The following text addresses some of the techniques from which entities may choose when defining, characterizing, and solving a problem or when making a decision. Additional information on many of these techniques can be found in the data analysis section of the Methodology.

ATTRIBUTE LISTING

Attribute lists enumerate all essential parts and features of the problem, cause, or effect under consideration. Participants then use these lists to systematically analyze the effect(s) of changing a given attribute (Gleim, p. 383). Attribute lists help characterize a problem or solution, particularly when elements vary in importance. For example, service response time may be more critical than service cost to EMS teams, in which case the attribute "time" would be weighted more heavily in problem-solving than the attribute "cost."

BALANCE SHEET ANALYSIS

Balance sheets divide a piece of paper into two halves onto which are written separate lists of the pros and cons of the various alternatives. They often resemble force-field analysis and can help move a group toward a decision (Governor's Center for Management Development, p. 6-58).

BLAST/REFINE

Blast/Refine is improvisational problem-solving and decision-making. It completely disregards (blasts away) any existing approach. An entirely new problem solution is then sought that will attain the original objectives. This technique is often used by the U.S. Navy (Gleim, p. 383).

BRAINSTORMING (GROUP CREATIVITY)

Brainstorming is a highly popular and effective group approach to idea generation, largely because its unstructured nature encourages creativity. Brainstorming relies on the spontaneous contribution of ideas from all members of a group in either a free-wheeling or round-robin fashion (Governor's Center for Management Development, p. 6-44). Ideas are then recorded for the entire group to see. Brainstorming follows four basic rules (Bittel, pp. 215-216):

- To reduce inhibition, ideas are not critiqued when presented.
- Free association is welcomed. Ideas need not be reasonable or logical.
- Quantity takes precedence over quality. The longer the list of ideas, the more likely that some of them will be useful.
- Combinations and variations are encouraged. Participants can build on each other's ideas to stimulate a chain of inspiration.

BRAINWRITING

Participants write their own ideas on a sheet of paper and then exchange their paper with other participants to build on the ideas of others and generate entirely new approaches (Governor's Center for Management Development, p. 6-47).

CREATIVITY

Creativity generates solutions that may not be reasonable or logical. The creative process has four stages (Bittel, p. 215):

- <u>Preparation</u>: Participants become fully informed about the problem and its causes and expose themselves to both traditional and non-traditional sources of ideas.
- <u>Incubation</u>: Participants allow the information gathered in the preparation stage to lie fallow for some period of time.
- <u>Insight</u>: Participants gain understanding of the problem, its causes, and possible solutions, often in a spontaneous manner.
- <u>Verification</u>: Participants test their insights against problem causes.

**CAUSE-EFFECT
ANALYSIS
(FISHBONE ANALYSIS)**

Cause-effect analysis is a systematic way of looking at effects and the causes that create or contribute to those effects. Effects can be problems or desired conditions. Steps in this process include (Governor's Center for Management Development, pp. 6-26 ff.):

- Write the effect to be analyzed on the right-hand end of a board or sheet of paper. This is the fish's head.
- Draw a horizontal line backwards from the head across the paper with several bones sloping to the left above and below this line.
- Write the main factors contributing to the effect at the end of these bones.
- On each bone, write the factors the group considers to be the causes.
- Identify the most significant factor(s), and collect additional data to verify causal relationship to the effect.

**CONTINGENCY
PLANNING**

Contingency planning uses alternative sets of assumptions about future circumstances to stipulate different management actions depending on the assumptions made. Contingency planning allows for forecasting error and lets entities better prepare for future change in its operating environment. (Gleim, p. 387).

**COST-BENEFIT
ANALYSIS (CBA)**

In CBA, both the costs and benefits of each alternative are estimated, and the costs for each are subtracted from the benefits for each to give net benefit. The alternative with the greatest net benefit is chosen for implementation. The idea is to optimize performance of an activity at minimum cost (Gleim, p. 383).

DECISION MATRIX

Decision matrices are closely related to paired comparisons but do not use the number of votes in each comparison to determine by how much one alternative is preferred to another. Rather, if item A is more important than item B, an "X" is placed in the box under item A. Once each alternative is evaluated against all others, the number of "X's" for each alternative is tallied to give a final relative ranking. Such matrices are useful when a large number of alternatives require priority ranking (Morrisey, pp. 78-82).

DECISION TREE

Decision trees are graphic portraits of the choice and evaluation steps of a problem-solving process. It shows how each alternative solution branches into various possible outcomes. When each possible outcome in the decision tree is assigned a probability, each branch of the tree (each decision choice and related events that follow) can be assigned a payoff value. The payoff values of the branches can be compared to determine which solution yields the best results. Decision trees enable participants to visualize the cumulative effects of a particular decision and calculate the payoff of a whole series of if-then statements (Bittel, p. 223).

DELPHI TECHNIQUE

Participants submit opinions to a group leader who summarizes them and feeds them back to the participants without revealing participants' identities. This process is repeated until opinions converge on an optimum solution. The Delphi technique is often used when time, distance, or circumstance prevent participants from convening in a single group. Since participants remain anonymous, this technique largely avoids the "groupthink" which can occur in more interactive group decision processes (Gleim, p. 383).

EDISONIAN METHOD

This refers to classical trial-and-error, experimental problem-solving. Due to its iterative nature, it may not be effective in limited-resource environments unless other approaches have not been successful (Gleim, p. 383).

FAILURE MODE AND EFFECT ANALYSIS

Failure mode and effect analysis involves identifying all events (failure modes) that might contribute to a system breakdown, including documentation of the various routes by which those events could cause a failure. Once this is complete, the effects of each failure and the steps leading up to it are listed. Finally, fault tree analysis (a variation of the decision tree) is used to estimate the likelihood of any given failure mode.

FAULT TREE ANALYSIS

This variation of the decision tree graphically depicts how subsystems depend on each other and the effect one subsystem's failure has on other subsystems. Once constructed, the fault tree is filled in with the probability that individual controls will fail to detect subsystem failure under a given set of circumstances (Morgan, pp. 33-34).

FLOWCHART

Flowcharts depict the inputs, activities, decision points, and outputs of a given process. Flowcharts use standard symbols connected by arrows to show how the system or work process operates and the order in which activities are completed. Flowcharts can be used to check the logic of a planned solution by following all possible routes through the chart to ensure that possible contingencies are addressed (Governor's Center for Management Development, p. 6-73).

FORCED RELATIONSHIP

This is a structured adaptation of free association. The elements of a problem are analyzed, and the associations among them are identified so as to detect patterns that may suggest new ideas (Gleim, p. 383).

FORCE-FIELD ANALYSIS

Force-field analysis identifies the forces that both help and hinder closing the gap between present circumstances and desired future states. To use this technique, participants should (Governor's Center for Management Development, p. 6-29):

- Draw a line down the center of a sheet of paper to represent the as-is situation.
- At the right edge of the paper, draw a second vertical line to represent the desired future state.
- Identify and list the helping forces to the left of the center line and the hindering forces to the right of the center line.
- Use arrows pointed at the center line of different lengths and/or different width to depict helping and hindering forces.

FREE ASSOCIATION

When freely associating, participants report the first thought coming to mind in response to a given stimulus. The idea is to express ideas without self-censorship or control. Free association is an element of brainstorming (Gleim, p. 383).

GANTT CHART

Gantt charts are bar charts with time on the horizontal axis and task assignment on the vertical axis. Task duration is represented by a bar running horizontally across the body of the graph from the starting date to the ending date of the task. Moving vertically up the chart on a given date reveals how expected and actual performance compare, which tasks should be in process on a given date, and how close to completion a task is on a given date (Gleim, p. 386).

Thus, Gantt charts document the tasks, activities, responsibilities, and schedule required to complete a project or implement a solution. Though the form can vary, all Gantt charts show what is to be done, by whom, and by when. Such charts can also document the assumptions used in planning or implementation (Governor's Center for Management Development, p. 6-75).

HISTOGRAM

A histogram is a specialized type of bar chart. Because of its immediate visual impact, a histogram is highly effective for summarizing and displaying data (Governor's Center for Management Development, p. 6-31).

IDEA CHECKLIST

The idea checklist is designed to enhance creativity by asking such broad questions as (Bittel, p. 217):

- Can old methods be modified or used in new ways?
- What can be copied or adapted to this problem?
- Can we break up, reduce, or omit something from this problem?
- Can we rearrange or redefine this problem?

LIMITING FACTOR ANALYSIS

This technique assumes that realizing a goal or solution to a problem will be limited by (at least) one crucial factor which, when known, can be used to reduce the number of alternatives (Gleim, pp. 383-384).

LINEAR PROGRAMMING (LP)

LP allows participants to arrive at optimal solutions when problems require the allocation of scarce resources amid constraints. LP is particularly useful when trying to determine the best location for a building, the most efficient system for delivering goods to multiple service sites, or similar problem solutions (Bittel, p. 224). LP defines the problem via a system of linear equations which, when solved simultaneously, seeks to satisfy an objective function (usually maximize revenue or minimize cost) subject to constraint equations (dollars, time, space, and so on). LP rarely completely recreates a problem, but it does provide useful approximations (Gleim, p. 384).

LIST REDUCTION

List reduction is used to process output from brainstorming so as to clarify alternatives and reduce them to a manageable number. The first step is to clarify all alternatives in a raw listing. Then the group identifies criteria which must be met for an alternative to remain under consideration. Alternatives are kept on the list only if they meet the criteria, as often determined by majority vote. Deleted items are bracketed rather than crossed out so the group can reconsider them if necessary. Criteria may be tightened until the list is manageably short (Governor's Center for Management Development, pp. 6-57).

MONTE CARLO METHOD

Monte Carlo incorporates random behavior into an otherwise deterministic computer model so as to simulate the uncertainty inherent in real-world situations. This model is run several times to establish average performance and average variability (Gleim, p. 385).

MORPHOLOGICAL MATRIX ANALYSIS

This technique plots decision variables along the axes of a matrix. This matrix can then be used to identify, characterize, and assess the relationships between these variables (Gleim, p. 383). Such analysis can help participants grasp a multi-variate problem and anticipate effects arising from the interaction of variables.

MULTIATTRIBUTE UTILITY (MAU)

MAU can be used to choose from among competing viable solutions to a problem. In MAU, numerical weights are assigned to each of the criteria (attributes) used to evaluate the possible solutions. These weights indicate the relative importance of each criterion. For example, if cost and response time are not equally important, they would get different weights. Each alternative solution can then be evaluated by adding its respective weights. The alternative with the highest (or lowest) score is then chosen for implementation.

Though MAU can be arbitrary, subjective, and complex, it is useful for distinguishing between alternative solutions, especially if participants realize that the solution chosen may still be a compromise (satisficing) alternative (Bittel, pp. 218-219).

NOMINAL GROUP TECHNIQUE (NGT or THE SLIP METHOD)

NGT is similar to brainstorming except that (Bittel, p. 217):
- A specific cause is posted in writing for the entire group to see.
- Each participant writes possible solutions on a card or slip of paper and passes them to the group leader.
- The group leader posts all possible solutions received.
- The group evaluates all possible solutions in open discussion.

OPERATIONS RESEARCH (OR)

OR seeks to find optimal solutions by applying such classical tools as statistics, simulation, linear programming, and other scientific and mathematical techniques. OR is really an overall approach which involves (Gleim, pp. 383-384):
- recognizing the system and interrelationships of a problem
- formulating a mathematical model
- testing the model
- implementing the optimal solution produced by the model

PAIRED COMPARISON

Paired comparisons help groups quantify preferences. Each alternative goes head-to-head against each other alternative in a matrix format, and participants vote for the alternative they prefer in each case. The number of votes for each alternative is recorded, and the totals for each alternative are tallied to identify the alternative preferred by the group (Governor's Center for Management Development, p. 6-70).

PARETO ANALYSIS

Pareto analysis is based on the familiar 80-20 rule and is designed to reveal inequalities. Data elements in each category are arranged in order and displayed with bars which depict the most significant causes or effects on the left and less significant causes in descending order toward the right (Governor's Center for Management Development, pp. 6-34 ff.).

PAYOFF TABLE

Participants estimate the probability of a given outcome and then use a table to indicate how these estimated outcomes would pay off if they came true. For example, if the entity has a 10 percent chance of servicing 100,000 clients next year, the payoff is 10,000 since 10 percent of 100,000 is 10,000. Similarly, if a 25 percent chance exists of servicing 200,000, the payoff is 50,000 (200,000 x .25 = 50,000). The entity can then add these payoffs to estimate how many clients it might serve next year (Bittel, p. 222).

PERT AND PERT/CPM (NETWORK)	PERT is an acronym for "program evaluation and review technique" and is primarily used to manage time and cost, particularly on complex projects. A PERT chart (or network) shows all the events that must occur for the entire project to be completed on time. Each leg of the chart is an event or task, including an estimate of the time required for completion. The chart establishes a strict priority relationship among tasks. PERT charts may include three estimated time frames -- best, worst, and average.

The critical path method (CPM) identifies which tasks have a direct effect on the completion of the entire project. A critical path is the string of vital tasks with the longest total completion time. Thus, PERT/CPM gives information on the effect of a delay in one task on the whole project and reveals where slack may appear to help reduce the critical path (Gleim, p. 386).

To make a PERT chart (Governor's Center for Management Development, p. 6-77):
- Identify all required activities.
- Determine which activities are dependent on other activities.
- Estimate the time required for each activity.
- Sequence the activities on paper with time moving from left to right.

PERT/COST	PERT/Cost applies costs to all activities on a PERT or PERT/CPM chart to allow examining any change in terms of both time and costs (Gleim, p. 386).
PIE CHART	Pie charts display the relationship of each part to the whole. The 360 degrees of a circle (the pie) represent 100 percent. The pie is divided into slices proportionate to each component's contribution to the entire problem or effect (Governor's Center for Management Development, p. 6-36).
RATIONAL ANALYSIS	Rational analysis systematically reviews existing, reasonable, and logical solutions to address each cause of a problem. It includes both primary research through direct observation, survey, or interview and secondary research through books, periodicals, or other sources. The idea is to determine how similar problems were solved and adapt such solutions to the present problem (Bittel, p. 215).
RISK RANKING (RISK ASSESSMENT MATRIX)	Risk ranking is covered on pages 1-C-20-26 of the Hub manual.

SATISFICING

The term "satisficing" combines the words "satisfy" and "suffice" and refers to a decision or solution which, though not optimal, is still good enough to meet the demands of the situation (Gleim, p. 383). Satisficing recognizes that entities often may lack the resources needed to fully identify, characterize, and solve a problem.

SIMULATION AND GAME THEORY

Simulations are computerized models that simulate actual and possible future conditions. They allow participants to test and measure how well their decisions might work under varying sets of circumstances. Simulation is used when an optimization model is not possible, as when the number of variables exceeds the number of equations describing the variables. To be effective, simulation requires a quantitative model which incorporates most features of the problem situation (Gleim, p. 384).

Game theory uses probability and other statistical methods to enable participants to try out different strategies to see what might happen (Bittel, p. 224).

STRATIFICATION

Stratification involves breaking a problem or decision into smaller, more manageable pieces. It facilitates reviewing, combining, and eliminating the elements of a complex problem. (Gleim, p. 383).

TIME CHART

Time charts display change over time and help summarize both occurrences of a situation and cause-effect relationships between two variables. The horizontal axis represents time, and the vertical axis represents frequency. Plotted points are usually connected via a solid line (Governor's Center for Management Development, p. 6-37).

WEIGHTED VOTING

Weighted voting quantifies the preferences of group members. No decision criteria are used, and votes are simply recorded. No discussion or effort to reach agreement takes place. Weighting occurs by giving each person more votes to cast than alternatives to consider. For example, giving six votes to each person to decide among four alternatives makes it possible to cast all six votes for one alternative, thereby possibly weighting the outcome of the voting (Governor's Center for Management Development, p. 6-69).

RESOURCES
Articles

Morgan, M. Granger. "Risk Analysis and Management." *Scientific American* 269:1:32-41, July 1993. Location: Methodology Project Information Resources Folders.

Books

Bittel, Lester R. "Problem-Solving, Decision-Making, and Innovation." In *The McGraw-Hill 36-Hour Management Course*. New York, NY: McGraw-Hill Publishing Company, 1989. Location: Methodology Project Information Resources Folders.

Governor's Center for Management Development. "Problem-Solving Process." In *Management of Managers: Training Materials*. Austin, TX: Office of the Governor, 1991. Location: Methodology Project Information Resources Folders.

Gleim, Irvin. "The Decision-Making Process for Planning." In *CIA Examination Review: Course Outline,* Volume I, 5th Edition. Gainesville, FL: Gleim Publications, 1991. Location: Methodology Project Information Resources Folders.

IMPAQ Organizational Improvement Systems. *IMPACT Thinking: Course Materials*. Orange, CA: IMPAQ Organizational Improvement Systems, 1993. Location: Methodology Project Information Resources Folders.

Morrisey, George. "Decision Matrix." In *Management by Objectives and Results in the Public Sector*. Reading, MA: Addison-Wesley Publishing Company, 1974. Location: Methodology Project Information Resources Folders.

Data Bases

A search of the UTCAT on-line data base at The University of Texas' Perry-Castañeda Library reveals the following:

- decision analysis
    - 219 books
    - 72 articles in academic periodicals
    - 142 articles in business periodicals
- decision-making
    - 1400 books
    - 735 articles in academic periodicals
    - 765 articles in business periodicals
- problem-solving
    - 639 books
    - 511 articles in academic periodicals
    - 299 articles in business periodicals

Note: Do a TK (title keyword) search in UTCAT to find books. Do a PK (periodical keyword) search in the academic or business periodical index to find articles.

Human Resources

The following SAO staff members have specialized training or ongoing interest in problem-solving or decision-making:

Employee	Title
Jarrett Oliver Johanna Peavy, CPA Tony Rose, CPA	Regulatory Effectiveness Project Team
Rachel Cohen, CPA Linda Lansdowne, CPA Sheila McNaney Bruce Truitt	Module Writers/Editors
Barbara Hankins, CPA Jeannie Henderson, CPA Randy Townsend, CPA	Reviewers

Periodicals

Decision Sciences
Published bimonthly by the American Institute for Decision Sciences
Location: The University of Texas, Perry Castañeda Library (HD 69 D4 D3248)

Executive Strategies
Published semimonthly by the National Institute of Business Management
Location: SAO Library

Governing
Published monthly by Congressional Quarterly, Incorporated
Location: SAO Library

Harvard Business Review
Published bimonthly by the Harvard University Graduate School of Business
Location: SAO Library

Innovations
Published monthly by the Council of State Governments
Location: SAO Library

Intergovernmental Perspective
Published quarterly by the U.S. Commission on Intergovernmental Relations
Location: SAO Library

Journal of Management Education
Published monthly by Sage Publications
Location: SAO Planning Office

Management Decision
Publish Monthly by MCB Publications (UK)
Location: The University of Texas, Perry Castañeda Library (HD 28 M2826)

Managerial and Decision Economics
Published bimonthly by Heyden & Son
Location: The University of Texas, Perry Castañeda Library (HD 30.22 M35)

On Achieving Excellence
Published Monthly by the Tom Peters Group
Location: SAO Library

Organizational Behavior and Human Decision Processes
Published monthly by Academic Press
Location: The University of Texas, Perry Castañeda Library (BF 636 A1 O7)

Public Administration Review
Published bimonthly by the American Society for Public Administration

Location: SAO Library

Public Manager
Published quarterly by Bureaucrat, Incorporated
Location: SAO Library

State Government News
Published bimonthly by the Council of State Governments
Location: SAO Library

Urban Institute Policy and Research Report
Published monthly by the Urban Institute
Location: SAO Library