Dynamic Strategic Planning

Overview

Primitive Decision Models

- **Still widely used**
- **Illustrate problems with intuitive approach**
- **Provide base for appreciating advantages of decision analysis**

Primitive Decision Models

BASIS: Payoff Matrix

Alternative	State of "nature" S1 S2 . . . Sm
A1	Value of outcomes
A2	
An	Onm

Primitive Model: Laplace

- **Decision Rule:**

  a) Assume each state of nature equally probable => $p_m = 1/m$

  b) Use these probabilities to calculate an "expected" value for each alternative

  c) Maximize "expected" value

Primitive Model: Laplace (cont'd)

- **Example**

	S1	S2	"expected" value
A1	100	40	70
A2	70	80	75

Primitive Model: Laplace (cont'd)

- **Problem: Sensitivity to framing**
  ==> "irrelevant alternatives

	S1a	S1b	S2	"expected" value
A1	100	100	40	80
A2	70	70	80	73.3

Primitive Model: Maximin or Maximax

- **Decision Rule:**
  - a) Identify minimum or maximum outcomes for each alternative
  - b) Choose alternative that maximizes the global minimum or maximum

Primitive Model: Maximin or Maximax (cont'd)

- **Example:**

	S1	S2	S3	maximin	maximax
A1	100	40	30	☑	2
A2	70	80	20	2	3
A3	0	0	110	3	☑

- **Problems**
  - discards most information
  - focuses in extremes

Primitive Model: Regret

- **Decision Rule**

  a) **Regret = (max outcome for state i) - (value for that alternative)**

  b) **Rewrite payoff matrix in terms of regret**

  c) **Minimize maximum regret (minimax)**

Primitive Model: Regret (cont'd)

- **Example:**

	S1	S2	S3
A1	100	40	30
A2	70	80	20
A3	0	0	110

→

0	40	80
30	0	90
100	80	0

Primitive Model: Regret (cont'd)

- **Problem: Sensitivity to Irrelevant Alternatives**

A1	100	40	30	0	40	0
A2	70	80	20	30	0	10

NOTE: Reversal of evaluation if alternative dropped
Problem: Potential Intransitivities

Primitive Model: Weighted Index

- **Decision Rule**
  - **a)Portray each choice with its deterministic attributed different from payoff matrix)**
    e.g.

Material	Cost	Density
A	$50	11
B	$50	9

Primitive Model: Weighted Index (cont'd)

b) Normalize table entries on some standard, to reduce the effect of differences in units. This could be a material (A or B); an average or extreme value, etc.
e.g.

Material	Cost	Density
A	1.00	1.000
B	1.20	0.818

c) Decide according to weighted average of normalized attributes.

Primitive Model: Weighted Index (cont'd)

- Problem 1: Sensitivity to Framing "irrelevant attributes" similar to Laplace criterion (or any other using weights)
- Problem 2: Sensitivity to Normalization

Example:

	Norm on A		Norm on B	
Matl	$	Dens	$	Dens
A	1.00	1.000	0.83	1.22
B	1.20	0.818	1.00	1.00

Weighting both equally, we have
A > B (2.00 vs. 2.018) B > A (2.00 vs. 2.05)

Primitive Model: Weighted Index (cont'd)

- **Problem 3: Sensitivity to Irrelevant Alternatives**

  As above, evident when introducing a new alternative, and thus, new normalization standards.

Organization of Lectures

- **INTRODUCTION**
- **PHASE 1: Recognition of Risk and Complexity Reality**
- **PHASE 2: Analysis**
- **PHASE 3: Dynamic Strategic Planning**
- **CASE STUDIES OF DYNAMIC STRATEGIC PLANNING: Example Applications to Different Issues and Contexts**

Outline of Introduction

- The Vision
- The Problem: Inflexible Planning
- The Solution: Dynamic Strategic Planning

The Problem: Inflexible Planning

- The Usual Error
  - Choice of a Fixed "Strategy" ; A Master Plan
  - "Here we are...There we'll be"
  - Management and Company commitment to plan -- leading to resistance to change when needed
- The Resulting Problem
  - Inflexibility and Inability to respond to actual market conditions
  - Losses and Lost Opportunities

Examples Of Inflexible Planning

- **Nuclear Power in USA**
  - **fix on technology**
  - **Uneconomic Plants**
  - **Bankrupt Companies**
- **Electricity in South Africa (see Case Studies)**
  - **fix on size**
  - **Huge Excess Capacity**
  - **Large Unnecessary Costs**

The Solution: Dynamic Strategic Planning (1)

- **3 PHASES**
  1. **Recognition of Risk and Complexity as Reality of Planning**
  2. **Analysis of Situation**
  3. **Flexible, Dynamic Planning**

The Solution: Dynamic Strategic Planning (2)

- **PHASE 1: Recognition Of Risk And Complexity Of Choices As The Reality Of Planning**
  - **Risk -- the fundamental reality to be faced in developing long-term plans**
  - **Complexity -- leading to Wide Range of Choices, especially hybrid choices, those which include elements of other alternatives and allow flexible response to events**

The Solution: Dynamic Strategic Planning (3)

- **PHASE 2: Analysis**
  - **Identifying Issues**
    - **Structuring the Situation**
  - **Decision Analysis of Choices**
    - **Decision trees**
  - **Determining Satisfaction of Decision-Makers, of Customers**
    - **Utility Analysis**

The Solution: Dynamic Strategic Planning (4)

- **PHASE 3: New Kind Of Decision-making -- Flexible, Dynamic**
  - **Builds INSURANCE into plans**
    - **in the form of flexibility**
  - **Commits ONE PERIOD AT A TIME,**
    - **to permit adjustment to changing conditions**

The Solution: Dynamic Strategic Planning (5)

- **Doing Dynamic Strategic Planning involves**
  - **Looking ahead many periods, appreciating the many scenarios with their opportunities and threats;**
  - **Choosing Actions to create flexibility,**
    - **so you can respond to opportunities and avoid bad situations; and**
  - **Committing to Actions only one period at a time.**
    - **Maintaining the flexibility to adjust to conditions as they actually develop**

Chess Analogy

- Dynamic strategic planning is comparable to playing chess as a grand master.
- Dynamic strategic planning compares to regular corporate planning as grand master chess compares to beginner play.

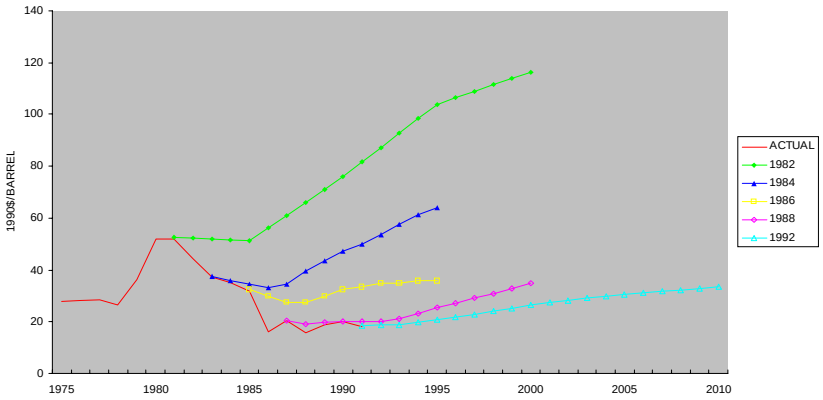
Outline of Phase 1 : Recognition of Risk and Complexity Reality

- Risk: Wide Range of Futures
  - The forecast is "always wrong"
- Complexity: Wide Range of Choices
  - Number of Choices is Enormous
    - "Pure" solutions only 1 or 2% of possibilities
    - Most possibilities are "hybrid", that combine elements of "pure" solutions
    - "Hybrid" choices provide most flexibility

Recognition Of Risk (1)

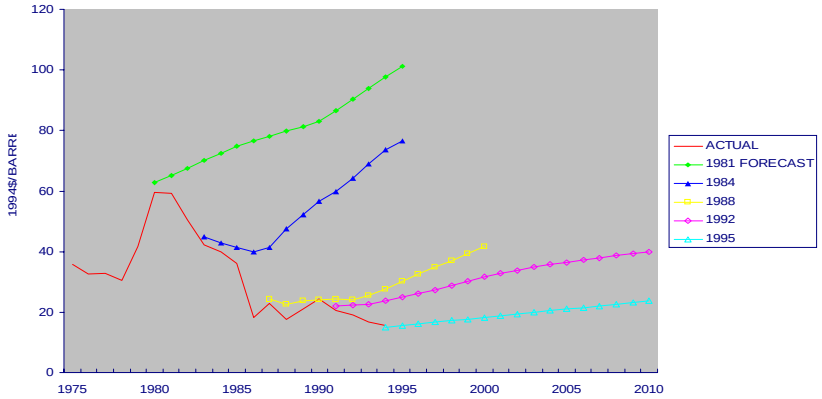
- **The usual error**
  - **Search for correct forecast**
- **However: the forecast is "always wrong"**
  - **What actually happens is quite far, in practically every case, from what is forecast**
  - **Examples: costs, demands, revenues and production**
- **Need to start with a distribution of possible outcomes to any choice or decision**

DOE Oil Price Forecasts



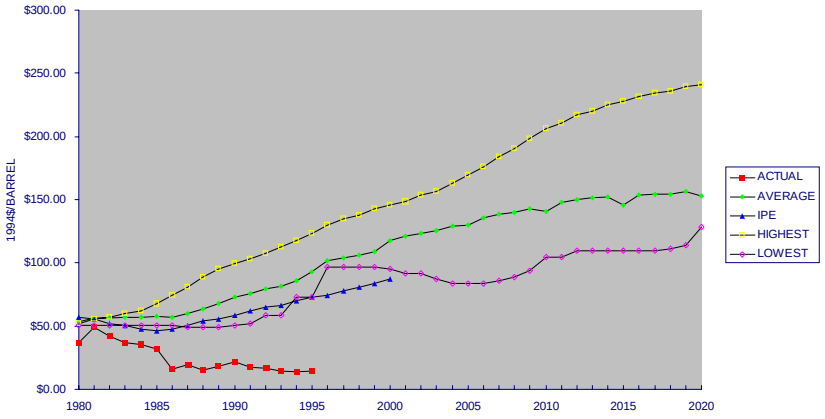
Source: M. Lynch, MIT

DOE Oil Price Forecasts



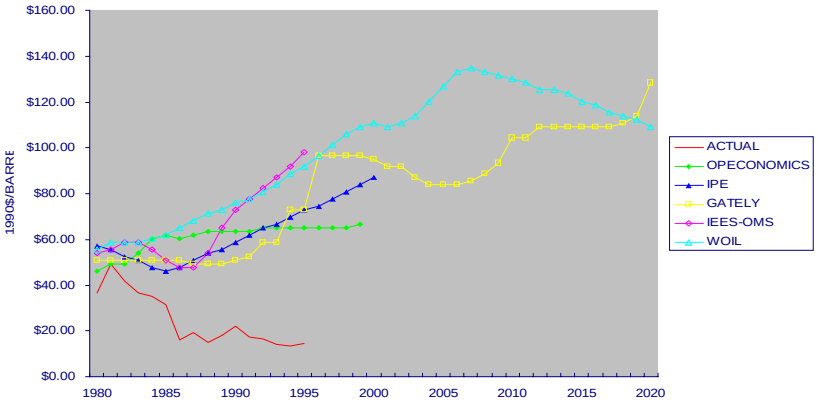
Source: M. Lynch, MIT

EMF6 Oil Price Forecasts



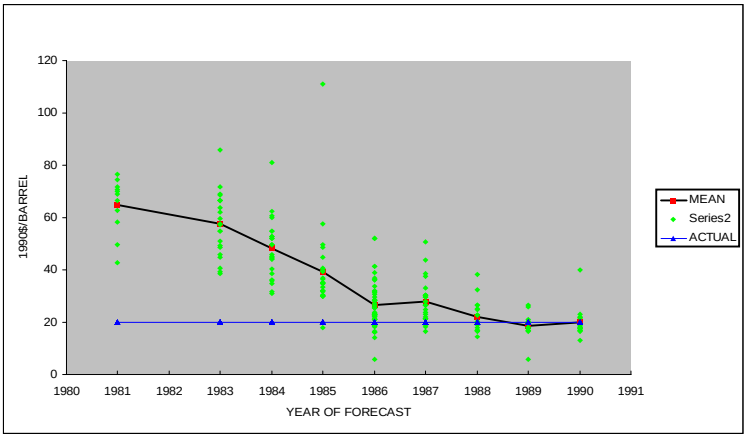
Source: M. Lynch, MIT

EMF6 Oil Price Forecasts (Low Forecasts)



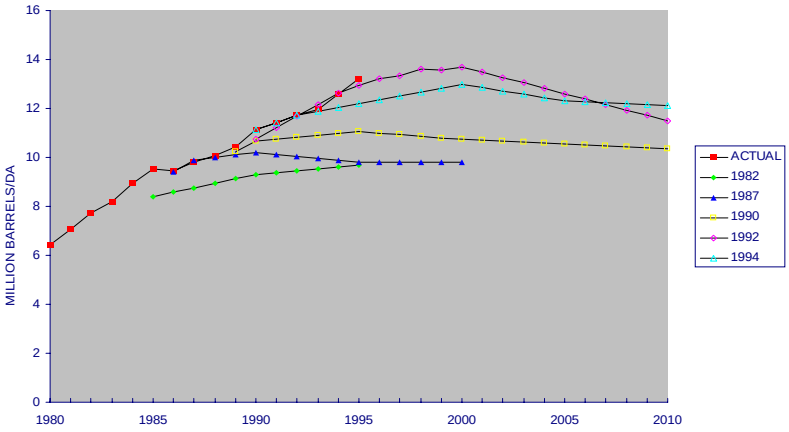
Source: M. Lynch, MIT

Forecasts of 1990 Price of Oil (IEW Survey)



Source: M. Lynch, MIT

DOE Forecasts of Non-OPEC LDC Production



Source: M. Lynch, MIT

Recognition Of Risk (2)

- **Reason 1 : Surprises**
  - **All forecasts are extensions of past**
  - **Past trends always interrupted by surprises, by discontinuities:**
    - **Major political changes**
    - **Economic booms and recessions**
    - **New industrial alliances or cartels**
- **The exact details of these surprises cannot be anticipated, but it is sure surprises will exist!**

Recognition Of Risk (3)

- **Reason 2 : Ambiguity**
  - **Many extrapolations possible from any set of historical data**
    - **Different explanations (independent variables*)***
    - **Different forms of explanations (equations)**
    - **Different number of periods examined**
  - **Many of these extrapolations will be "good" to the extent that they satisfy usual statistical tests**
  - **Yet these extrapolations will give quite different forecasts!**

Recognition Of Risk (4)

- **The Resulting Problem: Wrong Plans**
  - **Wrong Size of Plant, of Facility**
    - **Denver Airport**
    - **Boston Water Treatment Plant (See Case Studies)**
  - **Wrong type of Facility**
    - **Although "forecast" may be "reached"…**
    - **Components that make up the forecast generally not as anticipated, thus requiring**
    - **Quite different facilities or operations than anticipated**

Range Of Choices (1)

- **The Usual Error**
  - **Polarized Concept**
  - **Choices Narrowly Defined around simple ideas, on a continuous path of development**
- **Examples**
  - **Mexico City Airport: A Major New One Yes or No?**
  - **Size of Power Plants: 6 Megawatts Yes or No? (See Case Study of South African Power)**
  - **Compliance with Laws: As written? Yes or No?**
    - **Experience of Planning for Electric Vehicles for Los Angeles, California**
    - **Venezuela (See Case Study)**

Range Of Choices (2)

- **The Correct View**
  - **All Possibilities must be considered**
  - **The Number of Possible Developments, considering all the ways design elements can combine, is very large**
- **The general rule for locations, warehouses**
  - **Possible Sizes, S**
  - **Possible Locations, L**
  - **Possible Periods of Time, T**
  - **Number of Combinations: {S exponent L} exponent T**
- **Practical Example: Mexico City Airport**
  - **Polarized View: "Texcoco" of "Zumpango"**
  - **All Combinations: {2 exp 4}exp 3 = 4000+ !!!**

Range Of Choices (3)

- **The Resulting Problem**
  - Blindness to "98%" of possible plans of action
    - These are the "combination" (or "hybrid") possibilities that combine different tendencies
    - The "combination" designs allow greatest flexibility -- because they combine different tendencies
  - Blindness to many possible developments
    - those that permit a variety of futures
    - because they do not shut off options
  - Inability to adapt to risks and opportunities
  - Significant losses or lost opportunities

Range Of Choices (4)

- **Practical Example: Mexico City Airport**
  - Most of the possible developments are combinations of operations at 2 sites (instead of only 1)
  - The simultaneous development at 2 sites allows the mix and the level of operations to be varied over time
  - The development can thus follow the many possible patterns of development that may occur
  - There is thus great flexibility
  - Also ability to act economically and efficiently
- **Recommended Action**
  - Option on Zumpango Site
  - Wait until next sexennial
  - Then decide next step

Range Of Choices (5)

- **The Solution**
  - **Enumeration of Possible Combinations**
  - **General: Lists, Exact Numbering of Possibilities**
  - **Detailed: Simulations**
- **Practical Examples**
  - **General Enumeration**
    - **New Airports at Mexico City, Sydney (See Case Study)**
  - **Detailed Simulation**

Decision Analysis

- **Objective**
- **Motivation**
- **Primitive Models**
- **Decision Analysis Methods**

Decision Analysis

- **Objective**
  - **To present a particular, effective technique for evaluating alternatives to risky situations**
- **Three Principal conclusions brought out by Decision Analysis. Think in terms of:**
  1. **Strategies for altering choices as unknowns become known, rather than optimal choices**
  2. **Second best choices which offer insurance against extremes**
  3. **Education of client especially about range of alternatives**

Motivation

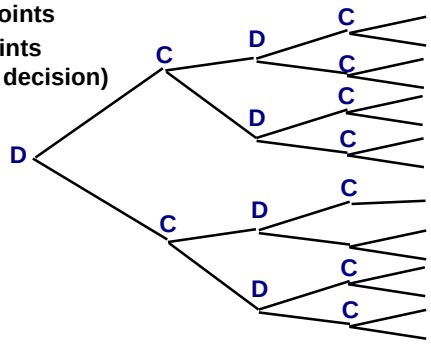
- **People, when acting on intuition, deal poorly with complex, uncertain situations**
  - **They process probabilistic information poorly**
  - **They simplify complexity in ways which alter reality**
    - **Focus on extremes**
    - **Focus on end states rather than process**
    - **Example: Mexico City Airports**
- **Need for structured, efficient means to deal with situation**
- **Decision Analysis is the way**

Decision Tree

- **Representing the Analysis -- Decision Tree**
  - **Shows Wide Range of Choices**
  - **Several Periods**
  - **Permits Identification of Plans that**
    - **Exploit Opportunities**
    - **Avoid Losses**
- **Components of Decision Tree**
  - **Structure**
    - **Choices; Possible Outcomes**
  - **Data**
    - **Risks; Value of Each Possible Outcome**

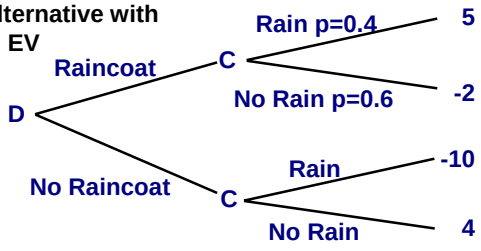
Decision Analysis

- **Structure**
  - **The Decision Tree as an organized, disciplined means to present alternatives and possible states of nature**
- **Two graphical elements**
  1. **Decision Points**
  2. **Chance Points (after each decision)**



Decision Analysis

- **Calculation**
  - Maximize Expected Value of Outcomes
- **For each set of alternatives**
  - Calculate Expect Value
  - Choose alternative with maximum EV



EV (raincoat) = 2.0 - 1.2 = 0.8

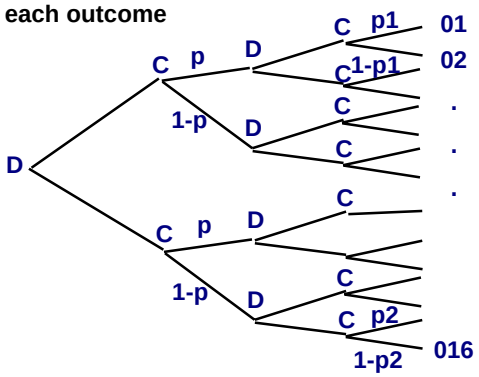
EV (no raincoat = - 4.0 + 2.4 = - 1.6

For Sequence of Alternatives

- Start at end of tree (rightmost edge)
- Calculate Expected Value for last (right hand side) alternatives
- Identify Best
  - This is the value of that decision point, and is the outcome at the end of the chance point for the next alternatives
- This is also the best choice, if you ever, by chance, reach that point
- Repeat, proceeding leftward until end of tree is reached
- Result: A sequence of optimal choices based upon and responsive to chance outcomes - "A Strategy"

Structure (continued)

- Two data elements
  1. Probability
  2. Value of each outcome



- When does it become a "messy bush"?

Results Of Decision Analysis

- **NOT as Simple Plan**
  - **Do A in Period 1; Do B in Period 2; etc.**
- **A DYNAMIC PLAN**
  - **Do A in Period 1,**
  - **BUT in Period 2:**
    - **If Growth, do B**
    - **If Stagnation, do C**
    - **If Loss, do D**

Decision Analysis Consequences

- **Education of client, discipline of decision tree encourages perception of possibilities**
  - **A *strategy* as a preferred solution**
  - **NOT a single sequence or a Master Plan**
- **In general, Second Best strategies not optimal for any one outcome, but preferable because they offer flexibility to do well in a range of outcomes**

  I.E., It is best to buy insurance!

Outline Of Phase 3: Dynamic Strategic Planning

- The Choice
  - Preferred Choice depends on Satisfaction of Decision-Makers, or Customers
  - Not a technical absolute
- The Dynamic Strategic Plan
  - Buys Insurance -- by building in flexibility
  - Commits only to immediate First Period Decisions
  - Balances level of Insurance to Feelings for Risk
  - Maintains Understanding of Need for Flexibility
- Examples -- See Case Studies

The Choice

- Any Choice is a PORTFOLIO OF RISKS
  - Nothing can be guaranteed
- Choices differ in two important ways
  - The "Average" Returns (Most Likely, Median, Expected)
  - Their Performance over a Range of Scenarios
- In General, they either
  - Perform well over many scenarios (they "fail gracefully" because they lose performance gradually)
  - Give good returns only for specified circumstances, otherwise they do not
- A Choice is for First Period Only
  - New Choices available later

The Best Choice

- Permit good performance over a range of scenarios
- They achieve overall best performance by
  - Building in Flexibility, to adjust plan to situation in later periods -- this costs money
  - Sacrificing Maximum Performance under some circumstances
- "Buy Insurance" in the form of flexibility, the capability to adjust rapidly and easily to future situations

The Preferred Choice

- One of the best choices, those that provide flexibility
- Depends on Feelings about Risk and Performance
  - What are acceptable levels for company?
- May not be the same for different companies, or at different times

Dynamic Strategic Plan (1)

- Buys "INSURANCE"
  - Against risks
  - By building in flexibility
- Management of Risk
  - Very similar to risk management for portfolios
  - Best strategies involve hedging of the risks

Dynamic Strategic Plan (2)

- COMMITS ONLY TO FIRST PERIOD DECISIONS
  - Decisions in Second and later periods deferred
  - Decisions for later periods will depend on market conditions at those times
- See Case Studies

Dynamic Strategic Plan (3)

- **BALANCES THE LEVEL OF INSURANCE TO THE FEELINGS ABOUT RISK AND PERFORMANCE**
  - **Amount of Insurance (Flexibility) is not fixed**
  - **Level of Insurance is a Choice**
  - **Choice must be appropriate to company**
  - **Level of Insurance thus depends on Company's situation, its feelings about risk and performance**
- **See Case Studies**

Dynamic Strategic Plan (4)

- **CAREFULLY MAINTAINS UNDERSTANDING OF THE NEED FOR FLEXIBILITY**
  - **Often Directors, Staff or Company become fixed on plan through personal commitments -- they make it difficult to make adjustments when desirable**
  - **Organizational ability to adjust plans to actual, market conditions must be carefully maintained**

Outline Of Examples

- **Example of Failed Planning**
  - **Electric Vehicles for Los Angeles**
- **Examples of Successful Dynamic Strategies**
  - **Ceramic Auto Parts**
  - **Airport Development in Australia**
- **Examples of Improvements through DSP**
  - **Size of South African Power Plants**
  - **Choice of Technology for Water Treatment**
- **Examples of Dynamic Strategies in Progress**
  - **Meeting Competition with Contracting Strategies**
  - **Facing New Laws -- Petroleos de Venezuela, SA**