Getting It Right, Volume One

How Managers Can Make Better Decisions by Using Calculations and Numbers

Howard Flomberg

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Contents

Acknowledgments

People who are mathematically inclined are frequently semi-literate. With that in mind, I would like to thank my son, Dave Flomberg for his support and encouragement, and for his assistance in turning my feeble attempt at communication into acceptable English. Most of the editing for the first edition was squeezed into his unbelievably tight schedule. Thanks Dave!

We are all products of our education. I would like to include one of my teachers and mentors Dr. Joe Megeath for giving me an invaluable education on real values.

One of the ongoing lessons that I receive is that I frequently learn more from my students than I realize. A paper turned in by a student, Melanie Tyler, brought many of the points that I was trying to tie up into focus. For that I thank her. This is yet another reminder that a good teacher frequently learns from the student.

I'd also like to thank Brooke Pruter for her insightful feedback and perspective.

This second edition has given me a chance to improve the book. I was able to fix some arithmetic errors, tweak the text and add come content.

There is a new section Analytic Hierarchy. Some faculty from other schools requested this tool. I am also putting many of the tables into Excel© spreadsheets. The publisher will make these available to instructors.

I'd like to thank the folks at University Readers. Their enthusiasm and professional support made the project flow. I heartily recommend them to other professors, especially those neophyte writers out there.

Ethical Pragmatism: "Doing what works best" while mindful of the obligation one has to society.

Howard P. Flomberg
Denver, Colorado

SECTION 1

What's to Come

Author's Rules

1. There are no replacements for the ultimate managerial tool, "Common Sense." [1]
2. You can't make a decision if you don't define the problem.
3. Doing nothing is always a valid alternative.
4. Sometimes the best answer is, "It Depends."
5. Be very careful when quoting statistics. They can be very misleading.
6. The word "Accurate" is by definition a very inaccurate term.
7. Use the tool that makes the most sense.
8. If you do not have an effective organization, nothing will work well.

[1] com·mon sense (n)—Sound practical judgment derived from experience rather than study.

Introduction

Decision-making has been a black art for centuries. In the 20th Century, however, methods and procedures for decision-making have achieved some success, thanks to management science techniques. Making a decision is, by its very nature, a blend of qualitative and quantitative processes.

Qualitative analysis is built around scrutiny of observed or anticipated actions. This research technique demands an analyst who can maintain an objective view of the situation. However, when we discuss quantitative analysis, we think of numbers and quantities. The mind wanders to counting, statistics and probabilities, an uncomfortable place for many. This has been the standard domain for decision theory for decades.

Statisticians and the mathematically inclined consider qualitative analysis to be a stepchild. In contrast, a person who is involved in the decision making process often intuitively operates using qualitative analysis. Qualitative analysis makes use of that person's experience, expertise and professional opinions.

This study revolves around techniques that use both qualitative and quantitative approaches. Some of the tools that will be covered are: Bayes Theorem, Game Theory and The Delphi Method.

Bayes Theorem evaluates probabilities with the assumption that past events can affect future events. Bayes gives us a way of using history to predict the future. Bayes is frequently taught using mathematic notation. Most non-mathematicians are inexperienced or uncomfortable with this notation. Alternative methods include tree theory and table manipulation. In this text, Bayes will be presented for the less-mathematically oriented reader.

John Von Neumann, the great Hungarian-American mathematician, co-wrote the classic thesis on Game Theory, Theory of Games and Economic Behavior (1944). Another great Princeton University mathematician, John F. Nash[1], further advanced Game Theory. Game theory gives

[1]Nash was the subject of the recent book (1998, Sylvia Nasar, Simon and Schuster Publishing) and subsequent movie "A Beautiful Mind." (2001, Universal)

the ability to methodologically examine a decision and evaluate the optimal payoffs and penalties.[2]

The Delphi method is a formal way of gathering the appropriate people so that a decision can be made. The technique comes from work done at the Rand Corporation in the 1950s. The technique was used to model of the effects of nuclear war. It traces directly back to the operations research work done by the British during World War II. Military planners have used decision theory very successfully. In his recent book "blink[3]" Malcolm Gladwell makes a point of comparing the similarities between Wall Street types and military planners. The point being made is that the frenetic world of the stock market as well as the complexities of conducting a military campaign both shares the need for immediate and effective decisions. This text will also evaluate and capitalize on Mr. Gladwell's concepts.

Decision-making is enabled by sound management principles. A well-run organization is an environment where appropriate decisions will be made. A poorly run organization frequently forces poor decisions. This book is essentially a toolbox that provides both qualitative and quantitative tools that will aide in decision-making. However if the organization does not work, nothing else will.

Probably the first recorded instance in identifying a management methodology is in the Bible. Exodus 18:12–27 tells the story of Moses' being totally swamped settling the daily problems of the Israelites. The passage tells us that Jethro, Moses' father-in-law comes to the camp bringing Moses' wife and children.

Apparently Jethro is quite taken aback at the lack of organization and Exodus 18:21 Jethro tells Moses:

> *"…thou shalt select out of all of the people able men, such as fear G–d. Men of truth, hating bribes; and place these over them as officers over thousands, officers over hundreds, officers over fifties and officers over tens."*

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[2]At one point in time, Nash, Von Neumann and Einstein were all resident at Princeton University—WOW

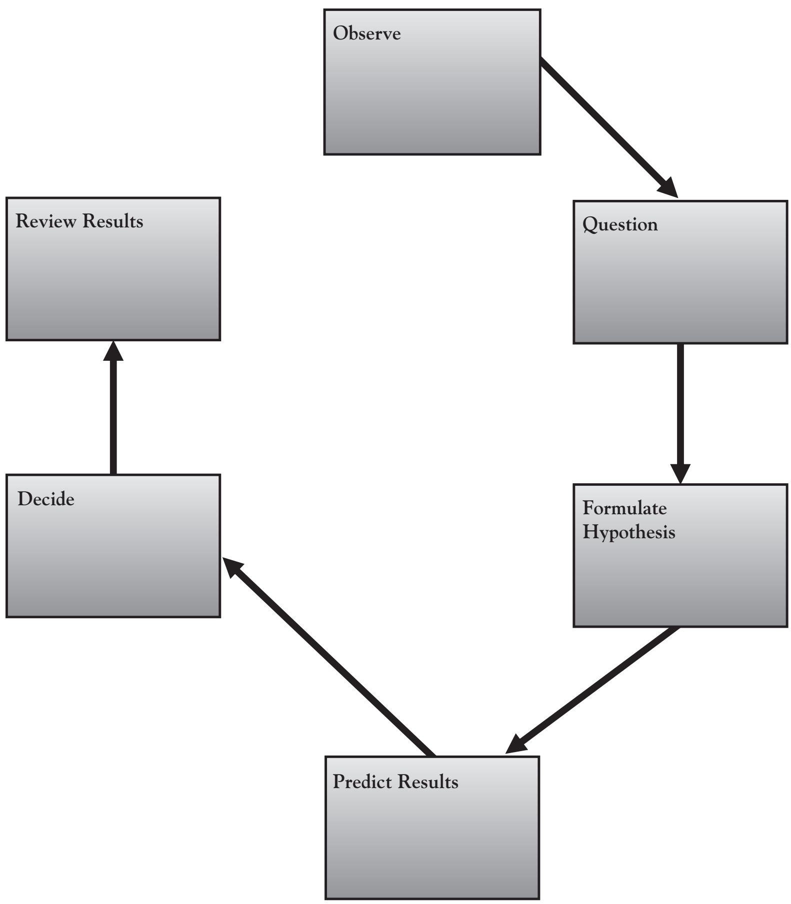
[3]Gladwell, Malcolm. Blink. New York: Little Brown and Company, 2005

Having given Moses this advice, like any good consultant, Jethro goes home to Midian. The key point is that Jethro tells Moses to establish a hierarchical organization. Identify leaders at the strategic, tactical and operational levels and have the decision made at the lowest possible level. This is good advice today. Note: I am quoting from the Bible as a historic reference only.

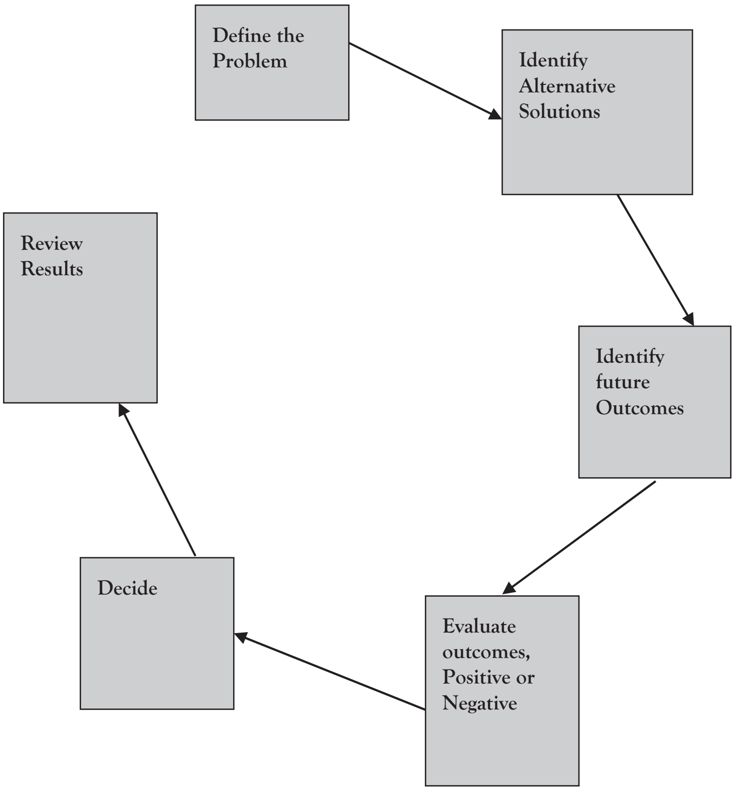
As I said, a good organization provides a bed for good decisions.

The Decision Model and Why It's Important

In high school, we learned the "Scientific Method."



Business has converted this process to what can we will be calling the Decision Analysis model. This is the model we will use for formal decision modeling:



What is Operations Research?

Operations Research can be considered the godfather of decision analysis. Its roots go back to World War II. Given the vastness of the logistics of running the war, British (and later, American) military management called upon the scientific community to produce a method to solve immense problems. The resulting method, operations research, involved gathering mixed teams from multiple disciplines to address these problems. The tools developed by this approach were primarily quantitative. The approach to decision making, however, was revolutionary, as the man said, "The Medium is the message.[4]"

Operations research has been adapted by business and science to solve many problematic situations. However, the technique of using mixed teams of professionals to attack a problem has become a major force.

Operations research places a heavy reliance on mathematic modeling. The methods include:

- Linear Programming
- Network Analysis—Pert, Gantt Charts, etc.
- Dynamic Programming
- Game Theory
- Queuing Theory

One final note: The techniques and methods discussed herein can be superb tools. However there are no replacements for the ultimate managerial tool, "Common Sense.[5]"

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[4]Marshal McLuhan, Understanding Media: The Extensions of Man, 1964.

[5]com·mon sense (n)—Sound practical judgment derived from experience rather than study; Encarta® World English Dictionary ©1999 Microsoft Corporation. All rights reserved. Developed for Microsoft by Bloomsbury Publishing Plc

Defining a Problem

Occam's Razor: one should not increase beyond what is necessary the number of entities required to explain anything[6].

In other words, the simplest solution is frequently the correct one.

You're driving along Interstate 25 north of the city of Cheyenne, Wyoming. Suddenly, you hear that annoying sound. It sounds like an airplane coming in for a landing. You get a sick feeling in the pit of your stomach. You have a flat tire. For those of you who have never been on Interstate 25 north of Cheyenne Wyoming, with the exception of a few antelope and scrub brush, there's no there, there. You pull over and check—yes, the tire is flat, and what do you do? What exactly is the problem that you have to solve? The obvious answer is:

"Hey stupid, I have a flat!" Let's examine the situation. We'll get back to our tire later.

Flomberg's Law #2: You can't make a decision if you don't identify the problem

Before the problem can be analyzed and a decision made, you must be aware that a problem exists. In the tire example above, your problem is that you're stuck on the side of the road with a flat tire, one hundred miles from anywhere. Or is that the problem?

Frequently the apparent problem is not the real problem but is problematic, or a *symptom.* A symptom indicates a problem exists, however it is not the problem. Solving the symptom might feel good for a while, however the problem still exists. The successful manager must distinguish between the problem and the symptoms. Treating a gunshot wound with pain medication only addresses a symptom of the situation—it might alleviate the pain. It does not heal the gunshot.

Another situation that the manager needs to deal with is the bias built into the word, problem. The dictionary definition of the word problem is: a question or puzzle that needs to be solved. A problem is not necessarily

[6]Occam's Razor is a logical principle attributed to the 14th Century philosopher William of Occam

a negative situation. A problem simply means that a decision must be made. If there is no decision to be made there, is no problem—only a course of action. Problems can be either positive or negative. An opportunity can present itself that has choices. The selection of the choice can affect the return. The flat tire situation only indicates that there might be a problem. In the flat tire situation, we can assume that the problem is a negative one. But is the flat a problem? It is not. The flat is a state of nature. It exists. Deal with it. *"I have been selected to three colleges."* Is that a problem? So, what is a problem? Is there a problem? The problem is, "Which College do I go to?" When identifying a problem, you must also deal with bias: "We've always done it that way!" This bias may take the form of the timeworn statements like: *"We have to live with that problem. It's not worth fixing."*

A Real Live Problem (Or Is It a Problem?)

Many years ago when I was a computer programmer, I was working on a customer's site, performing maintenance on the company's general ledger software. When I was looking for test data, my team leader, who was an employee of the company, pointed me to a file. As I was going through that file I realized that I was actually in the real corporate ledger. Did they want me poking around in there? Then when I started testing my software changes, I found that the books balanced to a $.23 difference. When I inquired, I was told that the, "problem had existed for a while, no one wanted to spend the time to resolve it."

Was there a problem? Were there two problems? Perhaps there were no problems? Management obviously felt there were no problems. Is bias a problem? Does the fact that I was representing a trusted consulting firm enter into the situation? If you were the auditor, what would you say about this situation? I'll come back to this in a moment.

We can list some of the properties of problem definition. The list might contain:

Who is the person who is making the decision (the Decision Maker)? At what level does the problem have to be solved? Can a team lead solve the problem or does it need to be escalated to the CEO? Perhaps some level of authority between the two is adequate.

The Goal—What are you trying to do? What is the Big Picture? Do you want to maximize profit? Do you want to minimize cost?

Constraints—What are the constraints that influence the decision? They can be monetary, legal, geographical, ethical or even governmental.

Alternatives—What are the alternatives for you to consider? The alternatives are frequently mutually exclusive.

Payoffs or Penalties—Each alternative should have payoffs or penalties. What are they?

Probabilities—Review past situations. Can history present probabilities of success or failure?

SECTION 2

Using Numbers and Calculations in Decision-Making

Using Numbers and Calculations in Decision-Making

Essentials of Statistics and Probability

Don't run! You're NOT going to have to calculate means or standard deviations. I assume that you've already labored through at least one course on "Sadistics"—err, I mean, Statistics. However, it is important to spend some time reviewing the application of statistics, simply to discuss what they mean and how to apply them in order to create a frame of reference for major topics.

Many years ago, upon graduating from college, I was employed as a Junior Programmer at a great metropolitan oil company whose name need not be mentioned. The first system I worked on was called "Oil Flow Balance (OFB)." OFB measured the efficiency of the refining process by measuring the amount of product in each of the many vats. I was assigned to extract data from an existing file and produce a summary report on the amount of product in a series of vats. I was fresh out of college, therefore I knew everything there was to know. I wrote a report that analyzed the data every which way—producing quantities to four decimal places. I was proud of the report and management loved it. Some weeks later, I found out the source of the numbers that I was calculating to four decimal places. A man would climb onto the vat with a long stick, stick it in the vat and read off the capacity. I was taking "It looks like 35,000 gallons" to a 4-decimal place number. And management bought it hook, line and sinker!

Examining Central Tendencies

Defining the Mean and the Median

Mrs. Whitcomb, the often maligned and feared English teacher, has been asked the "average" height of her students. She lines them up and measures them. Their heights are (see Table 1):

Table 1

Student	Height	Student	Height	Student	Height
Aaron	60	Georgette	53	Norbert	57
Betty	48	Howard	40	Otto	61
Charlie	52	Joe	58	Peter	61
Donna	47	Karen	57	Mean	55
Edward	73	Louis	59	Median	57
Frankie	55	Marianne	44		

Mrs. Whitcomb adds up their heights, divides that by the number of students in the class, 15. The average is 55 inches. In other words, the arithmetic mean is 55 inches. Next, Mrs. Whitcomb has them line up in size order and finds the student in the middle of the class—Karen and Norbert are both 57 inches. Coincidentally, they are standing in the middle of the line. The median height is 57 inches [note: being essentially lazy, I had Excel compute the mean and median]

Median ->57

40, 44, 47, 48, 52, 53, 55,
57, 57, 58, 59, 60, 61, 61, 75

Mean ->55

- Which "average" is more accurate, the mean of 55 inches or the median of 57.
- What do we mean by accurate?
- Hmmm—What if the mean was equal to the median?

Defining the Standard Deviation

Ms. Whitcomb then wonders: how valid are these numbers? Is the mean truly representative of the class? She asks Marianne, who is taking an advanced placement class in statistics, to figure out how valid these numbers are.

Marianne computes a standard deviation of 8.13 inches. She further explains: Assuming a normal distribution, the standard deviation is 8.13 inches. That tells me that 68% of the class is between 48.9 inches and 65.1 inches.

Mrs. Whitcomb, being confused at these numbers notices Edward, who is over 6 feet tall, clearly does not belong here. She discovers that Edward is in fact Howard's father and is just hanging around the class, having been fired from his job as a hod carrier. She banishes him and has Marianne recalculate her numbers. With Edward removed, the mean is now 53.7 inches, the median is now 56 inches and the standard deviation is 6.7 inches. So we can deduce:

	With edward	**Without edward**
Mean	55	53.7
Median	57	56
Standard Deviation	8.13"	6.7"
+/− 1 Standard Dev. (68%)	48.9 through 65.1	47 through 60.4

Ok, now what does this mean?

Mean, median and standard deviation are ways of looking at a group of numbers and evaluating their "Central Tendencies." Mean and median tell us where the central point is. Mean tells us the arithmetic center; median tells us the physical center. If the mean and median are the same (or reasonably close) we can say the distribution is, or approaches being normal, i.e. the famous Bell Shaped Curve. (Well, not quite, but we can live with that explanation for a while)

A normal distribution is identified by a set of data where:

- Mean = Median
- The distribution is symmetric about the mean

In addition, a normal distribution is identified by its mean and standard deviation. Standard deviation tells us how valid the mean is. If you noticed, Edward's height clearly affects the class averages. When we kicked Edward out the standard deviation went from 8.13 inches to 6.7 inches. The lower the standard deviation, the more accurate the mean is. The data is well "clumped," or gathered about the mean. We also know from our statistics class that in a set of data that is normally distributed:

- The mean +/− 1 standard deviation covers approximately 68% of the population
- The mean +/− 2 standard deviations cover approximately 95% of the population
- The mean +/− 3 standard deviations cover almost all of the population
- Greater than +/− 3 standard deviations is described as an Outlier and is generally not considered statistically valid.

This is called the Empirical Rule.

In this graph the numbers indicate the number of standard deviations away from the mean.

If you have a need to compute these numbers, Excel and most calculators will do the job for you. The focus of the rest of this book will be in USING statistics, not calculating them. There is no need to show you how to compute the standard deviation.

Statistics Are Not a Guarantee

First Example: Stock Valuation

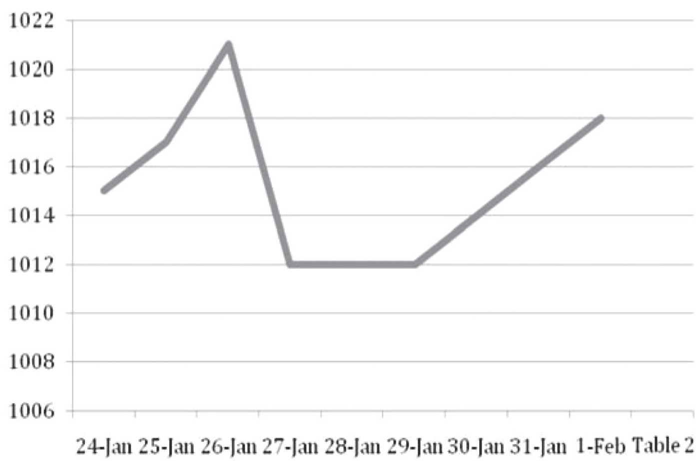
The daily closing price for the New Jersey Stock Exchange average for a 7-day period is (see Table 2):

Note that the Graph (see Graph 1) indicated a volatile set of sessions. The graph only displays a small part of the situation. I forced the next graph (see Graph 2) to display a zero-relative situation for this data

Is it still volatile? Note the difference? How would the two charts affect your investment strategy?

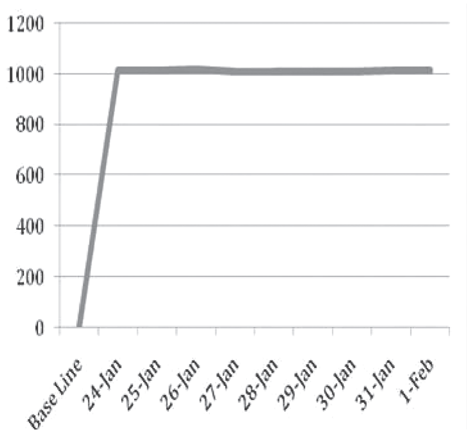
Table 2

Date	Price
24-Jan	1015
25-Jan	1017
26-Jan	1021
27-Jan	1012
28-Jan	1012
29-Jan	1012
30-Jan	1014
31-Jan	1016
1-Feb	1018



Graph 1

While we're at it, lets run an analysis on the numbers:



Graph 2

Table 3

Date	Price
24-Jan	1015
25-Jan	1017
26-Jan	1021
27-Jan	1012
28-Jan	1012
31-Jan	1016
1-Feb	1018
Mean	1015.86
Median	1016
Mode	1012
Stand dev	3.24
Range	9
Minimum	1012
Maximum	1021
Sum	7111
Count	7

Please note a few points:

- There are only seven observations.
- The Standard Deviation is approximately 3. This is less than 1% of the mean.
- The numbers are very tightly grouped.

Second Example: Company Salaries

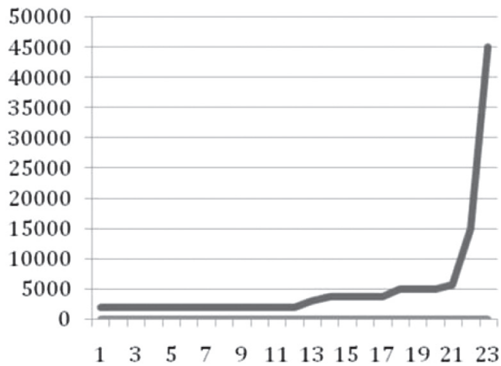
Table 4

No.	Salary	Type	No.	Salary	Type	No.	Salary	Type
1	$2,000	Employee	9	$2,000	Employee	17	$3,700	Employee
2	$2,000	Employee	10	$2,000	Employee	18	$1,000	Employee
3	$2,000	Employee	11	$2,000	Employee	19	$5,000	Employee
4	$2,000	Employee	12	$2,000	Employee	20	$5,000	Employee
5	$2,000	Employee	13	$3,000	Employee	21	$5,700	Employee
6	$2,000	Employee	14	$3,700	Employee	22	$15,000	Partner
7	$2,000	Employee	15	$3,700	Employee	23	$45,000	Partner
8	$2,000	Employee	16	$3,700	Employee			

Annual Salaries, Analyze the following

Salary stats	Company	Partners	Employees
Mean	$5,326	$30,000	$2,726
Median	$2,000	$30,000	$2,000

So if I tell you that the average worker makes over $5,000, am I telling you the truth? (This is a trick question).



Graph 3

Third Example: Determining Percentages

You are making $1,000 per week working for Gosdork, Inc.; your boss comes to you and says that due to a problem with Balance of Trade he has to cut your salary by 50%

The next month your boss says that he is restoring your 50% pay cut due to a new international agreement

Hmm. . . What is the problem? Or is there a problem? From whose point of view is there a problem?

Pay Before Cut	$1,000
50% of Pay	$500
Pay after Cut	$500

Pay After Cut	$500
50% of pay	$250
"Restored" Pay	$750

Variables of Calculation and Estimation

The following article appeared on Network Television on January 24, 2005. It was also listed on MSNBC.COM. The network thought it important enough run it again a year later on January 29, 2006. By sheer coincidence it was run again in 2007. After three years it MUST be true?

Jan. 24 Called Worst Day of the Year

British psychologist calculates 'most depressing day' Using a formula (Model) created by Dr. Cliff Arnal...a U.K. psychologist.

$$([W + (D-d)] \times TQ) / (M \times NA)$$

Where:

- (W) weather,
- (D) debt,
- (d) monthly salary,
- (T) time since Christmas, (Chanukah if Jewish?)
- (Q) time since failed quit attempt,
- (M) low motivational levels (NA) the need to take action.

"I'm sure it's right," said Dr. Alan Cohen, spokesperson for the Royal College of General Practitioners, referring to Arnal's equation.... However, "it is postulated that there are a number of different causes of depression," he said.

Discuss the reliability of this model (or lack thereof?)

Probability

Rev. Thomas Bayes

Probability is probably the most intuitive of the management sciences. People flip coins, shoot craps and spin the roulette wheel while not really understanding that they are dealing with probability. However, like many mathematics concepts, when you formalize and study it, probability loses much of its mystique. Simply put, probability is the way to deal with uncertainty.

"Mr. Jones, your 97-year-old grandfather has a 20 percent chance of surviving his operation."

"If I buy a Lottery ticket, I have just as much of a chance of winning 12 million dollars as anyone else does. Therefore my odds of winning are 50-50"

"When you're in Vegas, put a dollar on number 17 for me."

Each of the above circumstances approaches an uncertain situation and uses probability to understand it, even if the tool is being misused. As a side note, on a standard Las Vegas roulette wheel, the odds of hitting a number are 38 to 1 (Numbers 1 to 36 plus 0 and 00). The house pays 35 to 1, hence, the house edge of 2.8% vs. 2.6%. Those two-tenths of one percent pay the rent!

Flipping a coin is the standard example of probability. The coin dictates the probability. Properly flipped, with an honest coin, the probability of the coin coming up heads is .5; every flip is independent, with the probability never changing. In other words, the coin does not have a memory. This is referred to as **objective** probability.

Probability can also be subjective. You are sitting in the airport waiting for your flight. You strike up a conversation with a pilot sitting next to you. He informs you that the probability of your aircraft exploding is one chance in 12 million. You relax and sit back comfortably. As you're sitting there, you see an airplane taxi down the runway, lift off and explode.

Now how confident are you in the 1 in 12 million odds? The probability does not change, but your view of it has taken a severe hit. In this case, the probability as you perceive it, is highly subjective.

Some years ago I was in an airplane returning from Florida. The weather was quite bad and we had to put in at Colorado Springs to refuel before continuing on to Denver. The flight had been bumpy and some people were quite uncomfortable. As the pilot restarted the engines, the wind switched and blew directly into the engine. The result was a rather dramatically large fireball coming from the engine. I spent enough time in the Air Force to realize that this was actually a normal situation;

however some people on the airplane panicked and demanded to be taken to the terminal so that they could get off.

Looking at the situation objectively, we were in no danger. Subjectively, however, in some people's minds we were danger. Probability enables you to look at a situation and have some insight as to the preferable decision. Or at least give you the impression that you have insight.

It took a man named Thomas Bayes[1] to actually put it all together and make it useable. Bayes looked at past events and their effect on future events. He did this by examining Conditional Probability and *Joint* Probability.

Bayes' Rule and Conditional Probabilities

Mathematically, this is indicated by P (A|B) or the Probability of A happening given B has happened. For example:

We are investigating the probability of a person in a specific clinic having (or getting) cancer. Let's fill in the blanks. Suppose that we are looking at two situations:

- A person has cancer
- A person is a smoker

In our clinic, 10 percent of the people entering have cancer—therefore the probability of A is 10% or: $P(A) = .10$ By examination, we know that one half of our patients smoke or did smoke, therefore: $P(B) = .50$ We also know by checking with our patients that 80 percent of our cancer patients smoke or did at one time. Therefore: $P(B|A) = .80$

This can be read as: The probability of B (A person has cancer) given A (he was a smoker) is 80 percent. Now, can this information tell us the probability of a clinic patient getting cancer given that person is a smoker? The probability can be computed using the Bayes Rule:

$$P(A|B) = ((P(B|A)\ P(A))/P(B)$$

OK, I know I promised to keep it simple. Bear with me...

[1]Reverend Thomas Bayes (c. 1702–1761) was a British mathematician and minister.

This can be interpreted as: The probability of a person getting cancer GIVEN he is a smoker is equal to the probability of being a cancer patient who smokes, multiplied by the probability of having cancer. This amount is then divided by the probability of being a smoker.

Or:

$$\frac{(.8)(.1)}{.5} = \frac{0.8}{.5} = .16$$

Therefore—The probability of a smoker getting cancer—subject to the information that we have gathered—is 16%

Can this information be projected to the population at large? Why or why not?

This is an important and frequently ignored point. Bayesian probabilities can only apply if the specific case under examination is valid for the population it is applied it to.

Given this situation, you cannot now take a group of high school athletes and tell them that 16 percent of the smokers in that group will probably get cancer (why?).

However, you can say that any patient in this clinic who smokes or has smoked has a 16 percent probability of getting cancer. Does this mean that 16 percent WILL get cancer?

Bayes' Theorem

OK, you've made it this far. Take a deep breath and hang on. It does get simpler.

You run a plant that manufactures sausage. You purchase sausage casings from two plants, one in New Jersey and one in Connecticut. They both charge the same for their casings and transportation costs are similar. New Jersey produces 45 percent of your casings and Connecticut produces 55 percent. At the factory in South Bronx, the casings are placed in a common vat and then processed. After a rash of sausages exploding due to defective casings, the Quality Assurance (QA) manager determines that 5 percent of the New Jersey Casings are defective and 10 percent of the Connecticut casings are defective. The production manager, being a graduate of this school, decides to analyze the situation.

He decides that he needs to know the following:

1. What is the probability of a casing being from New Jersey, given it is defective?
2. What is the probability of a casing being from Connecticut, given it is defective?

—Or—

1. P (N|D) =?
2. P (C|D) =?

There are three basic methods to present this problem. You can use the formula, use a tree diagram or use a table. I will present both the tabular approach and a tree diagram.

The formulaic method has been outlawed as cruel and unusual punishment. Here's why: **PE(H) = [P(H)/P(E)] PH(E)** *Note: You may (should?) ignore this formula*!

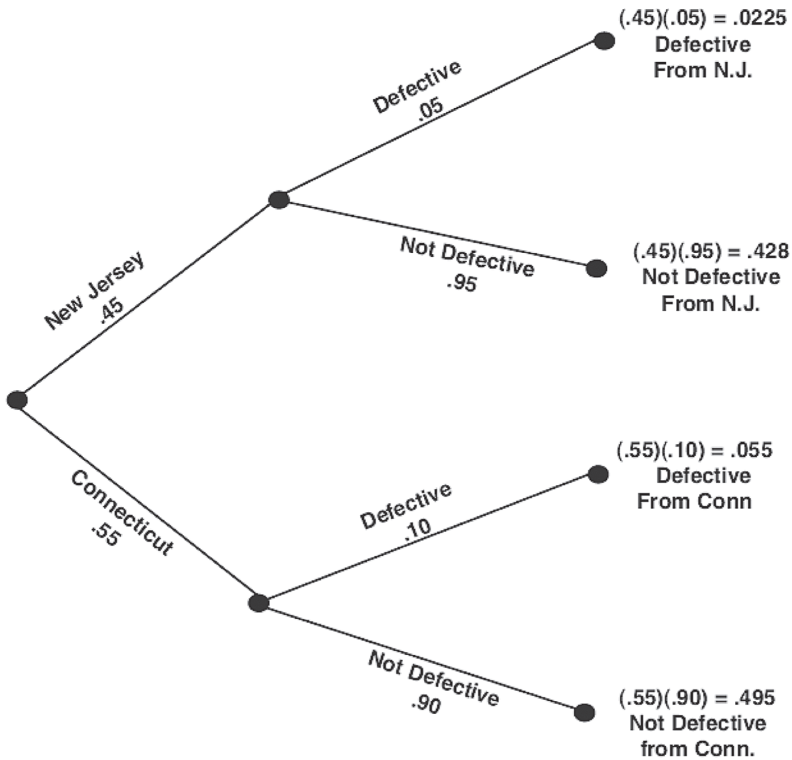
Using Tables

Events	Prior probabilities	Conditional probabilities	Joint probabilities	Revised probabilities
New Jersey	.45	.05	(.45)(.05) = .0225	.0225/.0775 = .29
Connecticut	.55	.1	(.55)(.1) = .055	.055/.0775 = .71
Totals			.0775	1.00

Now we can reliability state the following:

- Approximately 8% (actually 7.75%) of our casings are defective
- Approximately 29% of the defective casings come from New Jersey
- Approximately 71% of the defective casings come from Connecticut

Shall we simplify even more?



This tree presents the same information. We can see that (.0225 + .055 = .0775). Approximately 8 percent of our casings are defective. We can also extrapolate that .0225/.0775 or 29 percent of the defective casings came from New Jersey. Is this a definitive statement? No it is not. Is this enough information so that a reasonable investigation and decision can be made?

Riddle me this: Your neighbor makes fan belts. He also imports them from both New Jersey and Connecticut. Can he use these assumptions? Why or why not?

Next topic: Can we use quantitative analysis techniques on qualitative data? Here's an example: Suppose I survey the class and find out how many people have brown eyes, blue eyes or any other color. One might suppose that the distribution in a class of 30 people might be:

If a student is chosen at random, the probability that the student has brown eyes is 70 percent. The probability of the student having blue eyes

Eye Color	Count	Percent
Brown	21	70%
Blue	8	27%
Other	1	3%

is 27 percent. This is a valid use of the information. Now—I have read that 99.5 percent of the residents of the nation of Inner Slobovia have brown eyes. Since 70 percent of the class has brown eyes, I can therefore assume that 70 percent of the class is Inner Slobovian. What is wrong with this example? The Latin term is *non sequitur*, or, "it doesn't follow."

As foolish as this is, this type of reasoning is frequently observed and accepted as true

What is Utility Theory?

In economics, utility is a measure of the happiness or satisfaction gained consuming good and services. Utility takes two forms:

- Cardinal Utility—the increase in actual value gained from a transaction.
- Ordinal Utility—states that while utility cannot be measured, a customer is capable of ranking different alternatives available.

Ordinal Utility can be explained thusly. Sometimes, there are factors that are of value in making a decision that do not have a readily available value. These factors are measures of ordinal utility.

For example, you live in a state that does not have compulsory insurance. You have just purchased a new car and are deciding on whether to buy car insurance for $500. The cost is the same whether you have an accident or not. You consult the insurance tables and decide that people in your statistical category average about 8 accidents per thousand people.

In other words, given 1000 people, 8 will have an accident and 992 will not. Dividing each number by 1000, you can say that the probability of getting into an accident is .008 while the probability of NOT getting into an accident is .992. What do you do, assuming that an accident will cost you approximately $10,000? The following payoff table can be constructed:

	No accident	Accident	Expect cost
Probability of an accident	.992	.008	
Pin chase Insurance	500	500	$500.00
Do Not Purchase Insurance	0	10,000	$80.00

- The expected cost of purchasing Insurance is .992(500) + .008(500) = $500.
- The expected cost of no insurance is .992(0) + .008(10,000) = $80.

Therefore, simply going by the numbers, the answer is obvious. Buying insurance will cost you $500; however not buying Insurance will cost you $80. Now a person who is independently wealthy might choose to bypass insurance.

Buying Insurance is a form of Risk Aversion. In this case, the Ordinal Utility of having insurance overcomes the Ordinal Utility of not having insurance. To a wealthy person this utility is not a factor; that person is not nearly as risk averse.

Another example: you are broke. You expect a check in the next few weeks but you currently do not have funds. You receive an offer of a commercial loan in the mail for $10,000 at 25% APR. What do you do? The ordinal utility of having the money might outweigh the high interest rate. Your immediate need for funds can make the difference

Generally speaking, money does not have the same intrinsic value to all people. If you are living paycheck to paycheck, $100 may have a great deal of value. In this situation you would be wise to avoid gambling with this amount. A wealthy person has a different concept of the value of $100. The risk of a $100 bet does not have the same affect on the wealthy person. Perhaps this gives us the old gambler's adage: never gamble with money you can't afford to lose.

Defining Risk Premium

Let's play a game. I'll flip a coin. If it lands with the head side up, I'll give you $100. If the coin lands tail side up, I give you nothing. Oh, and it will cost you $50 to play. The probabilities here are pretty intuitive. Fifty percent of the time you get a net $50 payoff. Fifty percent of the time you lose your $50 buy-in; would you play? What if your buy-in was $40? How about $25, would you play then? Risk Aversion is an important factor in decision-making.

Let's change the rules of this game a bit. I'll give two options.

- Option 1, I give you $50, or,
- Option 2, we flip a coin and depending on the flip, you either get $100 or nothing.

Now there are three possible outcomes:

1. You keep $50
2. You have a 50% probability of getting $100
3. You have a 50% probability of getting nothing

Or you might say—you have 100% probability of keeping $50. You have a 50% probability of making $100. You have a 50% probability of making nothing. Make your choice. How risk averse are you? Most people will take the sure thing.

However let's decrease the amount of the Sure Thing. Do you go for the risk if the offer is $40? Do you go for the risk if the offer is $30? At what point do you choose to take the risk?

The difference between that point and the original $50 is that amount is the **risk premium**.

The Risk Premium is the reward for holding a risky investment rather than a risk-free one. If you choose to go for the risk at the $35 level, your risk premium is $15[2]

Insurance is a statement of Risk Premium. You insure yourself against loss depending on your willingness to take risk. Compare the person who takes a homeowner's policy with a $1000 deductible against a person who chooses to pay the additional amount of $15 per year over the life of the policy for a $200 deductible policy.

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[2]McMillin, Games, Strategies & Managers.

Understanding Game Theory by Examining Examples

The great American philosopher Yogi Berra[3] once said, "Half the game is 90 percent mental." With that as our guide, we look at the subject of Game Theory. Competition is instinctive. We compete in sports. We compete for the attention of the opposite sex. We measure our business success against that of our business competitors. Competitiveness is in our genes—our closest relatives— chimpanzees and bonobos[4] are fiercely competitive.

As a person ascends the management tree, and by sheer coincidence climbs Maslow's Hierarchy of Needs[5], the scope and the importance of the decision increase. A major part of decision-making is dealing with competition. Competition is the soul of a game. By analyzing the rules, payoffs and penalties of any competition, insight is gained into the game being played and how to play it.

You can classify the level of a manager by the scope and time span of his decisions. A functional manager, or supervisor, can make dozens of decisions a day. While these decisions are quite important to the function of the corporate entity, they have to be made quickly and frequently using the intuitive instincts of the supervisor. As a person climbs the ladder, the scope of his decisions increases. Not coincidently, the number and frequency of these decisions increases. A senior executive might make relatively few decisions in a year. The decisions, however, cover a vast scope of activities and have long reaching effects on the profitability of the company. The amount of information needed frequently far exceeds the detailed knowledge of a single person.

As a side note, game theory is the child of John Von Neumann[6], one of the premier minds of the Twentieth Century. Incidentally, Von Neumann was also one of the principle designers of today's computers.

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[3]This photograph is in the Public Domain.

[4]http://williamcalvin.com/teaching/bonobo.htm

[5]http://en.wikipedia.org/wiki/Maslow's_hierarchy_of_needs

[6]Von Neumann, Einstein and Nash all were at Princeton at the same time!

Game theory can be addressed from either a quantitative view or a qualitative view or simultaneously both. It is one Management Science discipline that truly spans that chasm.

Pascal's Wager

Blaise Pascal, the great Seventeenth Century mathematician, laid much of the foundation [7]for modern mathematic thought. Throughout his life, however, he had a fascination with spiritualism. As part of this interest, he wrote many religious works in addition to his massive volume of mathematic work.

One of his most famous religious works was Pensees, A collection of writings on human suffering and faith in God. As part of this essay, he "proved" the rationality of believing in god with the following statement, which has become known as Pascal's Wager:

Pascal's Wager

"If God does not exist, one will lose nothing by believing in him, while if he does exist, one will lose everything by not believing."

This can be diagrammed as:

Pascal's Wager

	God exists	God does not exist
Wager For God	Gain all	Status Quo
Wager Against God	Lose all	Status Quo

Ok, some people consider this the example hokey. The intention of this example is not to present a religious viewpoint, rather to demonstrate a use of the basics of Game Theory. The conclusion that Pascal drew was that wagering for God was the optimal solution, as it did not have a negative payoff. Conversely, wagering against God can have a decidedly negative payoff. *[Again, please do not contact the ACLU; this is just an example, not a statement of belief*]

[7]Hájek, Alan, "Pascal's Wager", The Stanford Encyclopedia of Philosophy (Spring 2004 Edition), Edward N. Zalta (ed.), URL <http://plato.stanford.edu/archives/spr2004/entries/pascal-wager/>.

Simply put, game theory allows us to identify the problem or decision to be made, list the payoffs or penalties, and provide a methodological manner of evaluating them.

The Prisoner's Dilemma

The classic example of game theory is "The Prisoners' Dilemma." John Nash, the subject of the movie "A Beautiful Mind," developed this format of analyzing Game Theory and its application. Many versions have been published; one version might be as follows:

> During the Stalin era, an orchestra conductor is traveling on a train in the Soviet Union. To keep busy during the long trip, he studies the musical score of the program he will be conducting. A KGB agent who happens to be sitting nearby observes him reading the score. Obviously, at least to the KGB agent, the score that is written in musical notation is in fact a secret code of some sort. The KGB agent arrested him on the spot. As he was being led away in chains the conductor pleaded that the document was the score for Tchaikovsky's Violin Concerto; an obviously silly response. After the conductor has been held incommunicado in jail for two days, the door bursts open and the KGB agents come in. "We have caught your friend Tchaikovsky and he's talking. You had better tell us everything."

Ok, it's a silly story, but it demonstrates the point. We have two people in a competition; each one wants to minimize the amount of time that he will spend in the Gulag.

One person is our hapless conductor. The other person is some poor soul whose only crime was to be named Tchaikovsky. They are both subjected to similar inquisition. In addition, they cannot communicate with each other. Their choices are:

- If they both hold out, they both will get a 3-year sentence.
- If they both 'confess' they will both get a 10-year sentence.
- If either one 'cracks' and informs on the other by confessing, he gets a 1-year sentence while his hapless compatriot will get a 25-year sentence.

	Conductor [C] confesses	**Conductor [C] doesn't confess**
Tchaikovsky [T] Confesses	Both get 10 years	C gets 25 years T gets 1 year
Tchaikovsky [T] Doesn't Confess	T gets 25 years C gets 1 year	Both get 3 years

As they sit in their cells, they realize independently that if they both did not confess, they might only get a 3-year sentence. Both being logical men, both confess. Both get a 10-year term. Imagine the discussion when they both meet at the Gulag and compare notes?

This example deals with a competitive situation where the actions of one party directly affect the other. The crux of the situation is one person's advantage is the other's loss. In a situation where communication is impossible or unlikely—as in a labor/union situation—acting in one's self interest is the usual best choice. In the "Prisoners' Dilemma," the cards are stacked against a mutually agreeable conclusion. In this case, there is a situation where there is a possibility that both can optimize their situation, no matter how unlikely.

Zero-Sum Games

What happens when there is one winner and one loser? Examples are football, baseball, war or perhaps a street fight. This is called a zero-sum game. Let's look at an example of a simple zero-sum game:

In Denver there are two Bagel Bakeries: New York Nick's (N) and Philadelphia Pete's (P). Former New Yorkers prefer Nick's while former Philadelphians flock to Pete's. For years the competition has proven to be extremely stable. Nick's daughter Nancy graduated from NYU with a new MBA and decided to revamp the situation. Nancy designed two new marketing campaigns, one using billboards along I-25, the other hitting evening rush hour drives via a local radio station. She is curious as to which one to use. Pete, hearing of this plan, calls his son Paul and has him come from Philadelphia, where he is studying business, to remedy the situation. Paul provides Pete with a similar set of plans.

	Pete – Billboard	Pete – Radio
Kick – Billboard	3, 1	5, 2
Kick – Radio	1, 1	1, 2

Where in (a, b): a = Nick's increase in market share, b = Pete's increase in Market share

The possible results are:

Nick's strategy	Pete's strategy	% Share of market change
Billboard	Billboard	Nick + 3%, Pete +1%
Billboard	Radio	Nick + 5%, Pete +2%
Radio	Billboard	Nick + 1%, Pete + 1%
Radio	Radio	Nick +1%, Pete + 2%

In other words: if Nick and Pete BOTH use a billboard, Nick gains 3% market share and Pete only gains a 1% market share. Which leads us to:

The Nash Equilibrium

DEFINITION: Nash Equilibrium—If there is a set of strategies with the property that no player can benefit by changing his strategy while the other players keep their strategies unchanged, then that set of strategies and the corresponding payoffs constitute the Nash Equilibrium.

Rules for the Nash Equilibrium:

1. Each player believes all other participants are rational.
2. The game correctly describes the utility payoff of all players.
3. The players are flawless in execution.
4. The players have sufficient intelligence to deduce the solution.

Back to the example: one option is that Nick would try and deduce the strategy that MINIMIZES his MAXIMUM gain. (MiniMax)

Using this example:

	Pete – Billboard	Pete – Radio
Kick – Billboard	3, 1	5, 2
Kick – Radio	1, 1	1, 2

For Nick

Where in (a, b): a = Nick's increase in market share, b = Pete's increase in Market share

MiniMax, Nick = (Billboard maximum = 5, Radio Maximum = 1)

Minimum of the Maximums (5, 1) = 1

And for Pete:

MiniMax, Pete = (Billboard maximum = 1, Radio Maximum = 2)

Minimum of the Maximums (1, 2) = 1

Table MiniMax = (1,1)

Note that equilibrium has been reached – of Pete using Billboard and Nick using Radio (1, 1). A 'Saddle Point' exists if both **MiniMaxes** are the same value. Another word for the Saddle Point is the **Nash Equilibrium**.

What happens when the table has no saddle point? In other words, the table is NOT in equilibrium; as for instance, in real life. We can start computing probabilities and deduce an appropriate answer. So, instead of cranking through statistics, let's look at what we have and how to apply it to the "real world." Let's repeat our example with a minor change:

	Pete – Billboard	Pete – Radio
Nick – Billboard	3, 1	5, 2
Nick – Radio	4, 4	1, 2

Where in (a, b): a = Nick's increase in market share, b = Pete's increase in Market share

- MiniMax, Nick = (Billboard maximum = 5, Radio Maximum = 4)
- Minimum of the Maximums (5, 4) = 4
- MiniMax, Pete = (Billboard maximum = 4, Radio Maximum = 2)

- Minimum of the Maximums (4, 2) = 2
- Table Minimax = (4,2)

Hmmm, there's no saddle point. The data is not in equilibrium. So what do we do?

Dominant Strategies

Here's a procedure (a procedure, not the procedure):

1. Check for a saddle point.
2. Are there any dominant strategies?
3. Work the model.

In a simple situation, the rules are changed somewhat.

Suppose the table looks like this:

(Note: when we are looking at a single result within the boxes of the tableau, we use: MiniMax across and MaxiMin Down

We are now looking at the situation from Nick's vantage point. We can observe that Nick has a positive payoff in all but one of the situations. The process

	Pete – Billboard	Pete – Radio
Nick – Billboard	3	5
Nick – Radio	1	−2

for determining the saddle point is slightly different.

	Pete – Billboard	Pete – Radio
Nick – Billboard	3	5
Nick – Radio	1	−2

We take the MiniMax across the bottom:

MiniMax = (3, 5) = 3

We take the MaxiMin (the Maximum of the Minimums) down the right side: MaxiMin = (3, −2) = 3

Therefore the saddle point for the tableau is 3, Billboard: Billboard

However, let's look at this game:

	I	II	III
A	7	9	8
B	**9**	10	12
C	8	8	8

In this case you (A, B, C) are trying for the larger number, while your opponent (I, II, III) is looking for lower numbers. By examination you see that choosing strategy B dominates strategies A and C. In each case choosing B yields a higher return then either A or C. Obviously you choose strategy B.

Your opponent notices that Strategy I dominates both Strategies II and III. In other words, by choosing I he minimizes any loss, he chooses strategy I. The resulting cell (B, I) is in fact the saddle point. Running a MiniMax routine against the game will return the same answer.

What if the game has no saddle point? Consider the following situation:

	I	II	III
A	14	9	8
B	9	10	12
C	8	8	8

I only changed one number (A, I) but the entire game has changed. Both A and B now dominate C. Neither A or B dominate each other. Which do you choose? Running MiniMax you get the following result:

MiniMax = 10

MaxiMin = 9

Which selection do you choose? Which selection should your opponent choose? Are there other factors that come into the situation?

OK, now let's look a the Nash Equilibrium in a bit more detail and realism: Bagels revisited: Assuming the following payoffs where in (a, b) a = Nicks payoff, b = Pete's payoff

	P1	P2	*Maximum Nick*
N1	3, 0	5.2	5
N2	1, 4	2.2	2
Maximum Pete	4	2	

- MiniMax, Nick = (N1 Max = 5, N2 Max = 2)
- Minimum of the Maximums (5, 2) = 2
- MiniMax, Pete = (P1 maximum = 4, P2 Maximum = 2)
- Minimum of the Maximums (4, 2) = 2

The Nash Equilibrium, Saddle point, is N2, P2
Achieving efficient outcomes

Note: In the interests of sanity I have provided two Excel™ spreadsheets to a simple look at this topic. They are shown below. They are in the file Game Theory as One Variable and Two Variables:

Game Theory 1

	One Variable		
			Maximums
	4	3	4
	3	4	4
Minimums	3	3	4
Max on Mins	3		
Minimax =	3	Maximin =	4
The table is NOT in equilibrium			
	Enter your values in the gray box		

Game Theory 2

Two Variables

A		B	A		B	
9	,	5	3	,	7	A
2	,	4	1	,	8	B

Minimax across =	9	7	=	7
	4	8	=	4
				4
Minimax up/Down	9	3	=	3
	5	8	=	5
				3

The table is NOT in equilibrium

Enter your values in the gray box

More Games

Two radio stations have to choose formats for their broadcast. There are three possible formats; each one will deliver a percentage of the audience. They are: Country Western (CW) = 50%, Elevator Music (EM) = 30%, All News (AN) = 20%. If both stations select the same format, they share the audience equally. If they have different formats they get their entire share.

You might set this up as follows:

	Station 1			
		CW	EM	AN
Station 2	CW	25, 25	50, 30	50, 20
	EM	30, 50	15, 15	30, 20
	AN	20, 50	20, 30	10, 10

The maximum audience that they can share is 80%. This situation exists when one station chooses EM and the other chooses CW.

If we run a MiniMax analysis we get:

- Station 1: (30, 50, 50) = 30
- Station 2: (50, 50, 50) = 50

There is NO equilibrium. Both you and your competition have access to this information. How do you maximize your audience?

Evaluating Information

Is There Such a Thing as Perfect Information (EVPI)

An interesting subset of game theory is the topic of the Value of Information. Gathering information costs money. The point is reached where the expense of gathering the information exceeds the potential value of the information 25. Let's look at an example.

You have three possible solutions to the problem of exploding sausage casing:

- Build a large plant
- Build a small plant
- Do nothing

You know that market conditions have an effect of the decision. Can you use any techniques to aid in the decision? After consulting your religious leader, examining chicken entrails and your magic 8-ball, you decide that the probability of a favorable market is 63 percent. Obviously, the probability of an unfavorable market is 1-.63 = 37%. If you construct a large plant and the market is favorable, you stand to make $193,000. If you construct a large plant and the market is unfavorable you stand to lose $68,000. Therefore, we can calculate the Expected Monetary Value (EMV) as:

EMV (Large Plant) = .63(193,000) + .37(−68,000) = 122,590 − 25,160 = 97,430

If you construct a small plant the same probabilities exist, however if conditions are unfavorable, you will probably lose $18,000. Therefore Computing the Expected Monitory value is:

EMV (Small Plant) = .63(85,000) + (.37)(-18,000) = 53,550 – 6,660 = 46,890

Doing nothing implies an EMV of Zero. We can now construct the following table:

	Favorable market	Unfavorable market		Favorable market	Unfavorable markel	EOL
Large Plant	193,000	−68,000				
Small Plant	85,000	−18,000				
Do Nothing	0	0				
Probabilities	.63	.37		.63	.37	

- In a favorable market the maximum EMV is $193,000—Build a large plant
- In an unfavorable market the maximum EMV is 0—Don't build anything (As an aside—does Game theory work here? Why or why not?)

We can compute the Expected Value of Perfect Information as Expected Value with Perfect Information (EVPI) = ((193,000)(.63) + (.0)(.37)) – 96,430 = 25,160 ; Or, the expected value under certainty less the Maximum EMV.

Therefore—The maximum amount that we should spend for perfect information is $25,160. In other words: Expected Value with Perfect Information is the expected or average return, in the long run, if we have perfect information before a decision has to be made.

What Is An Expected Opportunity (EOL)?

What if we choose not to take the optimal choice? What is our Expected Opportunity Loss (EOL)? The EOL is the cost of not picking the best solution. In other words, it's the amount lost by not picking the best alternative. Instead of taking the positive view, Value of Information, can we take the opposite tack, Opportunity Loss?

Let's start with the tableau we used to find EVPI and add a couple of extra columns:

Decision table with probabilities ***Opportunity loss table***

	Favorable market	Unfavorable market	Favorable market	Unfavorable markel	EOL
Large Plant	193,000	−68,000	0		
Small Plant	85,000	−18,000	108,000		
Do Nothing	0	0	*193,000*		
Probabilities	.63	.37	.63		

1. Select the best alternative from the favorable market—$193,000
2. Select the alternative from the unfavorable market—$0
3. Calculate the EOL for the first alternative (Large Plant) in a favorable market as
4. EOL = 193,000 − 193.000 = 0. By building a Large Plant in a favorable market there is NO opportunity loss.
5. Calculate the value in the table for the second alternative (small plant) as
   a. EOL = 193,000 − 85,000 = 108,000
   b. By building s small plant in a favorable market there is a $108,000 opportunity loss
6. Repeat for the third alternative (Do Nothing)
   a. EOL = 193,000 − 0 = 193,000

	Favorable market	Unfavorable market	Favorable market	Unfavorable markel	EOL
Large Plant	193,000	−68,000	0		
Small Plant	85,000	−18,000	108,000		
Do Nothing	0	0	*193,000*		
Probabilities	.63	.37	.63		

Repeat the calculations for an Unfavorable Market giving:

	Favorable market	Unfavorable market	Favorable market	Unfavorable markel	EOL
Large Plant	193,000	−68,000	0	68,000	25,160
Small Plant	85,000	−18,000	108,000	18,000	74,700
Do Nothing	0	0	*193,000*	0	121,590
Probabilities	.63	.37	.63	.37	

The minimum Expected Opportunity loss is $25,160—construct a large plant

Hierarchical Analysis

When I wrote the first edition of this book I must admit to ignorance about the topic of the Analytic Hierarchy Process (AHP). After some discussions with professors that were considering it, the topic came up a few times. I investigated and studied. I am adding the subject to this edition. I am convinced of its importance. The tool does use some techniques with daunting names (Eigenvectors) however I will not utter that word from this point hence, instead I will concentrate on a very straightforward technique.

The combination of AHP and Delphi[8] yield a model that Isabel Fernandez and Tuano Kekale[9] have referred to as Reverse Logistics. It is my belief that these two tools: AHP and Delphi create a new direction for Decision Sciences. The procedure for AHP is quite sequential in nature:

1. The problem is parsed into a series of sub-problems, each of which can be analyzed independently
2. Each sub-problem is then evaluated, either subjectively or objectively, depending on the environment of this sub-problem
3. This evaluation is then assigned numeric values or weights
4. A table is used to evaluate these weights allowing for an optimal solution to be chosen

[8]The Delphi Method is discussed in detail in this book.

[9]Better models with Delphi and Analytic Hierarchy Process approaches: the case of Reverse Logistics; Isabel Fernandez, Tauno Kekale University of Oviedo, Escuela Politecnica Superior de Ingenieros, Edificio de Energia, Campus de Viesques, 33204 Gijon-Asturias, Spain. 'University of Vaasa, Industrial Management, P.O. Box 700, FIN-65101 Vaasa, Finland

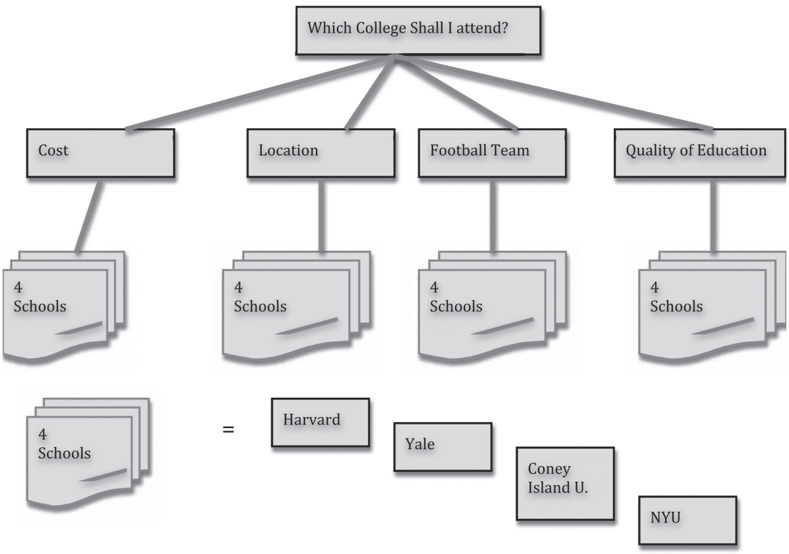
Problem: Selecting a College to Attend

Choices:

1. Harvard
2. Yale
3. Coney Island U
4. NYU

A set of criteria is constructed to evaluate each choice. The Hierarchy Chart would probably look like so:

Establish Priorities:



Making Comparisons

Value	Priority
Cost	.15
Location	.25
Football Team	.45
Quality of Education	.15
Total	1.00

Each criterion is then evaluated against each other Criterion: Cost v. Location, Cost v. Football Team and Cost v. Quality of education, etc.

The scale for this is:

This can be evaluated via an Excel table:

The fundamental scale for pairwise comparisons

Intensity of Importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another: its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensities of 2. 4. 6. and 8 can be used to express intermediate values. Intensities 1.1. 1.2, 1.3. etc. can be used for elements that are very close in importance.		

So, Cost v. Cost, Location v. Location, etc all equal 1 ~ both elements contribute equally to the objective

	Cost	Location	Football	Quality of educ.
Cost	1	1/3	1	1/4
Location	3	1	3	6
Football	2	1/3	1	4
Quality of ed.	8	1/6	1/4	1

Location v. Cost = 3 and Cost v. Location 1/3 ~ Location is strongly (3) more important to the objective.

Next convert the fractions to decimal values:

And divide each number by the sum of the column it appears in

	Cost	Location	Football	Quality of educ.
Cost	1.00	0.33	0.50	0.25
Location	3.00	1.00	3.00	6.00
Football	2.00	0.33	1.00	5.00
Quality of ed.	8.00	0.17	0.25	1.00

So we can conclude that about • of our objective weight is on Location, ~ on

	Cost	Location	Football	Quality of educ.	Average
Cost	0.10	0.18	0.11	0.02	0.10
Location	0.30	0.55	0.63	0.49	0.49
Football	0.20	0.18	0.21	0.41	0.25
Quality of Edu.	0.40	0.09	0.05	0.08	0.16
	1.00	1.00	1.00	1.00	1.00

Football and another ~ on the combination of Cost and Quality of Education.

Now if we repeat the process for the four schools, comparing them against each other, we can take the average of the Pairwise comparisons and us it to evaluate the school's value and come up with the optimum choice:

	Harvard	Yale	Coney Island	NYU	Average
Harvard	1.00	2.00	0.33	1.00	
Yale	0.50	1.00	0.25	0.33	
Coney Island	3.00	4.00	1.00	5.00	
NYU	1.00	3.00	0.20	1.00	
	5.50	10.00	1.78	7.33	

	Harvard	Yale	Coney Island	NYU	Average
Harvard	0.18	0.20	0.19	0.20	0.19
Yale	0.09	0.10	0.14	0.10	0.11
Coney Island	0.18	0.30	0.11	0.30	0.22
NYU	1.00	0.30	0.11	0.30	0.43
	1.45	0.90	0.55	0.90	0.95

So if we look at the subjective average from comparing Harvard against the other school we get .19 We can then multiply it against the values for Cost, location, football and quality we get:

(.19)(.10) + (.19)(.49) + (.25) (.19)+(.16)(.19) = .19 repeating this for the other
.19 for Harvard
.11 for Yale
.11 For Coney Island
.43 For NYU

Yielding .43 as the optimal choice—NYU.

We must remember that we are combining objective and subjective values. The values are only as valid as their source.

Making Forecasts

What's the weather going to be like tomorrow? Is the market going up or down? Should I buy or sell? We make daily decisions based on forecasts. I will be discussing two types of forecasts:

- Forecasts based upon trends.
- Forecasts based upon relationships between variables.

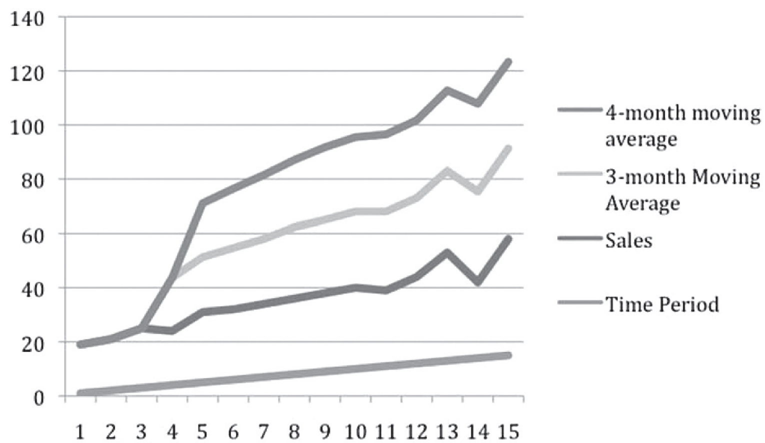
Analyzing Trends

Sausage sales have been increasing constantly. You wonder if you can use these months' sales to predict next month's sales so that you can efficiently order your casings and spices.

You have gathered the following information:

Time Period	Sales	3-month Moving Average	4-month moving average
1	18		
2	19		
3	22		
4	20	19.7	
5	26	20.3	19.75
6	26	22.7	21.75
7	27	24.0	23.5
8	28	26.3	24.75
9	29	27.0	26.75
10	30	28.0	27.5
11	28	29.0	28.5
12	32	29.0	28.75
13	40	30.0	29.75
14	28	33.3	32.5
15	43	33.3	32
Predict		37.0	35.75

(This graph was run using Excel® and shows the trend lines.)



Working with Moving Averages

A moving average smoothes out the trend and allows you to use this new set of numbers for the forecast. In the table below, two columns have been added, 3-month Moving Average and 4-month Moving Average. The 3-month moving average was computed by averaging the three preceding months. The 4-month average is computed by averaging the four preceding months. Which is more accurate? Consider this—the more months that you average, the more accuracy is delivered. However, the more months you include, the fewer months that you include in the calculation. By taking a moving average, we are smoothing out the variability of the trend and enabling a prediction. Most statistical programs provide a fairly full functioned approach to this topic.

There are many algorithms for conducting a trend analysis. I have presented the ones that are the simplest to compute by hand. Trend analysis produces estimates based upon history. The assumption that is being made is that the conditions that were captured will remain constant. As a manager you must evaluate this assumption as well.

Some questions:

1. What would a 2-month moving average imply?
2. What would a 5-month moving average imply?
3. Can you factor in probabilities? How?

Forecasting in the Real World

The forecasting models that we have defined are based upon the assumption that a trend exists. They are basically simplistic in that manner. The models that are used in industry and science are extremely complex. Later on, we'll delve into Regression and Correlation models. These models can deal with multiple variables and allow them to be weighted desired by the modeler. So, have I been wasting our time in this discussion? Lets put a few things together.

Using this model we can anticipate sales. However, there is a definite probability that there might be an increase in the price of raw materials of 10%. We can put a 48% probability on this happening. I now have this situation:

- Prices stay stable—52%
- 10% increase in costs yielding—48%

Which of the tools that we have discussed can be used to model this new situation?

Be aware that there are literally dozens of models that can be used for forecasting. I have presented on of the simplest methods. There are many textbooks that cover some other methods.

Understanding Linear Programming

Way back in the olden days, when I studied Management Science, there were no PCs, not even pocket calculators. We used an ancient tool called a slide rule. Linear Programming (LP) was a brutal exercise in matrix algebra (don't ask). The technique, misleadingly named "The Simplex Method," involved iterative manipulations of a matrix of numbers until the problem was solved. In spite of this situation, I was always intrigued by the power of LP. The power of this tool is what drew me into Management Science

Today we all have computers. Excel can be used to solve an LP problem. We can concentrate on setting up an LP problem and analyzing the results without getting bogged down in the grease of manual calculation

Problem formulation

LP is generally used as a solution to what is called a "Mix" problem. For example: Let's get back to the Sausage Company. You've solved the problem with exploding Sausage Casings. You are ready to start really pushing production.

You make two varieties of sausages: Pork (P) and Turkey (T). Your profit is $0.37 for a case of pork sausage and $0.49 for a case of turkey sausage. You want to maximize your profit. Total profit (Z) can be expressed as: $Z = 37(P) + 49(T)$

- Z = Total profit per day
- $37(P)$ = Profit from pork sausages
- $49(T)$ = Profit from turkey sausages.

All amounts expressed in cents.

Two resources are needed for production, materials and labor. Demand and contract requirements mandate that you MUST produce both pork and turkey sausages.

Therefore: $T >= 0, P >= 0$

The amount of labor used for the production of the pork sausages is one half the amount of labor involved in making turkey sausages. The total labor used might be expressed as: $P + 2T$

If you only have 40 hours of available labor per day, the function (or formula) is:

$P + 2T <= 40$ hours

While the cost for most materials is identical between pork and turkey, spices are an additional cost. Turkey sausages must be spiced more heavily. While it takes 4 ounces of spice for a case of turkey sausages, it takes only 3 ounces for a case of pork sausage. You only have 120 ounces of spice available per day. Therefore: $4P + 3T <= 120$ ounces.

The model can now be expressed as:

Maximize $Z = 37(P) + 49(T)$
Subject to
$P + 2T <= 40$
$4P + 3T <= 120$
$T >= 0, P >= 0$

There are many possible solutions for this problem. Any values of P and T that do not violate the restrictions are valid solutions, however, we wish to find the best, or optimal solution. LP can help us select the optimal solution.

Graphical problem-solving

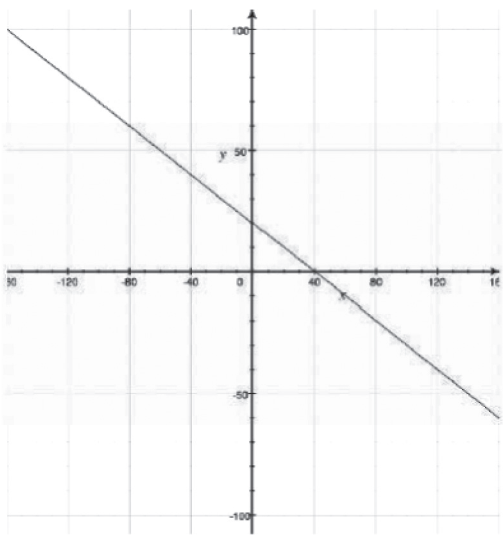
The simplest way to solve, or optimize, an LP problem is graphically.

Working from the model:

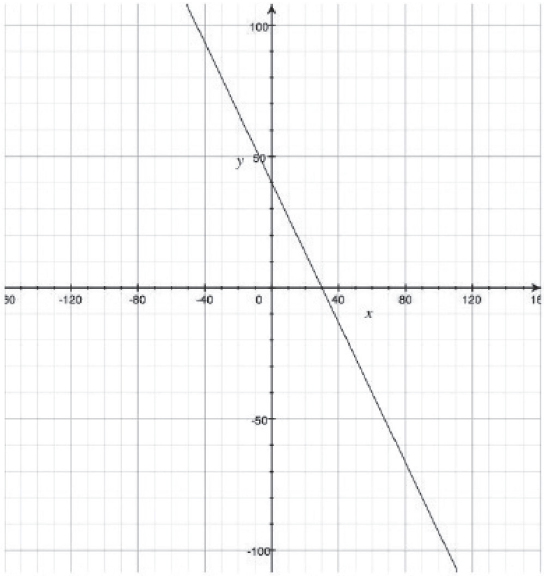
Maximize Z = 37(P) + 49(T)
Subject to
1P + 2T <= 40
3P + 4T <= 120
T >= 0, P >= 0

Plot the two equations.

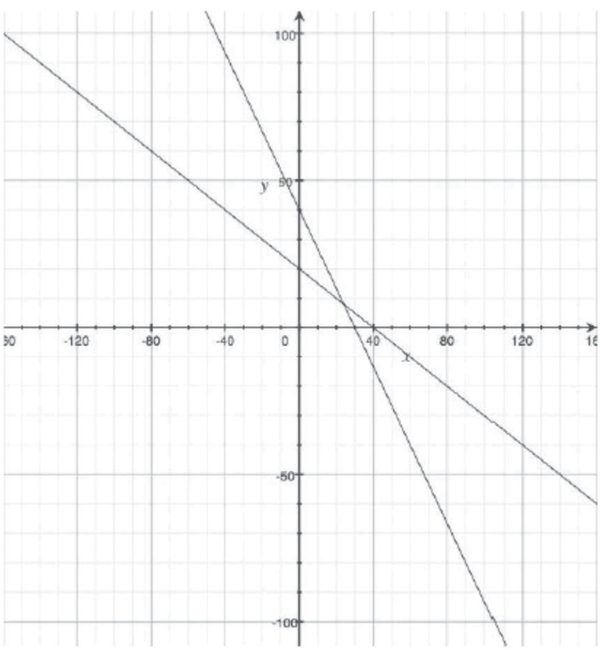
P + 2T = 40:



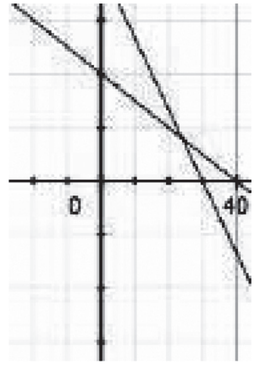
And 4P +4 3T = 120:



Plot both lines: on one graph:



Note that the two lines form an enclosed area in the bottom left hand corner of the first quadrant:



Note that 3 points define an area in the bottom left corner of the first quadrant.

This area contains (or bounds) all possible solutions. These are referred to as Feasible Solutions. In addition, we know that the optimal solution will be on one of the boundary points as in the table above.

Select the function that we wanted to optimize and sequentially insert all three sets of points to solve for Z:

Z = 37(P) + 49(T)
Z = 37(30) + 49(0) = 1,110
Z = 37(3) + 49(28) = 111 + 1372 = 1483
Z = 37(0) + 49(10) = 490

Therefore, the optimum value for the function of Maximize Z = 37(P) + 49(T) Is P = 3, T = 28. As an aside, the original setup was:

Maximize Z = 37(P) + 49(T)
Subject to
1P + 2T <= 40
3P + 4T <= 120
T >= 0, P >= 0

Therefore points 1 and 3 are, by definition, invalid. These points are approximated through observation

As with most tools, there are many programs that will simplify linear programming. The intent of this section is just to familiarize you with the tool.

Describing a Linear Regression

In your Mathematics 311 class, you start wondering whether the amount of studying really has an effect on the final grade. You notice that the entire class consists of people with approximately the same educational background and level of intelligence. You ask them to track the number of hours that they spend studying and their final grade. You get this result:

Name	Hours	Grade
Aaron	60	85
Betty	48	85
Charlie	52	74
Donna	47	71
Edward	73	99
Frankie	55	72
Georgette	53	85
Howard	23	70
Joe	58	60
Karen	57	87
Louis	72	90
Marianne	44	52
Norbert	57	87
Otto	61	95
Peter	61	87

You ask the class genius, Edward to do some research and he finds you a tool called Linear Regression. Linear regression looks at two sets of numbers and determines whether there is a relationship between them, i.e., can one set be used to predict the other. Well, all that being said, Edward finds an Excel tool and crunches the numbers. He comes back and tells you:

The R-Squared is .36.

WOW, now you know! "Get back here Ed. What does that mean?" Simply put—Linear regression produces a formula by which you can use one variable to predict another. For theis specific table, the regression formula is:

Grade = 44.0 + 0.656 Hours.

OR—if you take the number of hours that a person studied and multiplied that number by .656, then added 44 to it, you would get an approximation of the grade that they would receive.

How good an approximation? The "coefficient of determination", or R-Squared (R-Sq), is the number that tells us how good the fit is. The closer that the R-Sq is to one (or −1) the better the fit is. If the R-Sq is a negative number, we have a negative correlation. .36 is a weak correlation.

Observe the following table:

Name	Hours	Grade	Predicted	Error
Aaron	60	85	83.36	1.64
Betty	48	85	75.49	9.51
Charlie	52	74	78.11	4.11
Donna	47	71	74.83	3.83
Edward	73	99	91.89	7.11
Frankie	55	72	80.08	8.08
Georgette	53	85	78.77	6.23
Howard	23	70	59.09	10.91
Joe	58	60	82.05	22.05
Karen	57	87	81.39	5.61
Louis	72	90	91.23	1.23
Marianne	44	52	72.86	20.86
Norbert	57	87	81.39	5.61
Otto	61	95	84.02	10.98
Peter	61	87	84.02	2.98

In the fourth column (Predicted) we used the function *Grade = 44.0 + 0656 Hours* to find the predicted grade. The fifth column, Error, is the absolute value of the difference between Grade and Predicted. Obviously the lower grade is, the better the fit is.

Notice the Error column—there is quite a bit of inconsistency. It is obvious that the set of data is not very valid. I'm going to manipulate the numbers— while this might be Ok for a classroom example; one would NEVER do it reality, (or would one???)

Name	Hours	Grade	Predicted	Error
Aaron	73	99	98.01	0.99
Betty	72	90	97.20	7.20
Charlie	61	95	88.20	6.80
Donna	61	87	88.20	1.20
Edward	60	85	87.38	2.38
Frankie	58	80	85.74	5.74
Georgette	57	87	84.93	2.07
Howard	57	87	84.93	2.07
Joe	55	86	83.29	2.71
Karen	53	85	81.65	3.35
Louis	52	84	80.84	3.16
Marianne	48	85	77.56	7.44
Norbert	47	71	76.75	5.75
Otto	44	70	74.29	4.29
Peter	23	55	57.11	2.11

Our regression equation and R-sq are now:

Grade = **38.3** + **0.818** Hours and the **R-sq** = **.82**

Note that the predicted grades and errors are now much closer to the actual grades. The new R-Sq of .82 is a vast improvement over the previous one of .36. Not to beat the obvious, but, in this case I manipulated the numbers to make the case work. Obviously we shouldn't do this in real life. This is just a classroom exercise.

Minitab does a superb job of presenting the analysis:

Regression Analysis: Grade versus Hours

The regression equation is Grade = 38.3 + 0.818 Hours

Predictor	Coef	SE Coef	T	P
Constant	38.274	5.886	6.50	0.000
Hours	0.8184	0.1052	7.78	0.000

S = 4.70243 R-Sq = 82.3% R-Sq(adj) = 80.

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	1337.5	1337.5	60.48	0.000
Residual Error	13	287.5	22.1		
Total	14	1624.9			

Obs	Hours	Grade	Fit	SE Fit	Residual	St Resid
1	73.0	99.0	98.02	2.27	0.98	0.24
2	72.0	90.0	97.20	2.19	−7.20	−1.73
3	61.0	95.0	88.20	1.38	6.80	1.51
4	61.0	87.0	88.20	1.38	−1.20	−0.27
5	60.0	85.0	87.38	1.33	−2.38	−0.53
6	58.0	80.0	85.74	1.26	−5.74	−1.27
7	57.0	87.0	84.92	1.24	2.08	0.46
8	57.0	87.0	84.92	1.24	2.08	0.46
9	55.0	86.0	83.28	1.21	2.72	0.60
10	53.0	85.0	81.65	1.23	3.35	0.74
11	52.0	84.0	80.83	1.25	3.17	0.70
12	48.0	85.0	77.56	1.41	7.44	1.66
13	47.0	71.0	76.74	1.46	−5.74	−1.28
14	44.0	70.0	74.28	1.66	−4.28	−0.97
15	23.0	55.0	57.10	3.55	−2.10	−0.68 X

X denotes an observation whose X value gives it large influence.

Regression analysis is a powerful tool for forecasting. However like any tool, you cannot blindly use it. It still requires management thought for the tool to be effective. The job of a manager is to make decisions; these quantitative tools can be used to provide information for decision-making. They're not for blindly making decisions for us.[17]

Multiple Regression Examples: Analyze the following example of Multiple regression. You are looking at whether the price of electricity, price of gasoline and the price of a chicken affect one another.

Jan of	Elect. / 500 KWH	Gas/gallon	Price Whole Chicken
1996	48.5	1.19	0.94
1997	49.2	1.32	1.02
1998	46.4	1.18	1.02
1999	45.1	1.03	1.07
2000	45.2	1.36	1.06
2001	47.5	1.53	1.09
2002	48.7	1.21	1.09
2003	47.7	1.56	1.00
2004	49.2	1.66	1.06
2005	50.8	1.87	1.03
2006	57.2	2.34	1.05

Source: US department of Labor http: //data.bis.gov/c gi-bin/ surveymost

1. **Regression Analysis: Elect. *I* 500 KWH versus Gas/gallon, Chicken**
   The regression equation is
   Elect. / 500 KWH = 47.8 + 7.70 Gas/gallon – 10.1 Chicken
   R-Sq = 76.0% **R-Sq(adj) = 70.0%**

2. **A Second Regression Analysis: Elect. *I* 500 KWH versus Chicken**
   The regression equation is
   Elect. / 500 KWH = 52.4 – 3.5 Chicken
   R-Sq = 0.2% R-Sq(adj) = 0.0%

[17]Note: I used a tool called Minitab. This is a commonly used Statistics utility. There are many similar tools. A simple web search will provide many of them, There are also Excel add-ins which will do the job

3. **A Third Regression Analysis: Elect. *I* 500 KWH versus Gas/gallon**
   The regression equation is
   Elect. / 500 KWH = 37.5 + 7.58 Gas/gallon
   R-Sq = 74.3% R-Sq(adj) = 71.4%

Correlating your findings

Results for: MINITAB.XLS

Correlations: Elect. / 500 KWH, Gas/gallon, Chicken

	Elect. / 500	Gas/gallon
Gas/gallon	0.862	
Chicken	−0.047	0.099

Cell Contents: Pearson correlation

Descriptive Statistics: Elect. / 500 KWH, Gas/gallon, Chicken

Variable	N	N*	Mean	SE	StDev	Minimum	Q1	Median
Elect. / 500 KWH	11	0	48.68	1.00	3.32	45.1	46.4	48.5
Gas/gallon	11	0	1.477	0.114	0.377	1.03	1.19	1.36
Chicken	11	0	1.0391	0.0132	0.0439	0.9400	1.0200	1.0500

Variable	Q3	Maximum
Elect. / 500 KWH	49.20	57.2
Gas/gallon	1.66	2.34
Chicken	1.07	1.09

Correlation

Jan of	Elect./ 500 KWH	Gas/gallon	Price Whole Chicken
1996	48.5	1.19	0.94
1997	49.2	1.32	1.02
1998	46.4	1.18	1.02
1999	45.1	1.03	1.07
2000	45.2	1.36	1.06
2001	47.5	1.53	1.09
2002	48.7	1.21	1.09
2003	47.7	1.56	1
2004	49.2	1.66	1.06
2005	50.8	1.87	1.03
2006	57.2	2.34	1.05
	Elect./ 500 KWH	**Gas/gallon**	**Price Whole Chicken**
Elect./500 KWH	0	0.0988	−0.046767
Gas/gallon	0.0988	0	0.098839612
Price Whole Chicken	−0.046767	0.098839	0

Fuzzy Logic and Iterative Power

I'm not sure where this topic goes, or even if it belongs in this discussion. However I'll put it here—right between Quantitative and Qualitative, a fuzzy warm place, so it can at least feel like it belongs.

You step into a shower. The water is too hot. You turn the temperature knob to the right. You wait a while. The water is too cold. You turn the knob to the left a bit. Now the water is too hot again, but not as hot as before. You turn it to the right again, then left and then right. Eventually the water is just right. This "goldilocks and the three bears" approach to problem solving is Fuzzy Logic.

Fuzzy logic is a trial-and-error approach to problem solving. Perhaps this is a bit simplistic, but it is accurate. Fuzzy Logic has been successfully applied to control applications especially in manufacturing environments. Fuzzy Logic is a Rule-based approach[18]. Once you have defined

[18] http://www.aptronix.com/fide/whyfuzzy.htm

the environment you establish the rules. Lets take a look at a temperature control situation. Two rules might be:

1. If the temperature exceeds a target temperature, turn on the fan.
2. If the temperature falls below a different target temperature, turn off the fan.

By modifying the two target temperatures, we can regulate the effectiveness of the algorithm.

Fuzzy Logic reduces the design development cycle. During the development you can tune the process by simply modifying the rule set. Fuzzy Logic simplifies design complexity.

A rule set can be designed in simple English-like sentences. Fuzzy Logic improves time-to-market. A simpler product is easier to get off of the production line and into the store. A simpler product is less problematic and easier to debug and fix. The power of fuzzy logic is iteration. As we will see, iteration is a tool that is used heavily in modeling.

Meeting in the Middle: Combining Numbers with Observations (Can it Be Done?)

Where Incompatibilities Lie

Those of us raised in the mathematic disciplines have been conditioned to view qualitative techniques as somewhat irrelevant. While the "real" analysis is done in a mathematically based environment, qualitative analysis is done in the social and behavioral sciences. Any mathematician worth his salt "knows" that these are not real sciences. There is a thesis called the "Incompatibility Thesis"[19] which states that there is a profound difference between qualitative and quantitative techniques. Social Scientists long believed that their research is not bound by quantifiable observations. This school felt that social science inquiry was value-free, that time- and context-free generalizations were possible, and that real causes to social scientific outcomes could be determined reliably.

[19]Howe, K.R. (1988) Educational Researcher

In fact, there exists a continuum with purists and pragmatists lying at opposite ends. The standard belief is that some subjects are best analyzed by one school is best for analyzing some subjects. The other school best analyzes other subjects. The focus in these arguments is over the differences between them. Qualitative researchers discuss the superiority of in-depth research into the relationships between the causing agent and its results. Arguments raised against mixed-method research include the concept that researchers are uniquely trained in one discipline and cannot do justice to another.

I am reminded of two carpenters discussing the relative merits of a Phillips-head screwdriver versus a flat-head screwdriver. They are both valid and useful tools. However, the type of screw in hand tends to direct the choice of product.

While we group tools, and many things, into the two categories, they tend to have a tendency to involve, and perhaps define, each other. In statistics, we have both descriptive and inferential statistics. Descriptive statistics rely upon observation and measurement. These statistics describe the state of the data. Inferential statistics take the descriptive statistics and use them to make inferences or assumptions about the data. I maintain that when you make assumptions, you are delving into the qualitative arena. On the other hand, the Social Sciences are replete with statistical analysis. The principle complaint against this practice is the question as to whether they are quantifying Qualifiable variables.

In an earlier chapter, I presented this chart to represent the distribution of eye color in a group of 30 people.

Eye Color	Count	Percent
Brown	21	70%
Blue	8	27%
Other	1	3%

As I presented the material earlier, the entire concept of "Average eye color" is obtuse. However, we can us this chart to predict the probability of a member of the group's eye color. We are successfully using a quantitative tool in a qualitative environment. Simply stated, the pragmatist says, *"Use the tool that makes the most sense"*

Practical Ethics

The thrust of this work is a pragmatic approach to Decision Theory. Lets look at some terms and concepts.

A definition of pragmatism is:

prag-ma-tism n[20]—

1. Philosophy. A movement consisting of varying but associated theories, originally developed by Charles S. Pierce and William James and distinguished by the doctrine that the meaning of an idea or a proposition lies in its observable practical consequences.
2. A practical, matter-of-fact way of approaching or assessing situations or of solving problems.

John Stuart Mill and the Principle of Utility[21]

The only purpose for which power can be rightly exercised over any member of a civilized community, against his will, is to prevent harm to others.

By utility is meant that property in any object, whereby it tends to produce benefit, advantage, pleasure, good, or happiness, . . . or to prevent the happening of mischief, pain, evil, or unhappiness to the party whose interest is considered: if that party be the community in general, then the happiness of the community: if a particular individual, then the happiness of that individual.

An action then may be said to be conformable to the principle of utility. (meaning with respect to the community at large) when the tendency it has to augment the happiness of the community is greater than any it has to diminish it.[22]

Understanding Negative Utilitarianism

Negative utilitarianism requires us to promote the least amount of evil or harm, or to prevent the greatest amount of harm for the greatest number.

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[20]http://www.answers.com/pragmatism

[21]John Stuart Mill (1806–1873), British philosopher

[22]http://www.la.utexas.edu/research/poltheory/bentham/ipml/ipml.c01.html

Understanding Preference Utilitarianism

Preference utilitarianism is a particular type of utilitarianism that defines the good to be maximized as the fulfillment of persons' preferences. Like any utilitarian theory, preference utilitarianism claims that the right thing to do is that which produces the best consequences; when defined in terms of preference satisfaction; the best consequences can include things other than pure hedonism, like reputation or rationality.

Ethics and Decision-Making

Ethics is a general term for what is often described as the study of morality. Ethical behavior is that which is "good" or "right." Let's look at two different sides of the issue.

Ayn Rand and Objectivism

Rand's Objectivism is founded on three axioms:

1. Reality is real
2. Everything has a specific nature
3. People possess a consciousness, an awareness, of reality

In contrast to the traditional altruistic belief that morality should benefit others, Objectivism argues that the beneficiary of one's moral code should be oneself.[23]

What is the Judeo-Christian Viewpoint?

Morality is based upon the G-d's[24] law, i.e. the Bible. We are given free will to decide whether to follow good or evil. G–d wants man to be ethical (Not evil). While objectivism regards reason as an absolute; it holds that all knowledge is based on the evidence of the senses.

Objectivism holds that all beliefs, conclusions and convictions must be established by logical methods of inquiry and tested by logical methods

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[23]http://www.psychologicalscience.org/observer/getArticle.cfm?id=1820

[24]Note: As a Jew, I follow the tradition and spell His name G-d.

of inquiry and tested by logical methods of verification, In short, it holds that the scientific approach applies to all areas of knowledge.

"... One does not live for the sake of being moral; one acts morally in order to make the most out of his life.[25]"

Therefore, with all this in mind, I define Ethical Pragmatism as: **Doing "what works best" while mindful of the obligation one has to society.**

What is our obligation to society? In a speech in Tunis, American Ambassador William JU. Hudson said the following:

> *"Pragmatism is one of the distinctive aspects of the American way of doing business.... American business leaders dislike theory. They are constantly looking for things that work—an organizational technique, a marketing strategy, or a financial tool—whatever it is, they are seeking results, and are not much interested in the theory that may underlie the approach they take. The great inventor Thomas Edison is still admired in the U.S. for perfecting the light bulb. This is not because of the elegant theories he proposed that led to a light bulb. It is because he kept stubbornly trying different solutions—by some counts over 2,000—until he found the one that worked."*

Doing "what works best" while mindful of the obligation one has to society.

[25]David Kelley, 34

SECTION 3

Selecting and Using the Right Decision-Making Tools for the Appropriate Situation

Selecting and Using the Right Decision-Making Tools for the Appropriate Situation

"Punishing honest mistakes stifles creativity. I want people moving and shaking the earth, and they're going to make mistakes."

—H. Ross Perot, Founder, EDS

So far we've been concentrating on the tools, both qualitative and quantitative. If the corporate environment does not foster clear exchange of information, decisions will not be made. In Up the Organization, Townsend says that you've got to play "You Bet Your Job" occasionally. How do you establish an organization that allows people to make decisions, knowing that some of them will be wrong?

Making the Final Decision

Once upon a time, back in the European Middle Ages, the small city-states were involved in constant wars. The Gosdorks[26] were especially adept at strategy and tactics. In a war with a small Blogrod army, the Gosdorks had the Blogrod positioned so that they were attacking uphill on a hot day with the sun directly in their eyes. Normally, in this situation, the Blogrod general would surrender honorably and they all would go home for cocktails, having saved their honor.

[26] I don't remember the names of the actual combatants, so I made these up.

However, this Blogrod general decided to fight, and fight they did. Blogrodistan won the day, as the Gosdorks had never been up against such an uncivilized general, one that refused to follow the civilized rules.

I may have the story wrong, or it just might be a nice fairy tale, however the message is quite clear. You did not get into the position where you have to make this decision by accident. You have worked your way up through the ranks and are now expected to do your job, and you job is to make decisions.

While writing this book, I frequently turned to the Internet for references. I brought up Google and keyed in the words Information Overload. Google returned 5,060,000 references. If I spend 30 seconds looking at each reference— that's 42,166.7 hours; or almost five years, working 24 hours a day, 7 days a week to check each reference. That is a meaningless statistic; however it does prove a point. There is a common phrase in the Information Technology field: "The Paralysis of Analysis." An excessive amount of information frequently strikes the analyst and leaves him unable to make a decision. This is the primary danger of quantitative information. The analyst feels that, "we need just one more study, just one more set of data." If enough analysis is done, then we hope the problem will disappear of its own volition. Unfortunately…

For example, over the last three years there has been a 300 percent increase in the rate of leprosy in the USA. That is an impressive statistic. However when you examine the number—we come up with the probability of getting Leprosy has climbed to .23%. That's 23 cases in a population of 10,000 people of a disease that's easily treated with antibiotics[27]. The disease is commonly spread by exposure to armadillos. One source that I found refers to the, "shocking rise in incidence of Leprosy." Sound like we have an infestation of armadillos in this country?

In his classic management book, *Up the Organization,* Robert Townsend defines and discusses the word decision:

> *"All decisions should be made as low as possible in the organization. The Charge of the Light Brigade was ordered by an officer who wasn't there looking at the territory. There are two types of decisions: those*

[27]http://100777.com/node/501

that are expensive to change and those that are not. A decision to build the Edsel or Mustang (or locate your factory in Orlando or Yakima) shouldn't be made hastily; nor without plenty of inputs from operating people or specialists. "But the common garden-variety decision—like when to have the cafeteria open for lunch or what brand of pencils to buy—should be made fast. No point in taking three weeks to make a decision that can be made in three seconds—and corrected inexpensively later if wrong. The whole organization may be out of business while you oscillate between baby blue and buffalo-brown coffee cups."

***"The Huns at the Battle of Chalons." Illustration by A. De Neuville (1836–1885).* This image is in the public domain.**

Another point of view towards decision-making can be gathered from the fascinating book on leadership *Leadership Secrets of Attila the Hun*[28] (NO, I'm not kidding!). Dr. Roberts lists the "Attilaisms" for Decision Making:

- Every decision involves some risk.
- Time does not always improve a situation for a king or his Huns
- Fundamental errors are inescapable when the unqualified are allowed to exercise judgment and make decisions.
- Quick decisions are not always the best decisions. On the other hand, unhurried decisions are not always the best decisions.
- Chieftains should never rush into confrontation.
- A chieftain's confidence in his decision making preempts name-dropping to his Huns
- It is unfortunate when final decisions are made by chieftains headquartered miles away from the front, where they can only guess at conditions and potentialities known only to the captain on the battlefield
- When victory will not be sweet, the chieftain keeps his Huns from war.
- The ability to make difficult decisions separates chieftains from Huns.

[28]Roberts, Wess, PhD. L

Managing Projects: an Overview

A Construction Project: The Plan

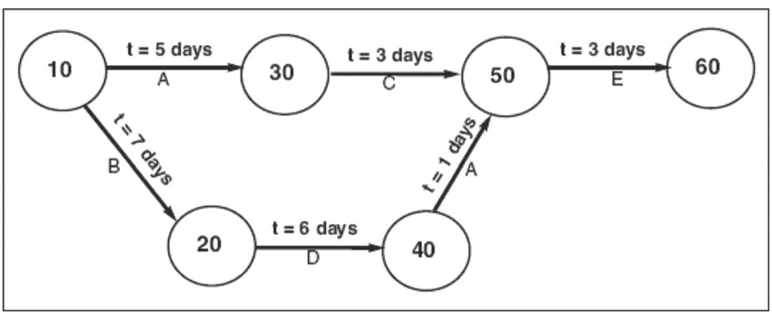
Frequently when asked to make a decision, a few questions arise:

- How much will it cost?
- How many people will be needed?
- How long will it take?

Interesting questions. How do you answer them? One excellent method is to go back into your project file, find a similar project and use the information to estimate the outlay of assets that can be expected. The most common way is to have all involved sit around a table and take guesses.

Industry has realized, finally, the importance and value of data. Many (most?) major corporations have added a position to the executive suite, CIO, or Chief Information Officer. Data Processing has become information technology. That file of past project has become a valuable asset. However, how do we build that file? Three tools have become commonplace. They all have a similar background.

One of them is called PERT charting. PERT stands for "Program Evaluation Review Technique". This technique was developed by the U.S. Navy in the 1950s to manage complex projects. An industrial version of a Pert Chart is a CPM Chart (Critical Path Method).



This pert shows two distinct processes:

1. A, C, E for 11 days
2. B, D, F, E for 17 days

Path 2, which is the longer of the two is the “Critical Path”. This path defines the length of the project. If this tasks slips, the entire project slips.

A Pert/CPM Chart shows tasks, their relationship and both estimated and actual start and finish times. The leading Project Management software is Microsoft Project®. MS Project provides an all-encompassing tool that allows presentation of a PERT chart (called a Network Diagram in Project) as well as a Gantt chart. The Gantt chart has become an industry standard. Henry Laurence Gantt (1861–1919) was a mechanical engineer who developed Gantt charts around the turn of the 20th century. Gantt charts are used as a visual tool to show scheduled and actual progress of projects. Today’s Gantt chart software also allows tracking labor and costs.

Gantt charts are frequently used on large construction projects like the Hoover Dam, started in 1931, and the interstate highway network started in 1956. However a Gantt chart is also quite useful for smaller project. Microsoft Project® is the tool most frequently used for the development of Gantt charts.

In this example, a Project Phase (Analysis) is shown with seven subordinate tasks. The estimated start and stop times are shown as well as the dependencies. Note that the tasks “Document Processes” and “Document Process Flow” cannot start until the task “Identify Processes” is complete. Both tasks can be done simultaneously.

MS Project, and many other available tools, allows a manager to track:

1. Phases
2. Tasks
3. Sub Tasks
4. Estimated Start and Finish

5. Actual Start and Finish
6. Dependencies
7. Labor
8. Calendar
9. Expenses

A project management tool models[29] the project. It allows management to create a repository of projects and use them as a tool for planning future projects. This repository also allows management to answer those annoying questions:

1. How much will it cost?
2. How many people will be needed?
3. How long will it take?
4. How will I know when it's done?

By the way, answering that fourth question often spells the difference between the project's success and failure. The prevailing method of project planning is a top-down, iterative process. The procedure can be explained as:

1. Identify the primary tasks.
2. Parse the tasks to its subordinate sub-tasks
3. Have I totally defined the project, or subordinate task at the current level?
4. Ask yourself: Have I totally defined the project at the level that I can work from. If the answer is "Yes"—you're done.
5. Can I parse each subordinate task to its next level? If the answer is "No"—you're done.
6. Go back to number 2 and proceed for each "leg" identified by a subordinate task.

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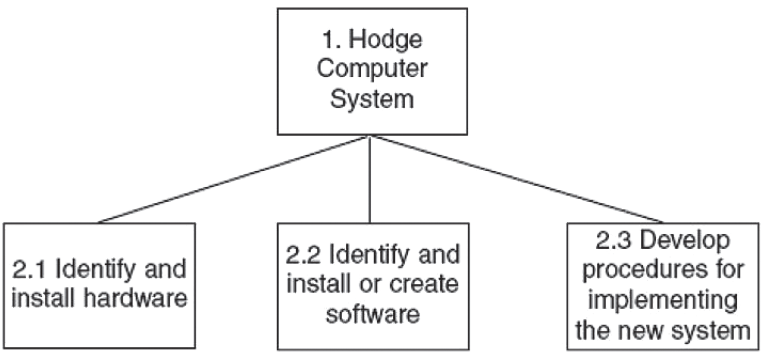
[29]Model: A representation of reality that can be used to aid in construction of the actual object

Factoring in the Human Element

Ms. Amy Hodge of Hodge Construction wishes to set up a computer system for tracking construction projects. Using the six-step procedure we start:

Level 0

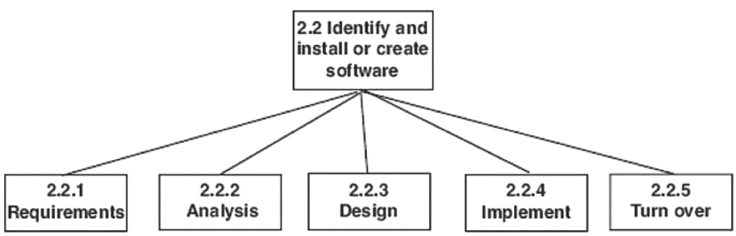
Has she totally defined the project, or subordinate task at the current level? While this is obviously not anywhere near the level that she can work from, at this highest level the project is completely defined. Questions four and five are not satisfied so she goes back to step 2 and parse:



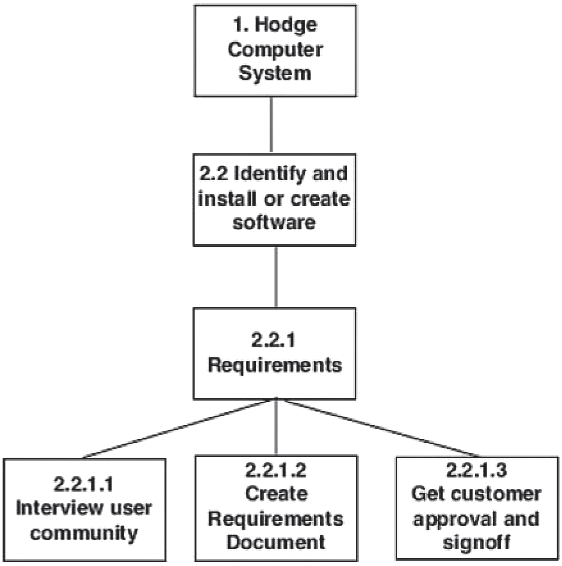
Level 2

She is now starting to build her hierarchy. Ms. Hodge can make a couple of observations. She has essentially created three sub-projects: hardware, software and integration. She has also started a numbering system. This numbering system allows her to track and place any task within the hierarchy. So let's go back to the questions. Obviously Ms. Hodge hasn't resolved question 5 ("Can I parse each subordinate task to its next level? If the answer is 'No'— we continue parsing.") Let's look at box 2.2 (above) Traditionally; developing software is done in a series of phases:

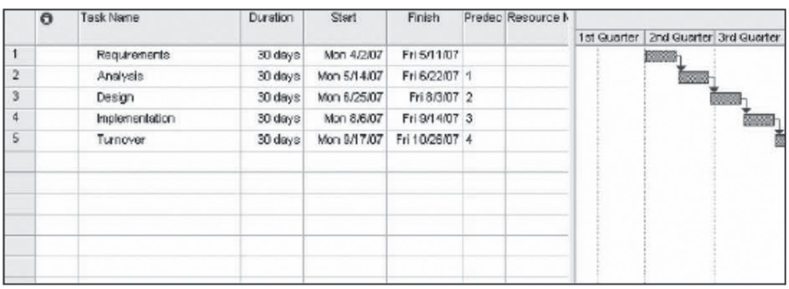
- Requirements—Scoping out the project and identifying completion criteria. In other words asking: How big is it? How much is it going to cost? What will the deliverables be?
- Analysis—Defining the project from the business point of view. This phase identifies and defines all of the processes and how they relate to each other.
- Design—Deciding how to accomplish the task technically. Looking at hardware and software requirements happens now. Programming specifications are now written.
- Implementation—This step involves assembling the system. Programs are now written and tested. The system is now constructed.
- Turnover—This is the final step. The customer reviews all of the test results and makes the decision to accept the system.



Again, a few observations: As we go down the hierarchy, the span increases drastically. At level one we had one task. At level two we had three tasks. At level three we have five tasks, and we've only parsed one third of the level. So potentially, we might have in excess of fifteen tasks at level five. Let's just follow one of our identified legs:



Next:
Setting up a Gantt chart
Building the base project plan

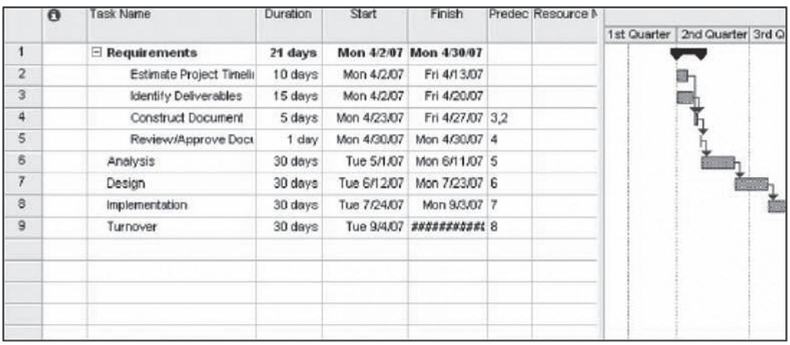


	Task Name	Duration	Start	Finish	Predec	Resource N
1	Requirements	30 days	Mon 4/2/07	Fri 5/11/07		
2	Analysis	30 days	Mon 5/14/07	Fri 6/22/07	1	
3	Design	30 days	Mon 6/25/07	Fri 8/3/07	2	
4	Implementation	30 days	Mon 8/6/07	Fri 9/14/07	3	
5	Turnover	30 days	Mon 9/17/07	Fri 10/26/07	4	

The five phases have been loaded in as tasks. Each task has been set to thirty days and a base linkage has been established. Please note that there are many books available to learn the essentials of manipulating MS Project. Next, the Requirements phase is parsed into the subordinate tasks. For this example, the following tasks have been identified and the following detail information:

	Task	Time in days	Predecessor tasks
1	Estimate Project timeline	10	
2	Identify Deliverables	15	
3	Construct document	5	1, 2
4	Review and approve document	1	3

This information is now transferred to the Gantt chart.



		Task Name	Duration	Start	Finish	Predec	Resource N
1		⊟ **Requirements**	**21 days**	**Mon 4/2/07**	**Mon 4/30/07**		
2		Estimate Project Timeli	10 days	Mon 4/2/07	Fri 4/13/07		
3		Identify Deliverables	15 days	Mon 4/2/07	Fri 4/20/07		
4		Construct Document	5 days	Mon 4/23/07	Fri 4/27/07	3,2	
5		Review/Approve Docu	1 day	Mon 4/30/07	Mon 4/30/07	4	
6		Analysis	30 days	Tue 5/1/07	Mon 6/11/07	5	
7		Design	30 days	Tue 6/12/07	Mon 7/23/07	6	
8		Implementation	30 days	Tue 7/24/07	Mon 9/3/07	7	
9		Turnover	30 days	Tue 9/4/07	##########	8	

As the detailed tasks are entered, the total duration for the phase is constructed. As predecessors are identified, the start and finish dates are computed. Ms. Hodge finds that the requirements phase will take 21 days to complete if started on April 2. The program also allows her to modify the calendar to allow for vacation time and holidays. Also, the actual Gantt chart will be cleaned up and formatted later. OK, Let's look at the next phase, Analysis. The Analysis phase has been parsed down to the task level. I'll discuss the WHO column soon!

	Task	Days	Who	Predecessor tasks
1	Identify Processes	15	All	
2	Document Processes	10	NW, DB, DG, JN	
3	Construct relationships and dependencies	5	All	
4	Define process flow	3	NW, DB, DG, JN	
5	Document process flow	4	NW, DB, DG, JN	
6	Construct analysis document	3	TT, TG NW, DB, DG, JN	
7	Review and approve document	1	TG, DG, TT	

As a result of the preliminary analysis, three distinct sets of deliverables (programs, screens, reports, etc) have been identified. The Requirements document and the Analysis document identified the information needed for these deliverables. The Design document provides the detailed specifications for these tasks and deliverables.

	Sub-system	Task	Days	Who	Predecessor Tasks
1	1	1	12	NW	
2	1	2	9	DB	
3	1	3	3	DB	2
4	2	4	2	DG	
5	2	5	4	DG	4
6	3	6	8	JN	
7	3	7	7	JN	6
8	3	8	2	JN	7
9	3	9	9	JN	8

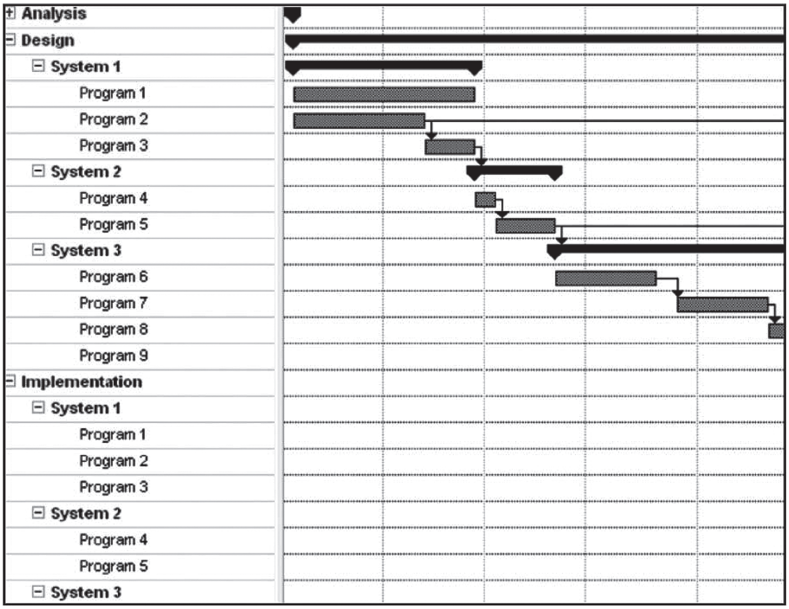
After completing this portion of the project plan, we now have all of the tasks and dependencies entered. A summary view is:

		Task Name	Duration	Start	Finish	Prede
1		⊞ Requirements	21 days	Mon 4/2/07	Mon 4/30/07	
6		⊞ Analysis	38 days?	Tue 5/1/07	Thu 6/21/07	5
14		⊞ Design	44 days	Fri 6/22/07	Wed 8/22/07	13
27		⊞ Implementation	45 days	Thu 8/23/07	Wed 10/24/07	26
40		⊞ Turnover	3 days	Thu 10/25/07	Mon 10/29/07	

Clicking on any plus (+) sign expands any tasks to reveal its subordinate tasks.

		Task Name	Duration	Start	Finish
1		⊞ Requirements	21 days	Mon 4/2/07	Mon 4/30
6		⊞ Analysis	38 days?	Tue 5/1/07	Thu 6/21
14		⊟ Design	44 days	Fri 6/22/07	Wed 8/22
15		⊟ System 1	12 days	Fri 6/22/07	Mon 7/9
16		Program 1	12 days	Fri 6/22/07	Mon 7/9
17		Program 2	9 days	Fri 6/22/07	Wed 7/4
18		Program 3	3 days	Thu 7/5/07	Mon 7/9
19		⊟ System 2	6 days	Tue 7/10/07	Tue 7/17
20		Program 4	2 days	Tue 7/10/07	Wed 7/11
21		Program 5	4 days	Thu 7/12/07	Tue 7/17
22		⊟ System 3	26 days	Wed 7/18/07	Wed 8/22
23		Program 6	8 days	Wed 7/18/07	Fri 7/27
24		Program 7	7 days	Mon 7/30/07	Tue 8/7
25		Program 8	2 days	Wed 8/8/07	Thu 8/9
26		Program 9	9 days	Fri 8/10/07	Wed 8/22
27		⊞ Implementation	45 days	Thu 8/23/07	Wed 10/24
40		⊞ Turnover	3 days	Thu 10/25/07	Mon 10/29

However a Detailed Gantt chart tells the entire story



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Getting It Right, Volume One

How Managers Can Make Better Decisions by Using Calculation and Numbers

Howard Flomberg

Howard Flomberg has been an adjunct professor and lecturer of computer information systems at Metropolitan State College of Denver since 1978. His course load has included systems analysis and design, business statistics, COBOL, visual basic, and computer architecture. Currently Mr. Flomberg is concentrating on teaching business statistics and advanced business statistics.

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