

Influence Diagrams, Decision Trees

Reference: Clemen & Reilly. *Making Hard Decisions*, 2nd ed. Chapter 3. Duxbury, 2001

NOTE: Some materials for this presentation courtesy of Dr. Dan Maxwell

The Elements of a Decision

- Objectives and means
- Alternatives to choose between
- Uncertainty in Events and Outcomes
- Consequences of the Decision

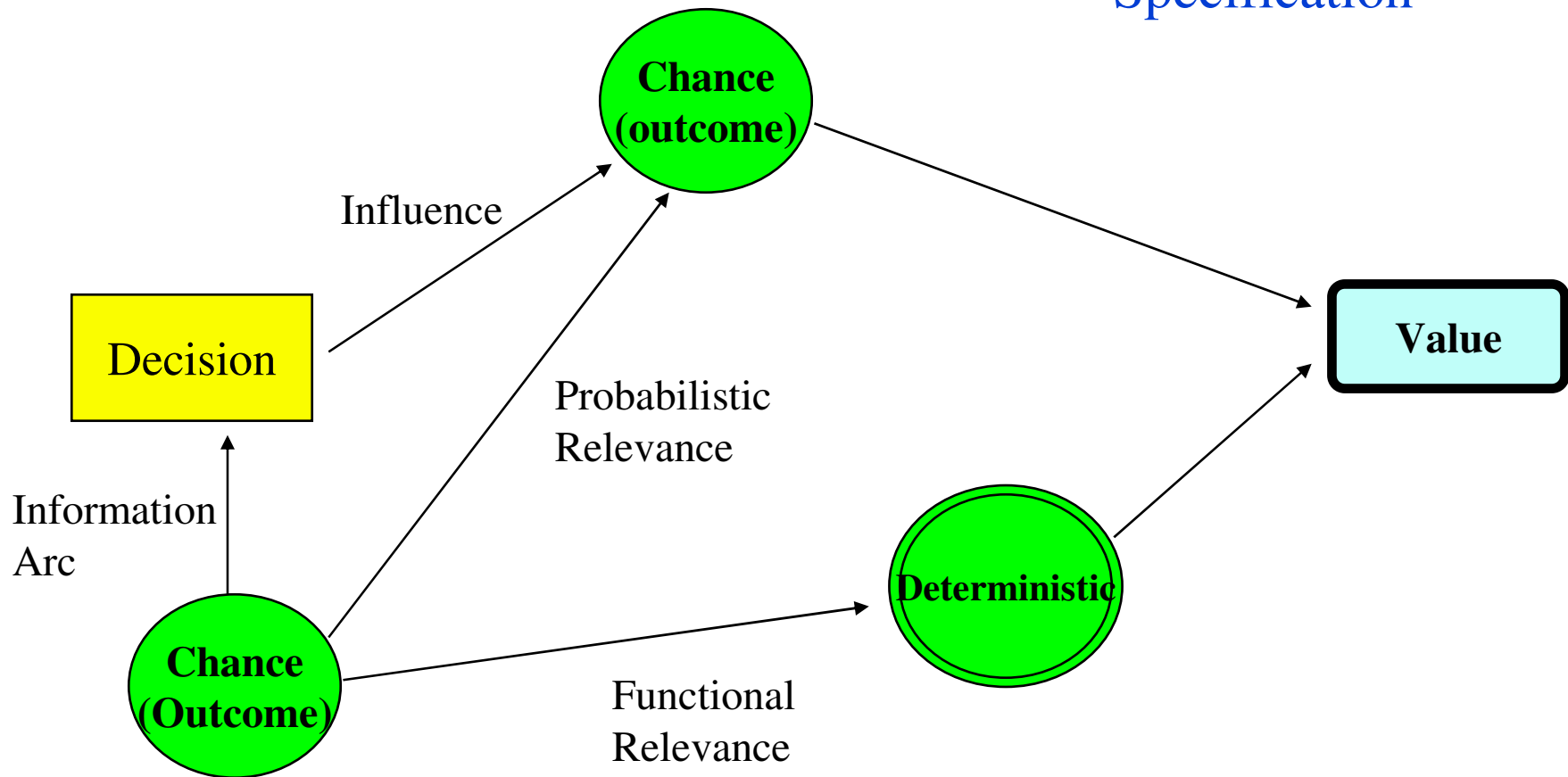
How do we structure the problem?

Common ways of structuring the decision problem:

- Influence Diagrams
- Decision Trees

Influence Diagrams

Three Levels of Specification



A Simple Influence Diagram

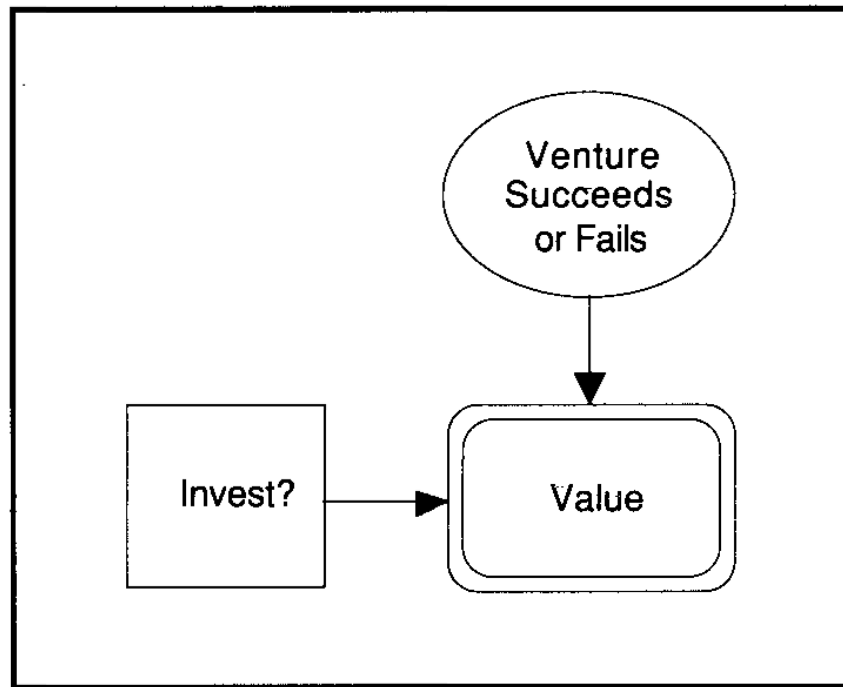
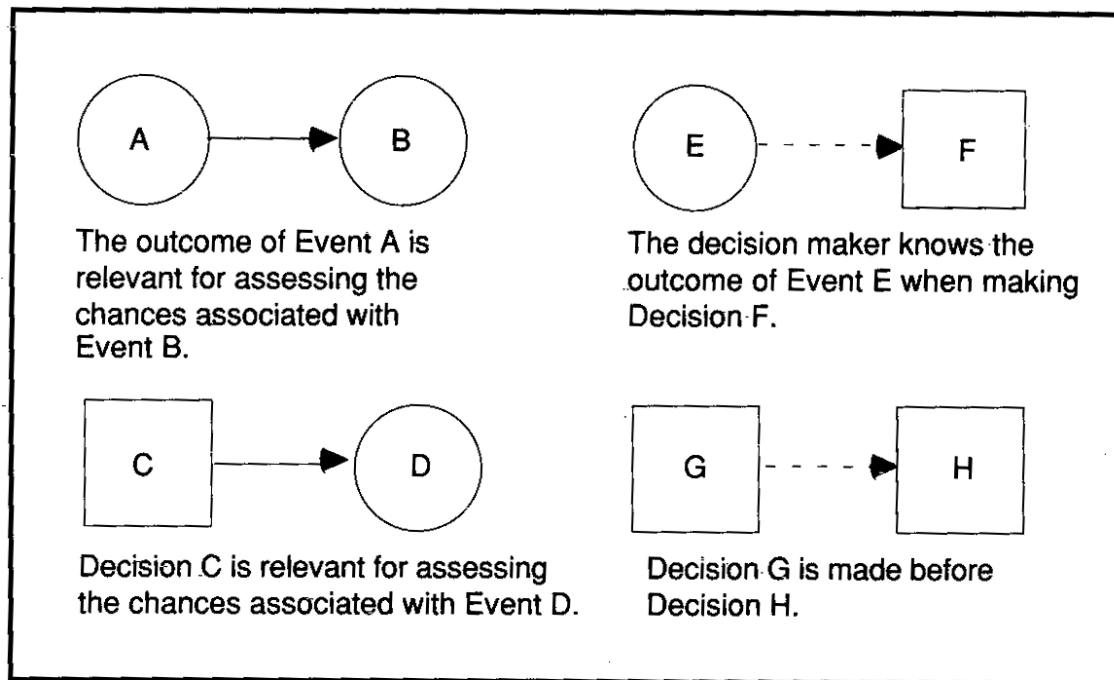


Figure 3.5 *Influence Diagram of Venture Capitalist's Decision*

Decision & Risk Analysis

Showing Influence with Arrows



Representing Influence with Arrows

Solid arrows into chance nodes represent relevance, and dashed arrows into decision nodes represent information.

Decision & Risk Analysis

Objectives Hierarchy into Influence Diagram

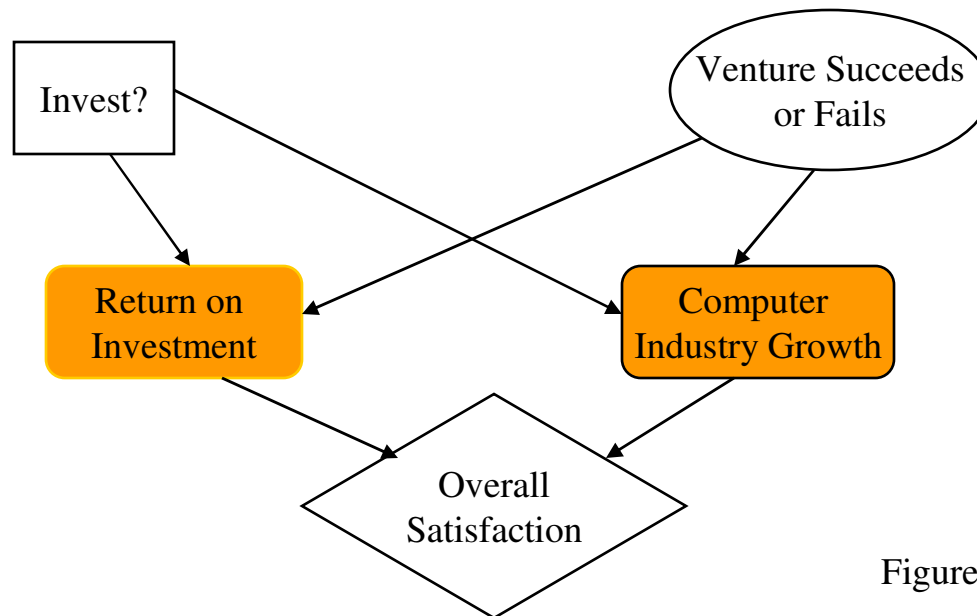
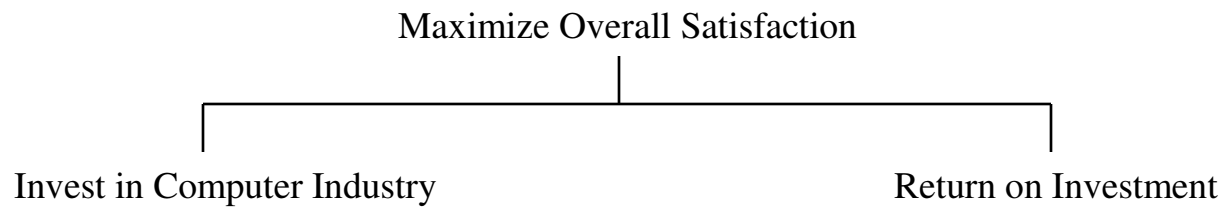
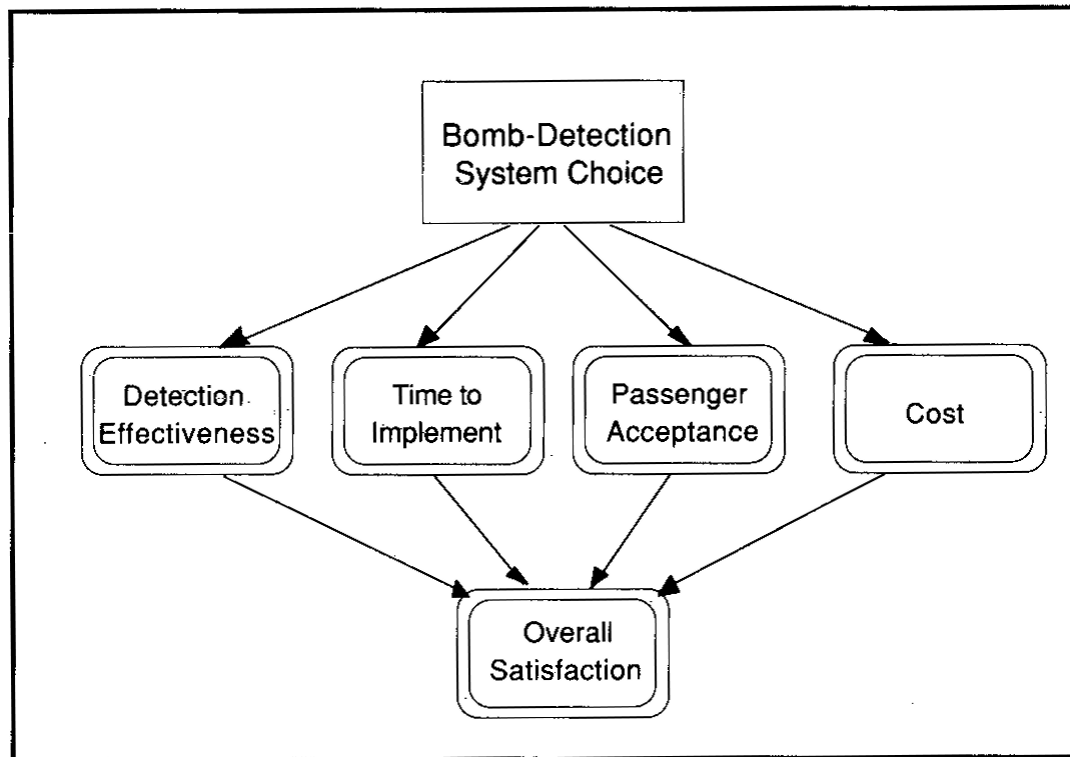


Figure 3.6

Decision & Risk Analysis

Multiple Objectives



Note: The Oval Shape can be Used as well as the Diamond Shape for the Final Satisfaction Node

Figure 3.7 *Using an Influence Diagram: Multiple Objectives in Selecting a Bomb-Detection System*

Decision & Risk Analysis

Basic Diagram for Investment

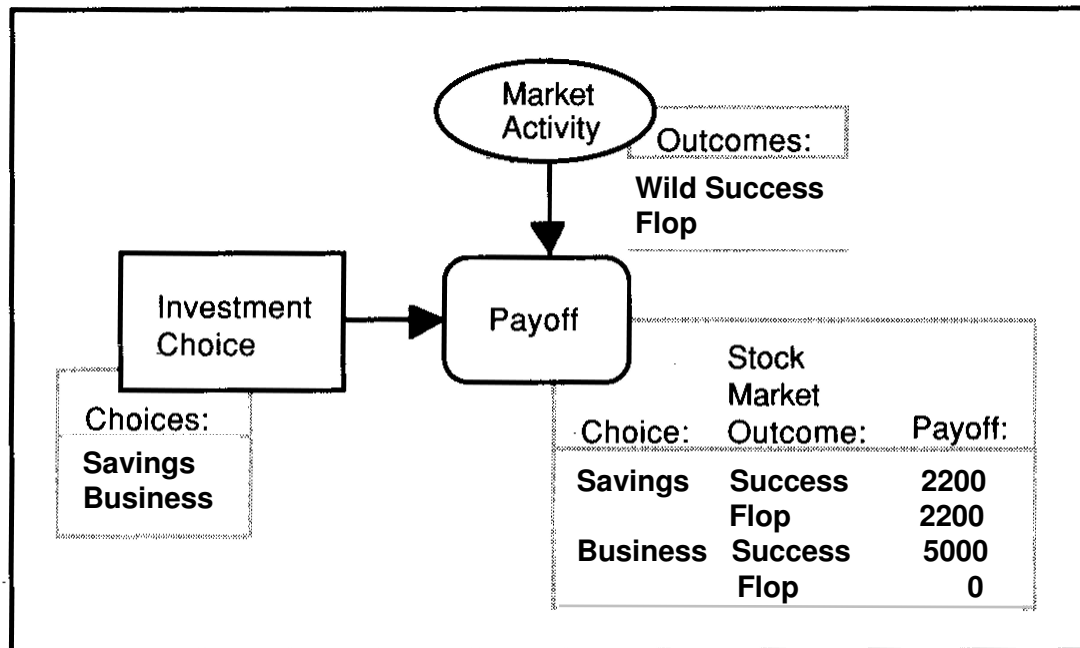


Figure 3.9 *Basic Risky Decision with Displayed Choices, Outcomes, and Payoffs*

Decision & Risk Analysis

An Influence Diagram for Evacuation

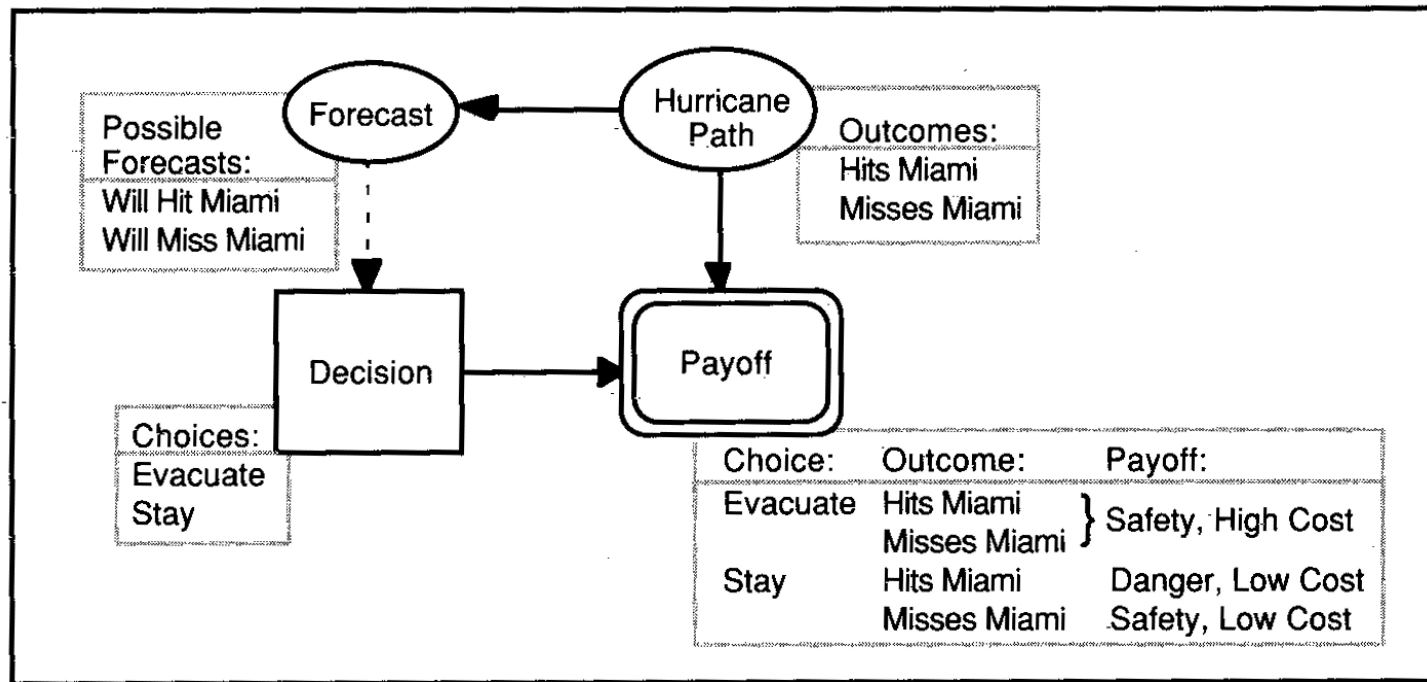


FIGURE 3.11 *Influence Diagram for Evacuation Decision*

Sequential Decision Problems

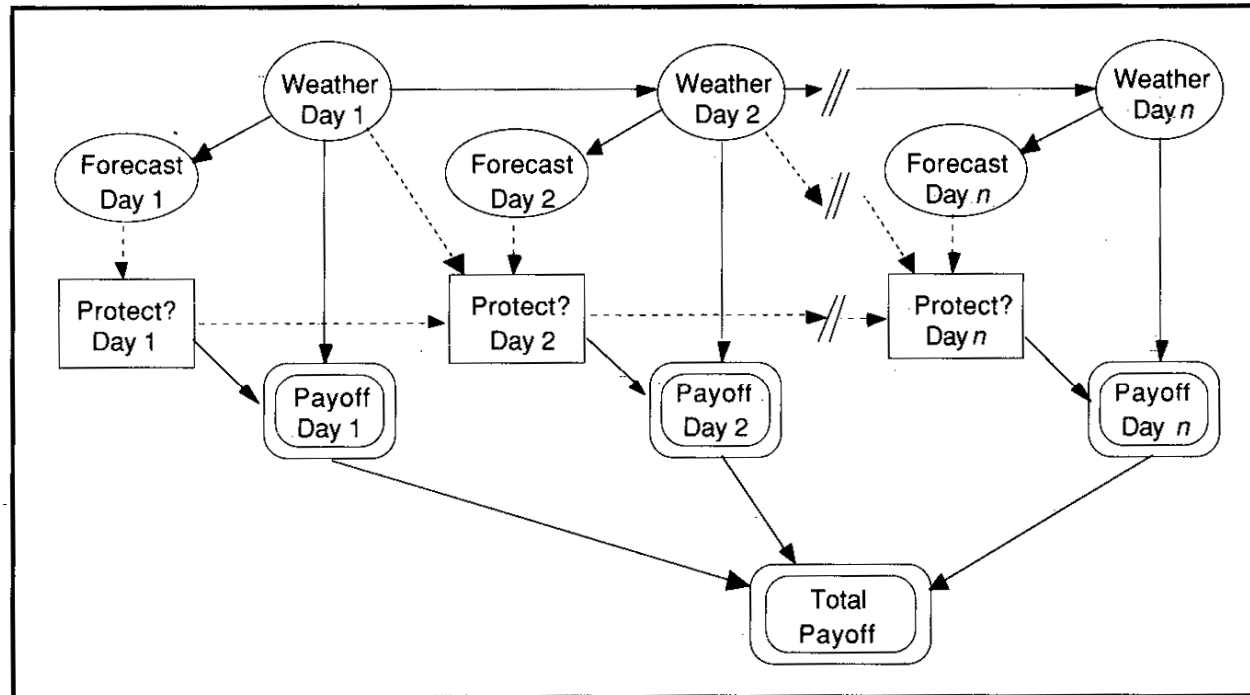
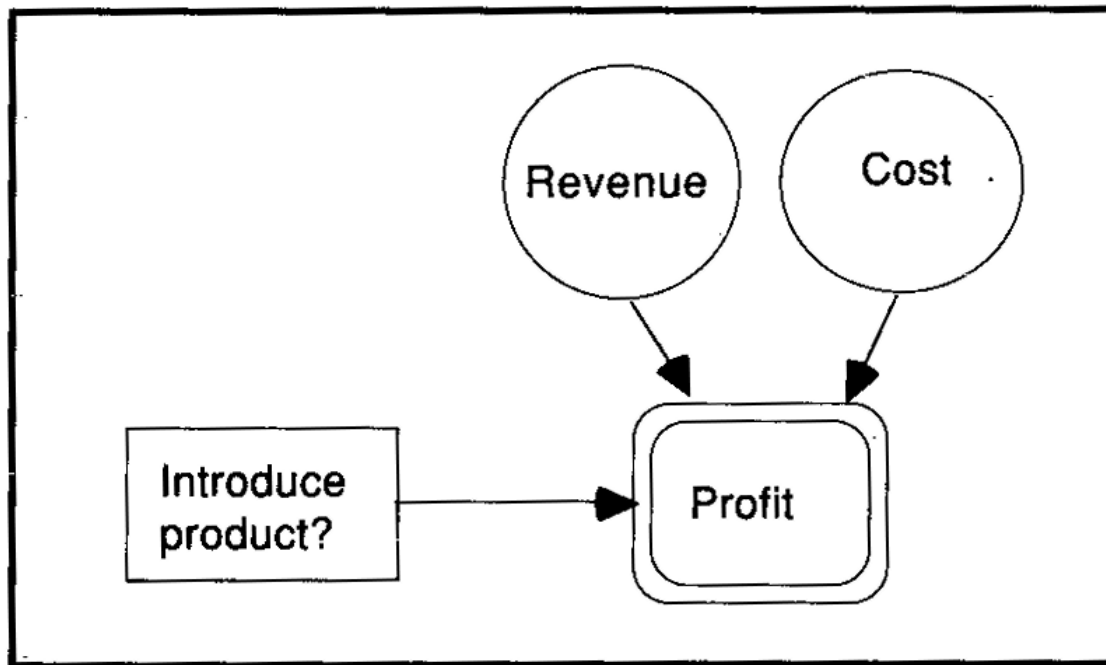


FIGURE 3.13 *Influence Diagram for Farmer's Sequential Decision Problem*

**Note: Payoff = Cash Flow;
Total Payoff = Net Present Value**

A Simple Influence Diagram for New Product



NOTE alternative method of representing payoff (consequence) node

FIGURE 3.14 *Simple Influence Diagram for New Product Decision*

Decision & Risk Analysis

New Product - Additional Detail

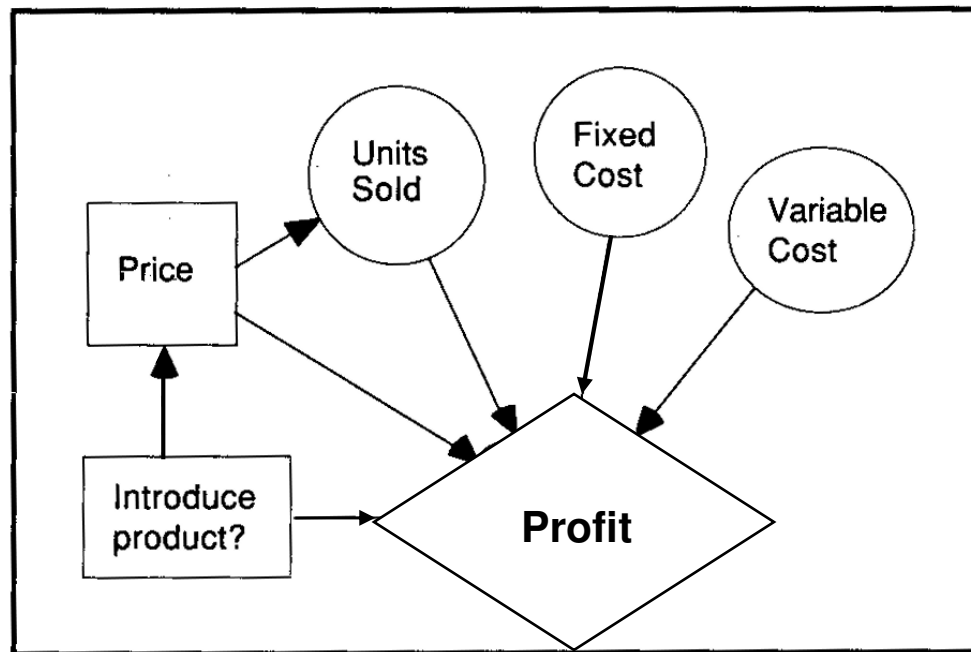


FIGURE 3.15 *New Product Decision with Additional Detail*

Decision & Risk Analysis

Deterministic Nodes

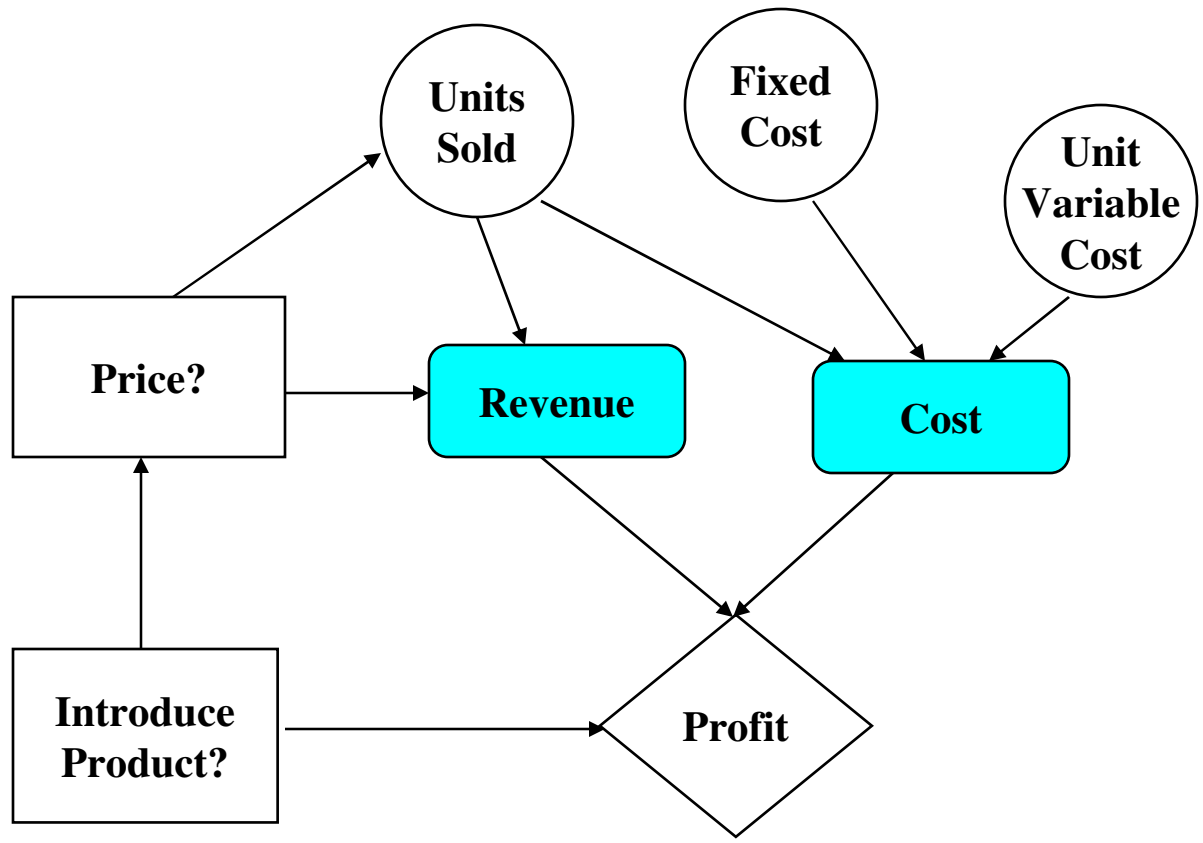


Figure 3.16

Another Representation of Deterministic Nodes

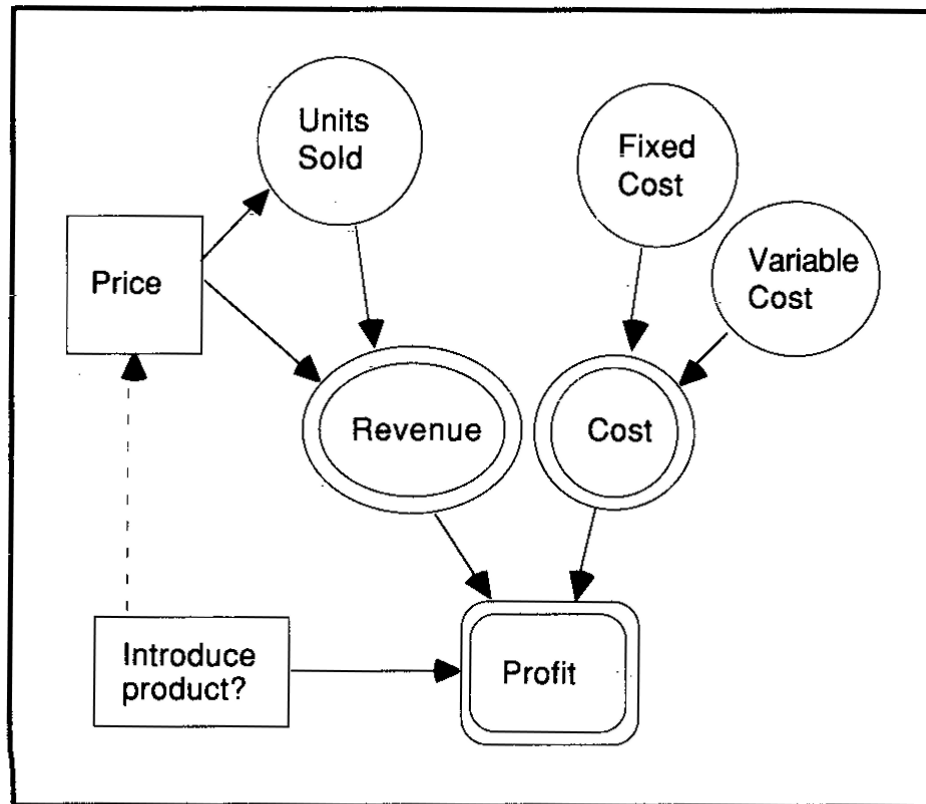


FIGURE 3.16 *New Product Decision with Deterministic Nodes*

Starting an Influence Diagram

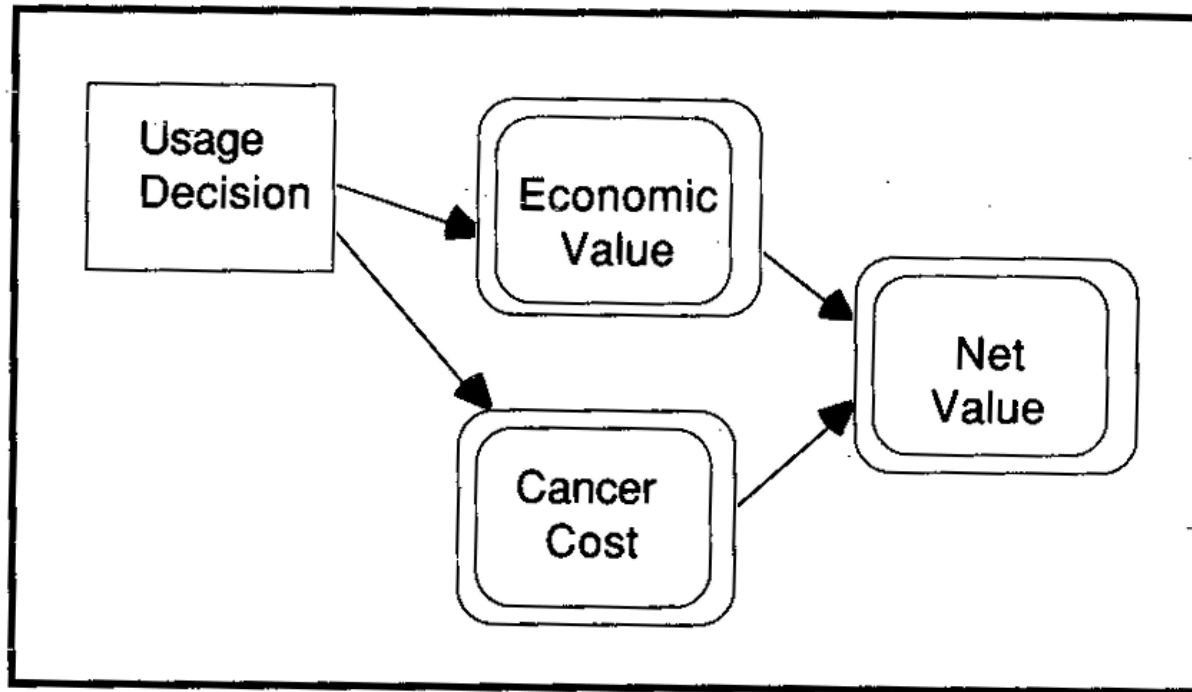


FIGURE 3.18 *Beginning the Toxic-Chemical Influence Diagram*

Decision & Risk Analysis

Intermediate Step

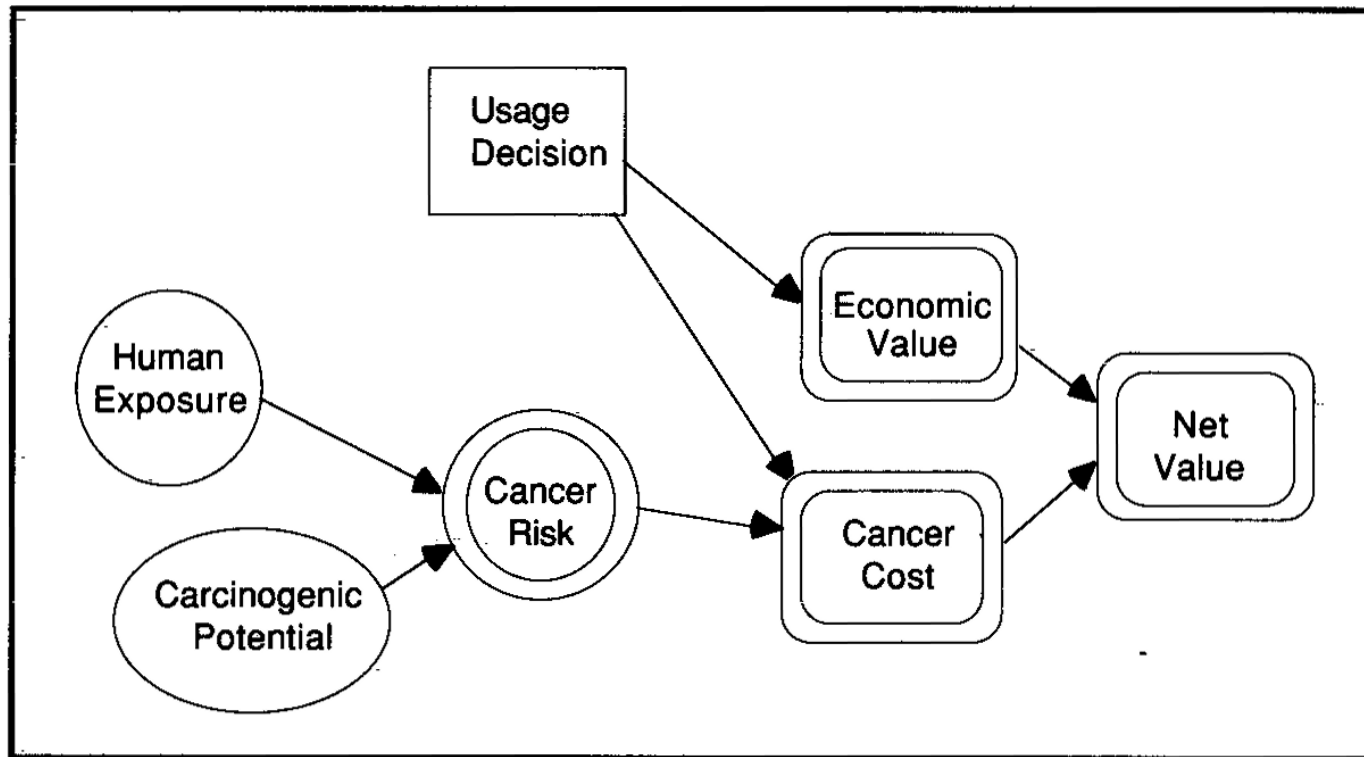


FIGURE 3.19 *Intermediate Influence Diagram for the Toxic-Chemical Decision*

A Completed Influence Diagram

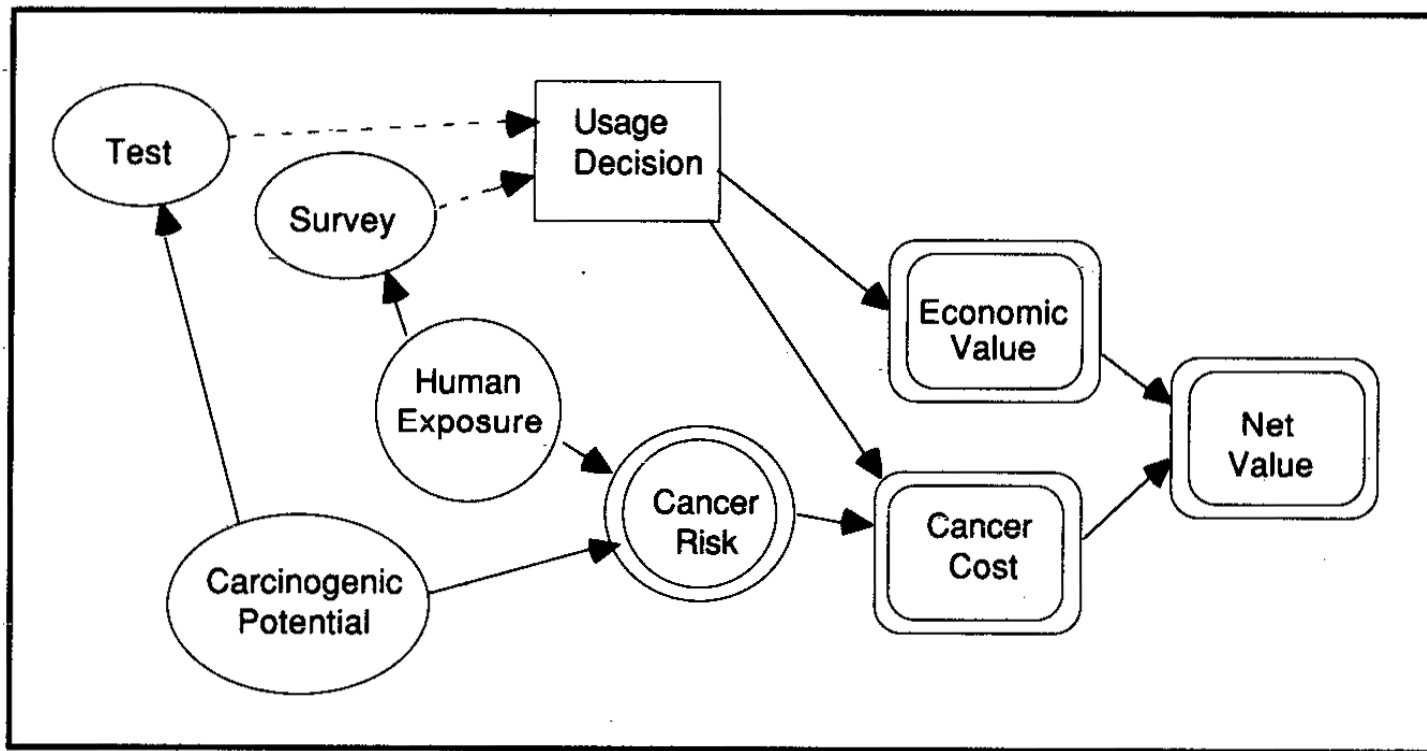


FIGURE 3.20 *Completed Influence Diagram for the Toxic-Chemical Decision*

Decision & Risk Analysis

Decision Tree Representation

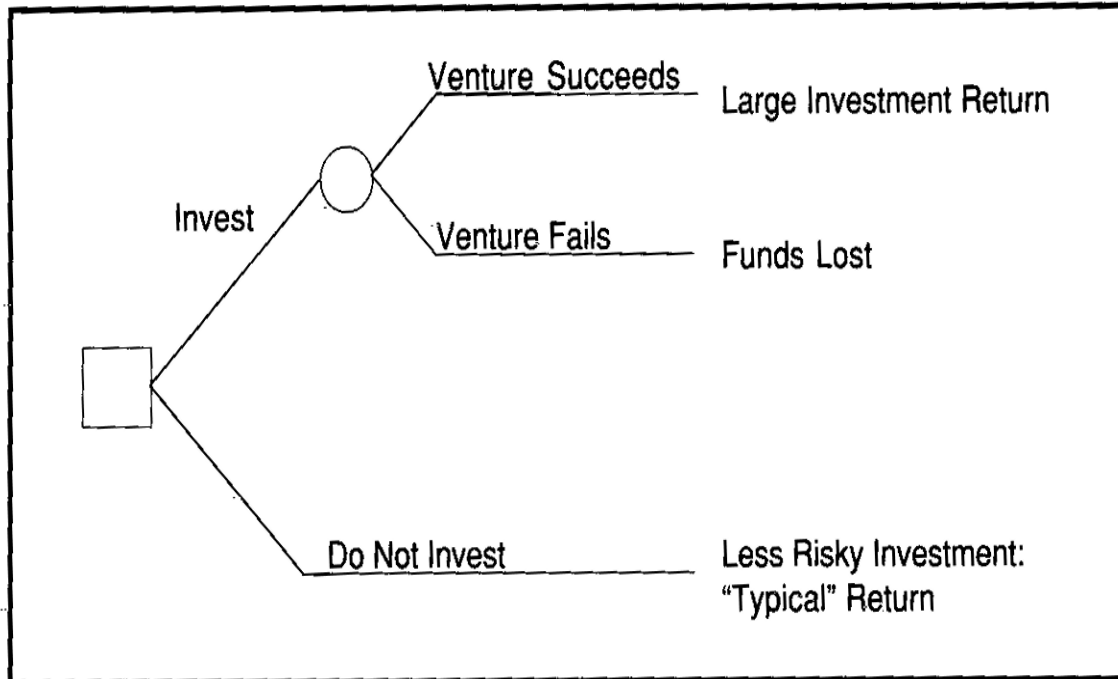


FIGURE 3.21 *Decision-Tree Representation of Venture-Capital Problem*

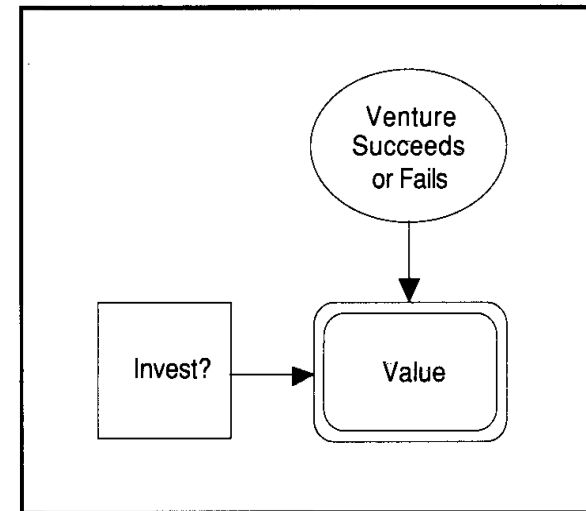


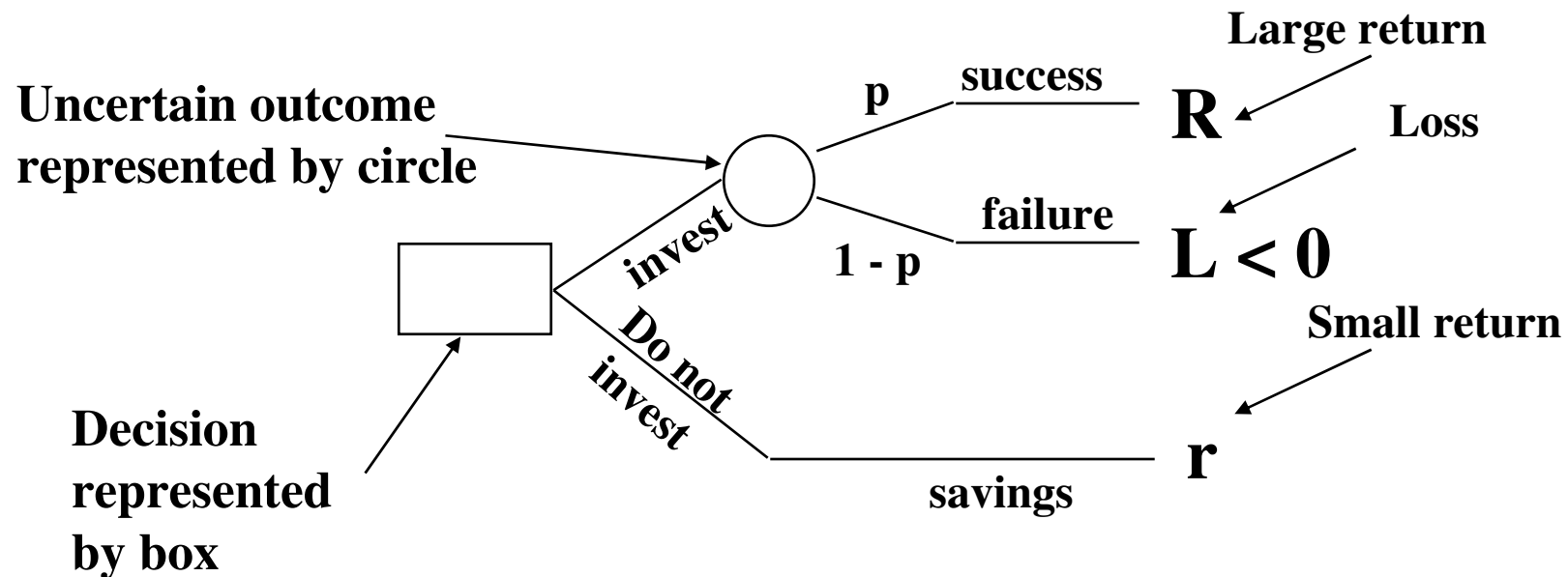
FIGURE 3.1 *Influence Diagram of Venture Capitalist's Decision*

Influence Diagram Representation

Decision & Risk Analysis

Decision Trees – Dealing with Uncertainty

- Probabilities replace the weights
 - Account for uncertainty
 - Used to evaluate expected values
- Example - Venture Capital Problem

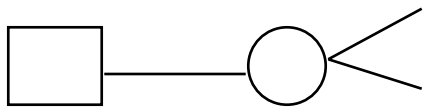


Decision Trees (continued)

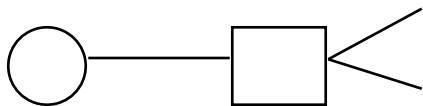
- Expected return on investment:
 - If investment is made $E(I) = pR + (1 - p)L$
 - If investment not made $E(N) = r$
- Decision:
 - Invest if $pR + (1 - p)L > r$
 - Don't invest if $r > pR + (1 - p)L$

What would you do if $r = pR + (1 - p)L$?

- Decision Trees evaluated left to right



decision must be made before uncertain event takes place

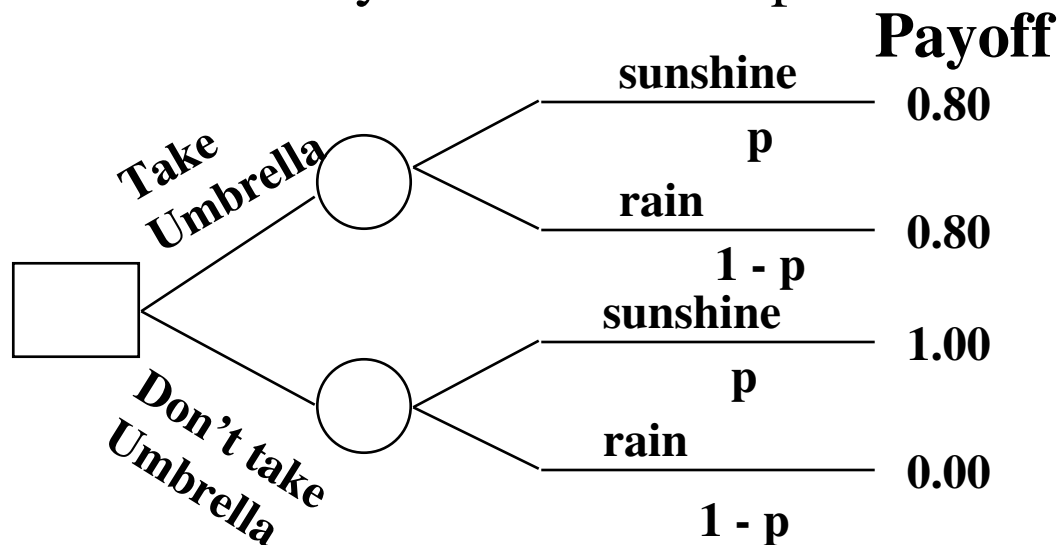


decision is conditional on the known outcome of the uncertain event

Example

Do I take my umbrella or not?

- If I don't and it is sunny, that is best - value 1.00
- If I do I won't get wet but it's inconvenient - value 0.80
- If I don't and it rains I ruin my suit - value 0.00
- Probability of sunshine is p



Payoff Calculation:

– Take umbrella
 $0.8p + 0.8(1-p) = 0.8$

– Don't take umbrella
 $1.0p + 0(1-p) = p$

Therefore:

Take umbrella if
 $p < 0.8$

Basic Decision Tree

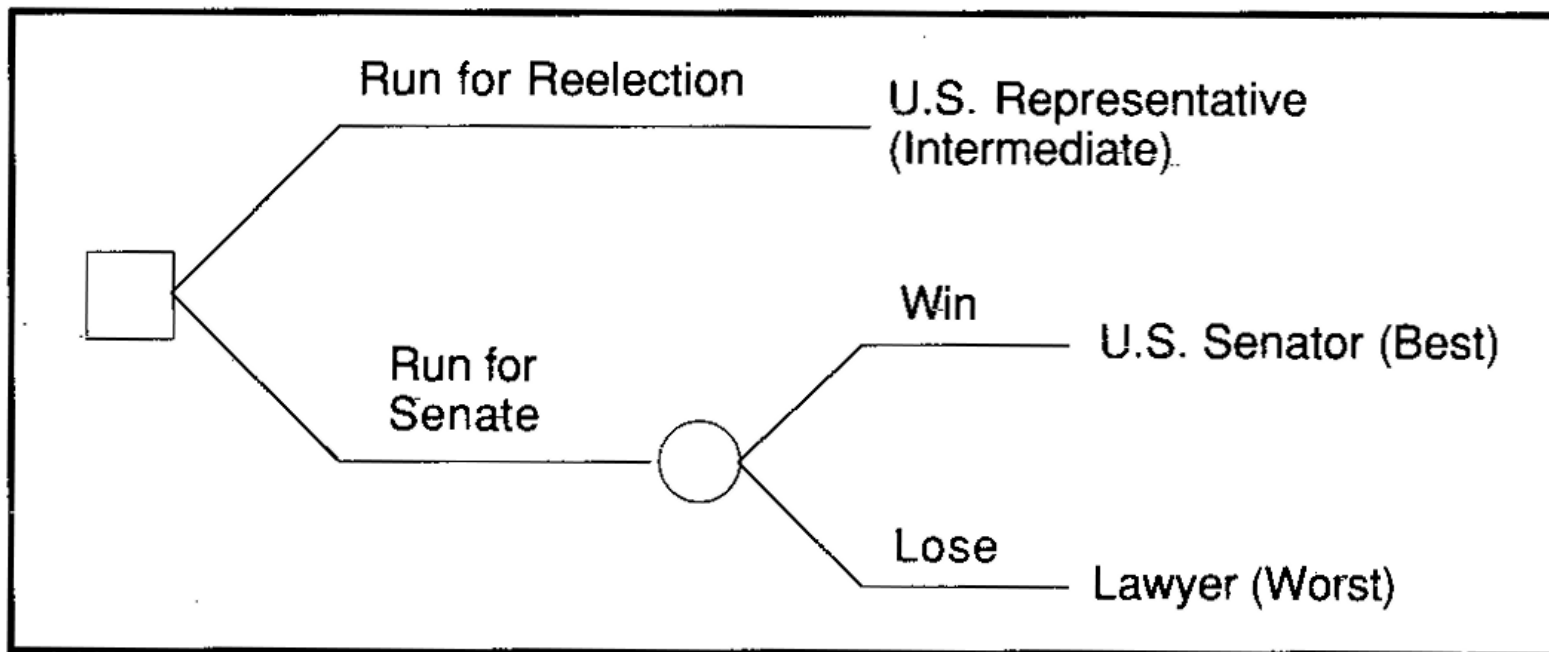


FIGURE 3.25 *The Politician's Basic Risky Decision*

Decision & Risk Analysis

Sequential Decisions

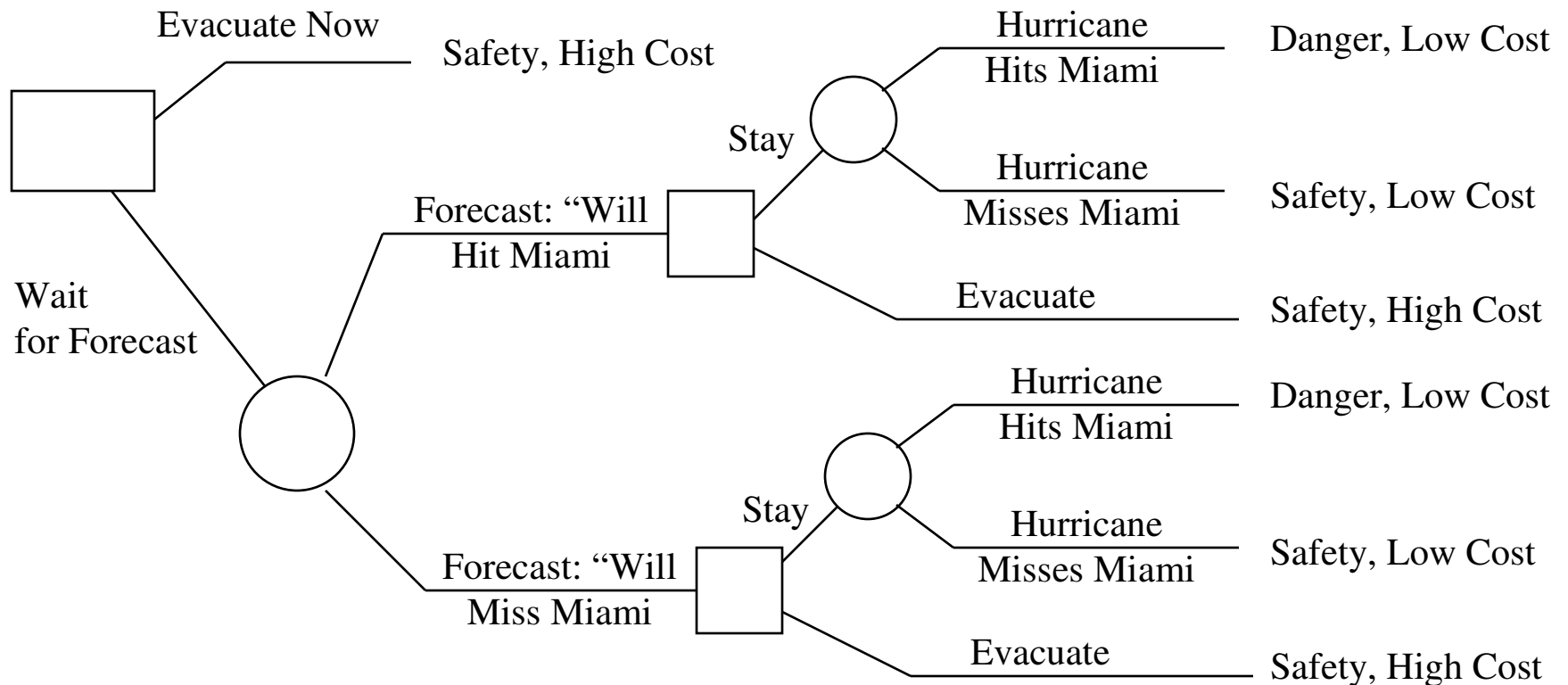


Figure 3.29

Decision & Risk Analysis

Sequential Decision Tree

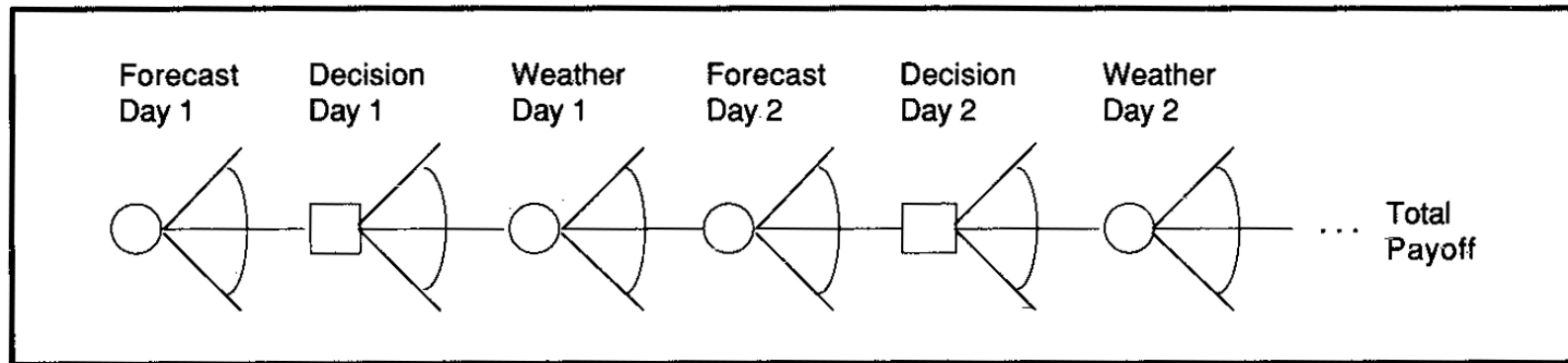


FIGURE 3.30 *Skeleton Version of Farmer's Sequential Decision Problem:
Decision-Tree Form*

Influence Diagram or Decision Tree

Influence Diagram

1. Gives basic information
2. Less messy
3. Graphically more appealing when presented to upper management

Decision Trees

1. Gives detailed info
2. More messy due to greater details
3. Not so appealing

Must be viewed as complementary techniques. One strategy is to start with influence diagram and fill in the details to develop a decision tree.