Chapter 7

Forecasting - The Forward Process [1]

Applications of the Analytic Hierarchy Process can be classified into two major categories: (1) Choice -- the evaluation or prioritization of alternative courses of action, and (2) forecasting -- the evaluation of alternative future outcomes. Up to this point we have looked at choice problems -- where the desirability of alternative courses of action were evaluated. Forecasting, the topic of this section, focuses on the evaluation of the relative likelihood of future outcomes.

It has been said that humans will forever seek three elusive goals: eternal youth (the fountain of youth), the ability to turn base metals into gold (the goose that lays the golden egg), and the ability to forecast the future with certainty. Even though we will never be able to achieve these ultimate goals, we have come a long way. We have developed technologies that have dramatically increased our expected life spans, discovered substitute metals and synthetics that are often more valuable than gold, and have developed technologies and forecasting techniques that enable us to predict such things as the next day's weather with remarkable accuracy. However, the more progress we make the more we expect. In our competitive world it is not enough to be able to forecast demand for a product better than we did ten or twenty years ago, we must be able to forecast better than our competitors today!

Historically, two separate approaches have been used for forecasting – quantitative forecasts, which employ a variety of mathematical models based on historical data, and qualitative forecasting methods that rely on intuition, personal experiences. Quantitative methods include such techniques as simple trend projection, regression models, and time series models ranging from moving averages, to Box Jenkins auto-regressive models. Qualitative methods include such techniques as a juries of executive opinion, sales force composites, delphi method, and consumer

[1] Choice models are sometimes referred to as "backward" processes and forecasting models referred to as "forward" models, for reasons to be explained later.

market surveys[2]. By in large, each technique produces its own forecasts (and there may be many alternative forecasts available from a single technique) and decision-makers are usually left to decide which to believe. While quantitative forecasts are more 'objective', a major limitation is that they are based solely on historical data – and there is not data for the future. Indeed, an assumption of regression analysis, one of the most often used quantitative forecasting techniques is that the results are only valid within the range of data used to estimate the parameters of the model and that range does not include the future. However, the use of historical data is, in many circumstances, far superior to using no data at all. If one is willing to assume that the future will be somewhat similar to the past, then quantitative methods may be appropriate. However, technological innovation coupled with domestic and international social changes, political changes (e.g., the break up of the Soviet Union), and economic changes (e.g., the global economy) make quantitative forecasting techniques even less reliable than they were in the past.

Occasionally we may be interested in forecasting simply because of a curiosity of what the future may bring. More often, however, we are interested in forecasting the future in order to make better decisions (by evaluating alternative courses of action). We will look at how AHP can be useful in synthesizing information in order to make better decisions under conditions of uncertainty. We will show how AHP can be used to combine forecasts (in the form of probability distributions) from a variety of factors and/or techniques. Although uncertainty cannot be eliminated, we will show how AHP can be used to derive probability distributions that, in essence, remove the uncertainty about uncertainty. The first three illustrations involve the use of AHP in conjunction with traditional quantitative forecasting techniques. The remaining illustrations involve the use of AHP as a forecasting methodology in its own right.

[2] Jay Heizer and Barry Render, *Production and Operations Management – Strategies and Tactics*, 3rd Edition, Allyn and Bacon, Boston, p. 124.

Illustration 1 – Synthesizing Forecasting Methods for a Composite forecast

AHP is an excellent way to combine the results of several forecasting tools to produce a single, composite forecast. Many firms benefit in using a variety of forecasting tools in tandem because the strengths of some tools offset the weaknesses in others. However, the problem in using multiple methods is how to arrive at a single numeric forecast. Recent research has indicated that a combination of forecasting approaches often produces better results than using only one approach.

Alternative approaches in forecasting future demand for a product might consist of:

- Consensus asking a group of experts, to come to a consensus on judgments about relative likelihoods (perhaps by using a Delphi approach)
- Surveys **-** such as sales force surveys, or buyer intention surveys
- Multiple regression
- Exponential smoothing
- Box Jenkins

Criteria such as accuracy, stability of estimates, and turning-point estimation can be used to assess the credibility of various forecasting tools. The synthesis of the model shown in Figure 1 provides weights for each of four traditional methods. These weights can then be applied to each forecast estimate in order to arrive at a weighted, composite forecast as shown in Table 1.

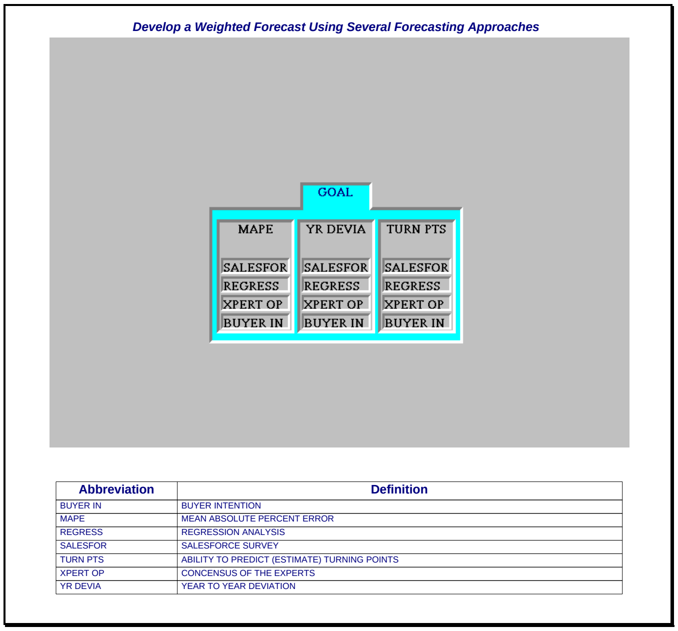


Figure 1 – Model for a Composite Forecast

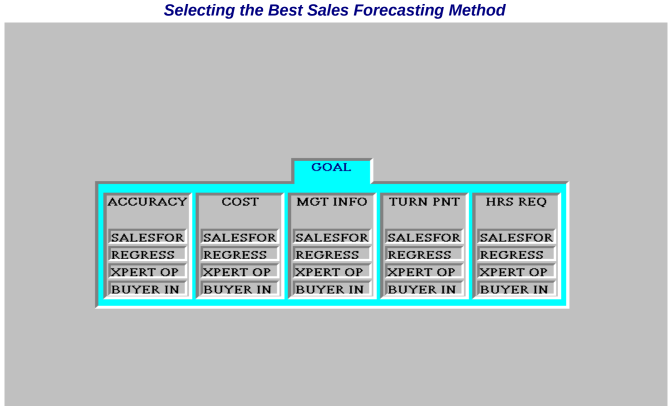
Table 1 – Deriving a Weighted, Composite Forecast

Forecasting Tool	Overall Priority	Forecasted Sales	Weighted Forecast
Sales force survey	.32	3,800	1,216.0
Regression	.18	3,725	670.5
Expert Consensus	.06	4,150	249.0
Buyer intention	.44	2,725	1,199.0
Expected Sales			3,334.5

Illustration 2 – Selecting a Forecasting Method

Instead of combining the results of quantitative forecasting techniques, it may be desirable to use a forecast from only one of the many quantitative techniques available. But which one? A model to select the best forecasting technique for a particular application is shown in Figure 2. The decision maker(s) make judgments about the relative preference of the techniques with respect to objectives such as accuracy, cost, management information provided, the ability of a technique to predict turning points, and the time required to implement the technique. Judgments about the relative importance of these objectives are also made. The resulting synthesis will indicate the overall relative preference of the various techniques.

Selecting the Best Sales Forecasting Method



Abbreviation	Definition
ACCURACY	PAST ACCURACY
BUYER IN	BUYER INTENTION
COST	COST OF IMPLEMENTING A METHOD
HRS REQ	TIME REQUIRED TO PERFORM FORECAST
MGT INFO	TYPE OF INFORMATION SUPPLIED -- DOES IT FIT THE NEED?
REGRESS	REGRESSION ANALYSIS
SALESFOR	SALESFORCE SURVEY
TURN PNT	ABILITY TO PREDICT (ESTIMATE) TURNING POINTS
XPERT OP	CONSENSUS OF THE EXPERTS

Figure 2 – Selecting A Forecasting Method

Illustration 3 – Deriving Probability Distributions

Consider an investor who is evaluating alternative stocks or options. The investor, after doing research, will form an opinion that a particular stock is likely to go up, or down. Suppose an investor is considering two alternative stocks and thinks they will both go up. Is one more likely to go up than the other? It may be that the investor feels that stock A is more likely to go up than stock B but that stock B has a greater probability of going up by more than 20 percent than does stock A. How can the investor incorporate these feelings into his or her decision process? If the investor could translate his or her knowledge about the stocks into probability distributions, he or she could then use the probability distributions in choosing among the stocks, or in even more complex decisions, choosing among alternative strategies for stock option puts and calls.

It would be unreasonable to expect the investor to specify directly the probability distribution for a stock's price performance (over a specified period of time). However, it is rather natural for the investor to express feelings about the anticipated stock's price performance via pairwise relative comparisons. For example, the investor should be able to translate his or her research about a stock into a judgment such as:

> the likelihood of a stock's going up 5 percent in a given period of time is moderately more likely than that it will remain at the current price,
>
> and,the likelihood of a stock's remaining unchanged is moderately to strongly more likely than that it will go up 20 percent.

Just as redundancy (in the pairwise comparisons) has been shown to produce accurate estimates of quantifiable physical phenomena (such as area or intensity of light), the redundancy in the investor's set of pairwise comparisons will result in probabilities that reflect the investor's judgments, which in turn are based on his or her research as well as experience. In making the pairwise comparisons, the investor will find himself or herself pressed to "think hard" and forced to question both assumptions and the

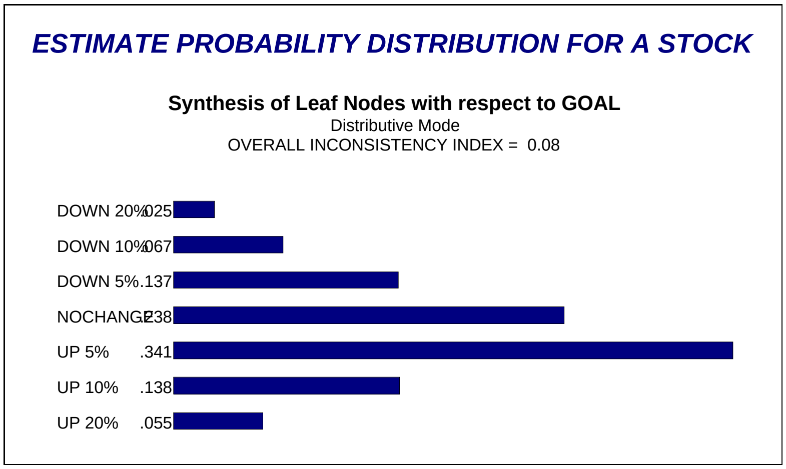


Figure 3 – Resulting Probability Distribution

ESTIMATE PROBABILITY DISTRIBUTION FOR A STOCK

Node: 0

Compare the relative IMPORTANCE with respect to: GOAL <

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

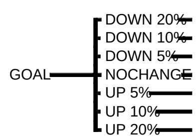
1	DOWN 20%	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	(7)	8	9	DOWN 10%
2	DOWN 20%	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	(8)	9	DOWN 5%
3	DOWN 20%	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	(9)	NOCHANGE
4	DOWN 20%	9	8	7	6	5	4	3	2	**1**	2	3	4	(5)	6	7	8	9	UP 5%
5	DOWN 20%	9	8	7	6	5	4	3	2	**1**	2	3	4	(5)	6	7	8	9	UP 10%
6	DOWN 20%	9	8	7	6	5	4	3	2	**1**	2	(3)	4	5	6	7	8	9	UP 20%
7	DOWN 10%	9	8	7	6	5	4	3	2	**1**	2	3	(4)	5	6	7	8	9	DOWN 5%
8	DOWN 10%	9	8	7	6	5	4	3	2	**1**	2	3	4	(5)	6	7	8	9	NOCHANGE
9	DOWN 10%	9	8	7	6	5	4	3	2	**1**	2	3	(4)	5	6	7	8	9	UP 5%
10	DOWN 10%	9	8	7	6	5	4	3	2	**1**	2	(3)	4	5	6	7	8	9	UP 10%
11	DOWN 10%	9	8	7	6	5	4	3	2	**(1)**	2	3	4	5	6	7	8	9	UP 20%
12	DOWN 5%	9	8	7	6	5	4	3	2	**1**	2	(3)	4	5	6	7	8	9	NOCHANGE
13	DOWN 5%	9	8	7	6	5	4	3	2	**1**	2	(3)	4	5	6	7	8	9	UP 5%
14	DOWN 5%	9	8	7	6	5	4	3	2	**(1)**	2	3	4	5	6	7	8	9	UP 10%
15	DOWN 5%	9	8	7	6	5	4	3	(2)	**1**	2	3	4	5	6	7	8	9	UP 20%
16	NOCHANGE	9	8	7	6	5	4	3	2	**1**	2	(3)	4	5	6	7	8	9	UP 5%
17	NOCHANGE	9	8	7	6	5	4	3	(2)	**1**	2	3	4	5	6	7	8	9	UP 10%
18	NOCHANGE	9	8	7	6	5	(4)	3	2	**1**	2	3	4	5	6	7	8	9	UP 20%
19	UP 5%	9	8	7	6	5	4	(3)	2	**1**	2	3	4	5	6	7	8	9	UP 10%
20	UP 5%	9	8	7	(6)	5	4	3	2	**1**	2	3	4	5	6	7	8	9	UP 20%
21	UP 10%	9	8	7	6	5	(4)	3	2	**1**	2	3	4	5	6	7	8	9	UP 20%

Figure 4 – Judgments

validity of available data. An Expert Choice model[3], as well as a typical set of comparisons and resulting probability distribution are shown in Figure 5, Figure 4 and Figure 3 respectively.

The translation of the investor's research into a subjective probability distribution is a significant accomplishment since this probability distribution can subsequently be used to evaluate investment alternatives (using criteria relevant to the investor, such as expected value, standard deviation, and the probability of gaining or losing more than a specified percent, along with other factors about the company such as its quality of management). In a sense, it can be said that this process of deriving a probability distribution removes the uncertainty about uncertainty by translating fuzzy feelings (such as research or analyst opinion that it will

ESTIMATE PROBABILITY DISTRIBUTION FOR A STOCK



Abbreviation	**Definition**
GOAL	
DOWN 10%	DOWN 10%
DOWN 20%	DOWN 20%
DOWN 5%	DOWN 5%
NOCHANGE	NOCHANGE
UP 10%	UP 10%
UP 20%	UP 20%
UP 5%	UP 5%

Figure 5 – Simple Model to Estimate Probability Distribution for a Stock

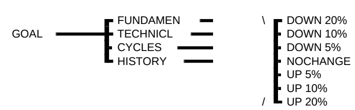
[3] More discrete intervals and subintervals can be included if desired.

probably go up a little, or a lot) into a distribution of probabilities. A distribution of probabilities is far richer and in some cases necessary when making rational choices such as deciding on stock option trades.

This approach can easily be expanded to accommodate judgments based on specific factors and to synthesize forecasts derived from different forecasting perspectives. Four common perspectives on forecasting stocks/options/futures are:

- Fundamental analysis (companies fundamentals, price earnings ratios, supply, demand, and so on.)
- Technical analysis (charts, moving averages, support and resistance levels, Elliot waves, and so on.)
- Cyclical analysis
- Historical analysis (what the price is relative to its historical highs, lows, and so on.)

ESTIMATE PROBABILITY DISTRIBUTION FOR A STOCK



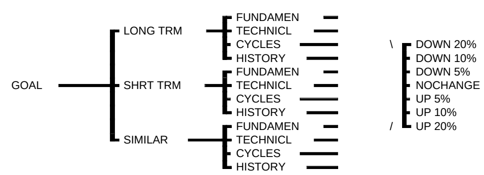
Abbreviation	Definition
GOAL	
CYCLES	CYCLICAL ANALYSIS
DOWN 10%	DOWN 10%
DOWN 20%	DOWN 20%
DOWN 5%	DOWN 5%
FUNDAMEN	
HISTORY	HISTORICAL PERSEPCTIVE
NOCHANGE	NOCHANGE
TECHNICL	TECHNICAL ANALYSIS, CHARTS, SUPPORT, RESISTANCE, ELLIOT WAVES
UP 10%	UP 10%
UP 20%	UP 20%
UP 5%	UP 5%

Figure 6 – Model Synthesizing Different Approaches

Some professional analysts use only one perspective, while others use a combination, trying to synthesize in their heads the likelihoods indicated by each perspective and the relative importance they attach to each perspective at a particular time. This kind of synthesis can be accomplished with AHP as shown in Figure 6.

In order to assess the relative influence in synthesizing these approaches to forecasting stocks, their relative success in both the short term and long term as well as their success in similar environments can be included in the evaluation as shown in Figure 7.

ESTIMATE PROBABILITY DISTRIBUTION FOR A STOCK



Abbreviation	Definition
GOAL	
CYCLES	CYCLICAL ANALYSIS
DOWN 10%	DOWN 10%
DOWN 20%	DOWN 20%
DOWN 5%	DOWN 5%
FUNDAMEN	
HISTORY	HISTORICAL PERSEPCTIVE
LONG TRM	SUCCESS OVER THE LONG TERM
NOCHANGE	NOCHANGE
SHRT TRM	RECENT SUCCESS
SIMILAR	SUCCESS UNDER SIMILAR ECONOMIC AND BUSINESS CONDITIONS
TECHNICL	TECHNICAL ANALYSIS, CHARTS, SUPPORT, RESISTANCE, ELLIOT WAVES
UP 10%	UP 10%
UP 20%	UP 20%
UP 5%	UP 5%

Figure 7 – Model Including Relative Influence of Approaches

Illustration 4 – Forecasting Alternative Outcomes

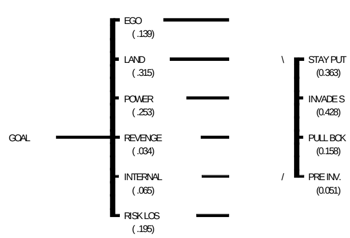
Many AHP forecasting models are simple, straightforward models designed to measure the relative importance of influencing factors on alternative outcomes. As an example, we will look at the following model, constructed by a retired intelligence officer one week after Iraq invaded

Kuwait. Forecasting Saddam Hussein's next move was of obvious interest. The model was used to asses the relative likelihood that Saddam Hussein would (1) stay put where he was in Kuwait, (2) invade Saudi Arabia, (3) pull his forces back to pre-invasion locations, but leave a puppet government, or (4) pull back to pre-invasion locations, without leaving a puppet government.

The factors thought to influence Saddam Hussein's behavior (his objectives) included: (1) his ego, (2) gain of land that was in dispute, (3) the power to do what he wanted to (in addition to increasing his ego), (4) revenge for the wrongs he perceived from his Arab neighbors, (5) distraction from internal problems, and (6) minimizing the risk of loss in confrontation with other powers.

Judgments were made about the relative likelihood of the outcomes with respect to each of Saddam Hussein's objectives. Following this,

Forecast Saddam Hussein's Next Move (8/9/90)



Abbreviation	Definition
GOAL	
EGO	
INTERNAL	distraction from internal problems.
INVADE S	invade Saudia Arabia
LAND	gain land that is in dispute
POWER	power to do what he wants (in addition to increasing his ego.)
PRE INV.	pull back & remove puppet government
PULL BCK	pull back and leave a puppet
REVENGE	
RISK LOS	risk of loss in confrontation with other powers
STAY PUT	stay in Kuwait

Figure 8 – Synthesis of Outcomes

judgments were made about the relative importance of Saddam Hussein's objectives. The synthesis of these judgments was that an invasion of Saudi Arabia was the most likely outcome (see Figure 8).

A look at a gradient sensitivity plot (Figure 9) for the risk of loss objective was very revealing.

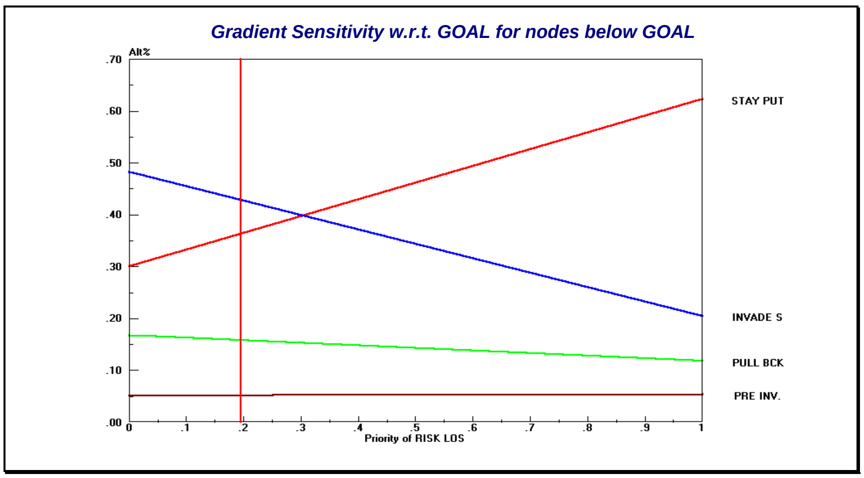
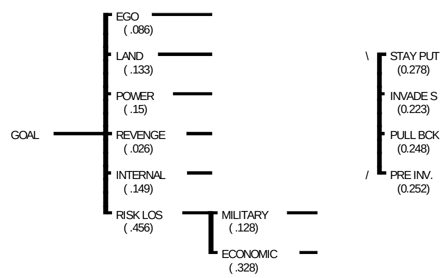


Figure 9 – Gradient Sensitivity Plot on Risk of Loss

If the risk of loss were to become more important, the most likely outcome would be for Saddam Hussein to stay put, rather than invade Saudi Arabia -- a result that is not surprising. During this time, the United States and other coalition nations were beginning to send forces into the region. About a week later, the model was revised and re-evaluated, taking into account the buildup of coalition forces (Figure 10).

Forecast Saddam Hussein's Next Move (8/16/90)



Abbreviation	Definition
GOAL	
ECONOMIC	economic loss
EGO	
INTERNAL	distraction from internal problems.
INVADE S	invade Saudia Arabia
LAND	gain land that is in dispute
MILITARY	military loss
POWER	power to do what he wants (in addition to increasing his ego.)
PRE INV.	pull back & remove pupet government
PULL BCK	pull back and leave a puppet
REVENGE	
RISK LOS	risk of military and economic loss
STAY PUT	stay in Kuwait

Figure 10 – Synthesis of Outcomes One Week Later

The only structural change in this model is the addition of sub-objectives under the risk of loss objective. A significant change in the evaluation of the model was due to judgments that took into account the buildup of coalition forces. The risk of loss objective was now evaluated as being much more important to Saddam Hussein than in the first model.[4] The results of this model show that the most likely outcome has changed from that of invading Saudi Arabia to staying put -- which is precisely what Saddam Hussein decided to do.

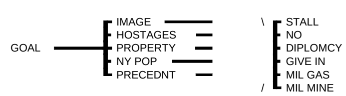
[4]An interesting observation, made after the Gulf War ended by General Norman Schwarzkopf, was that the press had helped the coalition efforts by giving the impression that the coalition forces were much stronger at this time than they actually were.

Two forecasting models were shown in this illustration. If the United States and the coalition forces had not already decided to build up forces in the region, the likely outcome of an invasion of Saudi Arabia would have certainly called for a choice model to evaluate alternative actions, including a force buildup.

Illustration 5 – Forecasting models interacting with choice model(s).

As an illustration of how forecasting model(s) can interact with choice models, consider the following hypothetical situation, aired by a major television network. The President of the United States must respond to terrorist demands made while the terrorists hold an oil tanker (along with some passengers) hostage off the tip of lower Manhattan. The choice model is shown in Figure 11). When one considers the relative preference of the alternatives with respect to each of the objectives, for example, the relative

Decide how to respond to terrorists



Abbreviation	Definition
GOAL	
DIPLOMCY	DIPLOMACY VIA ZURICH
GIVE IN	GIVE IN TO DEMANDS OF TERRORISTS
HOSTAGES	
IMAGE	PRESIDENTIAL IMAGE, DOMESTIC AND ABROAD
MIL GAS	MILITARY ACTION WITH GAS ATTACK
MIL MINE	MILITARY ACTION - MINING AND SINKING SHIP
NO	SAY NO, WILL NOT GO ALONG WITH THEIR DEMANDS
NY POP	POPULATION OF NEW YORKERS IN SURROUNDING AREAS
PRECEDNT	BREAKING PRECEDENT OF NOT NEGOTIATING WITH TERRORISTS
PROPERTY	
STALL	DON'T DO ANYTHING FOR NOW

Figure 11 – Choice Model

preference of mining and sinking the ship as opposed to a gas attack with respect to the effect on the New York population, questions arise as to what is *likely* to happen to the New York population under each of these alternative actions.

If there are several possibilities, each of which is affected by several

INVESTMENTS GIVEN PRESENT ECONOMIC COND, MOVING TOWARD...(8/87)

Abbreviation	**Definition**
GOAL	
BONDS	Bonds and fixed income securities
CASH	Cash & Equivalents
EFFORT	Effort in managing, tracking, decision making
EROSION	Prevent erosion due to inflation
GROWTH	Increase in real value
INTLSTCK	International stocks
METALS	Precious metals (primarily gold) and collectibles
REAL EST	Real estate
SAFETY	Safety of principle
US STOCK	U.S. Stocks

Figure 12 – Evaluation of Alternative Investments

factors, a forecasting model could be employed. Therefore, in order to evaluate the alternatives in this model, it can be helpful to first construct separate forecasting models for one or more of the alternatives in order to estimate what is likely to happen if that alternative is pursued.

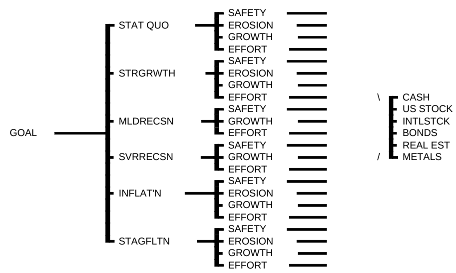
Illustration 6 -- Deriving Scenario Likelihoods

Another common way of incorporating uncertainty and forecasting with AHP is through scenarios. Planners use scenarios as a way of describing future conditions. Scenarios serve as a background for planning and evaluating alternative courses of action.[5] The need to include scenarios in an AHP model often becomes self-evident. The AHP model shown in Figure 12 was used to evaluate the relative attractiveness of alternative investments (cash or cash equivalents, U.S. stocks, international stocks, bonds, real estate, and precious metals), with respect to investor objectives that included safety of principle, growth, protecting against erosion from inflation, and effort required for investment management.

When considering a judgment such as "What is more important, safety of principle or growth?", the need for scenarios became apparent as the answer obviously depends on the economic environment that would ensue. Thus, economic environment scenarios were included below the goal, as shown in Figure 13.

[5] J. Brooke Aker, *Consumer Issues*, Presentation at The Planning Forum, April 4, 1991, New York, N.Y.

INVESTMENTS GIVEN PRESENT ECONOMIC COND, MOVING TOWARD...(8/87)

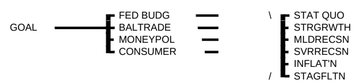


Abbreviation	Definition
GOAL	
BONDS	Bonds and fixed income securities
CASH	Cash & Equivalents
EFFORT	Effort in managing, tracking, decision making
EROSION	Prevent erosion due to inflation
GROWTH	Increase in real value
INFLAT'N	Inflation-Interest&Inflation ^^
Economy<>or^	
Oil ^	
INTLSTCK	International stocks
METALS	Precious metals (primarily gold) and collectibles
MLDRECSN	Mild Recession-Economy V
Interest&Inflation<> orV	
Oil<> or V	
REAL EST	Real estate
SAFETY	Safety of principle
STAGFLTN	Stagflation-Interest & Inflation ^^

Figure 13 – Model with Economic Scenarios

Priorities for the scenarios can be derived from pairwise comparisons of the relative likelihood of the scenarios. These can be based on historical data as well as expert judgment given current conditions. Sometimes there may be ambiguity in making such judgments. For example, when judging whether a strong growth scenario is more or less likely than a mild recession scenario, the answer may depend on factors such as the Federal budget deficit, balance of trade payments, Federal monitory policy, consumer confidence, and so on. A subsidiary model including these factors can be used to resolve ambiguities (see Figure 14). The resulting priorities from the model

Subsidiary model to derive scenario likelihoods



Abbreviation	Definition
GOAL	
BALTRADE	Balance of Trade
CONSUMER	Consumer confidence
FED BUDG	Federal Budget Deficit
INFLAT'N	Inflation
MLDRECSN	Mild recession
MONEYPOL	Federal Monetary Policy
STAGFLTN	Stagflation
STAT QUO	Status Quo
STRGRWTH	Strong growth
SVRRECSN	Severe recession

Figure 14 – Subsidiary model to derive scenario likelihoods

in Figure 14 are entered as priorities for the scenarios in the model of Figure 13.

Illustration 7 – Analytical Planning (The Forward/Backward Process)[6]

Analytical planning is a process that involves the iterative application of both forecasting and choice. On the one hand, we can look *forward* (from the present to the future) and forecast what is likely to happen. This is called the *forward process*, a primarily *descriptive* step concerned with the following kind of question: given the present actors and their policies, what *will* be (believed to be or likely to be) the future resulting from their actions? On the other hand, we can step into the future, determine what we desire, look *backward* to the present, and choose the actions or policies that will help us achieve the desired future. This is the *desired planning process*, or the *backward process* - a *normative* approach

[6] Saaty, Thomas L. and Forman, Ernest H., *The Hierarchon - A Dictionary of Hierarchies*, The Analytic Hierarchy Process Series - Volume V, RWS Publications, Pittsburgh PA, 1993

concerned with the question: given a desired future, what *should* our policies be to attain the future?

Complex environments with competing actors and forces may preclude us from easily achieving our desired future as set forth in the backward process. To see whether or not this is the case, the preferred actions or policies from the backward process can be incorporated into the forward process, which produces a forecast of likely futures. This forecast of likely futures can then be compared with the desired futures of the backward process. Any significant discrepancies would indicate that the desired future is not likely to be attained with the planned actions or policies. Discrepancies can be resolved by either finding other actions or policies that will bring the likely future closer to the desired future, or, if that is not possible, identifying alternative objectives for the desired future. In other words, if it is not possible to achieve particular objectives, more realistic objectives should be identified.

Thus, all hierarchic decision-making is one of three types: a forward process, a backward process, or a combination of both processes. The forward process hierarchy is used to project the *likely* or logical future. All problems of prediction fall into this class - what people prefer and what is likely to come about as a result of exercising their preferences. The backward process hierarchy is used to find promising control policies to attain a *desired* future. Problems of choice and decision, as opposed to problems of prediction, are expressions of desire. They are backward processes in which we set priorities on what is important, or on what should be important, and use it to identify the best choice to attain it.

What should we do today to prepare for tomorrow?

For the long-range planner the important question is not what should we do tomorrow, but what should we do today to prepare for an uncertain future. On the one hand, it is desirable to stay open to change and invention to attain better and more fulfilling futures. On the other hand, to cope with the future we need to design plans that will survive and be effective.

How do we reconcile the two objectives – to ensure the survival of adaptive plans and also to admit change in the environment for variety, excitement, and progress in the future? This is the dilemma: no sooner do we have a plan to work with than the changes it brings about call for a new plan. Because of this contradiction some people have concluded that planning is useless. The rebuttal to this is that as long as things are changing it is better for us, if we want to control them to our advantage, to be planning and re-planning than to be simply reacting.

Strategic, adaptive planning is a process of learning and growth. Above all it is an ongoing event kept in the foreground to be seen, studied, used as a guide, and revised as change is noted in the environment. Strategic planning is the process of projecting the likely or logical future and of idealizing desired futures. It is the process of knowing how to attain these futures, using this knowledge to steer the logical future toward a more desired one, and then repeating the operation. The backward process affords people an opportunity to expand their awareness of what states of the system they would like to see take place, and with what priorities. Using the backward process, planners identify both opportunities and obstacles and eventually select effective policies to facilitate reaching the desired future.

What do all plans have in common?

In the simplest way all plans have three things in common – a starting point, a goal (or ending point), and a means of connecting the two. The first component of any plan is its starting point. People's starting points are usually where they stand at the present time: they command certain resources that enable them to reach some other point; they make certain assumptions about influences beyond their control when designing a plan; they are locked by certain constraints of nature and environment that provide boundaries for the plan. Although usually taken for granted, one needs to make explicit account of all resources and constraints to facilitate maximizing planning efficiency. This would also require careful revision of the time to implement a plan because the starting point can be different than it was during the study.

The second component is the goal. Given that the other two components are conceived and executed properly, this component becomes merely a target. Goals may not be clearly defined, however, or they could be set at a point impossible to reach. The goal should not be envisioned without good knowledge of the forces and influences that affect and shape it. It must be well designed, reasonably accomplished, reevaluated, and changed as required by the circumstances.

The last component of a plan is the means. This component is the plan itself, since it describes the method by which one travels from the starting point to the goal. It must include factors that affect the goal, the internal and external forces that affect these factors, the objectives of the operation, the conscientious sequence of steps to be followed, and the likely decision points required for control in the process. The factors could be environmental, economic, cultural, social, political, and technological. Further, they may or may not be controllable to some degree by the decision-maker.

Planning involves looking forward and backward:

Many planning processes move only in one direction. That is, they follow a time-sequenced order of events beginning at the present time $t=0$ and terminating at some future point $t = T$. The first sequence, called the forward process, considers the factors and assumptions of the present state, which in turn generate some logical outcome. The second sequence, the backward process, begins with a desired outcome at time T and then works backward to identify and evaluate the factors and intermediate outcomes required to achieve that desired outcome.

In the forward process, one considers the relevant present factors, influences, and objectives that lead to sensible conclusions or scenarios. The factors/influences/objectives may be economic, political, environmental, technological, cultural, and/or social in nature. The backward process begins with the desired scenarios then examines the policies that might achieve those scenarios. Iteration of the two processes narrows the gap between the desired and the logical scenarios.

The forward planning process provides an assessment of the state of the likely outcome. The backward planning process provides a means for controlling and steering the forward process towards a desired state.

Perhaps the best reason for using the forward-backward planning process is classical planning theory itself. The theory states that there are essentially two planning goals. One is the *logical* or reachable goal that presumes that the assumptions and factors affecting the outcome will remain substantially unchanged from the present state of affairs. Marginal changes in strategy and inputs will affect output only slightly or not at all. The other planning goal is a *desired* one whose attainment requires a great deal of change in inputs - both internal and external. These changes must not only be implemented, but they must survive against the entrenched policies of the system. Inertia is a powerful force.

Combining the Forward and Backward Processes

To integrate forward and backward hierarchical planning, one projects the likely future from present actions, adopts a desired future, designs new policies, adjoins them to the set of existing policies, projects a new future, and compares the two futures - the projected and the desired – for their main attributes. The desired future is modified to see what policy modification is again needed to make it become the projected future, and the process is continued[7].

7 For details and examples of the Forward / Backward process see (1) Saaty, Thomas L., *Multicriteria Decision-Making – The Analytic Hierarchy Process*, RWS Publications, Pittsburgh PA, 1990, p 130 - 151. and (2) Saaty, Thomas L. and Kearns, K. P., *Analytical Planning*, RWS Publications, Pittsburgh PA, 1991