projection
- Certainty?

When building a model:

- Examine conditions and make appropriate assumptions:
  - Certainty. Models based on this assumption are easy to work with and can yield “optimal solutions”
    - Financial models are often constructed this way

When building a model:

- Uncertainty. Analysts should attempt to avoid this assumption
  - Try to acquire more information so the model can be built assuming a risk situation
- Risk. Most major business decisions are made with assumptions of risk – use What if analysis

Types of Analyses/Models

- Explanatory – descriptive models
- Algebraic – predictive, show relationships
  - Indicates which values or behaviors across multiple dimensions must be introduced into the model to effect a specific outcome
  - Highest level of user interaction and associated variable data consolidation
  - Manager specifies an outcome and a starting point

Model-Driven DSS May Include Multiple Models!

- A regression model that identifies relationships among variables
- A financial model of an income statement
- An optimization model like linear programming

General Model Problem Types

- Cost-benefit analysis
- Forecasting
- Finance and investment
- Inventory control and stockout
- Location, allocation, distribution
- Manpower planning and assignment
- Project planning and control
- Queuing and congestion
- Reliability and replacement policy
- Sequencing and scheduling

Accounting and Financial Models

- Break-Even Analysis
- Budget Financial Models
- Pro Forma Financial statements
- Ratio Analysis

Decision Analysis

- Decisions are modeled by an approach in which the alternatives are listed with outcomes
  - Single Goal -
    - Approached by the use of a decision table or tree
  - Multiple Goal -
    - Approached by the use of multi-attribute utility analysis and the analytical hierarchy process

Decision Tree

- Advantages
  - Shows graphically the relationships of the problem
  - Can deal with more complex situations

AliahTHINK!

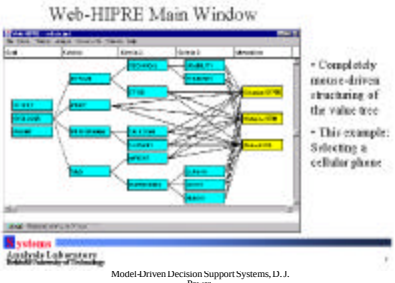
Hierarchy Screen
Graphical display of the hierarchy. Colors represent prioritization type and presence of sub-criteria.

Analytic Hierarchy Process

- Multi-criteria decision technique that can combine qualitative and quantitative factors in the overall evaluation of alternatives
- Step 1
  - Develop the hierarchical representation of the problem.

Step 1 Diagram

http://www.hipre.hut.fi/



Analytic Hierarchy Process

- Step 2
  - Generate relational data for comparing alternatives
- Step 3
  - Use comparisons of step 2 to determine the relative priority of each attribute to each attribute one level up in the hierarchy
- Step 4
  - Priorities are determined

Influence Diagrams

- Provides graphical presentation of a model
  - Rectangle = decision variable
  - Circle = uncontrollable or intermediate variable
  - Oval = result (outcome) variable
    - Intermediate or final
  - Shapes are connected by arrows that indicate specific relationships

Forecasting Models

- Judgement Methods
  - Based on subjective estimates and expert opinion rather than hard data
  - Used for long range where external factors may play a significant role
  - Used when historical data is limited or non-existent
- Time-Series Analysis
  - Set of values for a business or economic variable measured at successive intervals of time
  - Moving average, exponential smoothing

Forecasting

- Regression and Econometric Models
  - Association or casual methods
  - Use data analysis tools like regression to find data associations and cause-effect relationships
  - More powerful than time-series methods
  - $\Psi = b_0 + b_1X_1 + b_2X_2$

Network and Optimization Models

- Linear programs are composed of:
  - Decision variables
  - Objective function
  - Coefficients of the Objective Function
  - Constraints
  - Constraint Coefficients
  - Capacities

LP_SOLVE

http://pinnacle.edrc.cmu.edu:8080/milp.shtml

max: -x1 + 2 x2;
C1: 2x1 + x2 < 5;
-4 x1 + 4 x2 < 5;
int x2,x1;

Simulation Models

- Special type of modeling tool that imitates reality
  - Involves testing of specific values of decision or uncontrollable variables and observing impacts on output variables
    - Descriptive rather than a normative tool
    - Describes and/or predicts the characteristics of a given system under different circumstances
    - Needed for very complex problems

Advantages of Simulation

- Theory is easy to understand
- Model is simple
- Allows “What - if” questions
- DSS managers work directly with managers
- Model is built for one problem, and will only solve the one it was designed for
- Allows inclusion of real life complexities of problems, simplifications are not needed

Disadvantages of Simulation

- Optimal solution cannot be guaranteed
- Constructing a model is slow and costly
- Solutions are not transferable to other problems

Simulation Methodology

- Problem definition
- Constructing the simulation model
- Testing and validating the model
- Design the experiments
- Conducting the experiments
- Evaluation of the results

Types of Simulation

- Probabilistic
- Time Dependant vs. Time Independent
  - Is the time frame important to your experiment?
- Visual Simulation
  - Graphic display of computerized results
  - Animation facilitates explanation

Modeling Languages and Spreadsheets

- Spreadsheet history
- End user built DSS

Questions?

- What are the major types of models used in Model-Driven DSS?
- What are the advantages of developing and using models in a DSS?
- What is the role of statistical analysis in DSS?
- Why use simulation?