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Using Software Applications
to
Facilitate and Enhance Strategic Planning

by

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13. ABSTRACT *(maximum 200 words)*This thesis is an evaluation of current computer software applications and their use in strategic planning. Military and business strategy are reviewed and discussed and the premise for sharing ideas between communities is proposed. The concepts of cognitive mapping and analytic hierarchy process, while not recent developments, will still be new to many readers of this thesis. A discussion of the strengths, weaknesses and capabilities of each approach is presented. Each of these approaches is also used as the basis for the two computer software applications which are discussed and evaluated in the thesis. Cognitive mapping, with its concepts linked by relationships to form a network map, is used by Graphics COPE to structure the problem being considered by a planning group. The Analytic Hierarchy Process, using multi-variable criteria, is capable of "what if" analysis and goal seeking to choose among alternatives during a planning process. The planning process, and where these two fit into it, will be discussed step by step. Rationale for considering using this process will be discussed, as will the reasons for using computers in support of military strategic planning. And, advice will be given to those military analysts and planners who feel the need to search for computer applications to help them do their job.

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Using Software Applications to Facilitate and Enhance Strategic Planning

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ABSTRACT

This thesis is an evaluation of current computer software applications and their use in strategic planning. Military and business strategy are reviewed and discussed and the premise for sharing ideas between communities is proposed. The concepts of cognitive mapping and analytic hierarchy process, while not recent developments, will still be new to many readers of this thesis. A discussion of the strengths, weaknesses and capabilities of each approach is presented.

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EXECUTIVE SUMMARY

This thesis is designed to aid military strategic planners in their efforts to improve their planning capability. Whether they are looking for a strategic planning model to employ, a computer application to automate their process, or simply assistance in the decision making portion of the cycle, it is covered here. As military budgets continue to dwindle, prudent planning and wise use of assets will be the highest priority for military planners. These efforts can be greatly aided by computer applications and an issue-driven planning process.

In an effort to help the busy planner, evaluations on two strategic planning computer software applications are offered in this thesis. Graphics COPE is a window environment software package that is designed to help structure problems through the use of cognitive mapping and is considered a group decision support system. Cognitive mapping and COPE are more fully explained in the Thesis. Expert Choice is a decision support software which uses The Analytic Hierarchy Process created by Dr. T.L. Saaty. It can do inferencing and rank ordering of multi-attribute variables to choose among decision alternatives.

The names of additional software packages, with their company addresses, are included in the appendix to aid further interest. The list is small in comparison to many other business software applications that are available on the market, but it is felt that more design of strategic planning packages will be undertaken in the near future. Many of these companies will send demonstration disks upon request.

The proliferation of the personal computer on the desktops, and in the homes, of many military members--sometimes even the commanding officer--has lead to greater awareness of the power and capability of the PC. This awareness has lead to the search for software applications that will enable a shrinking personnel pool to accomplish many of the same tasks previously done by more people. This thesis offers advice on features to search for, what steps in the strategic planning process are supported, and what the user can be expected to do with the packages.

The military has several options as it enters this period of downsizing and declining budgets. The one proposed in this thesis is to work smarter, in essence *more effectively* and *more efficiently*, by tapping into the capabilities of the computer. Using the computer not to replace the decision making process of humans, but rather to use the power of the computer to supplement and complement the thinking of humans. This thesis does not provide answers to all of the questions. That is not its aim. Its aim is to arm the reader with a process, some knowledge and to point in the right direction.

I. INTRODUCTION

A. PURPOSE

The research questions this thesis set out to answer are: (1) what computer software capabilities are currently available to strategic planners, and (2) how can they be used by military strategic thinkers and planners?

The authors chose two software packages and evaluated their features, capabilities and limitations. This smaller subset of packages, from those available, was used to evaluate whether or not software packages could be of any use in a strategic planning process. Graphics COPE, the first package evaluated, deals more with problem structuring--setting the problem up. Expert Choice, the second package evaluated, provides the means to choose from alternatives--after the problem is set up.

Our aim is to provide the reader with the background and technical information necessary to evaluate the use of computer applications in support of strategic planning. There are volumes of background information which we did not have the space to include. Likewise, it would be possible to delve even more deeply into the technical side of computers and their software applications. Again, this is not our aim. The reader should be comfortable with the level of information presented here. Should a more in-depth study be stirred, the references provide more information on the major topics.

B. STRUCTURE

The thesis is divided into four sections: Strategic Thinking and Planning, Strategic Thinking with Computers, Graphics COPE, and Expert Choice. These chapters will lay a foundation for strategy and its military and business uses; show how the power of computers can be used to aid the decision making process; and provide details of the capabilities of Graphics COPE and Expert Choice and their use by strategic planners.

Strategic Thinking and Planning provides a background in military strategy, business examples of strategy and the distinctions between the two. It discusses how the military has borrowed concepts from business in the past and it presents an eight-step strategic planning process for use by the military. This is Chapter II in the thesis.

Strategic Thinking with Computers defines Decision Support and Group Decision Support Systems and how they facilitate storing and using data to support decision making. Prominent approaches to the design of strategic planning software are discussed and two of the approaches--problem structuring and multi-attribute analysis--are discussed in detail in Chapter III.

Graphics COPE is a computer software application which is very useful in supporting the problem structuring function. Concepts and issues that participants can verbalize are entered into the computer. Concepts which are related to each other are linked and a cognitive map is constructed by the computer. This process--along with the capabilities, strengths and weaknesses of the software--will be discussed in Chapter IV.

Expert Choice is based on the Analytic Hierarchy Process and is a multi-attribute software package which formulates the problem into a hierarchy by breaking it down into related elements. From there, the user is allowed to conduct comparisons to seek solutions to the problem. This approach and its capabilities, strengths and weaknesses are discussed in Chapter V.

C. REFERENCE TO LITERATURE

Although there are only a small number of strategic planning applications available, and the scope of this thesis considered an even smaller subset of that number, their mention in the literature has steadily increased over the last three years. Buede (1991) feels the greatest deficiency in these applications is the problem structuring ability. We feel that this is because the designers of strategic planning applications either (1) already have the problem structured in their own mind and do not need this assistance, or (2) have always been handed this information and do not realize the muddy, swirling waters of the political process which must be navigated to achieve a well-structured problem.

Dr. Dennis Buede (1991), has done the most exhaustive evaluation that we came across in our literature search. Our efforts to learn the two packages discussed here mirrored his discussion of their ease of use. Graphics COPE, the first package evaluated, is probably easier to use in its Windows format than its older DOS version, but it is not what is termed "user friendly." Expert Choice, the second package, was much easier to negotiate and enter variables. But then again, the problem is well-defined and structured before it is in a form that Expert Choice can accept.

II. STRATEGIC THINKING AND PLANNING

The study and development of strategy consumes the efforts of military and business planners alike. Each strives to gain the edge over their competitors by formulating and implementing successful strategies. Sometimes there is crossover of successful processes or philosophies from one discipline to the other. To discuss how computers can assist in strategic planning, we must define military and business strategy, cite examples of each and discuss how they differ. With the proper foundation laid, we can discuss the use of business software applications in the military strategic planning process. Bryson's (1988) Strategic Planning Process will be proposed as model because of its relative ease of use for large public bureaus.

A. BACKGROUND

1. The long tradition of strategy formulation

Strategic thought and philosophy have progressed and evolved through the centuries until today there are as many disciplines as there are disciples willing to take up the cause. From military strategy to strategic planning to strategic issues management, the spectrum subdivides and branches out into a field spanning from corporate boardrooms to the smallest warfighting unit in the armed services.

a. Military examples of strategy

Military applications of strategy and its study have a long, documented past. This study has traveled from Sun Tzu, and his ancient Chinese writings, to modern strategies considering the use of nuclear missiles versus conventional war--or at the other end of the spectrum, trying to define the low-intensity conflict and its myriad variations. There is a rich historical base of military operations on which strategists can study, dissect, and theorize. Successful military operations down through the centuries have depended on their leaders to be well versed in strategy and its effective implementation.

Written well over two thousand years ago, "The *Tao-te Ching*, or *The Way and Its Power*, applies the same strategy to society that Sun Tzu attributes to warriors of ancient times:"

> Plan for what is difficult while it is easy, do what is great while it is small. The most difficult things in the world must be done while they are still easy, the greatest things in the world must be done while they are still small. (Sun Tzu 1988, p. 2)

A quick analysis of this Taoist logic reveals its basic wisdom--that it is best to plan now for the rough times ahead and when this planning is done, accomplish those necessary tasks while they are still relatively easy. The Taoist philosophy suggests that it becomes harder to plan when tasks are upon you and presenting conflicts for resolution.

A more recent example of military strategy is embodied in War Plan Orange. This was a Naval effort, aided some by the Army, undertaken for over 40 years to script the inevitable war in the Pacific with Imperial Japan. The Orange Plan consisted of a three-phase plan to deal with Japan's aggression in the Pacific during what became World War II. The assumption may be made that this planning was done at the highest levels and then sent down the chain of command for compliance. But, as is normally the case in the military, and increasingly so in the corporate world, "Orange Plans more often reflected the personal convictions of talented midlevel officers who were recruited for the elite duty than the dicta of higher authorities ." (Miller 1991, p. 8)

How successful was this military strategy? "The Orange Plan, fallacious in every detail of large naval encounters, was nevertheless correct in strategic principle." (Miller 1991, p. 355) It incorrectly predicted: the preeminence of battleships and gun battles, a one-ocean, two-nation war, and the number of ground troops which were involved, yet these divergences did not "negate the validity of the plan, which was *implemented almost in its entirety in the course of the war."* (Miller 1991, p. 5, emphasis added)

Miller (1991, p. 9) best sums up the American military way of planning by quoting a chief of naval operations 40 years after the war. "A robust plan, he observed, flows best from 'plurality of perspective and the resulting competition of ideas. . . . The process may be somewhat untidy, but it is distinctly American. It works.' " Planning done at levels below the top has been done by the military for many years and does not seem to differ very much from what some in the corporate world are striving toward.

b. Business examples of strategy

Businesses too, have been involved in strategy making since the late 1950's when a more systematic approach to doing business was invented (Ansoff 1984). Two examples of business applications of strategy are *generic* and *competitive* strategies (Mintzberg 1991). An example of a generic application would be a forecast from the planners that gas-guzzling cars would no longer be in demand in ten years. The message to the car manufacturers would be: shift your efforts to more economical cars. Here the threat would be to all car manufacturers--not to a particular car company or competitive position but to the generic mission. To counter that threat, the manufacturer would devise a plan with the long-range aspects being given prime consideration. The second application of strategy is that the firm must compete with other firms in the market which is called *competitive* strategy. Using our car manufacturing example, it would detail which strategy would enable one firm to gain a competitive advantage over another in manufacturing economy cars. (Mintzberg 1991)

Thompson (1984) provides an illustration of a corporation which worked both its long-term strategy and its competitive strategy to its advantage. Pillsbury, in evaluating its strategic situation in 1973, found itself holding some low-growth, cyclical business interests when a new chairman of the board assumed power. By the end of the decade they had divested the low-growth companies and acquired several dominant food manufacturers holding the number one or two position in fast growing areas. The *long-term* strategy was to focus direction on becoming an international food company.

One acquisition, Green Giant, even helped Pillsbury to gain supermarket shelf space for its less widely distributed lines and improve its *competitive* strategy against its competitors. With their restaurant business they used a "grow-and-build strategy" to improve the competitive standing of Pillsbury-owned Burger King, Steak and Ale, and Poppin Fresh Pie Shops. Their goal was to double the number of outlets and triple earnings. One successful example was the Steak and Ale restaurants growing from

52 outlets in 1973 to 165 outlets in 1978. Pillsbury is an example of a corporation which worked its long-term and competitive strategies effectively.

2. How military and business strategy diverge

a. Military strategy focuses on the battle

Military strategy, although mostly looking long range, is not the same as organizational strategic planning. Military strategy has various definitions. The *American Heritage Dictionary* defines it as, "the science and art of military command as applied to the overall planning and conduct of large-scale combat operations." Clausewitz distinguished it from tactics as follows, "Tactics constitutes the theory of the use of armed forces in battle; strategy forms the theory of using battle for the purposes of war." (Paret 1986)

In comparison, Carl Builder (1989) considers strategy as a "concept for relating means to ends." He believes military strategy takes two forms:

- In war or contingency plans, the means are existing military forces and the ends are those military objectives which political leaderships might authorize in the event of a conflict.
- In force planning, the means are taken to be future military forces and the ends are the expected purposes for which those military capabilities are to be acquired. (Builder 1989, p. 53)

Thus, whatever definition is used, military strategy focuses much more on the warfighting capability and war planning of our force levels than on any organizational planning.

b. Business strategy focuses on organizational capability

Bryson defines *strategic planning* as: "a disciplined effort to produce fundamental decisions and actions that shape and guide what an organization is, what it does, and why it does it." (1988, p. 20) Building more on this definition, organizational strategic planning involves assessing an organization, figuring out what it needs to do, developing a plan to do that and then implementing that plan. A corporation conducts strategic planning to help it identify threats against its place in the market and opportunities which it wants to exploit to gain a higher market share and return on investment. It wants to use strategic planning to be able to react to market changes by having a plan with built-in flexibility--a mechanism which allows it to shift its competitive strategy and not scuttle the generic aspects of its long-term plan.

An effective argument could be made that the Department of the Navy, not realizing the difference between generic and competitive strategies, was caught when the Union of Soviet Republics was disintegrating as a threatening conventional military force. During this historic period, in an article entitled, "The Way Ahead," the military chiefs of the Navy and Marine Corps wrote that although the "winds of change" were blowing throughout the world, "our fundamental interests remain unchanged," leading one observer to comment that "The Way Ahead," "looked and sounded a lot like the past." (George 1992, p. 29)

Competitive strategy is something all military planners understood for the past 45 years of the Cold War as we tried to match or better the Soviet Union's military. In being overly concerned with the competitive strategy, however, we may have missed out on some important generic strategies--for which we need an *organizational* strategic planning process.

When one looks at the changes that have taken place in recent global politics and the economic fluctuations which have caused deficit pressures here in the states, the military needs to look to organizational strategic planning to complement its military strategic planning to ensure that is has organizational *resources* and *capabilities* to meet its missions. The business world is rich with examples of strategy formulation and implementation which have been successful, from which the military can borrow.

B. THE MILITARY BORROWS FROM BUSINESS

1. PPBS

The military has recognized the need for organizational strategic planning in the past. A good example of the military adoption of a process from the business sector was Robert McNamara's introduction, as Secretary of Defense, of the Planning, Programming and Budgeting system into DoD. The PPBS was supposed to be, "an advanced version of strategic planning." (Ansoff 1984, p. 188)

Keller (1990) states the purpose of the PPBS was "to produce a plan, a program, and, finally a budget for the Department of Defense." This budget was then to be forwarded to the president for approval and submission to congress for authorization and appropriation.

McNamara, as Kennedy's Secretary of Defense, introduced this notion of a program budget after the Rand Corporation had developed it the previous decade (Keller 1990). Before this time, the SecDef had not been involved in the services' budgeting process other than to split up the total appropriation for DoD. McNamara saw this process as an avenue to provide department-wide guidance on strategic issues and, of course, their funding.

The PPBS was an attempt by McNamara to directly link defense expenditures to missions. It also introduced guidance from the secretary in an attempt to get the service budgets heading generally in the same direction.

2. PPBS not delivering strategic planning

While McNamara was in office, PPBS was introduced and used mostly as intended. Once he left his position, however, PPBS lacked a champion. It reverted to simply a budgeting system. Programs were tied to line items in the budgeting process--and costs were calculated years out in the future.

The main reason PPBS failed as a strategic planning process was the failure to convince leaders that it was either useful or doable. Klay (1989, p. 437), for example, cited a study by Doh (1971) which found, "that those federal agencies that exhibited the greatest effort to adopt PPBS were those in which senior leaders saw advantages to themselves or to their agencies in doing so." In the instances where it failed, many felt it was a threat to their authority. "A key element of both strategic planning and strategic management is the repeatedly expressed intent to serve the needs of top officials." (Klay 1989, p. 437) A process which is formulated by threatening top leadership instead of serving them is less likely to be utilized.

It will never be known if PPBS could have been an effective strategic planning approach for DoD. What is known is that there was never any attempt to enlist the participation of leadership in a manner which might foster ownership or commitment (Klay 1989). It exists today, with each administration making its own changes to it, as a functional budgeting tool--providing value in the process but not to the extent envisioned at its inception.

3. Search continues for strategic planning approaches and tools

Since PPBS failed as an effective strategic planning tool, DoD continues its search for other business approaches as substitutes. For some, the substitutes are quality management techniques. For others, it is the use of strategic management. For still others, it is the application of computer technologies to aid in organizational planning. There are many alternatives in business from which to choose, but the avenue we wish to explore in the thesis is the use of computers and software to facilitate organizational strategic planning. To help the reader understand how computers can support the planning process, we first must acquaint the reader with the basic steps of strategic planning. That becomes the focus of the next section.

C. BASIC STEPS IN STRATEGIC PLANNING

There are many different models of organizational strategic planning: long range planning (Ansoff 1984), comprehensive strategic management (Frederickson 1983), and incremental strategic planning (Mintzberg 1991). Each has its advantages and disadvantages. (See Byrson 1988, Ch. 2 for a review) We have chosen Bryson's model as our starting point because it has several attractive features for DoD organizations.

1. Bryson's strategic planning model easier to use

Bryson's model relaxes the requirements of comprehensive strategic planning and management which are difficult to implement in large public bureaus. It deals instead with issues as they surface rather than attempting to link all organizational decisions in a hierarchy of goals. Public organizations usually cannot afford the time and effort necessary to do a full strategic planning process every time an issue becomes strategically important. Even full-blown annual reviews are too time consuming for management. Most firms are conducting comprehensive strategy revisions about five years apart and are filling in the gaps by identifying and resolving the key strategic issues that emerge from their analyses (Bryson 1988).

2. Considers political issues

Unlike most models, Bryson's model takes into account the political context of public bureaus. Given our system of governance, policy and strategy formulation are not the province of one person. Many people are involved in the process and myriad views must be taken into account. Thus, public bureaus operate in an arena of shared power. This occurs because historically, the executive branch and congress must share in the policy-making process. For example, the secretary of defense, in formulating strategy for the DoD, does not control his own budget, his personnel, or even his organizational structure. He sets DoD policy with the president, congress and their staffs.

3. Focus is on managing change

Eadie (1989, p. 173) defines a *strategic issue* as: "a problem or opportunity that, if action is not taken *now*, is likely to saddle the organization with unbearable future costs." The purpose of strategic issues management is to provide balance between an organization and its environment. Selective issues are chosen and dealt with as they surface opposed to a comprehensive planning process which links decisions through a rational, formal procedure (Roberts 1991). Strategic issues management focuses on, "developing and managing a *change agenda*, whose basic result is the maintenance of a favorable balance between organization and environment." (Eadie 1989, p. 171)

Strategic issues management (Eadie 1989, p. 171) involves:

- identifying and selecting strategic issues;
- formulating strategies to address the issues;
- and managing implementation of the strategies.

Most strategic plans are done with the realization that benefits are in the future and that the process will be a long-term commitment--five to seven years is the estimate from Ansoff (1984, p. 199). Bingman (1989) singles out DoD as a candidate for strategic issues management, but says it has yet to catch on. Eldridge writes, "Currently, there are few reasons for government managers to apply the principles of strategic (issues) management. After all, implementing change is both difficult and threatening." (1989, p. 333)

4. Bryson's model for strategic issues management[1]

Bryson's eight-step model of strategic planning (see Figure 2-1).

1. Initiating and agreeing on a strategic planning process.
2. Identifying organizational mandates.
3. Clarifying organizational mission and values.
4. Assessing the external environment: opportunities and threats.
5. Assessing the internal environment: strengths and weaknesses.
6. Identifying the strategic issues facing an organization.
7. Formulating strategies to manage the issues.
8. Establishing an effective organizational vision for the future.

Figure 2-1. Bryson's eight-step strategic planning process

Step 1. Initiating and Agreeing on a Strategic Planning Process. The initiator of this process must decide who the key decision makers are, inside and outside the organization, and get their consensus on the "purpose of the effort, preferred steps in the process; the role, functions, and membership of the strategic planning team; and commitments of necessary resources to proceed with the effort." Identifying which decision makers and groups will be involved in the planning process is the next task.

Step 2. Clarifying Organizational Mandates. These are things that an organization must do. Bryson believes that many organizations fail to fully understand their mandate. This is usually not a problem for a DoD organization because of its strong mission-oriented environment, but clarification of the organization's mandate is

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[1] Although this process will be laid out in a linear fashion--the steps appearing to happen in succession--they are actually part of an iterative process, which can have multiple steps occurring simultaneously. Also, implementation may actually begin before all of the steps are completed.

important to ensure that all participants in the process understand their mandate and support it.

Step 3. Clarifying Organizational Mission and Values. "An organization's mission, in tandem with its mandates, provides its *raison d'être,* the social justification for its existence." Organizations must always be the means to an end, not an end themselves. For a DoD organization this could be providing security for American embassies, training entry-level servicemenbers, or providing humanitarian assistance in a struggling nation.

A *stakeholder* analysis should be conducted by the organization prior to the mission statement being written, "because the key to success in public and nonprofit organizations is the satisfaction of key stakeholders." A stakeholder is defined as, "any person, group, or organization that can place a claim on an organization's attention, resources, or output, or is affected by that output." Members of congress, the president, and the taxpayers would all be considered stakeholders for DoD organizations.

Step 4. Assessing the External Environment. "The planning team should explore the environment outside the organization to identify the opportunities and threats the organization faces." The focus should not be only on the threats, as many organizations do, but also on the positive gains to be realized from opportunities. These opportunities and threats often are not monitored by organizations. Consequently they lose track of what is happening in the larger world which might effect the organization. For a DoD organization this might take the form of community concern over a planned base expansion or closure, or the effects on the civilian populace of conducting training at night.

Step 5. Assessing the Internal Environment. Strengths and weaknesses are what the organization should be concerned with internally. Information is needed on resources such as personnel, equipment and training areas. Organizations sometimes find it hard to get a clear picture of what their *present* strategy is--not necessarily what is documented, but what is actually the practice. Measuring performance is difficult for most DoD organizations as most mission outputs do not yield quantitative results. Yet, even though this step is difficult, the DoD will continue to be challenged to prove its effectiveness and efficiency as a military force. An absence of performance criteria by which to grade units may also cause more serious organizational conflict--thereby degrading unit readiness.

Step 6. Identifying the Strategic Issues Facing an Organization. The first five steps culminate in this step. "Strategic planning focuses on achievement of the best 'fit' between an organization and its environment." Organizations need to respond quickly to strategic issues or they will find that they have lost the advantage of an opportunity or been hurt by a threat.

> Strategic issues, virtually by definition, involve conflicts of one sort or another. The conflicts may involve ends (what); means (how); philosophy (why); location (where); timing (when); and the groups that might be advantaged or disadvantaged by different ways of resolving the issue (who). In order for the issues to be raised and resolved effectively, the organization must be prepared to deal with the almost inevitable conflicts that will occur.

The statement of the strategic issue should contain three elements:

- A single paragraph description of the issue--framed as a question which the organization can do something about.
- A list of the factors which makes the issue a policy question.
- A definition of the consequences of failure to address the issue.

Bryson provides three basic approaches to identifying strategic issues:

- The direct approach
- The goals approach
- The "vision of success" approach (Barry 1986)

The *direct approach* involves going straight from a review of the mission; strengths, weaknesses, opportunities, and threats (SWOTs); and mandate, to identifying strategic issues. Bryson evaluates this approach as having the best application for governments and public agencies--when there is no agreement on goals. It is best when no one authority figure in the hierarchy can impose goals on the other members.

"The *goals approach* is more in line with (comprehensive strategic planning), which stipulates that an organization should establish goals and objectives for itself and then develop strategies to achieve them." When there is traditional authority at the top of the structure which can impose goals on others, then the issues will involve how best to translate goals and objectives into actions. This approach is seen as having applicability to nonprofit or a single-function public organization.

The *vision of success* is where the organization visualizes its "best" picture of itself in the future and then moves from where it is now to that vision. This process works best when it will be difficult to identify goals and objectives. It is seen as having the most relevance for a nonprofit organization.

Step 7. Formulating Strategies to Manage the Issues. Bryson likes to use a five-part strategy development process as follows:

- Identifying the practical alternatives and visions for resolving the strategic issues.

- List the barriers to achieving those alternatives and visions.
- Develop major proposals to achieve the alternatives and vision and to deal with the barriers.
- Identify the actions necessary to implement the proposals (two to three years).
- Spell out a detailed work plan to implement the actions (six to 12 months).

Strategies must also be evaluated for their effectiveness based upon political, cultural, social, ethical, moral and legal factors prior to their implementation.

Step 8. Establishing an Effective Organizational Vision for the Future. This description of what an organization should look like can include such things as core values, unit mission, evaluation criteria and important rules and regulations. When this description is well known by the employees of an organization it frees them to act on their own initiative in positive ways.

Most organizations are unable to generate a vision of success until they have gone through several iterations of the planning process. "A challenging yet achievable vision embodies the tension between what an organization *wants* and what it *can have.*" (Bryson 1988, p. 61) This tension is what occurs when we as individuals stretch our current realities and attempt to move toward our personal vision (Senge 1990). Organizations want vision that motivates and spurs people to action but not so daunting that it demoralizes them into nonaction (Bryson 1988). Figure 2-2 (page 21) represents Bryson's model.

I skate to where I think the puck will be. *Wayne Gretzky*

Bryson (1988) uses this quote to illustrate his concept of strategic thought. While Gretzky's quote seems common sense, Bryson feels it is an example of his planning process. In the context of the strategic planning process just outlined, the comment takes on a fuller meaning. To skate to where the puck is, Gretzky has to know the rules of the game, the potential moves of the players, the playability of the ice, the way the puck moves over the ice and how fast he is. He has to consider the threats, opportunities, strengths and weaknesses of both teams; the environment; an appropriate vision (winning perhaps); and what the issues are facing his team. He does many of these simultaneously--skipping some--and all the while iterating through the process continuously until the game's end. To those who would say that Grtezky engages in tactics, adapting Clausewitz's (1976) definition of strategy and tactics reveals this--*Tactics constitutes the theory of the use of hockey players in controlling the puck; strategy forms the theory of using the puck to win the game.*

The two primary challenges instituting this strategic planning process, as with any under consideration, will be managing the information needed to support the process and formulating the decision process with a complex set of stakeholders. Assistance in managing the information is offered in Chapters IV and V of this thesis.

A. CONCLUSIONS

This chapter has set a foundation for strategic thought and planning which can be used to evaluate the use of computer applications to assist planners. Chapter III will discuss the various ways computers can assist humans in mapping thoughts, choosing alternatives and making decisions. It will also introduce approaches currently being used in the business world to accomplish some of the tasks inherent in strategic planning, as well as the two packages that this thesis will evaluate.

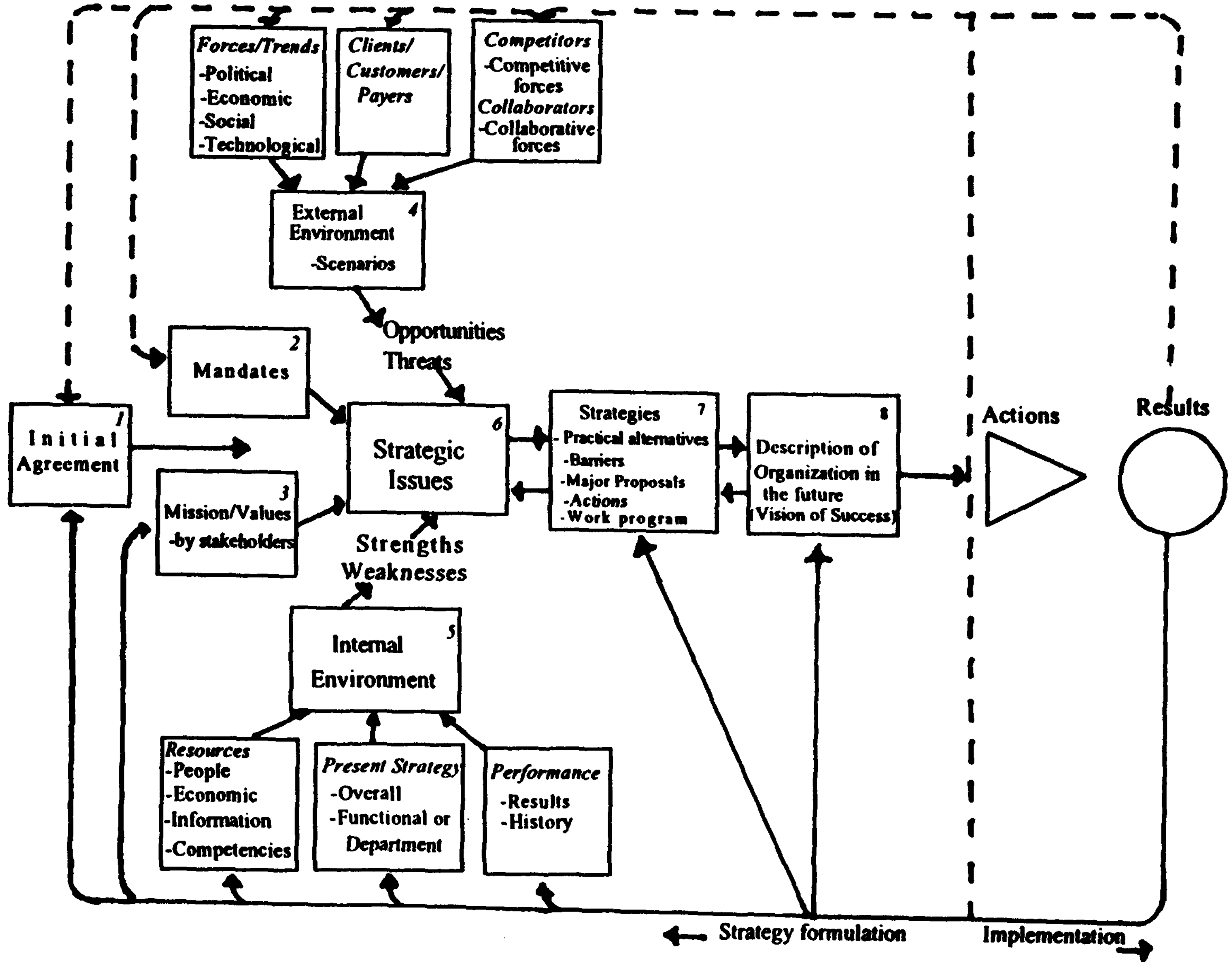


Figure 2-2. Bryson's strategic planning process.

III. STRATEGIC THINKING WITH COMPUTERS

As computer programs for business applications continue to enter the market in larger and larger numbers, there exists a larger pool of possible applications for use by government and Department of Defense (DoD) agencies. As the availability of microcomputers has proliferated to the desktops of managers and commanders, so has the demand for applications which can assist in an assortment of tasks--whether it be daily reminders, word processing or strategic planning.

How do management support systems work and how might they assist in strategic planning? This chapter will discuss decision support systems, cognitive mapping with computers, the analytical hierarchy process, and introduce the two software applications evaluated in this thesis--Graphics COPE and Expert Choice.

A. DSS/GDSS

1. DSS and GDSS defined

Decision Support Systems (DSS) and Group Decision Support Systems (GDSS) have become valuable tools for decision makers and strategic planners. A Decision Support System is an interactive information system that relies on an integrated set of user friendly hardware and software tools to produce and present information targeted to support management in the decision making process (Long 1990, p. 288). A

Group Decision Support System is a DSS that can facilitate solutions of problems by a set of decision makers working together as a group (Turban 1990, p. 834).

The four major characteristics of a DSS are:

- they incorporate both data and models;
- they are designed to assist managers in the decision making process of semistructured or unstructured tasks;
- they support, rather than replace, managerial judgment; and
- they are designed with the objective of improving the effectiveness of the decisions that are made, rather than the efficiency with which they are made. (Turban 1990, p. 9)

A DSS supports decision making. It is not designed to replace a decision maker's judgments, but rather it is a tool which should support them. DSS are designed to support decision making processes involving semistructured and unstructured problems. It is a set of decision support tools that can be adapted to any decision environment. It makes general-purpose models, simulation capabilities, and other analytical tools available to the decision maker. It provides rapid responses to a user's request for information and has the capability of interfacing with the corporate data base (Long 1990, p. 290).

With advances in technology and the continually increasing use of personal computers both at home and in the office, the DSS is becoming a popular planning and decision making tool. Decision makers at tactical and strategic levels are often confronted with complex decisions that are affected by factors that are beyond a human's ability to properly synthesize. These are the types of decisions where a DSS should be utilized (Long 1990, p. 289).

2. Major components of a DSS

A DSS is comprised of three major components: Data Management, Model Management, and the Communication or Dialog subsystem. The Data Management component includes the database of relevant information and the database management system that manages it. The Model Management component is the software that includes the quantitative models that provide the system's analytical capabilities. The Communication or Dialog subsystem is the system that allows the user to communicate with and command the DSS.

The *data management subsystem* is composed of a DSS database, a database management system, a data directory, and a query facility (Turban 1990, p. 119). The DSS database is an organized collection of data that is relevant to the needs and structure of the organization. The database is created, managed, accessed, and updated by a set of software programs known as the database management system. The data directory is a list of all data, including data definitions, in the database. The query facility of the data management subsystem provides a means for the user to access the data. A query language is used to request, select, and manipulate data.

The *model management subsystem* of the DSS contains a model base that consists of financial, statistical, managerial, and other quantitative models. These models provide the DSS with analytic capabilities. Three types of models in the model base are: strategic, tactical, and operational (Turban 1990, p. 119).

Strategic models are broad in scope and generally cover a time frame of several years. They are used to support top management's strategic responsibilities. Developing corporate objectives, planning for mergers and acquisitions, nonroutine capital budgeting, and environmental impact analysis are examples of strategic model applications (Turban, p.119).

Tactical models are often used by middle management of an organization to assist in allocating and controlling resources. They cover a time frame of one month to less than two years and are usually only applicable to an organizational subsystem. Labor requirement planning, sales promotion planning, plant layout determination, and routine capital budgeting are examples of tactical model applications (Turban, p.120).

Operational models help first-line managers with decision making in a daily to monthly time frame. They support day-to-day activities. Production scheduling, inventory control, and quality control are examples of operational model applications (Turban, p. 120).

The *communication, or dialog, subsystem* of the DSS contains the hardware and software that provide the system with a user interface. The user interface allows for bi-directional communication between the DSS and the user. The user interface is an extremely important component of the DSS. An effective user interface provides for good human-machine interaction and a system that is easy to use or "user friendly." When the user interface is ineffective or poorly designed, managers become reluctant to use and rely on the DSS (Turban, p. 124).

Figure 3-1 shows the capabilities and characteristics that are provided by the three major components just described. (Turban 1990, p. 111).

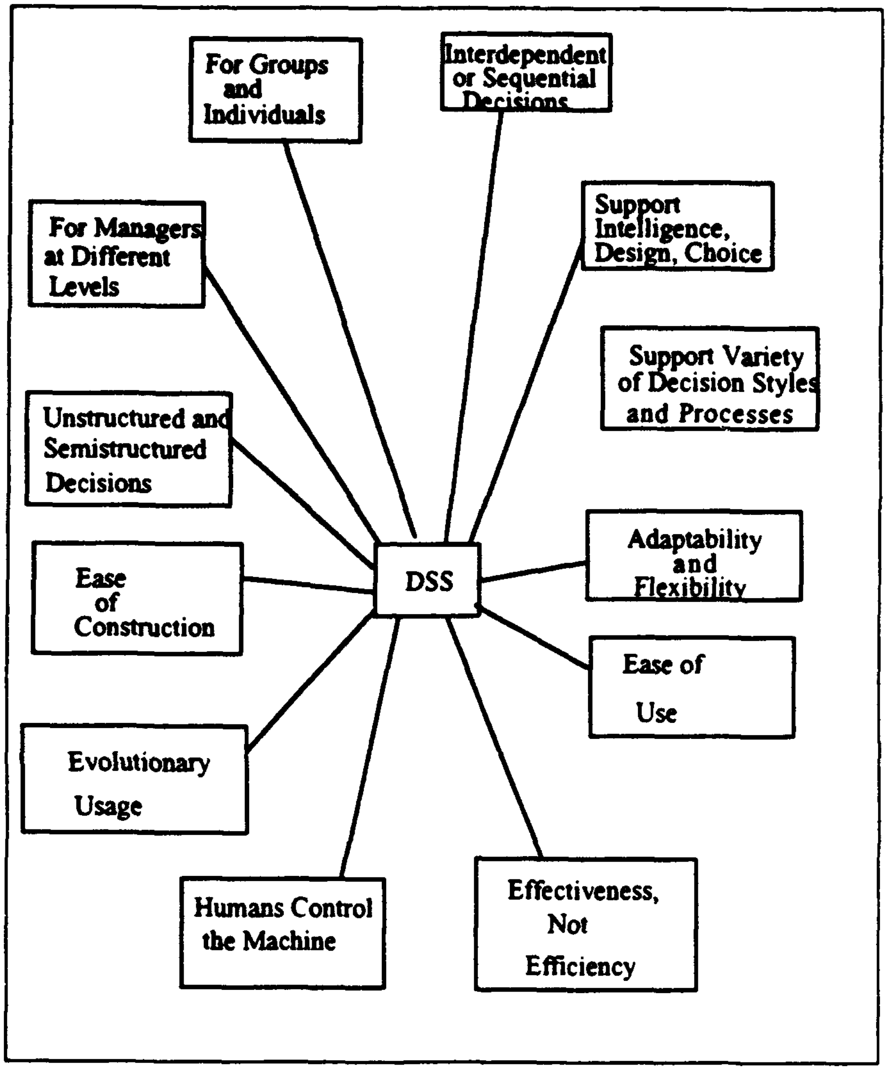


Figure 3-1. DSS Capabilities

3. Benefits of using DSS/GDSS

"Today's global economy dictates that a world class enterprise have a rich decision making process." (Dyer, p. 1). Decision support methods and tools are used to gather and process data, and also to assist with the task of mapping large amounts of information to help the decision maker arrive at the best possible solution.

Information is critical to the decision making and strategic planning processes. As situations become more complex, greater amounts of data and information must be considered. Extensive amounts of time must be spent obtaining and analyzing the information before any planning can be done or a decision can be made. As more competing factors and alternatives are added to the decision process, more investigation is required by an organization before a decision can be reached or a solution is obtained. As factors relating to the situation change, the outcome of the process is sure to be affected.

DSS enable managers to use modeling techniques for structuring the information associated with complex problems. They provide statistical analysis tools that can be used for such common applications as risk analysis and trend analysis (Long 1990, p. 93).

DSS provide the decision maker with the opportunity to engage in "what if" scenarios to determine what effect a change in one or more decision variables will have on the outcome. Some DSS provide the ability to "goal seek" or determine that value of a decision variable that will attain the goal that is desired (Forman 1992, p. 125). These qualities give the user the ability to try several different strategies under various situations and configurations, quickly and objectively. This gives the planner the ability to explore various forecasts for the future.

DSS provide tools for presenting data in a variety of reports and graphical forms. This feature facilitates communication between levels of management in an organization (Long 1990, p. 91). Many DSS also possess the capability to link or consolidate data from other software. Some other benefits of a DSS include the ability to quickly recall ideas and information to allow a problem to be revisited, and the ability for uncovering the justification for conclusions and recommendations through the use of an audit trail (Buede 1991, p. 19).

Many organizations have been successful using DSS for a variety of applications. Some of the most common applications come in the areas of marketing, financial planning, resource allocation, engineering, manufacturing and operations. Less work has been done in the area of strategic planning. This is probably because the area is less well-defined and the payoffs are not as visible, measurable, or immediate as in the areas listed above (Mockler 1989, p. 104).

4. Strategic planning software design approaches

Strategic planning is a very difficult task for today's managers. The fact that it involves all functional areas of an organization and many outside factors, along with uncertainties of the future, makes it an unstructured decision situation and a candidate for DSS applications (Turban 1990, p. 106). A DSS can help ensure completeness, increase productivity, and enhance the communication process in any organization (Buede 1991, p. 19).

As stated earlier, there has not been as much software development in the strategic planning arena as there has been in other business areas. But planning and allocating of scarce organizational resources--personnel, capital and time--becomes more important and use of personal computers more prevalent, more applications will be developed.

Beude (1991) classifies decision theory software into five categories:

- *Structuring*--packages that support only the problem-structuring function that precedes the analysis function.
- *Multi-attribute utility analysis*--packages that automate the hierarchical structuring of evaluation criteria, assignment of weights to criteria and scores to options, and computation of weighted scores across all criteria.
- *Value matrix*--packages that assist the user in creating a matrix of options and criteria for the purpose of developing a weighted score for each option across all criteria.
- *Decision tree*--packages that support the analysis of uncertainty, values, and risk for multiple, sequential decision options.
- *Inference*--packages that support only the probabilistic analysis of nested or sequential events. (Buede 1991, pp. 25,26)

The first software analyzed in this thesis is Graphics COPE. It is considered a problem structuring application, and although it has no analytical analysis capability, it could assist in forming a model that could be analyzed by other packages (Buede 1991). Buede considers it "a powerful structuring tool for the *trained* analyst." (1991, p. 41, emphasis added)

Expert Choice, the second software package evaluated, is considered a multi-attribute utility analysis package. Its multiple elicitation aids, one-way sensitivity analysis, rational storage and several other features are considered excellent (Buede 1991). It does no problem structuring.

A selected list of sources for other computer software which have strategic planning applicability is contained in Appendix A.

B. PROMINENT APPROACHES TO DESIGN OF STRATEGIC PLANNING SOFTWARE

1. Problem Structuring

One of the five software categories (Buede 1991) is problem structuring. Packages which support this function precede the analysis function and assist in providing the following :

- an understanding of the situation;
- an appreciation of what is not known;
- a list of alternative actions that could be taken, and
- a plan for selecting among alternatives. (Buede 1991, p. 3)

Graphics COPE uses cognitive mapping and the SODA technique to structure a problem so that a group can reach consensus about its issues, goals and an action plan. It does so by taking individual construct maps and, through the skill of an expert facilitator, aggregates them into a group map. Through this process, the individuals grasp ownership of the group situation and see how their individual constructs are linked to other members' concerns. With individual concerns addressed and "on the table," participants are much more likely to form a group consensus on problems and their solutions (Eden 1990).

a. Cognitive mapping

As already discussed, a DSS uses a database. For this information to be of value to the user, it must first be organized into appropriate categories (Mockler 1987). Cognitive mapping does that for the decision maker by first building a personal construct map, such as Figure 3-2. By using a physical construct of the issues, goals, options and other various inputs, it can give a graphical picture of the situation as the planners "see" it. It provides elements of the thoughts rather than the thinking itself (Eden 1992). It helps participants converse when their concepts and words are identical but the meanings attached to them are very different. The reality that one person has is not the same reality for the next person in the group. The facilitator must elicit this reality from each person and then "construct" a group reality--a starting point for further group efforts.

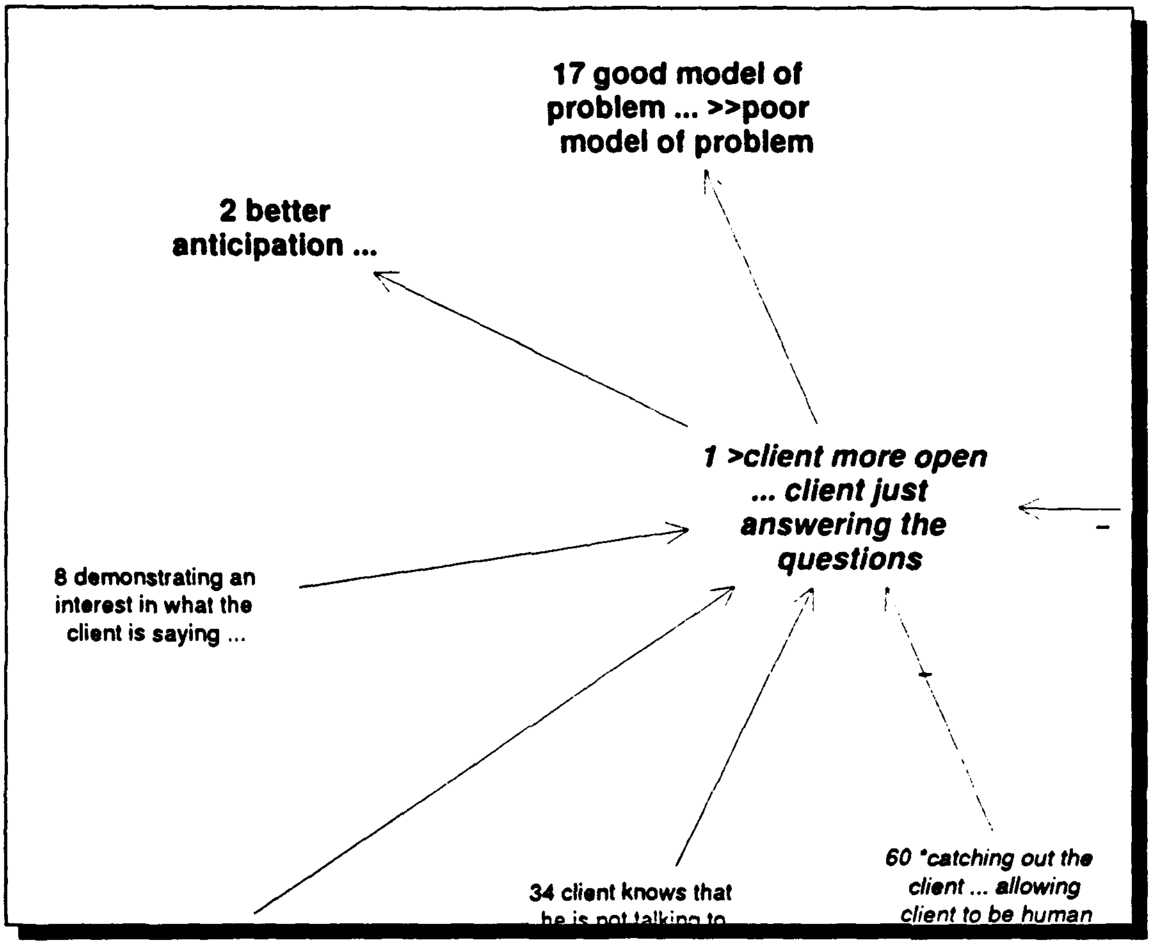


Figure 3-2. Cognitive map.

Shown above are concepts entered onto the screen in text which are linked to other concepts. The overall map then reveals one person's view of the reality of the problem. These individual maps can then be aggregated into a group map so that every person's issues are surfaced, addressed and placed into a larger whole. Once this is done, ownership of issues can be given up to the group and all individuals can go on to discuss the "group" situation. The group then needs to sort through their differences and to establish a map on which they can work. This is what aggregated cognitive mapping does for issue identification and strategy formulation.

Once a cognitive map is construed, analysis is performed:

- to establish the *goals, options, assumptions*, etc., within the map hierarchy and the *rough shape* of the model;
- to establish where closely connected clusters of argument indicate *key elements* in the policy debate;
- to show *how "robust"* conclusions were: whether they were weakly or strongly supported by argumentation; and finally,
- to identify those *potential options* that have consequences in many areas within the policy debate.

Mapping information is entered into the database for analysis and presentation. Cropper (1990, p. 6) says, "analyses are based primarily on the structure that is created by selective linking of the concepts." In other words, analyses come from the constructs which are entered into the model--both the positive and negative poles, and the links which are drawn between nodes.

The aims of cognitive maps are numerous and Eden (1990) lists those gleaned from workshops and interviews with senior managers as:

- an instrument to help negotiation towards best solution,
- a way of 'hearing several people at once' by setting the views of one person in the context of the ideas of the others,
- a method for providing structure to multiple and conflicting aspects of argumentation,
- a method which is designed to suggest action to resolve issues,
- a method for developing a consensus about a system of goals,
- a method that does not violate the natural role of discussion,

- an efficient way of avoiding 'group-think' and 'bounded vision,'
- a designed scheme for attending to both the content of issues and to the need for a recognition that people change organizations
- a designed environment for ensuring effective decision making. (Eden 1990, p. 36)

b. Strategic Options Development and Analysis

SODA is a group decision support system (GDSS) which uses a facilitator to capture both individual and group views on the issues, information and alternatives of a problem. Further, SODA:

- uses the technique of 'Cognitive Mapping' to capture wisdom as a qualitative model,
- uses specially designed computer software--Graphics COPE--as a tool to aid the representation and analysis of cognitive maps,
- through the computer software, can act as a GDSS at meetings of the decision making team,
- provides interactive support to a group by recording, modifying, analyzing and representing in 'real-time.'

The SODA technique can best be represented by talking about the six stages and the activities which occur in each.

Stage one--the interviews. Interviews are conducted on key individuals involved in the process, as well as those who could sabotage the outcome. The primary aim of this stage is eliciting data, which is added to the personal knowledge base as it is received. This data is added to the cognitive map being constructed so that the map may be used interactively during the interview. (Eden 1990)

Stage two--computer modeling and analysis using Graphics COPE. The facilitator(s) use(s) Graphics COPE to construct a "model of the knowledge and arguments she discovers." (Eden 1990, p. 36) Goals, assumptions and key issues are identified. Analysis is performed to refine the issues as well as to set the agenda for an action-oriented workshop. The analyses may then be used by the facilitator to gather some sense of how to run the workshop (Cropper 1990), which is next.

Stage three--workshop one. This workshop, a focus group meeting, is conducted to promote issue awareness and focus discussion by using the aggregated individual maps which have been generated by the facilitator. As this process continues, the personal knowledge base increments into an organizational knowledge base.

Stage four--computer modeling and analysis using Graphics COPE. The facilitator focuses the group discussion onto the relevant issues through the group cognitive map and moves the group toward developing consensus and resolving conflict (Eden 1990). This process begins to yield an organizational memory, or corporate memory as it is often called, which the group can continue to tap into. "Cluster analysis can be used to...create groups of constructs which are relatively densely connected within each group and more weakly connected to members of other groups. Graphics COPE also provides an analysis of the relationships between each group so that a summary map of the groups can be created." (Cropper 1990, p. 14)

Stage five--group decision support system workshop. Now that the cognitive map is fully robust and analyzed for a coherent theme to its contents, it is time for the group to come up with its action plan. They do this by drawing upon the organizational memory that has been building the model up to this point, as well as setting action plans to achieve goals previously identified.

Stage six--control and review. This is where the action plan that has been designed is monitored and evaluated as it is implemented. Changes to the model can be made as necessary.

Eden (1990) offers the following as typical outcomes of SODA projects:

- a clear statement of goals and strategic direction,
- a management team with a common understanding and commitment to action to deliver selected policies,
- a focus or specification for research into new areas of business, or key assumptions revealed through Graphics COPE,
- a comprehensive business model which can be used as a decision support tool by members of the management team, and
- an action package with time scales and responsibilities identified.

c. Graphics COPE tie-in

While SODA is a GDSS in its own right, the powerful analysis tools available though the processing capability of Graphics COPE make the two a formidable team. Whether it be analysis of concepts, clustering of sets or map construction, Graphics COPE has the ability to provide the outcomes just listed.

2. Structuring through Hierarchy

Often, decision making and strategic planning are made difficult by the diversity of the information that is available. In today's increasingly technological world, strategic planning is dependent on a complex system of interacting elements. For example, the economy of a country is highly dependent on its energy and resources. The available energy is highly dependent on geography and politics. Military strength of the country has a great influence on politics. Technology plays an important role in the military strength of a nation, and is itself reliant on ideas and resources. Ideas are contingent on politics for their acceptance and support. It is easy to see that in a complicated network of factors, causes and effects are not clearly identifiable (Saaty 1990, p. 4).

According to psychological theory, the human brain has a limitation of its short term memory capacity to about seven items (Miller 1956). When complex problems are broken into groups and subgroups, the human mind is then more capable of making judgments and comparisons. The solution to solving complex problems does not lie in a more complicated way of thinking, but instead in one of organizing the factors of the problem into a framework that can be understood (Saaty 1990, p. 5). When the problem is organized into a structured hierarchy, the user or decision maker can then capitalize on his or her own personal experience and knowledge in solving the problem. This is the theory behind The Analytic Hierarchy Process (AHP).

a. The Analytic Hierarchy Process

The Analytic Hierarchy Process was developed by mathematician Thomas L. Saaty in the early 1970's at the Wharton School of the University of Pennsylvania. Saaty's theory had its beginnings while he was working on problems of contingency planning for the Department of Defense in the fall of 1971 (Saaty 1980, p. ix). AHP is designed to assist decision makers in making logical and unbiased decisions while considering their expertise, preferences, experience, and instincts.

AHP is based on three principles: the principle of constructing hierarchies, the principle of establishing priorities, and the principle of logical consistency (Saaty 1990, p.17). The principle of constructing hierarchies is based on the concept of breaking down complex problems into like elements or homogenous clusters, usually ranging between five and nine elements. With this approach, the human mind is better able to perceive a complete picture of the situation. When attempting to gain a complete understanding of a situation, it is natural for the human mind to make judgments and comparisons between similar elements against certain criteria. This is the basis for the principle of establishing priorities (Saaty 1990, p. 17). The third principle of AHP, logical consistency, is based on the ability of the human mind to establish relationships among ideas or objects in such a way that they relate well to each other and their relations exhibit consistency (Saaty 1990, p. 18).

However, before AHP can be effectively utilized, a complex problem must be correctly defined and all of the issues and details associated with the problem must be identified (Saaty 1990, p. 222).

b. Making judgments through comparisons

AHP gives decision makers the ability to model complex problems using a hierarchical structure that shows the relationships of goals, criteria, uncertainties, and alternatives (Dyer, p. 12). It provides the user with a framework which formulates the problem into a hierarchy (Forman 1992, p. 221). The user defines the problem by grouping elements together that share the same properties until a top level or goal node is reached. The user then enters all of the separate elements or criteria for the problem. Criteria can be further subdivided into subcriteria. The user instructs the AHP as to which variables are the most important by making comparisons among criteria and subcriteria based on their own knowledge, experience, values, and expertise. The user is asked to pairwise compare all of the criteria and subcriteria. The comparisons are made on a scale based on the relative importance of the paired criteria. For example, the user is asked how much more important is criteria A than criteria B with respect to another criteria. That is, are the criteria equal in importance? Is one moderately, strongly, or extremely more important than the other? The decision maker makes a verbal judgment and AHP weights the criteria based on those judgments. Figure 3-3 shows the integer values assigned for the verbal comparisons.

Integer	Definition
1	Equal importance
3	Moderately more important
5	Strongly more important
7	Very strongly more important
9	Extremely more important
2,4,6,8	Intermediate values for greater accuracy

Figure 3-3. Integer values

AHP incorporates both the qualitative and quantitative aspects of the way humans think. Defining the problem and the hierarchy is the qualitative part. The ability to express judgments and preferences concisely comes from the quantitative aspect (Saaty 1990, p. 18).

c. Advantages of AHP

The AHP pursues judgments from people by asking the right question that produces the intended answer (Saaty 1991, p. 29). If the inappropriate question is asked, the results are not likely to make sense. Figure 3-4 shows the advantages of using AHP for problem solving and decision making (Saaty 1990, p. 23).

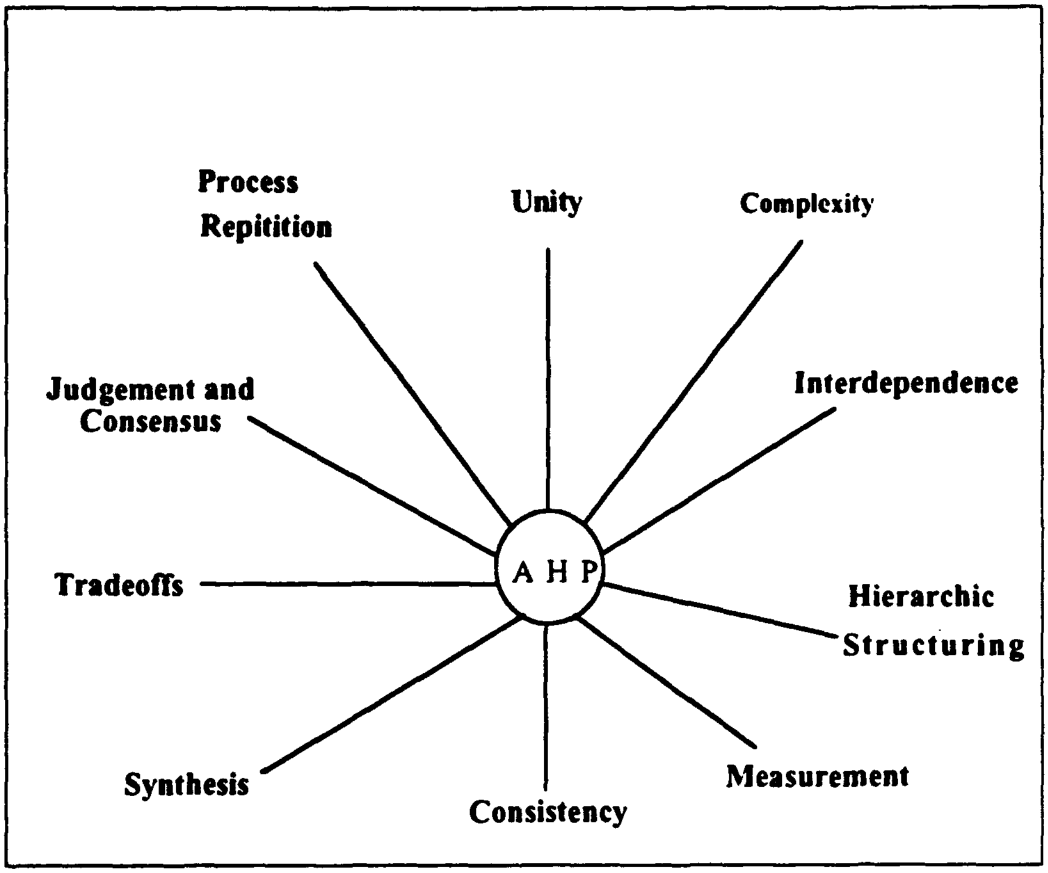


Figure 3-4. AHP advantages

The advantages displayed in Figure 3-4 are explained in detail as follows:

- UNITY--The AHP provides a single, easily understood, flexible model for a wide range of unstructured problems.
- COMPLEXITY--The AHP integrates deductive and systems approaches in solving complex problems.
- INTERDEPENDENCE--The AHP can deal with the interdependence of elements in a system and does not insist on linear thinking.

- **HIERARCHIC STRUCTURING**--The AHP reflects the natural tendency of the mind to sort elements of a system into different levels and to group like elements in each level.
- **MEASUREMENT**--The AHP provides a scale for measuring intangibles and a method for establishing priorities.
- **CONSISTENCY**--The AHP tracks the logical consistency of judgments used in determining priorities.
- **SYNTHESIS**--The AHP leads to an overall estimate of the desirability of each alternative.
- **TRADEOFFS**--The AHP takes into consideration the relative priorities of factors in a system and enables people to select the best alternative based on their goals.
- **JUDGMENT and CONSENSUS**--The AHP does not insist on consensus but synthesizes a representative outcome from diverse judgments.
- **PROCESS REPETITION**--The AHP enables people to refine their definition of a problem and to improve their judgment and understanding through repetition. (Saaty 1990, p. 23)

d. Tie-in to Expert Choice

Chapter V of this thesis provides a description and evaluation of a software application called Expert Choice. The design of Expert Choice is based on Saaty's AHP. It provides the user with the ability to make judgments about criteria after a situation has been structured into a hierarchy. It is not important to go into a detailed discussion of the mathematical theory behind the AHP for the purpose of this thesis.

C. BRYSON'S MODEL AND SOFTWARE

As discussed in Chapter II, Bryson's strategic planning model has eight steps in strategy formulation which culminate in implementing the action plan to achieve results. Cognitive mapping, using the SODA technique and Graphics COPE, and the AHP have been discussed in this chapter. We feel that after exploring the capabilities of each software package that each can greatly assist in accomplishing steps in Bryson's model.

Graphics COPE, as a problem structuring program, can be applied to the first six steps of the model. These steps deal with identifying mission and values, mandates, strengths, weaknesses, opportunities and threats, and issues. They involve people inside and outside the organization. This portion of the process enables participants to have graphical representation of the issues and the possible alternatives to solve them.

The 7th step could use cognitive mapping to identify practical alternatives, barriers to those alternatives, and proposals to overcome those barriers. But Graphics COPE provides no capability to do any ranking, inferencing or strategizing. This portion of the process could be handled by Expert Choice. Expert Choice can handle ranking and inference problems. Once the issues and alternatives are decided upon, then Expert Choice is one of the most powerful analytical tools for ranking or inferencing problems (Buede 1991).

The strengths and weaknesses of each application should be more clearly detailed in the evaluation chapters--Chapters IV and V.

IV. GRAPHICS COPE

A. INTRODUCTION

This chapter provides an evaluation and description of the computer software application named Graphics COPE. It is designed to aid in building cognitive maps but has uses in other areas as well. The cognitive map may be entered in Graphics COPE and then analyzed using tools Graphics COPE provides. Although Graphics COPE allows constructs and interconnections to be shown, it is a text based program and thus has its limits. It does not provide the capability for quantitative analysis.

COPE (DOS application) is a command-line driven software application in use for over ten years to build and analyze cognitive maps. After the cognitive map is entered into the computer, the user can use the various tools available to analyze the map and explore other avenues or links of the map. **Graphics COPE** (Windows application) builds on this beginning by using the power of graphical interface of windows presentations to display the maps in various font sizes and graphical representations of arrows to represent links between concepts. Although a command line is also available in Graphics COPE, it is less necessary because commands, such as concept entry and editing, can be done directly on the map. (Moriarty 1992, p. 7)

As discussed in Chapter III, cognitive mapping is relating perceptions of the problem, or issue, together, in order to construct a view, or map, of the interrelationships formed by the identification of the goals, issues, strategies and actions. The Graphics COPE model consists of concepts, which usually have positive and negative poles--referred to as bipolar concepts--and the links which connect them (Figure 4-1). As stated earlier, Graphics COPE is not a quantitative application, rather it is an application designed to enable the user to identify and better understand the issues which are important and how they are linked to each other to imply consequences and explanations.

Referring to Bryson's model discussed in Chapter III, Graphics COPE is very well suited for use in steps 1 through 6. Its strength lies in assisting the user identify the mandates, environment, missions, values and strategic issues which are involved in the strategic planning process. Because Graphics COPE involves constructing a network rather than a hierarchy, it is not effective in giving guidance for the outright selection of the best option or even rank ordering the options available. It therefore is limited to a support role in step 7 of Bryson's model--an identifier of the many factors which will affect the choice of strategy.

By virtue of its graphical representation of the issues under consideration, it assists greatly in the description of the organizations' "vision of success" (Bryson 1988, p. 51), step 8 in the model--and the last step before strategy implementation.

B. MAP BUILDING

The key element of Graphics COPE is its "permanent graphical mapping." (Moriarty 1992, p. 9) The user inputs ideas and relationships into a graphical map on the screen. The model is permanent because it can be saved and retrieved to be viewed or edited. The following sections are abridged from the Graphics COPE Reference Manual (Moriarty 1992).

Graphics COPE has a powerful analysis programming language built into it. GCL is aimed at two target audiences: the end users and the support programmers. The end users are given powerful commands to assist in analysis and to allow easy access to data. Through GCL, the programmer has access to the heart of Graphics COPE and capacity for advanced analysis and modification.

1. Creating a model

From the **File** menu, select **New Model** option to create a new model. If there is a model of the same name you enter, you will be asked if you want to open that model. Graphics COPE will not overwrite an existing model. Otherwise, it will present you with an empty model with the name you have requested. To load an existing model you select the **Open Model** option and choose the name of the model from the model dialog box. Graphics COPE will then load that model onto the screen and is now ready to receive concepts or edit existing ones.

2. Entering Concepts into the computer

Once a group or individual has determined the issues that affect the problem under consideration, it is relatively easy to enter these concepts into the computer. The user merely double-clicks the left mouse button anywhere on the screen and then proceeds to type in the text of the issue and hit the [Enter] key. Concepts are automatically numbered sequentially as they are entered into the computer, although you may manually override this system and edit any numbered concept you choose.

Concepts are entered into Graphics COPE as a short statement with two contrasting parts.

HAPPY rather than SAD

This would be an example of a concept with two poles. The first is referred to as the emergent (or positive) and the latter is the contrasting (or negative) pole. Concepts are entered with a single dot separating the poles.

HAPPY.SAD

Concepts are limited to 159 characters each. Although this may seem to limit the size of the concepts, it actually should not take 159 characters to express a single concept. If more than 159 characters are needed, then there is probably more than one concept contained in the text. As mentioned, text numbering is automatic and lies in the range from 1 to 29,999. (Moriarty 1992)

Bipolar concepts have already been described, but there are five other concepts which Graphics COPE uses. *Assertions* do not naturally have an opposite pole and are entered as follows:

...The dollar is falling

and will be displayed as:

The dollar is falling ... The dollar is falling

Emergent pole only concepts have a contrasting pole which is the exact opposite of the emergent pole, thus the contrasting pole can be deduced from the emergent pole. If the user chooses to enter an emerging pole only:

Strategic planning

it will be displayed as:

Strategic planning ... [not] Strategic planning

With *contrasting pole only* concepts the emergent pole can be omitted and the contrasting pole is entered:

.Strategic planning

and is displayed as:

[not] Strategic planning ... Strategic planning

Monotonic concepts are special forms of bipolar concepts which can decrease or increase in value and use a shorthand form of entry:

Interest rates+

and is displayed as:

[+] Interest rates ... [-] Interest rates , or

an increase in interest rates ... a decrease in interest rates

Shorthand bipolar concepts have common text in both poles and are entered in shorthand form as:

More.Less.training

and will be displayed as:

More training ... Less training

3. Linking concepts

To build a model in Graphics COPE, concepts are usually *linked* together to construct the problem under consideration. The two primary types of links that are used are *causal* and *connotative*. Causal links are more frequently used and they indicate that one concept caused or "leads to" to another concept. A simple problem follows:

> I never have enough time to work. I think it is because I seldom plan my work and therefore I don't work efficiently, but I really would like to get more work done.

This problem would be entered using causal links in the following manner:

Not enough time to work. Would like to get more work done

Don't plan.Work efficiently

These are two separate concepts which can be linked to show how you view the problem. "Not planning leads to not enough time to work" yet if you "work efficiently" it may lead to getting "more work done." The causal belief here is that "not enough time to work" is caused by "not planning."

This link is represented on the map by an arrow and in text as "+". Now that the concepts have been entered, we can link them by clicking and holding on the first concept and then dragging the mouse to the second concept. A rubber band will follow the mouse cursor. As concepts and links are added and the model expands, the user will want to explore the capabilities of the analysis functions of Graphics COPE (more on analysis later).

Connotative links are represented by the "." character in text and by a single straight line (an arrow with no head). This type of link merely associates the two concepts in some way and are therefore bi-directional. The link 3.4 also implies the link 4.3 (using concept numbers here instead of text).

Temporal links are used to show that one concept follows another in time. It is represented on the map by an arrow with a T in it. In text the letter 't' is used.

User-defined links are for whatever purpose the user desires and may be different for each model. They are represented on the map by a 1 or a 2 by default. Link logic, using the OR and AND type of concept, is supported by using the LOGIC command.

4. Sets

In Graphics COPE, "a set is a method of classifying concepts that constitute an arbitrary set of concepts, such as the set of concepts which are the company objectives." (Moriarty 1992, p. 17) The user gives each set a unique name which can be used as the basis for further analysis by GCL. Sets must be whole words, with no spaces, and cannot use the word "model." Three classes of set names are used, one created by the user, the second consists of styles in the model (allows user to specify style for analysis), and the third is three special names which refer to the current model.

5. Map editing

During editing the user can add or delete text from a concept, change concept numbers, (if you changed number 1 to number 100, the next new concept would be 101 and so forth) delete an entire concept, and change or move links. Graphics COPE uses the Windows clipboard so text and data can be cut or copied and then pasted. The most recent version will also allow the user to copy/cut to the clipboard for import into other windows applications. Figure 4-1 (also Figures 4-3,4) is a map that was copied to the clipboard in Graphics COPE and then pasted into a frame in Ami Pro for Windows. It is also an example of a cluster of concepts which are related--in this case each is related to concept number 1.

Notice that concept number 20 is not all of the way on the screen. In Graphics COPE that could be remedied either by scrolling the screen to the right or by "fishing reel" the link to bring it closer to the other concepts. This is done by manipulation of the mouse and the [Ctrl] key. Once the model is built, then the user is ready to use Graphics COPE's powerful analytical tools.

The **Edit Menu** is very similar to an edit menu found in all windows-type applications. It can do the standard cut, copy, paste, delete, undelete and other functions. It also contains two functions that are special to Graphics COPE. **Mix** is used to integrate numbered concepts from multiple models so that the source models are *not* known. **Renumber** is used to tidy models by specifying a range of numbers to be renumbered.

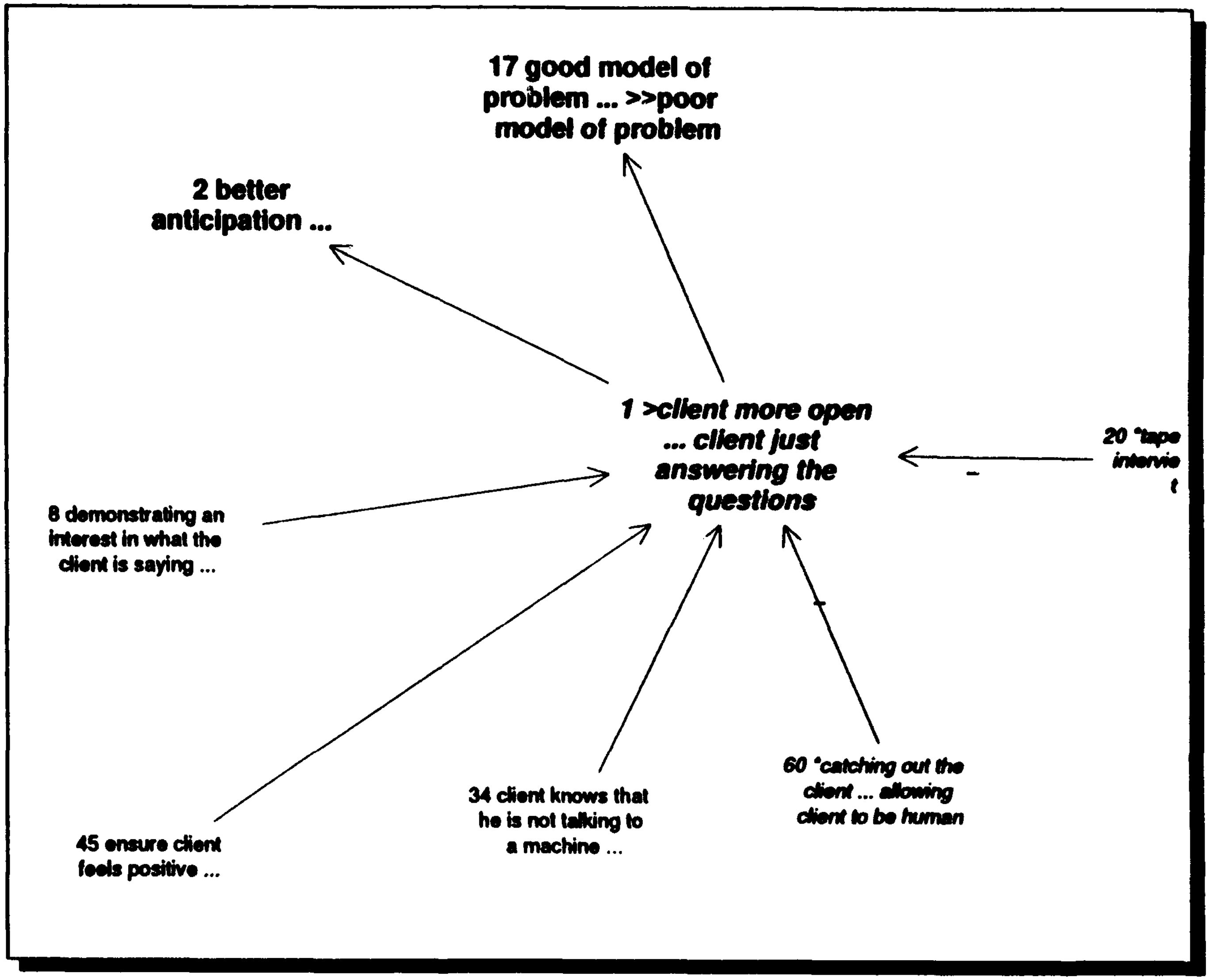


Figure 4-1. Cognitive map

C. ANALYSIS

The analysis menu is shown in Figure 4-2.

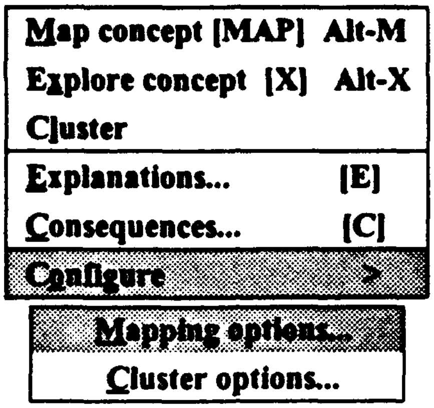


Figure 4-2. Analysis Menu

The analysis menu is one way to access some of Graphics COPE's analytical power. The top box in Figure 4-2 shows the initial pull-down menu with the options available. **Map Concept** is available when a single concept is selected and it cause a new map to be drawn around that concept. To activate **Explore concept** a concept must be selected. When executed, this command will reveal those concepts linked to the selected concept. **Cluster** performs a cluster analysis on the model. Figure 4-3 (next page) is an example of a cluster analysis. The results of a cluster are placed in sets called "Cluster1", "Cluster2", etc. By typing the **MAP** command and the name of the cluster, the user can view the sets.

Configure reveals the lower two menu selections which actually display to the right of the **Configure** selection. **Mapping options** produces a dialog box which allows the user to determine what map options are desired. Options include banded or fanned maps, spacing and levels. Banded maps include concepts linked to the central concept up

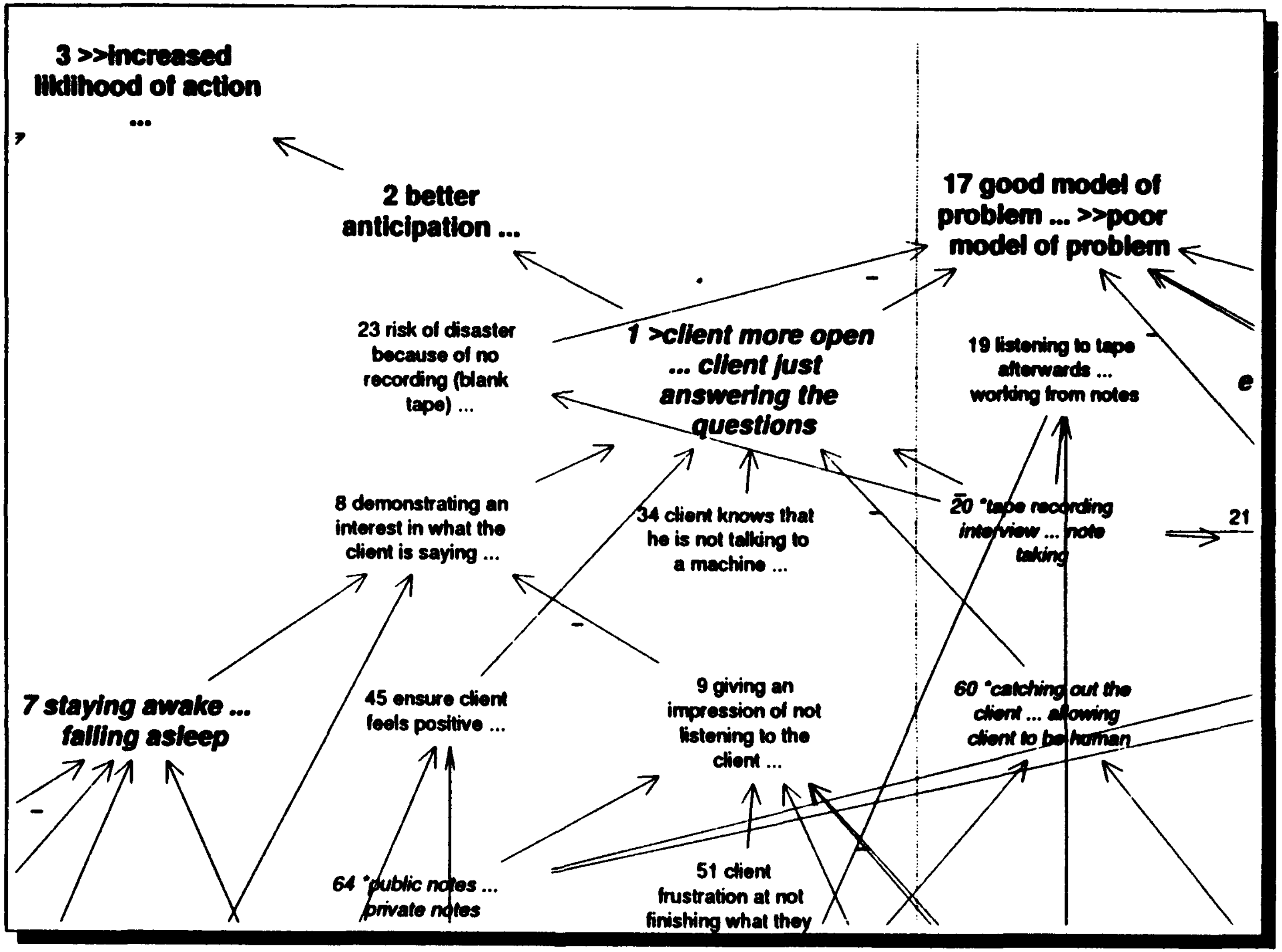


Figure 4-3. Cluster analysis--'CLUSTER1'

to branch points and concepts linked to those concepts up to branch points, and so on up to the level specified. Banded maps result from a complex algorithim and can become too large if too many levels are specified. Fanned maps are simpler, with each concept directly linked to the central concept and each concept directly linked to those concepts, up to the level specified. **Cluster options** allows the user to set the cluster analysis options, such as using consequences or explanations to direct the analysis, the concepts to bound the analysis, and the size to limit the analysis.

One form of cluster analysis is **Hieset,** which looks at the "root" concepts in the Set (e.g., "Cluster1") designated, and traces all of the explanations of each concept until either a tail or another concept in the Set is reached. Figure 4-4 (next page) is an example of a Hieset. Notice the dotted line which runs vertically down the right one-third of the page. This is a page break, meaning this Hieset would take two full pages to print out, as concepts can be viewed extending off the screen available in this view.

There are also 15 analysis commands which can be utilized at the command line (i.e., entered at the keyboard). **LOGIC,** which changes Boolean logic status of a concept, **ZOOM,** which focuses on a set, and **BAND,** which displays Taylor banding levels around a concept, are a few examples of the commands which may be invoked.

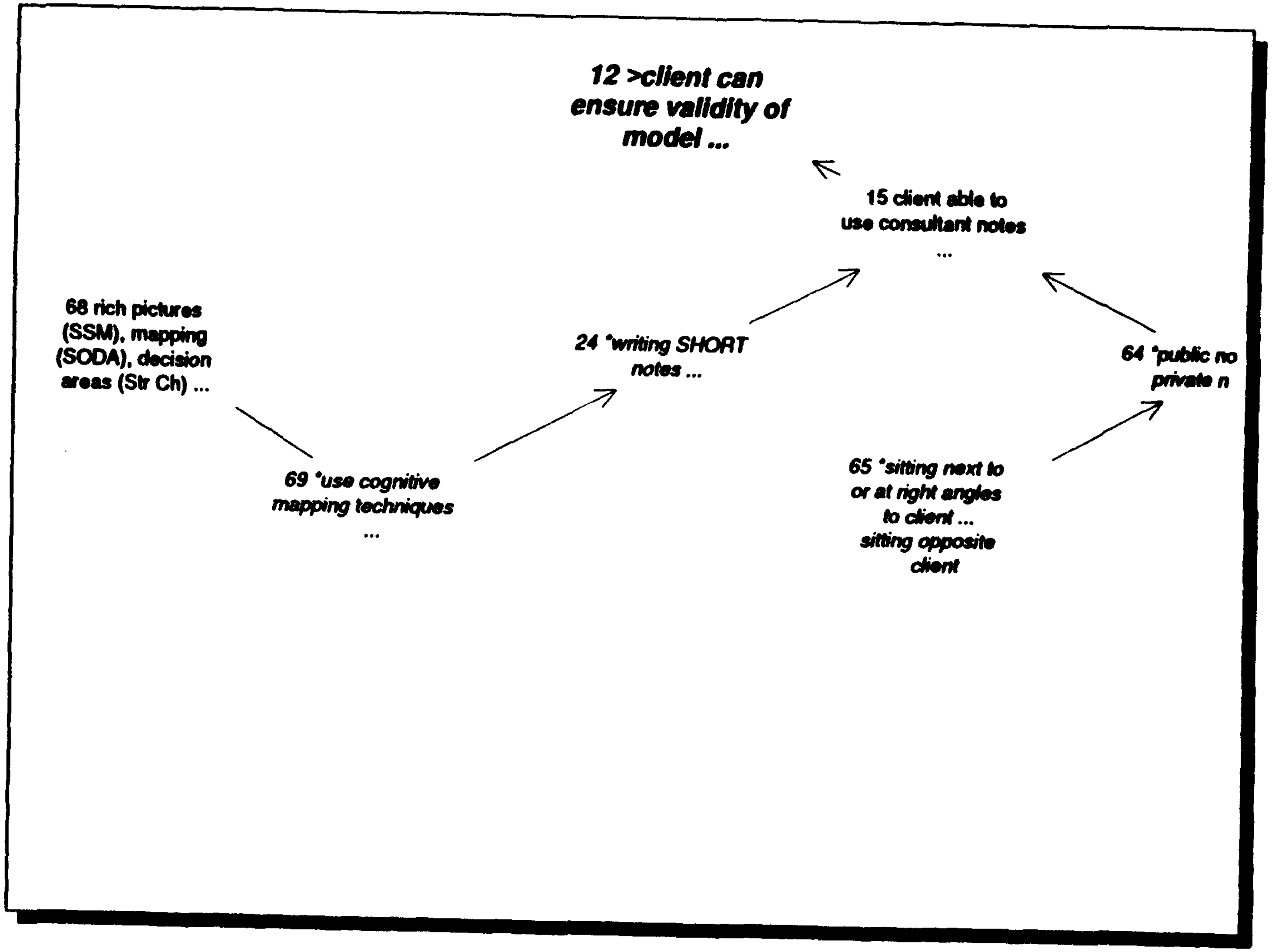


Figure 4-4. Hieset from cluster analysis

D. LISTS

The **List Menu** provides the user with various lists of the categories contained in Figure 4-5.

All concepts	[L]
Heads	[LH]
Tails	[LT]
New concepts	[LN]
Sets	[LS]
All links	[LR]
Selected links...	
Find text in concepts	[FIND]

Figure 4-5. List Menu

All concepts provides a textual listing, in sequential order, of all the concepts which have been entered into that model. This list is shown down the left edge of the screen and can span more than one screen. To view multiple screens, the user can use the mouse to scroll the pages. **Heads** provides a list of the heads of each concept, and **Tails** provides the list of tails for the concepts. **New Concepts** produces a list of concepts that have been added since the last session. **Sets** gives a list of all the sets which have been created and if the user has added descriptions to the sets, this too, is provided. **All links** gives the user a numbered list of each concept which has links. Here is a three-number example of links:

- 1 > +2+17
- 2 > +3
- 4 > -35-33

Concept number one is linked to the positive pole of concepts 2 and 17. Concept number 2 is linked to the positive pole of 3 and 4 is linked to the negative poles of concepts 35 and 33. **Selected links** allows the user to specify the concepts to be listed with their links. **Find text in concepts** allows the user to do a word search through all of the concepts.

The **List Menu** allows the user to verify which concepts the model contains during any one evolution of the model building, as well as providing different forms with which to separate the concepts into more precise categories. It is seen as a valuable model management tool, as well as an aid for participants who have difficulty understanding graphical representation and desire more traditional information formats.

E. PRINTING AND EXPORTING

Graphics COPE provides the capability to print entire maps, as well as just the current window. When an entire map is printed--and it runs over more than one page--it is read from the upper left and prints all of the leftmost pages until it reaches the bottom of the map. Then it repeats this process until the rightmost pages are printed and the entire map can then be pieced together. A page break print option exists to help with aligning multi-page maps once they are printed.

Copying map views to the Windows clipboard and then pasting them into Ami Pro was very effective for the purposes of this thesis (see Figures 4-1, 4-3, and 4-4). Graphics COPE can export to COPE but since GC is more powerful than COPE, some concepts could be truncated to fit into COPE. Also, the user is allowed to export a set from one model to another within Graphics COPE.

F. SYSTEM REQUIREMENTS

The following is required to run Graphics COPE:

- IBM PC/AT compatible, or better, PC compatible computer. 386sx, 386dx, 486sx, or 486dx processor is required. It will use a math coprocessor if installed.
- VGA graphics card, or better.
- As much RAM memory as possible, 2Mb absolute minimum, 4Mb recommended minimum and 8Mb if you are running multiple applications. Windows 3.x allows full use of all memory in the computer.
- Mouse
- Hard disk drive with 3Mb free.
- High density (1.2Mb) 5.25 inch or (1.44Mb) 3.5 floppy disk drive.

Graphics COPE requires DOS 3.x, 4.x or 5.x (MS-DOS or PC-DOS) and Windows 3.x. It will no longer run in Windows 2.0. Graphics COPE is available from:

Strategic Decision Support Research Unit
Department of Management Science,
Strathclyde Business School,
Livingstone Tower,
26 Richmond Street,
Glasgow, G1 1XH.
Scotland

International telephone:	+44 41 552 4400 extension 3141
Telex	77472 UNSLIB G
Fax	041-552 6686
E-mail	CIHS05@UK.AC.STRATH.VAXA

G. DOCUMENTATION AND HELP

The Graphics COPE Reference Manual is very well organized and covers the mechanics of the application adequately. The manual used was written for version 1.0 and the latest disk was version 1.1.4. Updated information was contained in README.TXT and README.WRI files on the disk. The manual is a three-ring binder in which the material is attractively presented. Graphics of menus and screens are used to match word descriptions of functions. It lists the commands alphabetically and provides descriptions and examples. It contains an index.

The on-screen help function allows the user to call up all of the command-line commands for review, and learn what each pull-down menu contains and the function of each selection. It can conduct searches for specific topics and defines what each function key does. It even offers help in using Help.

H. SUMMARY

Graphics COPE is a visually stimulating software application which holds great potential in the hands of an experienced analyst or facilitator. Its many analytical features provide it with much more capability than a simple mapping tool. The ability to cluster sets (Figure 4-3), create hierarchical sets (Figure 4-4), and construct multiple map views are all very valuable to the analyst. Graphics COPE provides the facilitator the very real ability to shape the cognitive map to the reality of the problem confronting the group or organization in a way which will allow those involved in the group decision process to view the problem's issues and their links.

The tasks of facilitating (conducting interviews to identify issues then building individual maps into an aggregated group map), and the entering and manipulating of the data in the computer, require a very high skill level. According to one user who has attended a workshop conducted by the software designers, "Graphics COPE is not a 'user friendly' application." Thus, the user should weigh the potential benefits of the application against the costs of training personnel and the time necessary to learn the system. Before an organization attempts to "map" its cognitive world, it would be well served to obtain training in facilitating and constructing cognitive maps.

V. EXPERT CHOICE

A. INTRODUCTION

This chapter provides an evaluation and description of the computer software application known as Expert Choice (Version 8.0). The software is designed to assist the user in solving complex problems that have many criteria and several courses of action. This chapter demonstrates the capabilities of Expert Choice through the use of a simple example model. It guides the reader through the processes of building a model, making judgments through comparisons, synthesizing the model, and conducting sensitivity analysis. The printing, linking and reporting features of the software package will also be discussed.

Expert Choice is an application software for use in multi-criteria or multi-objective decision making. This software package is designed to assist the user in organizing information involved with the solving of a complex problem. When dealing with complex problems involving numerous interacting elements, the human mind usually has difficulty structuring and solving them. According to psychological theory, the human brain has a limitation of its short term memory capacity to about seven items (Miller 1956). When complex problems are broken into groups and subgroups, the human mind is then more capable of making judgments and comparisons. The solution to solving complex problems does not lie in a more complicated way of thinking, but instead in one of organizing the factors of the problem into a framework that can be understood. When the problem is organized into a structured hierarchy, the user or decision maker can then capitalize on his or her own personal experience and knowledge in solving the problem. This is the theory behind Expert Choice.

Expert Choice is designed to help the user organize the factors of a complex problem. It gives the user the ability to organize decisions into a hierarchy structure. It models the way a human mind thinks. Expert Choice enables the user to make tradeoffs and comparisons among competing objectives. It provides for a means of evaluating and measuring every aspect of the decision. The user has the ability to incorporate his or her judgments into every facet of any complex decision (Forman 1992, p. 2). The solution to the problem will reflect the expertise of the decision maker and not the computer. The software is based on Saaty's Analytic Hierarchy Process (AHP) that was discussed in chapter III and is programmed by Ernest Forman (Bahouth 1993, p. 64).

B. STRUCTURING THE MODEL

Once an individual has completed the process of defining a problem and identifying its criteria, subcriteria, and alternatives, he or she can then begin to build a model using Expert Choice. An example problem that will be used here is the one of selecting military installations for realignment and closure. Although this is a simple model compared to a typical strategic planning problem, it is sufficient for demonstrating the use and capabilities of Expert Choice.

The first step in creating this model is entering the goal node and its description. In this model the goal node is "Select Base For Realignment/Closure". The goal node is defined as node zero at level zero (See Figure 5-1). When building a model it is important to keep in mind the relation of the node to the nodes above it and below it (Forman 1992, P. 21). The node above any node is referred to as a parent node. The nodes below a parent node are referred to as children nodes and the nodes below the children nodes are descendants. By selecting **INSERT** from the **EDIT** menu, the user is able to enter criteria as children under the goal node. The criteria for the Base Closure Model are:

- **VALUE**--The military value of the installation. It includes the current and future mission requirements and the impact on operational readiness of DoD's total force; the availability and condition of land, facilities and associated airspace at the existing and potential receiving locations; the ability to accommodate contingency, mobilization and future total force requirements at existing and potential receiving locations; and cost and manpower implications.

- **ROI**--(Return On Investment) the extent and timing of potential costs and savings, including the number of years, beginning with the date of completion of the closure or realignment, for savings to exceed the costs.

- **IMPACTS**--The economic impact on communities; the ability of the existing and potential receiving communities' infrastructure to support forces, missions and personnel; and the environmental impact.

Although this is a fictitious model developed strictly for demonstration purposes, the criteria listed above are actual criteria adapted by the DoD in 1991 from the 1988 Base Realignment and Closure Commission (McMillan 1991, p. 21). The criteria nodes make up level one of the example model. In a realistic model, these criteria would be divided into many subcriteria and would be represented by several layers in the model.

It is very easy to navigate through an Expert Choice model by using the mouse to select the desired node or by using the up, down, left, and right arrow keys. In this model, by selecting one of the three level one nodes (VALUE, ROI, or IMPACTS) and the **INSERT** command from the **EDIT** menu, the user is able to add alternatives as children nodes. For this example model, the three alternatives being compared are the fictitious military installations Fort X, Fort Y and Fort Z. Once the alternatives are inserted under one of the level one nodes, they can be replicated to its peers (other level one nodes). The alternatives in this model make up level two. Figure 5-1 displays the completed model.

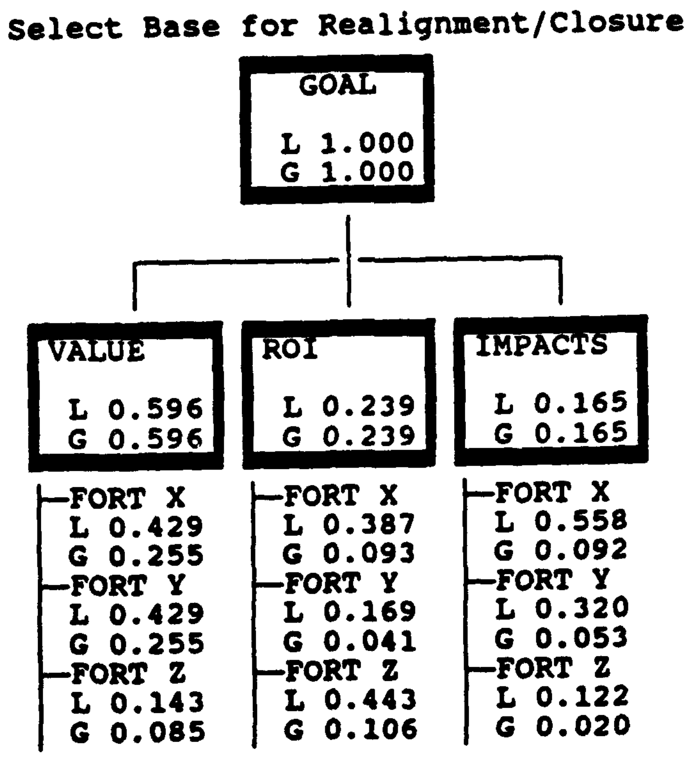


Figure 5-1. Base closure model

The goal node of the model has a priority of 1.000. For any set of branch nodes, the sum of the priorities is 1.000. In level one of the model, each of the three criteria has a local and global priority of 0.333. It is derived by dividing the parent node priority of 1.000 by three, since that is the number of children nodes. In level two of the model, the local priority is 0.333 because there are three alternatives under each criteria node. These local priorities are with respect to the parent node. The global priorities however are now different. Global priorities are calculated by multiplying a node's local priority by the global priority of its parent (0.333 multiplied by 0.333 = 0.111). At this point in the model, the initial priorities of all the alternatives (each Fort) are the same since no judgments have yet been entered. Models in Expert Choice can be created as large as six levels and each node at any level can branch into as many as seven nodes in the next level. This gives the user the ability to create very large models. Information screens can be created that contain descriptive information about each node in the model and can be saved in separate files.

C. COMPARISONS AND JUDGMENTS

Once the problem is structured into a hierarchy and the model is complete, the user is able to start making comparisons and judgments. Expert Choice gives the decision maker the ability to look at elements of the problem in isolation: one element compared against another with respect to a single criterion (Forman 1992, p. 41). The judgments of the decision maker are the basis for the process of solving the problem in Expert Choice. Priorities of the nodes of the model are determined by making comparisons among the criteria and alternatives or by entering the priorities by specifically assigning values for the elements of the model. Pairwise comparisons can then be made from the ratios formed by the assigned values. The pairwise comparison method of the Expert Choice model generally leads to more accurate results (Forman 1992, p. 242). Priorities are derived from the value system of the decision maker and therefore, each decision maker will obtain priorities that reflect their own views after comparisons are made among the criteria for each particular problem. For example, a $10,000 difference in the price of a new car, for the decision maker who is weighing criteria and alternatives for the problem of selecting a new car, will probably be very significant. On the other hand, a $10,000 difference in the price of a computer system for a data processing purchaser of a major corporation could very well be insignificant.

When making comparisons in Expert Choice, the user has the option of starting at the top of the model and working down or starting at the bottom and working up. Comparisons are made on groups of nodes with respect to their parent node. To start making comparisons, the user simply moves to the parent node and selects it as the current node. Then, the user selects one of three modes from the **COMPARE** menu: the Verbal Comparison Mode; the Numerical Comparison Mode; or the Graphical Comparison Mode.

The Verbal Comparison Mode is the default mode for conducting pairwise comparisons in Expert Choice. The user is asked two preliminary questions about each pair of nodes being compared. First the user is asked if the nodes are equal. If the answer is no, the user is then asked which node is more important, preferable, or likely, depending on the type of criteria being evaluated. The user is then asked to make a verbal judgment of how much more important one criteria is over another. Figure 5-2 displays a typical query. In this example, its the question of how much more important is the criteria **VALUE** than **ROI** when deciding on bases for closure or realignment.

Goal: Select Base for Realignment/Closure

With respect to GOAL

VALUE: Military Value is MODERATE to STRONGLY more IMPORTANT than ROI: Return on Investment

```
EXTREME-------------

VERY STRONG------

STRONG---------------
                          <--
MODERATE----------

EQUAL-----------------
```

FIGURE 5-2. Comparison query

Figure 5-3 shows the numerical scale that corresponds to the verbal judgments that are made during the comparisons. Judgments can be made for intermediate levels in this scale. For example, a judgment can be made that is midway between **VERY STRONG** and **EXTREME** and it would hold a numerical value of eight. The intermediate values provide the decision maker with finer levels of distinction.

Verbal Scale	Numerical Scale
Extreme	9
Very strong	7
Strong	5
Moderate	3
Equal	1
Intermediate Values	2,4,6,8

FIGURE 5-3. Integer values

In the example Båse Closure model, the criteria **VALUE** was judged to be moderately more important than the criteria **ROI.** It was then judged to be moderately more important than the criteria **IMPACTS. ROI** was judged to be equally as, to moderately more important than the criteria **IMPACTS.** Expert Choice provides the user with the ability to easily return to the previous comparison to correct any mistakes that might have been made. After the last judgment is entered, Expert Choice automatically calculates priorities of the criteria based on the user's judgments and displays them as a bar chart (see Figure 5-4). For this example, **VALUE** is judged to be the most important criteria (about 59%), followed by **ROI** (about 25%), and then **IMPACTS** (about 16%).

Verbal judgments of IMPORTANCE with respect to:
GOAL Node: 0

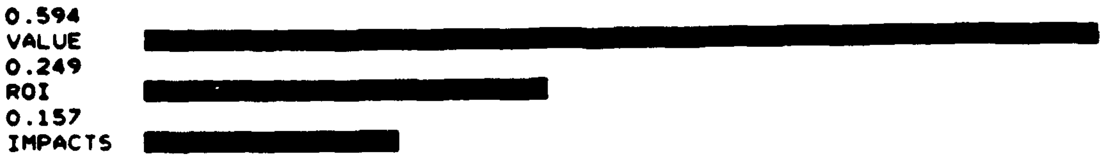
1	VALUE	9 8 7 6 5 4 ■ 2	1	2 3 4 5 6 7 8 9	ROI
2	VALUE	9 8 7 6 5 4 ■ 2	1	2 3 4 5 6 7 8 9	IMPACTS
3	ROI	9 8 7 6 5 4 3 ■	1	2 3 4 5 6 7 8 9	IMPACTS

1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

GOAL: Select Base for Realignment/Closure

IMPACTS --- Economic/Environmental Impact
ROI --- Return On Investment
VALUE --- Military Value

PRIORITIES



INCONSISTENCY RATIO = 0.051.

FIGURE 5-4. Judgments and priorities

Expert Choice provides a measure of inconsistency for the comparisons made among the criteria. In Figure 5-4, the inconsistency ratio is measured to be 0.051 for the comparisons that were made. An inconsistency ratio of 0.000 would indicate that all comparisons are perfectly consistent. As models grow in complexity and number of comparisons, so does the possibility of judgments being made that are inconsistent. An inconsistency ratio greater than zero indicates that there is some inconsistency in the judgments. Since the real world is not perfectly consistent, some inconsistency is expected and a value less than 0.100 is tolerable (Forman 1992, p. 63). If the inconsistency ratio is more than 0.100, the user can reexamine his judgments and ask Expert Choice where the inconsistency has occurred and then can correct that judgment (Bahouth 1993, p. 62).

When building a model in which criteria have measurable factors such as cost, weight, or length, the Numerical Comparison Mode may be preferred. The user is able to enter numerical values for making comparisons among criteria. If a certain criteria costs three times as much as another, or is three times heavier, that criteria would be assigned a value 3.0. The user has the ability to distinguish to a tenth of a point by entering values that range from 1.0 to 9.9.

Figure 5-5 is a screen display of a comparison between **VALUE** and **ROI** in the Numerical Comparison Mode. The values of 3.0, 3.0, and 2.0 are the values that were entered when the comparisons were made in the Verbal Comparison Mode. Here in the Numerical Mode, the decision maker can change the value of 3.0 for a criteria to 2.9 or 3.1 or some other value that more accurately reflects his judgments. For this example, the original judgments will hold and the priorities calculated at the end of the Verbal Mode remain the same.

JUDGMENTS WITH RESPECT TO GOAL

	VALUE	ROI	IMPACTS
VALUE		3.0	3.0
ROI			2.0
IMPACTS			

Matrix entry indicates that ROW element is _____

1 EQUALLY 3 MODERATELY 5 STRONGLY 7 VERY STRONGLY 9 EXTREMELY

more IMPORTANT than COLUMN element unless enclosed in parenthesis

FIGURE 5-5 Numerical comparison

A useful feature of the Numerical Mode is the Geometric Mean feature. This feature calculates the geometric mean of several judgments when dealing with a group of decision makers who are unable to reach a consensus on a judgment.

The third comparison mode of Expert Choice is the Graphical Comparison Mode. The Graphical Comparison Mode is useful when "fuzzy" judgments are made and there is not much redundancy, such as when verbal judgments are made with only two factors or there are many missing judgments (Forman 1992, p. 59). The three submodes of the Graphical Comparison Mode are the pie chart, the horizontal bar, or both. The left and right arrow keys or a mouse can be used to easily change the priorities in the Graphical Mode. Using the Verbal Comparison Mode with the Base Closure model, Military Installations X, Y, and Z were compared with respect to each of the three criteria. Figure 5-6 gives a summary of the comparisons that were made.

CRITERIA	JUDGMENT
VALUE	
Fort X vs. Fort Y	Equal
Fort X vs. Fort Y	Moderate
Fort Y vs. Fort Z	Moderate
ROI	
Fort X vs. Fort Y	Equal to Moderate
Fort X vs. Fort Z	Equal
Fort Z vs. Fort Y	Moderate
IMPACTS	
Fort X vs. Fort Y	Equal to Moderate
Fort X vs. Fort Z	Moderate to Strong
Fort Y vs. Fort Z	Moderate

The preferred installation is listed first

FIGURE 5-6. Comparison summary

Now that all judgments for all pairs have been made, synthesis can be performed on the model to arrive at an overall decision. Figure 5-7 is a display of the completed model after all the judgments have been made. The local and global priorities are now different than those of the model shown in Figure 5-1, before judgments had been made.

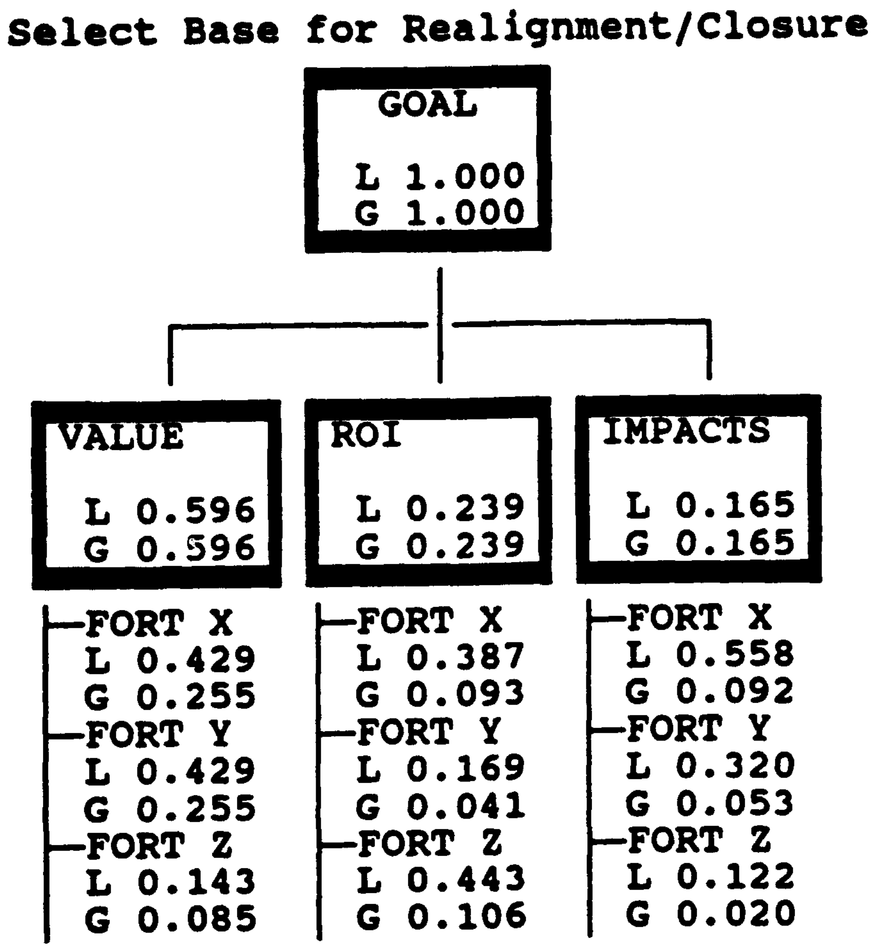


FIGURE 5-7. Completed model

D. SYNTHESIS

Synthesis in Expert Choice is a process that converts the decision maker's priorities into global priorities throughout the model to give a final weight to each of the criteria. The software package does this by calculating, for each alternative, the sum of its global priorities under all the criteria (Forman 1992, p. 261). Synthesis will select the best alternative, prioritize alternatives, or forecast depending on the desires of the decision maker. There are two modes of synthesis to select from: the Distributive Mode and the Ideal Mode. The user can select either mode to synthesize the model and the synthesis will not change the model in any way (Forman 1992, p. 85).

The Distributive Mode of Expert Choice is used when the purpose of the model is to derive priorities for all alternatives or when the purpose is to forecast what is likely to happen in the future. It can also be used when the purpose is to choose the highest priority alternative and when the alternatives not chosen continue to be relevant after the choice is made. The Distributive Mode allows for rank reversal to occur when alternatives are added to or removed from the model.

The Ideal Mode is the appropriate synthesis mode when the purpose of the model is to choose the highest priority alternative and when the alternatives not chosen are no longer relevant after the choice is made. The Ideal Mode is a new feature that was added to Version 8.0 of Expert Choice. The Ideal Mode prevents rank reversal from occurring. The situation of rank reversal occurring when alternatives are added or deleted had been a criticism of previous versions of Expert Choice.

For the example Base Closure model, the Distributive Mode was selected to prioritize all of the alternatives. Figure 5-8 shows the priorities of the alternatives after synthesis has been completed. The results of the synthesis show that Fort X is the most preferable of the three installations with respect to the criteria **VALUE**, **ROI**, and **IMPACTS**. Since Fort Z is the least desirable, the decision maker or strategic planner would select it as the base to close.

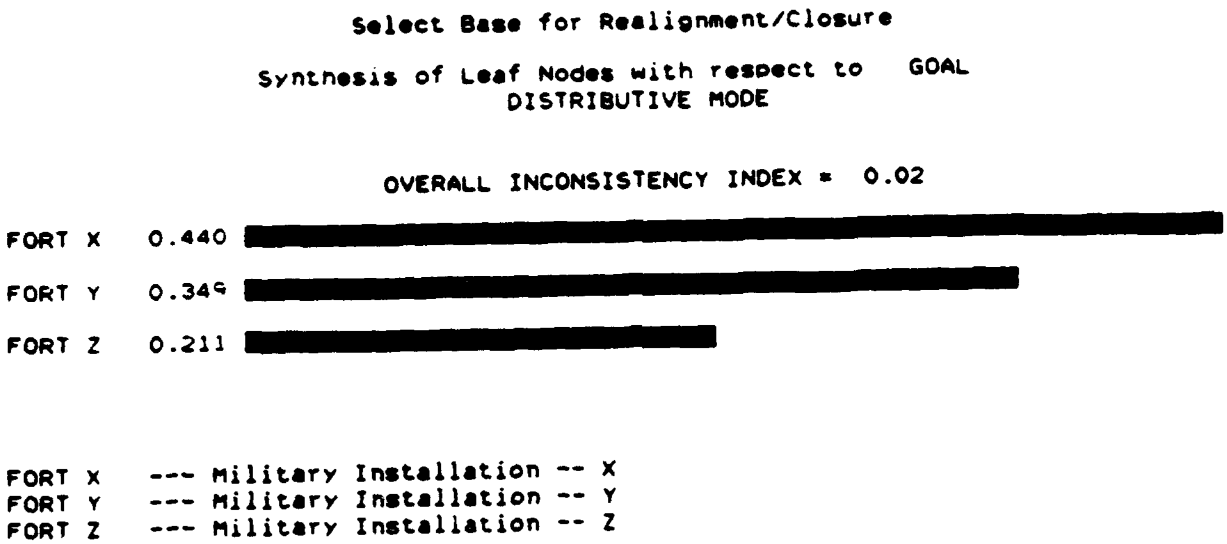


FIGURE 5-8. Priorities after synthesis

E. SENSITIVITY ANALYSIS

Sensitivity analysis can be used on Expert Choice models to investigate the sensitivity of the alternatives to changes in criteria importance. Expert Choice possesses excellent interactive sensitivity analysis tools in the form of graphical output accompanied by numerical values (Bahouth 1993, p. 63). The four graphical sensitivity analysis modes are: the Dynamic Mode, the Gradient Mode, the Performance Mode, and the Two-Dimensional Mode. Changes made in any one mode will be reflected in any of the other three modes when the user goes directly from one mode to another. However, these changes are not permanent and will not be reflected when the user returns to the model. Sensitivity analysis can be performed on any node in the hierarchy.

The Dynamic sensitivity analysis mode shows the decision maker how the priorities of the alternatives change as the priorities of the criteria are increased or decreased. Changes can easily be made by dragging the mouse or using the arrow keys on the bars for the criteria that the user wants to change. The original priorities can be restored quickly by selecting **HOME**. Figure 5-9 is a display of the graphical and numerical output of the Dynamic Mode.

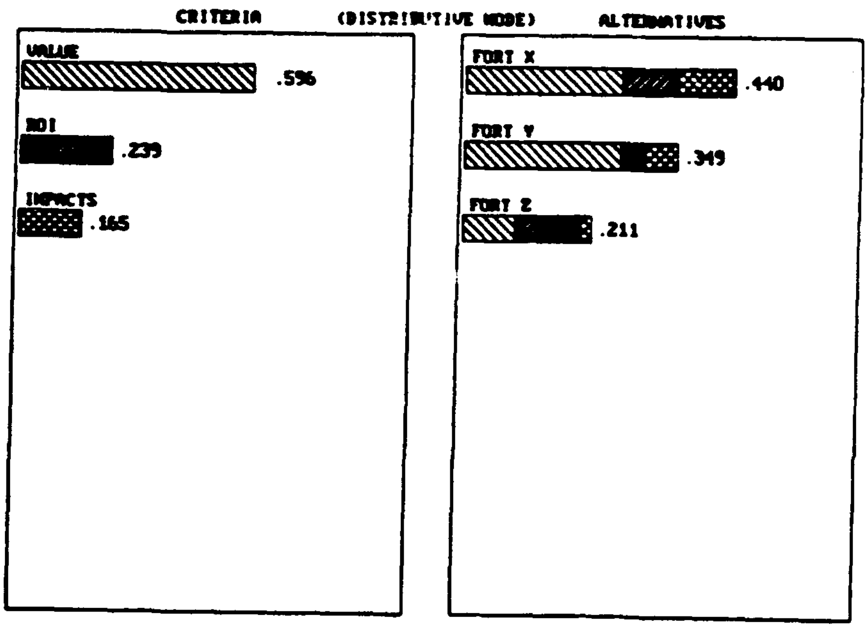


FIGURE 5-9. Dynamic mode

In the Gradient sensitivity analysis mode, a gradient graph shows how the weights of the alternatives will change as the weight of the criterion changes. Each criterion of the model is represented on a separate graph. Figure 5-10 is a display of the gradient sensitivity graph for the criterion VALUE.

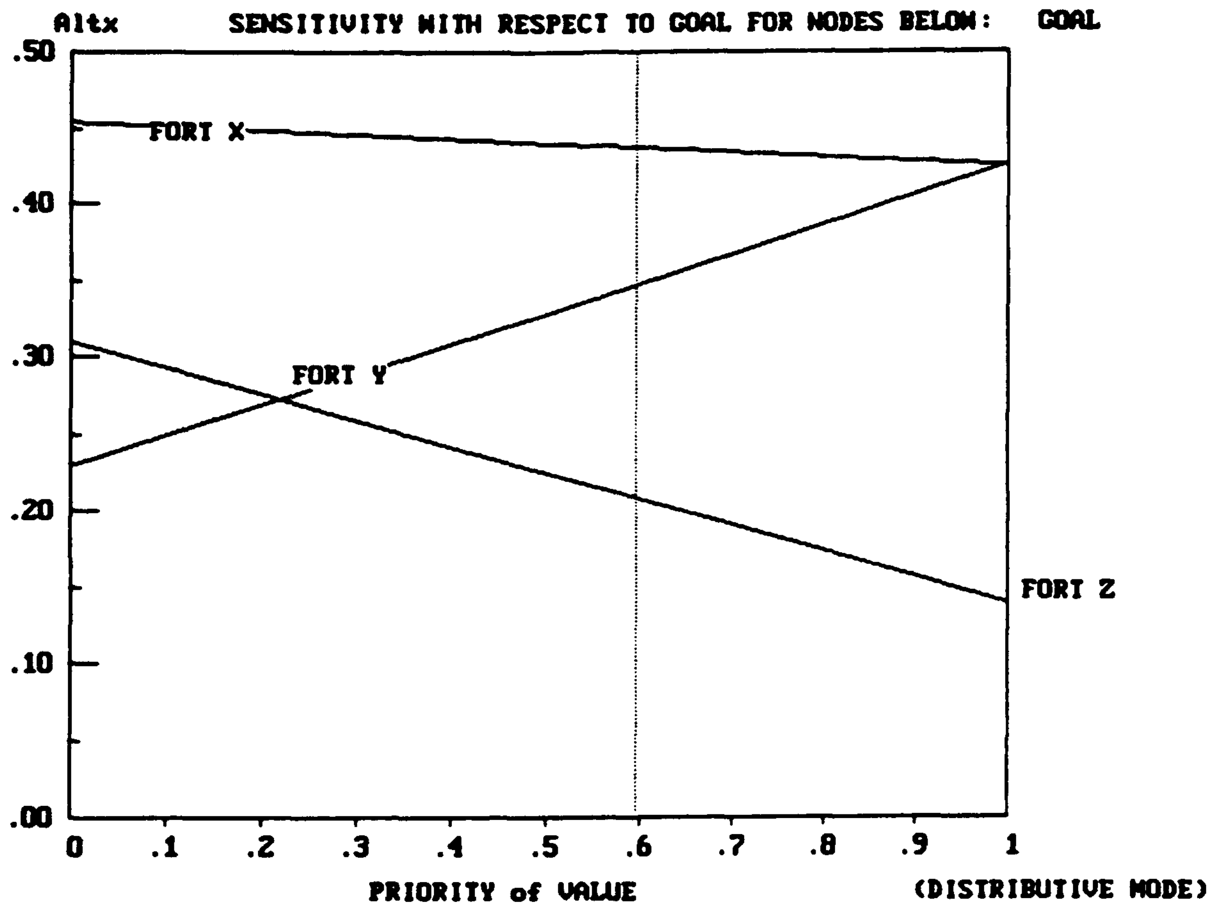


FIGURE 5-10. Gradient sensitivity graph

The vertical line represents the priority of the criterion VALUE and the diagonal lines represent the alternatives. The priorities of the alternatives are given by the intersection of that line representing the alternative and the vertical line representing the criterion priority, read from the Y-axis. The decision maker can use the mouse or the left and right arrow keys to increase or decrease the priority of the criterion (shift the vertical line right or left). As the vertical line shifts right or left, the priorities of the alternatives will change. The points at which alternative lines cross each other are the "trade-off points". These are the points at which the weight of one alternative outweighs the other when the weight of the criterion is changed (Forman 1992, p. 100). The up and down arrow keys are used to display the gradient sensitivities for the other criteria.

When changes are made to one gradient sensitivity screen, the changes will affect the slopes of all of the alternatives and the location of the vertical line on the other graphs. This feature shows the decision maker how changes in the weight of the criteria will affect the weights of other criteria and alternatives under those criteria. The user can prevent this from happening by selecting **HOME** to reset each gradient graph before moving on to another one. Changes to priorities in the Gradient mode will not affect the original model.

The most interesting sensitivity mode is the Performance Mode (Bahouth 1993, p. 63). This mode shows how each alternative performs on each criterion. This is represented by the intersection of the alternative graph and the vertical lines. Changes in the criteria priorities will cause instantaneous changes in the overall composite priorities. The overall priorities are shown on the rightmost vertical line and read from the right-hand Y-axis.

Figure 5-11 is a display of the performance sensitivity graph for the example model. The scale on the right-hand Y-axis is different from the scale on the left-hand Y-axis and is used to give the alternatives' final composite priorities. As in the other modes, **HOME** can be selected to restore original priorities.

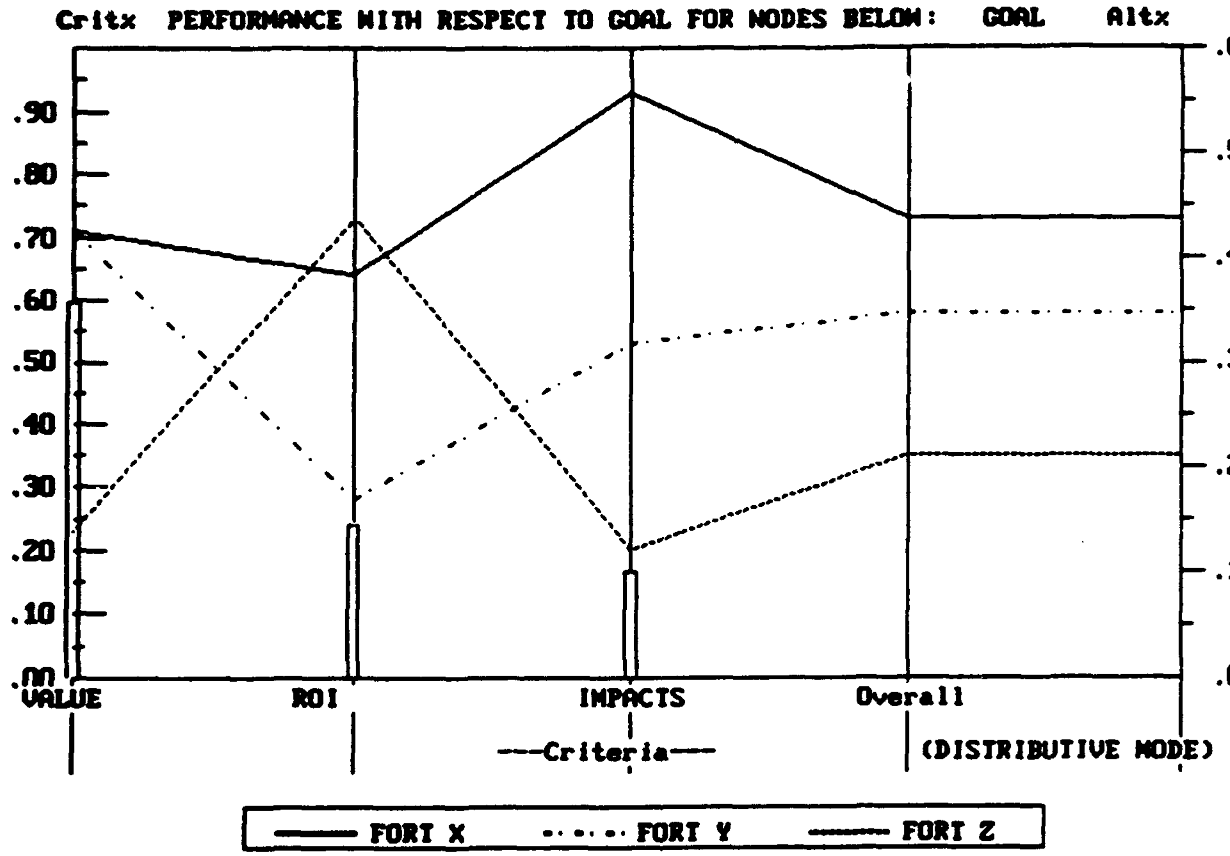


FIGURE 5-11. Performance sensitivity graph

Figure 5-12 is a display of the Two-Dimensional Plot sensitivity analysis mode. This plot shows the decision maker how well the alternatives perform with respect to any two criteria. The circles in the plot represent the alternatives. Key trade-offs are indicated by plots that go from the upper left to the lower right on the graph (Forman 1992, p. 106). Original priorities are restored when the user returns to the main menu.

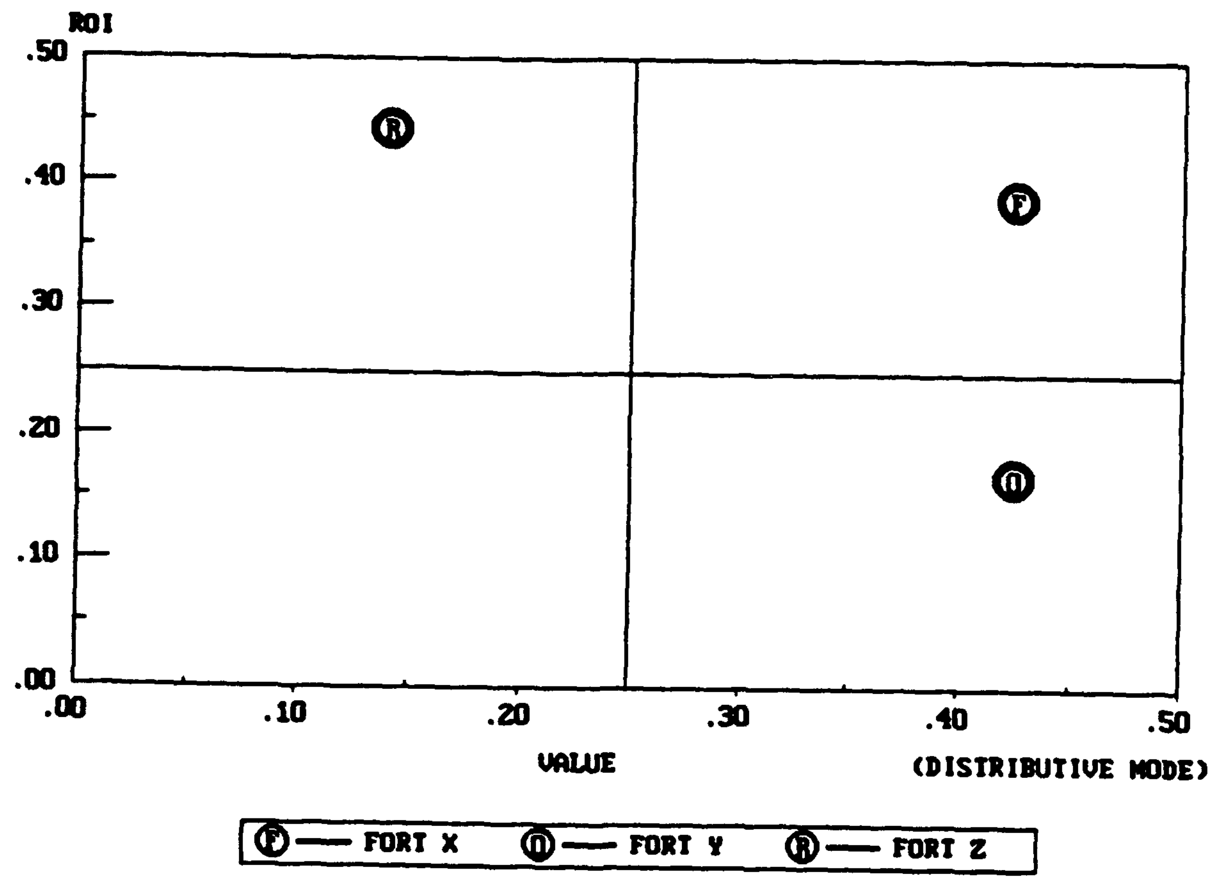


FIGURE 5-12. Two-dimensional plot

F. ABSOLUTE MEASUREMENT AND THE RATINGS APPROACH

Up to now, the discussion of the prioritizing of alternatives in an Expert Choice model has concentrated on relative measurement. That is, the alternatives are weighted after being compared to all the other alternatives in the model. Another way to rank alternatives in an Expert Choice model is accomplished with absolute measurement. With absolute measurement, standards are set by inserting a set of nodes under each criterion that are referred to as "intensities". Each alternative can be rated as to its intensity under each criterion. This is known as the Ratings Approach in Expert Choice (Forman 1992, p. 155). The Ratings Approach for entering judgments is used when the user is evaluating the alternatives against standards, rather than against each other (Forman 1992, p. 68). The Ratings Approach can be particularly useful with very large models that possess hundreds of alternatives. It would be very difficult and time consuming to perform pairwise comparisons for all of the alternatives. A second benefit of using the Ratings Approach is the prevention of rank reversal. Rank reversal cannot occur using this method of comparison (Forman 1992, p. 154).

G. PRINTING, REPORTING, AND LINKING

Expert Choice provides good printing capabilities. It is possible to print from almost any screen in Expert Choice (Forman 1992, p. 115). A printer with graphics capability is required to print the sensitivity analysis graphs. Printing can be done quickly and easily by selecting **GO** from the **REPORTING** menu.

The questionnaire feature that is provided allows the user to produce a questionnaire from any node in the model. It allows the user to collect judgments about criterion being compared from people in widely scattered locations or from a large group of people (Forman 1992, p. 119). When the questionnaires have been completed and collected, all the judgments can be entered into one model using the Geometric Mean feature of the software package.

> One of the excellent features is the report generating utility ... One of the reports that can be generated is a questionnaire for comparing all pairs in the hierarchy. This questionnaire can be given or mailed to experts, requesting their input. I find this automatic questionnaire generating facility to be very useful. (Bahouth 1993, p. 64)

The Link utility of Expert Choice can be used to export priorities and results from one or more Expert Choice models to spreadsheet programs such as *Lotus* or *Excel* (Forman 1992, p. 109).

H. SYSTEM REQUIREMENTS

Expert Choice Version 8.0 will run on an IBM or compatible PC. DOS 5.0 or greater and a minimum of 640KB RAM are required to run the program. Expert Choice requires a hard disk with at least 1.4 MB for the program files and 1.6 MB for the sample models. The program can be used with Windows 3.1. The package comes with an installation program that automatically installs both the sample models and program files.

I. SUMMARY

Expert Choice is easy to use. "... a user who is familiar with the PC environment and knows the basic theory of AHP will be able to use Expert Choice even without documentation." (Bahouth 1993, p. 64) Expert Choice is an excellent decision support tool when dealing with ranking and inferencing problems. It has a well designed user interface and effective sensitivity analysis and reporting tools (Bahouth 1993, p. 65).

The biggest drawback to the use of Expert Choice in strategic planning is its lack of support for problem structuring (Buede 1991, p. 52). This is a common problem of a large percentage of the software tools that are currently available in this field. Since many of these packages have been designed by professional decision analysts with vast experience in problem structuring, they tend to focus on computation and analysis of values and uncertainties, rather than problem structuring (Buede 1991, p. xiv). Before a planner or decision maker can use Expert Choice to build a hierarchical model, the difficult task of problem structuring must be completed. As outlined in Chapter III, this task involves the identification of mission and values, mandates, strengths, weaknesses, opportunities and threats, and issues. Expert Choice does not provide support in this area.

Expert Choice, Inc. is currently conducting beta testing of a groupware version of Expert Choice, called Team Expert Choice. With this groupware version, several decision makers can enter judgments simultaneously and anonymously, if desired (Bahouth 1993, p. 65).

Expert Choice sells for $495 for a single user version and is available through Expert Choice, Inc., 4922 Ellsworth Avenue, Pittsburgh, PA 15213; telephone: (412) 682-3844; fax: (412) 682-7008. A demonstration version disk can be ordered for $10.

VI. CONCLUSION

A. OVERVIEW

This thesis has discussed the application of computer software as a tool to aid in strategic thinking and planning. Specifically, it introduced, described and evaluated two software packages--Graphics COPE and Expert Choice--as to their effectiveness as tools for aiding the strategic planning process. These two packages were from the larger, but still not extensive, business strategic planning software market.

The research questions we set out to answer were: (1) what computer software capabilities are currently available to strategic planners, and (2) how can they be used by military strategic thinkers and planners? The first question has been answered through our discussion of the five categories of strategic planning software (Beude 1991), and the more in-depth evaluations of Graphics COPE and Expert Choice. We have answered the second question by proposing the use of Bryson's strategic planning process in conjunction with software applications from each end of the continuum. We feel that Graphics COPE can assist at the beginning, in the problem structuring stage of the strategic planning process. At the other end of the spectrum, the decision making step, we feel that Expert Choice will lead the analyst to order the problem so that alternatives can be evaluated and ranked.

Because tremendous amounts of information are gathered and evaluated throughout this strategic planning process, we believe that computers and computer software can be helpful in managing and structuring this information. Using computers to aid in the strategic planning process provides help: (1) structuring the problem, (2) selecting alternatives, and (3) enabling changes to be made quickly as the situation changes. Thus, the use of strategic planning software can lend flexibility and thoroughness to the strategic planning process.

Chapter II has provided the foundation for military and business strategy. It provides the rationale for the military to conduct *organizational* strategic planning. During our research we found no strategic planning model which properly fit the Department of Defense. Thus, Bryson's model was presented as one for use because of its ease of use, its focus is on managing change, and its consideration of political factors.

Chapter III has defined Decision Support Systems (DSS). It lists the major characteristics, components, and benefits of DSS. These systems can provide the decision maker with analysis tools, "what if" and goal seeking capabilities, and with modeling techniques to assist in problem structuring.

One of the most attractive features of these software applications for use in strategic planning is the data management component. The data management component contains the database that provides the storage and manipulation capabilities that are extremely useful in the strategic planning process.

Other attractive features of the use of DSS to aid in the strategic planning process are the capabilities for presenting data in a variety of reports and graphical forms. These can enhance communication between levels of management in an organization. Also, the ability to quickly recall ideas or revisit problems, even years down the road, make DSS an attractive aid to the strategic planning process.

Problem structuring is one of two approaches for the design of strategic planning software that is described in this thesis. Problem structuring is breaking down the problem into issues, related elements, and alternative courses of action, and then modeling the relationships among factors or elements that affect the problem. Unfortunately, many of the software packages currently being offered for use in strategic planning lack adequate support in the area of problem structuring. Graphics COPE is considered a problem structuring package. It uses cognitive mapping and Strategic Options Development and Analysis (SODA) to structure complex problems.

Cognitive mapping is described as a method for modeling ideas about a problem. The model is a collection of related issues, objects, or ideas that are linked together to indicate how one concept causes, or leads to, another concept. Cognitive maps are a way of channeling the participants' thoughts to the template the group has chosen for its situation. The mapping information can be entered into software which acts as a database that stores it for analysis and presentation. The SODA method uses the technique of cognitive mapping to capture the views of a group and to reach a consensus on issues, information, and alternatives to a problem.

The second approach for designing strategic planning software is that of organizing a problem into a hierarchy. The Analytic Hierarchy Process (AHP) was developed by Thomas L. Saaty to assist decision makers in making logical and unbiased decisions while considering their expertise, preferences, experience, and instincts. The AHP provides the foundation for Expert Choice. Expert Choice gives the user or decision maker the ability to organize a problem and its related elements and criteria into a hierarchy. The decision maker can then instruct Expert Choice as to which criteria are the most important by conducting pairwise comparisons among criteria at all levels of the hierarchy.

B. CONCLUSION

We believe that Graphics COPE (SODA) and Expert Choice (AHP) offer several advantages to the planners and analysts who are devoting time and energy to information processing with the intent of formulating an action plan. To the staff or group which must first find its group consensus on issues, mandate and alternatives, SODA offers a method for structuring the problem situation--with or without the use of computer. When coupled with the powerful computing capabilities of Graphics COPE, an in-depth analysis of the issues and their related concepts can be conducted. A drawback of Graphics COPE is the need for a trained facilitator to conduct the interviews and have functional knowledge of COPE and its workings.

AHP provides the ability to make judgments and comparisons among criteria or related elements of a problem. Its many tools provide the analyst the ability to rank criteria, select the best alternative, and even forecast future scenarios. Expert Choice is an easy package to learn and use, even for the user with little to no experience using personal computers.

Our recommendation to planners considering jumping into the computer application arena would be to evaluate your needs before you leap. Should you need significant assistance in mapping your situation and structuring the problem *and* you have a person to send for training in their nuances, SODA and COPE could well be your answer. If you need help in choosing among alternatives and would like to change variables, goal seek, and do "what if" analysis in a logical, powerful manner, then AHP and Expert Choice fit the bill. When you need help doing both and you don't have the time or the money to learn, you may be better off waiting for the technology to reach your level rather than taking your level to the technology.

The nature of computer technology makes it subject to rapid changes. Further studies in this area are almost mandated by the need to be aware of the current state of the business. And as this state moves more and more to applications which are easier for the user, more users will move to embrace the technology.

The wise user will explore the options carefully and use the technology appropriate for the task at hand. You now should be more aware of the strategic planning software capabilities which are out there, as well as the technology currently available in the two applications which we reviewed. Ultimately, users will have to determine if any of these packages fit their needs.

APPENDIX A

ALPHABETICAL LISTING OF SOFTWARE VENDORS

Arborist
TEXAS Instruments, Inc.
Data Systems Group
P.O. Box 100137
800-847-2787

Arizona State
Professor Craig W. Kirkwood
Department of Decision and Information Systems
College of Business
Arizona State University
Tempe, AZ 85287-4206
602-965-6350

Auto-Intelligence
Intelligence Ware, Inc.
9800 S. Sepulveda Boulevard, Suite 730
Los Angeles, CA 90045
213-417-8896

Best Choice
Sterling Castle Software
702 Washington Street, Suite 174
Marina del Rey, CA 90292
213-306-3020 or 800-722-7853

Cope 10.8
Strategic Decision Support Research Unit
Department of Management Science
Strathclyde Business School
University of Strathclyde
Livingstone Tower,
26 Richmond Street
Glasgow,
Scotland G1 1XH
44 41 552-4400 ext. 3141

Criterium
SYGENEX, Inc.
15446 Bel-Red Road, Suite 450
Redmond, WA 98052
206-881-5500

DATA (for Macintosh)
TreeAge Software, Inc.
23rd Floor
One Post Office Square
Boston, MA 02109
617-426-5819

DAVID
Center for Academic Computing
Duke University
North Building, Research Drive
Durham, NC 27706-7756
919-684-3695

Deciding Factor
Power Up!
Channelmark Corp.
2929 Campus Drive
P.O. Box 7600
San Mateo, CA 94403
800-851-2917

Decision {Decision.WKS}
Once Begun Computations
Searsport, ME 04974
207-338-1082

Decision Aide II
Kepner-Tregoe, Inc.
P.O. Box 704
Princeton, NJ 08542
800-223-0482

Decision Analyst
Executive Software, Inc.
Two North State Street
Dover, Delaware 19901
705-722-3373

Decision Map
Softstyle
7192 Kalanianaole Highway
Suite 205
Honolulu, HI 96825
808-396-6368

Decision Pad
Apian Software
P.O. Box 1114
Menlo Park, CA 94016-1114
415-851-8496

Expert 87
Magic7 Software Company
101 First Street Suite 237
Los Altos, CA 94022
415-941-2616

Expert Choice
Decision Support Software, Inc.
4922 Ellsworth Ave.
Pittsburgh, PA 14213
412-681-3844

Graphics COPE
(same as COPE)

HiView
Decision Analysis Unit
The London School of Economics
Houghton Street
London, England WC2A 2AE
01-405 7686

Idea Generator Plus
Experience in Software
2000 Hearst Avenue
Berkeley, CA 94704
800-678-7008

Lightyear
Thoughtware, Inc.
1699 South Bayshore Drive
Coconut Grove, FL 33133
800-848-9173

MAUA 2.0
Booz-Allen & Hamilton, Inc.
1953 Gallows Road
Vienna, VA 11180
703-893-0040

MAUD
Decision Analysis Unit
The London School of Economics
Houghton Street
London, England WC2A 2AE
01-405 7686

P/G%
Decision Aids, Inc.
1720 Parkhaven
Champaign, IL 61820
217-359-8541

PASS
Mr. Jim Peerenboom
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439
312-972-8994

Planning Tools 2.0
ATR, Inc.
900 Artesia Blvd., Suite 110
Redondo Beach, CA 90278-2704
213-379-1205

PREFCALC
Euro-Decision
B.P. 57-78530
Buc, France
33-3-956-37-05

Smartedge 3.0
Haviland-Lee, Inc.
P.O. Box 5036
Pasadena, CA 91107
714-611-1610

SMLTree 2.0
Dr. James P. Hollenberg
445 East 68th Street
New York, NY 10011
111-734-5681

Stella for Business 2.1
High Performance Systems, Inc.
13 Dartmouth College Highway
Lyme, NH 03768-9989
603-795-4857

Stratatree
Decision Support Software, Inc.
4922 Ellsworth Ave.
Pittsburgh, PA 14213
412-681-3844

Supertree
SDG Decision Systems
3000 Sand Hill Road
Menlo Park, CA 94025
415-854-9000

TreeVal
Decision Analysis Group
ISSM MC-0021
University of Southern California
Los Angeles, CA 90089-0021
213-743-3083

XIA 2.0
Booz-Allen & Hamilton, Inc.
1953 Gallows Road
Vienna, VA 11180
703-893-0040

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4401 Ford Ave.
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