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Microcomputers, Risk Analysis, and Litigation Strategy

Stuart S. Nagel

MICROCOMPUTERS, RISK ANALYSIS, AND LITIGATION STRATEGY

by

STUART S. NAGEL*

Litigation strategy mainly refers to deciding whether to go to trial or settle out of court. Risk analysis mainly refers to procedures for making meaningful decisions when one alternative provides a reasonably certain benefit or cost (like accepting a settlement), and another alternative provides a benefit or cost that is contingent on the occurrence of a probabilistic event (like going to trial). Microcomputers mainly refer to self-sufficient machines that are capable of making probabilistic and other useful calculations quickly, accurately, and easy to understand.

This article covers three important aspects of litigation strategy. The first part is concerned with varieties of sensitivity analysis in civil and criminal cases. Sensitivity analysis refers to how the bottom-line conclusion of going to trial, accepting a settlement, or choosing another alternative is affected by changes in the inputs, which mainly relate to such matters or criteria as (1) the predicted damages, (2) the probability of receiving them, (3) the settlement offered, (4) the litigation costs, and (5) the settlement costs.

The second part deals with the use of decision matrices and microcomputers for analyzing litigation-strategy decisions, including sensitivity analysis. A decision matrix involves putting (1) the alternatives to be decided on the rows, (2) the criteria for deciding among them on the columns, and (3) the relations between the alternatives and the criteria in the cells.

The third part deals with the leading alternative to the decision-matrix approach to litigation strategy. That leading alternative is the decision-tree approach. A decision tree tends to involve only two alternatives. At least one of them branches into various paths toward various outcomes. Each path may have different probabilities. Each outcome may have a different monetary value.[1]

I. SENSITIVITY ANALYSIS AND LITIGATION STRATEGY

The article is built around two key civil and criminal examples which are

*Professor of Political Science, University of Illinois; member of the Illinois Bar. B.S., 1957, J.D., 1958, Ph.D., 1961, Northwestern University.

[1]On systematic litigation strategy in general, *see* TULLOCK, THE LOGIC OF THE LAW (1971); Greenberg, *Quantitative Aspects of Legal Analysis*, INS. L.J. 589-607 (1976); Nagel, *Applying Decision Science to the Practice of Law*, 30 PRAC. LAW. 13-22 (1984); S. NAGEL, APPLYING DECISION SCIENCE TO LAW PRACTICE (American Law Institute-American Bar Association, 1984). On sensitivity analysis in general, *see* C. MOORE, PROFITABLE APPLICATIONS OF THE BREAK-EVEN SYSTEM (1971); NAGEL, PUBLIC POLICY: GOALS, MEANS AND METHODS 296-322 (1984) (Unknown Variables).

embodied in the first two tables. The first table deals with damages litigation. It illustrates such aspects of sensitivity analysis as (1) the basic data needed, (2) variations possible on the basic data, (3) threshold values above or below which the best alternative changes, (4) insensitivity ranges within which change can occur without affecting the best alternative, (5) change slopes showing how much the gap changes between the first and second alternatives as a result of a one-unit change in each input, (6) multiple threshold values which involve more than one input changing simultaneously, (7) worst and best scenario analysis, and (8) the relevance of microcomputers to these forms of sensitivity analysis.[2]

The second table deals with criminal prosecution. It illustrates such aspects of sensitivity analysis as (1) incremental analysis which involves comparing the gain of one alternative with the gain of a second alternative on each criterion, (2) precentaging analysis which converts years, dollars, and other criteria into dimensionless percentages for comparison purposes, (3) criterion weights for indicating the relative importance of criteria measured on different dimensions, (4) convergence analysis which indicates at what point each input becomes large enough to cause allocation percentages to reach a maximum, and (5) the relevance of microcomputers to these forms of sensitivity analysis.[3]

A. *Damages Litigation*

1. The Initial Analysis

Table 1 shows some data for illustrating basic varieties of sensitivity analysis. The problem is one of deciding whether to accept a settlement or go to trial in a damages case from the perspective of a plaintiff's attorney operating under a contingency fee arrangement. The criterion in choosing between those alternatives is to maximize average income minus average expenses. The data is hypothetical for illustrative methodological purposes.

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[2]On a decision analysis of damages litigation, *see* Friedman, *An Analysis of Settlement* 22 STAN. L. REV. 67 (1969); Greenberg, *The Lawyer's Use of Quantitative Analysis in Settlement Negotiations*, 38 BUS. LAW. 1557-86 (1983); S. NAGEL & M. NEEF, DECISION THEORY AND THE LEGAL PROCESS 141-46 (1979) (Out-Of-Court Civil Sellouts).

[3]On a decision analysis of criminal prosecution, *see* Lachman & McLauchlan, MODELING THE CRIMINAL JUSTICE SYSTEM 145-58 (1977) (Models of Plea Bargaining); R. POSNER, ECONOMIC ANALYSIS OF LAW 429-60 (1977) (Civil and Criminal Procedure); NAGEL & NEEF, DECISION THEORY AND LEGAL PROCESS 63-140 (1979) (The Two-Person Bargaining Situation in Plea Bargaining).

TABLE 1

Sensitivity Analysis for Plaintiff Litigation Strategy in a Damages Case[4]

Criteria / *Alternatives*	*Average Income* (Y_1) Cell #	Thresh-hold and Range	Change Slope	*Average Expenses* (Y_2) Cell #	Thresh-hold and Range	Change Slope	*Net Gain*
Accept a Settlement (X_a)	a1	$1,000 ($1,200 up to ∞) ($1,200 down to $0)	-$1	a2	$300 ($100 up to ∞) ($100 down to $0)	+$1	$700
Go to Trial (X_b)	b1	$2,400 ($2,200 down to $0) ($2,200 up to ∞)	+$1	b2	$1,500 ($1,700 down to $0) ($1,700 up to ∞)	-$1	$900

[4]Notes:

a. The symbol in the upper lefthand corner of each main cell shows (1) the alternative under consideration by a lower-case letter, and (2) the criterion under consideration by an arabic numerical.
b. The number in the middle of each main cell shows the average or predicted value of the alternative on the criterion.
c. The lower number in each main cell shows the threshold value of the alternative on the criterion (e.g., the $1,200 in cell 1). That is the value to which the predicted value would have to change in order for the first and second place alternatives to be tied. The threshold value is always the predicted value plus or minus the profit gap which is the difference between the net gain of trial and the net gain of settlement.
d. The ranges at the bottom of each cell show how much the average or predicted value could change without affecting which alternative is in first place. The first range favors trial, and the second range favors settlement.
e. The number in the upper righthand corner of each main cell shows by how much the gap in net gain would change between the first and second place alternatives if the average or predicted value were to go up by one unit.
f. The numbers in the net gain column show the initial results before doing the sensitivity analyses. They indicate that going to trial is the better alternative by a $200 difference.

The first cell shows that a settlement offer has been made that will generate $1,000 in income, figuring a 20% contingent fee on a $5,000 offer. The second cell reading down shows that going to trial will generate $2,400 in predicted income, figuring a 40% contingent fee on an average damage award of $6,000. The $6,000 can be determined by averaging similar previous cases, including those in which no damages were awarded. A less simple alternative is to note that the prior cases in which damages were awarded averages $10,000, and 60% of the cases resulted in damages awarded. The third cell on the expense column shows the cost of a settlement would be $300, figuring ten hours of time that is worth thirty dollars an hour to the lawyer involved. The last cell shows the cost of going to trial would be $1,500, figuring twenty-five hours of time that is worth sixty dollars an hour to the lawyer involved.

With that hypothetical data, one can initially conclude that on the average it would be more profitable to go to trial than to accept a settlement in that particular case or that type of case. Going to trial yields a net gain of $900, whereas accepting a settlement yields a net gain of only $700. That conclusion should not be influenced by the initial offer of the defendant. In other words, if the plaintiff succeeds in getting the defendant to move from one dollar to one thousand dollars, the settlement should be just as strongly rejected as if the defendant had moved down from $1,100 to $1,000. An acceptable settlement is one that is better than going to trial, not necessarily one that involves hard-won concessions.

2. The Sensitivity Variations

The situation can be made more realistic, although more complicated, by adding a *non-monetary* criterion of attitude toward risk by the lawyer. It could be scored highly favorable (five points), mildly favorable (four points), neutral (three points), mildly unfavorable (two points), and highly unfavorable (one point). Dealing with non-monetary criteria will be the key variation in Table 2 dealing with criminal cases from a prosecution perspective. One might, however, note that one's attitude toward risk should logically become more unfavorable when the size of the settlement becomes greater. One then not only has the risk of losing the case, but also the risk of losing a large settlement and the risk of suffering long-term regret as a result of being unlucky enough to have been on the losing side of an unaverage case with insufficient opportunity to average out over a large set of similar cases.

We could also *add* to the alternatives by referring to types of settlements and types of trials, such as a bench trial or a jury trial. We could also talk in terms of a different overall goal than maximizing lawyer income minus lawyer expense, such as client income minus client expense, or some combination of the two goals. We could also vary the problem to cover cases with an hourly rate or a flat fee, rather than a contingency fee, and to cover cases from the perspective of defense counsel in damages litigation.

The *threshold values* in parenthesis at the bottom of each cell involve applying a sensitivity analysis to Table 1. They show, for example, that the second place alternative would come up to the net gain of the first place alternative if any one of the following occurrences were to happen:

(1) The settlement offer is increased from \$5,000 to \$6,000. Doing so increases the 20% settlement fee from \$1,000 to \$1,200, and increases the settlement net gain from \$700 to \$900.
(2) The predicted damages from trial is decreased from \$6,000 to \$5,500. Doing so decreases the 40% damages fee from \$2,400 to \$2,200.
(3) The settlement expense is decreased from \$300 to \$100 by decreasing the hours and/or the hourly cost.
(4) The trial expense is increased from \$1,500 to \$1,700 by increasing the hours and/or the hourly cost.[5]

Along related lines, the *insensitivity ranges* in parenthesis at the bottom of each cell also tell us:

(1) The settlement fee can range from \$0 up to \$1,200 and have no effect on which alternative is in first place. This is referred to as the insensitivity range of an alternative on a criterion.
(2) The trial fee can range from \$2,200 up to infinity and have no effect on which alternative is in first place. Knowing the insensitivity range is useful in informing one of the range of numbers that are not worth arguing over in terms of the bottom-line conclusion.
(3) The settlement expense can range from zero to one hundred dollars without affecting the outcome.
(4) The trial expense can range from \$1,700 to infinity without affecting the outcome of the trial alternative being in first place. That allows a lot of room for error in estimating the trial expense or in estimating any of the decisional inputs.

Change slopes are another informative measure in sensitivity analysis. They are the numbers in the upper right-hand corner of each of the main cells. They show how much the gap in net gain changes between the first place and second place alternatives when each input is increased by one unit. In this table, those numbers tell us:

(1) If the settlement fee increases by one dollar, the gap decreases by one dollar.
(2) If the trial fee increases by one dollar, the gap increases by one dollar.
(3) If the settlement expense increases by one dollar, the gap increases by one dollar.
(4) If the trial expense increases by one dollar, the gap decreases by one dollar.

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[5]For further detail on threshold analysis in the legal context, *see* Nagel, *Lawyer Decision Making and Threshold Analysis*, 36 U. MIAMI L. REV. 615-42 (1982).

That kind of information can often be helpful in indicating what changes can have the most impact. In this simple situation, however, all the one-unit changes have the same marginal rate of return, although in different directions. Change slopes can also show by how much the percentage of scarce resources allocated to an alternative will change as a result of a one unit change in each input. Allocation problems are referred to in connection with Table 1.

Multiple threshold values are another form of sensitivity analysis. In Table 1, the threshold values for each input assume the predicted values for the other inputs are held constant. One might, however, ask what are the combined threshold values of two or more inputs, such as trial income and trial expense. The answer to that example is any pair of numbers for b1 and b2 such that b1 minus b2 equals $700. Likewise, the combined threshold values for a1 and a2 are any pair of numbers such that a1 minus a2 equals $900. On a higher level of generality, one could talk in terms of the basic threshold or break-even equation which in this context is a1 minus a2 equals b1 minus b2. That means the combined threshold value of a1 and b1 is any pair of numbers that will preserve the equality. Likewise, the combined threshold values of any three inputs like a2, b1, and b2 are any three numbers that will preserve the equality.

Worst and best scenario analysis is still another form of sensitivity analysis. It involves giving a range to each input value. One end of the range is the reasonable score that most disfavors a settlement, and the other end of the range is the reasonable score that most favors a settlement rather than a trial. With ranges like that for each of the four inputs, the net gain would also be a range. On the settlement row, the net gain might thus be a low of $400 and a high of $1,200. On the trial row, the net gain might be a low of $600 and a high of $1,600. Thus the mid-point on that settlement range would be $800, and the mid-point on the trial range would be $1,100. One could, therefore, conclude the following:

(1) If the worst trial net-gain is better than the best settlement net-gain, then going to trial is obviously better.
(2) If the net-gain ranges overlap as here, it makes sense to choose the alternative which has the higher mid-point.
(3) One does not normally look to which alternative has the highest maximum or the highest minimum in choosing the best alternative.

B. *Criminal Prosecution*

1. The Basic Problem And Data

Table 2 shows the basic data for illustrating sensitivity analysis as applied to prosecution litigation strategy in a criminal case. The problem here is one of deciding whether to accept a plea bargain or to go to trial from a prosecutor's perspective. The overall criterion is to maximize benefits minus costs, but here the benefits are non-monetary, and the costs are monetary.

TABLE 2

Sensitivity Analysis for Prosecution Litigation Strategy in a Criminal Case[6]

Criteria	*Average Sentence*		*Average Expense*		*Net Gain*		
Alternatives	*Raw Score (Years)*	*Part/Whole %*	*Raw Score (Dollars)*	*Part/Whole %*	*Raw Score*	*Sentence P/W% Minus Expense P/W%*	*Average or Allocation %*
	a1		a2				
Accept a Settlement	2 years (1.38)	36% (25%)	$240 ($346)	25% (36%)	NA	+11% (0%)	30½%
	b1		b2				
Go to Trial	3½ years (4.12)	64% (75%)	$720 ($614)	75% (64%)	NA	-11% (0%)	69½%
Difference	1½ years	28%	$480	50%	NA	22%	39%
Total (Whole)	5½ years	100%	$960	100%	NA	0%	100%

[6]Notes:

a. The number in the upper lefthand corner of each main cell shows the average or predicted value of the alternative on the criterion.

b. The percentage in the upper righthand corner of each main cell shows the part/whole percentage of each alternative on each criterion. It is calculated by dividing the predicted value by the total of the predicted values for the criterion.

c. The number in the lower lefthand corner of each main cell shows the threshold value of the alternative on the criterion. That is the value to which the predicted value would have to change in order for the first and second place alternatives to be tied.

d. The number in the lower righthand corner of each main cell shows the threshold part/whole percentage of the alternative on the criterion. It is calculated by dividing the threshold value by the total of the threshold values for the criterion.

e. The symbol "NA" means not applicable. One cannot meaningfully subtract costs measured in dollars from benefits measured in years, although one can meaningfully subtract dimensionless percentages.

f. The numbers in the column labeled "Sentence P/W% Minus Expense P/W%" show the initial results before doing the sensitivity analyses. They indicate that going to trial is the better alternative if the criteria have equal weight.

g. The numbers in the column labeled "Average or Allocation P/W%" indicate what percent of one's scarce resources should be allocated to the projects on rows 1 and 2, assuming being high on both criteria is desired.

The first cell shows that defense counsel, the public defender, or the defendant has offered to plead guilty to a recommended two year sentence. The second cell reading down shows that going to trial will generate a predicted sentence of three and one-half years. The three and one-half years can be determined by averaging previous similar cases including those in which there was no sentence due to an acquittal, probation, or a suspended sentence. A less simple alternative is to note that the prior cases in which sentences were given averaged five years, and seventy percent of the cases resulted in convictions and sentences. The third cell on the expense column shows the cost of a plea bargain would be $240, figuring twelve hours of time that is paid at twenty dollars an hour to the assistant state's attorney. The last cell shows the cost of going to trial would be $720, figuring thirty-six hours of time that is paid at twenty dollars an hour.

2. Handling Non-monetary Benefits

In Table 1, we were able to subtract the costs from the benefits because both were measured in dollars. In Table 2, that is not possible since the benefits are measured in years, and the costs are measured in dollars on each alternative. Incremental analysis is one way to approach this data. It involves determining the difference down each criterion rather than across each alternative. Doing so shows that the difference on sentencing is one and one-half years favoring trial, and the difference on expense is $480 favoring settlement. The problem can thus be treated as one of determining whether the prosecutor would prefer to obtain an extra one and one-half years in sentencing or $480 in expenses saved. If the one and one-half years is preferred, then the prosecutor should go to trial. If the $480 is preferred, then the prosecutor should accept the settlement.

That approach works well for dealing with criteria measured on different dimensions when there are only two criteria and two alternatives, as in Table 2. With more than two criteria, one will have more than two differences, some of which will favor the first alternative and some the second alternative. With more than two alternatives, one will have to compare alternative A with B. The winner then gets compared with C. The alternative that wins that comparison then gets compared with alternative D, and so on until one has gone through all the alternatives. The last uneliminated alternative is the overall winner.

To avoid the complexities of incremental analysis with multiple criteria and/or multiple alternatives, one can use part/whole percentaging analysis to deal with the problem of criteria measured on different dimensions. That approach involves adding down each criterion to determine the total or whole, which is five and one-half years on sentencing and $960 on expenses. One then divides each score on each criterion by the total or whole for the criterion. Thus two years is converted into thirty-six percent of five and one-half years, and three and one-half years is converted into sixty-four percent. Likewise, $240 is converted into twenty-five percent of $960, and $720 is converted into seventy-five percent. One can now subtract the percentage cost from the percentage benefits, because percentages have a dimensionless character which years and dollars do not have. Making that subtraction yields a net gain of plus eleven percentage points for accepting a settlement, and minus eleven percentage points for going to trial. One can therefore conclude from this unweighted part/whole percentaging analysis that accepting a settlement is the better alternative.

The defect in this analysis is that it does not consider the relative importance of the two criteria. One way to deal with that is to go through the following steps:

(1) Decide which criterion is the least important. Assign it a weight of one. For example, assign expense a weight of one.
(2) Decide how many more times each other criterion is more important than the base criterion. For example, assign sentencing a weight of two.
(3) Multiply each part/whole percentage by the weight of the criterion to which the percentage pertains. If the criterion is negative like expense, then consider the weight as being negative. This means thirty-six percent and sixty-four percent get multiplied by two, and twenty-five percent and seventy-five percent get multiplied by minus one.
(4) Add the weighted part/whole percentages across each alternative. This means adding seventy-two percent to minus twenty-five percent for accepting settlement, which yields forty-seven percent. It also means adding 128% to minus seventy-five percent for trial, which yields fifty-three percent.
(5) Observe which alternative has the highest or best weighted part/whole percentage. In the above example, trial is the best alternative with a weighted p/w% of fifty-three percent versus forty-seven percent for a settlement.[7]

3. The Sensitivity Variations

Each number in parenthesis in Table 2 is the threshold value for the alternative on the criterion to which the threshold value pertains. The threshold values in Table 2 can be interpreted as follows:

(1) If the two-year settlement were only 1.38 years, then there would be a tie between settlement and trial, assuming equal weights for sentencing and expense.

[7]For further details on dealing with non-monetary benefits and other multidimensional goals, *see* SAATY, THE ANALYTIC HIERARCHY PROCESS: PLANNING, PRIORITY SETTING, RESOURCE ALLOCATION (1980); EDWARDS & NEWMAN, MULTI-ATTRIBUTE EVALUATION (1982); and Nagel, *Part/Whole Percentaging and the Useful Method in Policy/Program Evaluation* 8 EVALUATION & PROGRAM PLANNING 107 (1985).

(2) If the three and one-half year average trial sentence were 4.12 years, then there would also be a tie assuming the other inputs are held constant.
(3) If the $240 for settlement expense were $346, there would be a tie. Put differently, if the settlement expense were more than $346, trial would be the better alternative.
(4) If the $720 for trial expense were $614, there would be a tie. Put differently, if the trial expense were less than $614, trial would be the better alternative.

Each of those threshold values can be instantly shown with the floppy disk program called Policy/Goal Percentaging Analysis, mentioned at the end of the previous section on damages litigation. One can also determine the threshold values with a hand calculator in a simple situation like this with only two alternatives and two criteria. When we were dealing with criteria that were all measured on the same dimension, as in Table 1, the threshold equation was $a1 - a2 = b1 - b2$. Where part/whole percentaging is involved, the threshold equation is $a1/(a1+b1) - a2/(a1+b1) = b1/(b1+b2) - b2/(b1+b2)$. Thus in either situation, if one wants to determine the threshold value for any input one inserts the numerical values for the other inputs into the threshold equation and solves for the value of the input that is represented by a letter.

One can also determine a threshold weight by solving for W in a similar manner. Thus with the data from Table 2, the appropriate threshold equation would be, $W(36) - (25) = W(64) - (75)$. That equation simplifies to $36W - 25 = 64W - 75$, and to $75 - 25 = 64W - 36W$, and to $50 = 28W$. Thus the threshold weight is 50/28 or 1.79 which rounds off to a threshold weight of 2. That means if sentencing is less than twice as important as saving money, then accept the settlement. If, however, sentencing is at least twice as important as saving money, then go to trial. Table 2 could also show the insensitivity ranges and the change slopes, as the microcomputer program and Table 1 do. One might also note the program is capable of doing an incremental analysis with any number of alternatives and criteria, but incremental analysis does not lend itself to sensitivity analysis the way part/whole percentaging does.

4. Allocation And Sensitivity

Allocating scarce resources is another type of litigation strategy besides accepting a settlement versus going to trial in civil or criminal cases.[8] We could add a Table 3 to illustrate allocation analysis and its special forms of sensitivity analysis. For the sake of simplicity, however, assume that the alternatives in

[8]For further details on allocation analysis, *see* MCMILLAN, MATHEMATICAL PROGRAMMING: AN INTRODUCTION TO THE DESIGN AND APPLICATION OF OPTIMAL DECISION MACHINES (1970); SHOUP & MEHAY, PROGRAM BUDGETING FOR URBAN POLICE SERVICES (1971); S. NAGEL, POLICY EVALUATION: MAKING OPTIMUM DECISIONS 179-254 (1982) (Finding an Optimum Mix in Allocating Scarce Resources).

Table 2 are two different cases or projects, rather than settlement versus trial. Also assume that both criteria are desirable goals, rather than benefits and costs. If only the first criterion were being considered, one would allocate thirty-six percent of one's time, money, or other resources to the first case and sixty-four percent to the second case, assuming that thirty-six percent and sixty-four percent satisfy the minimum ethical or other constraints. If both criteria were being considered, one would average their respective part/whole percentages. That means allocating thirty and one-half percent of the resources to the first project and sixty-nine and one-half percent of the resources to the second project, assuming both criteria are positive. If any criterion is negative, then allocate in proportion to the sum of the weighted part/whole percentages, but give nothing but the minimum to any case or project that has a negative or losing sum.

Ordinary threshold analysis is not so applicable to an allocation problem because such an analysis tells us the value of each input at the point where the second place alternative becomes the first place alternative. That is useful in a problem designed to determine which alternative is best. In an allocation problem, however, the second place alternative (and even alternatives lower than second place) are generally allocated some portion of the scarce resources. In an allocation problem, one might want to know at what convergence value a disputed weight or other input becomes so large that the alternative which the input favors comes close to its maximum allocation (i.e., within five percentage points). For example, if the weight of sentencing were infinity or a huge number, then the allocation would be thirty-six percent to Project 1 and sixty-four percent to Project 2 since the goal of high sentencing would totally dominate the other goals.

Convergence analysis tells us the weight (short of infinity) where the allocation will be at least thirty-one percent and sixty-nine percent, which is within five percentage points of thirty-six percent and sixty-four percent. One amazing aspect of convergence analysis is that often a weight of two is in effect the equivalent of infinity because it produces virtually the same effect. In the simple example of Table 2, a weight of two for sentencing does have that effect because a weight of one results in allocations of thirty and one-half and sixty-nine and one-half percent. Thus, moving up to a weight of two increases the thirty and one-half percent over thirty-one percent, and doing so decreases the sixty-nine and one-half percent below sixty-nine percent. The microcomputer program informs the user of the convergence value of each input, with convergence defined as being within five percentage points of the maximum or whatever definition the user wants.[9]

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[9]*See supra* note 8.

C. *Some Conclusions On Sensitivity Analysis*

From the analysis, one can conclude that it is useful in decision-making situations to know the following:

1. The goals one is seeking to achieve, the alternatives available, and the relations between goals and alternatives.
2. The threshold value for each goal-weight and relation, showing to what value those inputs would have to change in order to enable the second place alternative to become the first place alternative.
3. The insensitivity ranges for each input showing how much the input could range below or above the threshold without affecting the alternative that is in first place.
4. The change slope for each input, showing how much the gap changes in the profitability of two alternatives as a result of a one-unit change in each input.
5. Multiple threshold values, showing how much two or more inputs need to change in order to enable the second place alternative to become the first place alternative.
6. Worst and best scenario analysis, showing for an alternative the worst it could do if all the inputs were scored least favorably, or showing the best it could do if all the inputs were scored most favorably.
7. Threshold percentage values, showing for each input the value to which those inputs would have to change to enable the second place alternative to become the first place alternative where part/whole percentages are used to deal with goals being measured on different dimensions.
8. Allocation change slopes for each input, showing how much the percentage allocation to each alternative would change if there were a one-unit change in each input.
9. The convergence value for each input, showing at what value the input reaches a point where the alternative that it favors is within a certain number of percentage points from the maximum that the alternative could be allocated.

From the analysis, one can also conclude that it is useful in decision-making situations to experiment with how the bottom-line conclusion changes as a result of making such changes in the inputs as:

1. Adding or subtracting an alternative.
2. Adding or subtracting a criterion.
3. Rewording an alternative or a criterion.
4. Adding a minimum requirement or an alternative or a criterion.
5. Adding a maximum requirement on an alternative or a criterion.
6. Re-defining how a criterion is to be measured.
7. Changing the weights as to the relative importance of the criteria.

8. Changing the scores of one or more alternatives on one or more criteria.
9. Changing the method for dealing with multi-dimensional criteria.
10. Changing what weights or relations are considered to be unknown.
11. Changing the method of dealing with conflicting constraints.
12. Changing the type of alternatives from a small set of discrete alternatives to a continuum of possibilities.
13. Changing the problem from one of going to trial to a related but different problem, such as whether to appeal, how much time to devote to a case, or the order in which to process cases.

II. MICROCOMPUTERS AS DECISION AIDS

A. *Damages Cases*

1. Criteria For Choosing Between Settlement And Trial

The criteria for deciding between those alternatives include benefit items such as (1) the average damages in similar cases when damages are awarded, (2) the proportion of similar cases in which defendants are found liable, and (3) the proportion of the damages that goes to the attorney in a contingent fee relation. The criteria also include such cost items as (1) the number of hours likely to be consumed by each alternative and (2) the hourly cost for each alternative. Additional benefit and cost criteria could be added such as number of months to collect and the going interest rate in order to calculate the present value for damages to be awarded later versus a settlement offered now. Once one understands the handling of the criteria in Table 3 however, it is relatively easy to add additional criteria.

TABLE 3

Data for Illustrating Microcomputer Analysis Applied to a Damage Case

Goals	*Benefit Items*					*Cost Items*			*Net Items*	
	(1) Average Damages If One Gets Them	(2) Probability of Receiving Damages	(3) Average Damages or Expected Value	(4) Percentage Fee	(5) Total Benefits	(6) Number of Hours	(7) Hourly Cost	(8) Total Costs	(9) Lawyer B-C	(10) Client
Options			(1) x (2)		(3) x (4)			(6) x (7)	(5) – (8)	(3)x[1–(4)]
Settle	$5,000	1.00	$5,000	.20	$1,000	10	$30	$300	$700	$4,000
Go to Trial	$10,000	.60	$6,000	.40	$2,400	25	$60	$1,500	$900	$3,600

Within the cells of Table 3 are shown hypothetical figures indicating how each alternative scores on each criterion. Reading across the settlement row, an offer of $5,000 has been made. If the percentage fee is twenty percent, then the total benefits or income will be $1,000. On the other row, going to trial means an average award of $10,000 if damages are awarded. Only about sixty out of one hundred cases like this, however, result in damages being awarded. We therefore discount the $10,000 by .60 to obtain an expected value of $6,000. Doing so is the equivalent of saying that six out of ten cases like this would generate an average of $10,000 in damages apiece, and four out of ten cases would generate no damages. We then, in effect, sum those ten amounts to obtain $60,000 and divide by ten to obtain an average of $6,000. We then apply a forty percent fee to the average trial damages and obtain a predicted total income of $2,400.

Going to trial thus does better on predicted benefits than accepting a settlement. A settlement, however, does better on having lower costs. Settling would only involve a predicted ten hours, valued at thirty dollars an hour, for a total cost of $300. Going to trial would involve a predicted twenty-five hours, valued at sixty dollars an hour, for a total cost of $1,500. If we subtract the predicted total cost from the predicted total income we obtain a $700 profit from accepting a settlement. The predicted profit from going to trial, however, is $900.

Those calculations are from the perspective of the benefits and the costs of the lawyer. Column 10 uses the benefits and costs of the client, which provide an interesting contrast. From the client's perspective, the total benefits from settling are eighty percent of the $5,000 in Column 3. That $4,000 figure is the net item for the client in the context of the amounts shown in Table 3 since the client does not pay for the lawyer's hours in a contingency fee arrangement. Likewise, on the trial row, the total client benefits are sixty percent of the $6,000. That $3,600 net figure for going to trial is $400 less than the $4,000 for settling. This is in contrast to the lawyer's perspective where going to trial is the more profitable alternative.

Under such circumstances, the lawyer has an ethical obligation to put the client's interest ahead of the lawyer's interest. The ideal situation, however, is to make the settlement alternative (which is better for the client) also better for the lawyer, or to make the trial alternative (which is better for the lawyer) also better for the client. Sensitivity analysis can be helpful in clarifying how that can be done. Such analysis is helpful even if the same alternative is better from both perspectives. If, for example, the trial alternative were better from both perspectives, then the lawyer would go to trial although he might reconsider if (1) avoiding the psychological problems of going to trial is worth more than the $200 difference in profit, or (2) some of the amounts in Table 3 are subject to change to make the settlement profit higher than the trial profit. That is where sensitivity analysis especially comes in.

2. The Nature Of Tie-causing Values

TABLE 4

Tie-Causing Values in the Damages Case From the Lawyer's Perspective[10]

Goals	*Benefit Items*					*Cost Items*			*Net Items*
Options	(1) Average Damages If One Gets Them	(2) Probability of Receiving Damages	(3) Average Damages or Expected Value	(4) Percentage Fee	(5) Total Benefits	(6) Number of Hours	(7) Hourly Cost	(8) Total Costs	(9) Lawyer B-C
Settle	$6,000	1.20	$6,000	24%	$1,200	3.33	$10	$ 100	$900
Go to Trial	$9,167	.55	$5,500	37%	$2,200	28.33	$68	$1,700	$700

[10]Notes:

a. If any information item in Table 3 changes to its tie-causing value in the above Table 4, then the profit from settling will rise from $700 to $900, or the profit from going to trial will drop from $900 to $700.

b. For example, if one were to substitute the $100 from the top row of column 8 in the above Table 4, for the $300 from the top row of Column 8 in Table 3 thereby lowering the total cost from $300 to $100 then the total profit from column 9 of Table 3 rises from $700 to $900 making for a tie between settling and going to trial. Likewise one gives the same interpretation from changing the 10 hours in Table 3 to the 3.33 hours in Table 4.

c. In other words when one of the basic components changes to its tie-causing value, we assume the other basic components remain constant, although not the products or sums of the basic components.

Table 4 shows the tie-causing values for each information item in the Table 3 analysis. Determining the tie-causing values is the essence of sensitivity analysis. For example, if the settlement offer can be raised from $5,000 to $6,000, then there would be a tie between the new profit figures of settlement and trial. This is so because a twenty percent fee applied to $6,000 would generate total income of $1,200. If we subtract the $300 in costs from the $1,200 in income, we then get $900 which is the trial profit figure. Thus, any settlement offer greater than $6,000 would make settlement more profitable than going to trial assuming (1) the other figures in Table 3 remain the same, and (2) those figures are reasonably accurate as known by attorneys who are knowledgeable about the specific kind of damages case which is being considered.

One could check to see that changing any of the amounts in Table 3 to any of the amounts in Table 4 will result in either (1) raising the settlement profit from $700 to $900, or (2) lowering the trial profit from $900 to $700. For example, suppose the number of hours involved in going to trial were wrongly estimated at twenty-five when they were really about 28.33. Multiplying sixty dollars an hour by 28.33 gives a total cost of $1,700. That total cost is $200 more than the original total cost of $1,500. The $900 profit from going to trial would thus drop to $700. That means if going to trial were to consume more than 28.33 hours, then it would be better to accept the settlement.

TABLE 5

Tie-Causing Values in the Damages Case from the Client's Perspective[11]

Options / *Goals*	*Benefit Items* (1) Average Damages If One Gets Them	(2) Probability of Receiving Damages	(3) Average Damages or Expected Value	(4) Percentage Fee	(5) Total Benefits	*Cost Items* (6) Number of Hours	(7) Hourly Cost	(8) Total Costs	*Net Items* (9) Client B-C
Settle	$4,500	.90	$4,500	28%	$3,600	—	—	—	$3,600
Go to Trial	$11,111	.67	$6,667	33%	$4,000	—	—	—	$4,000

[11]Notes:
a. If any information item in Table 3 changes to its tie-causing value in the above Table 5, then the profit from settling will drop from $4,000 to $3,600, or the profit from going to trial will rise from $3,600 to $4,000.
b. See notes 2 and 3 of Table 4.

Table 5 shows the tie-causing values from the client's perspective. Each figure in the second row of that table shows what it would take to improve the trial alternative to make it as desirable from the client's perspective as the settlement alternative. For example, if the client is offered a thirty-three percent contingency fee arrangement, rather than a forty percent arrangement, then going to trial would generate for the client the same $4,000 in net profit. This is so because if the percentage fee is thirty-three, then the client gets sixty-seven percent of the $6,000 expected value, which means the client on the average gets $4,000. Lowering the trial percentage free from forty percent to thirty-three percent, however, would then cause settlement to be the more profitable alternative for the lawyer. A better effect would occur if the lawyer can improve the trial alternative sufficiently so that the average damages when awarded are $11,111 rather than $10,000, since $11,111 times a sixty percent probability times the complement of a forty percentage fee is also $4,000. Likewise, raising the probability of receiving damages to sixty-seven percent would generate an expected value (on the $10,000 base) of $6,667 and sixty percent of that is $4,000.

Thus, by looking at data like that shown in Tables 4 and 5 the lawyer can see what it would take to make a settlement more attractive than going to trial from the lawyer's perspective. If the lawyer can succeed in improving the settlement offer to $6,000, then both the lawyer and the client would be better off with that alternative. Likewise, if the lawyer can succeed in improving the trial damages to $11,111, then both the lawyer and the client would be better off with that alternative. This kind of sensitivity analysis does help clarify what it would take to bring the second place alternative up to first place and additionally, what it would take to reconcile what otherwise might be a conflict of interest.

3. Solving For Tie-causing Values

All the amounts in Table 4 can be calculated by using simple high school algebra. To do so, we need to express the nine criteria in algebraic symbols which could consist of the following:

1. D = average damages if one gets them.
2. P = probability of receiving damages or expected value.
3. PD = average damages or expected value.
4. F = percentage fee.
5. FPD = total benefits.
6. H = number of hours.
7. C = cost per hour.
8. HC = total cost.
9. FPD-HC = benefits minus costs.

We also need to recognize that at the break-even point, FPD-HC of settling equals FPD-HC of going to trial. Thus, in order to solve for any one of the eighteen numbers in Table 4 one inserts the estimated values from Table 1 for all the information items except the one for which a tie-causing value is being calculated. For example, if we want to know the tie-causing value of the settlement offer, we solve the equation (D)(1.00)(.20)–(10)($30) = ($10,000)(.60)(.40)–(25)($60). The equation simplifies to (D)(.20)–$300 = $900. Using the methods of high school algebra, D = ($1,200)/(.20) = $6,000.

The algebra is even easier for calculating the tie-causing values in Table 5 from the client's perspective. The threshold equation is then PD times 1-F of settling set equal to PD times 1-F of going to trial. Thus, to determine any figure in Table 5, each of the variables gets a turn at being the unknown variable to be solved when known or given amounts are inserted for the other variables.

4. Dealing With Two Or More Tie-causing Values

Tables 4 and 5 show the tie-causing value for each information item if all the other information items are held constant at their original values in Table 3. Suppose, however, one wants to know what combinations of D and P will generate a tie between trial and settlement. One could change the question to ask for the tie-causing value of DP, which is $6,500. The answer to the original question, however, is that there are an infinite number of combinations of D and P that generate a tie between settlement and trial. These include $9,167 and sixty percent, $10,000 and fifty-five percent, and numerous combinations in between. The fully developed microcomputer program will show all those combinations as a curve on a graph, with the damages on the vertical axis and the probability of victory on the horizontal axis. One can then decide whether the predicted combination of P and D is likely to be above that tie-causing curve, just as one can decide whether a predicted value is likely to be above or below a tie-causing value in Table 4 or 5.

The analysis can also be extended to three values by thinking in terms of a tie-causing band across the graph, rather than just a curve, provided that one can indicate a minimum and maximum value for each variable. It is even possible to work with more than three values simultaneously if necessary.

5. Variations On The Basic Ideas

There are a number of variations on the basic ideas shown in Tables 3, 4, and 5 concerning fee-paying arrangements, a defense perspective, and the introduction of non-monetary criteria. On *fee-paying arrangements,* Tables 3 and 4 involve a percentage fee. If a case involves an hourly fee, then the total benefits from the lawyer's perspective equal the number of hours multiplied by the hourly fee. If the case involves a flat fee, then the total benefits equal the flat fee. From the client's perspective, the benefits minus costs with an hourly fee become PD minus the number of hours multiplied by the hourly fee. If the case involves a flat fee, then the net item becomes PD minus the flat fee.

The tables show the perspective of a plaintiff. From a *defense perspective,* damages and the probability of paying them represent additional cost items, rather than benefit items. Thus, the defense perspective wants to choose the alternative between settlement and going to trial which will provide the lower total costs where total costs are PD plus the total hourly cost. There is normally no conflict between the defense attorney in damages cases and his or her client. The defense attorney is normally a salaried employee of the client, and they both are interested in keeping down both the damages awarded and the total hourly cost.

One could add a *non-monetary criterion* to Table 3 called psychological case enjoyment. It could be scored on a 1-5 scale, where 5 = great pleasure, 4 = mild pleasure, 3 = no pleasure, 2 = mild displeasure, and 1 = great displeasure. For a lawyer who greatly enjoys trials, going to trial might receive a 5 and settling a 3. A non-monetary variable like that can be handled through part/whole percentaging, the same as the non-monetary variable of average prison sentence. That is a criterion in criminal cases to which we now turn.

TABLE 6

Data for Illustrating Microcomputer Analysis Applied to a Criminal Case[12]

Goals	*Benefit Items*			*Cost Items*			*Net Items*	
Options	(1) Average Sentence if Awarded (Years)	(2) Probability of a Sentence	(3) Average Sentence or Expected Value (Years) (1) x (2)	(4) Number of Hours	(5) Cost Per Hour	(6) Total Hourly Cost (4) x (6)	(7) Prosecutor %B-%C (3) - (6)	(8) Victim %B-%C (3)
Settle	2	1.00	2.00 (36%)	12	$20	$240 (25%)	? (+11%)	2.00
Go to Trial	5	.70	3.50 (64%)	36	$20	$720 (75%)	? (-11%)	3.50
Increment (Difference)			+1.50			+$480		+1.50
Whole (Sum)			5.50 (100%)			$960 (100%)		

[12]Threshold Raw Score Weight:
B-C of Settle = B-C of Trial
W(2.00) - $240 = W(3.50) - $720
$720 - $240 = 3.5W - 2W
$480 = 1.5W
W* = $480/1.5 = $320/1 year

Threshold Percentage Weight:
B-C of Settle = B-C of Trial
W(2.00/5.30) - ($240/$960) = W(3.50/5.30) - ($720/$960)
W(36%) - (25%) = W(64%) - (75%)
75% - 25% = 64%W - 36%W
50% = 28%W
W* = 50%/28% = 1.79
rounded to 2

B. *Criminal Cases*

1. Criteria For Choosing Between Settlement And Trial

Table 6 shows relevant data for a criminal case. The alternatives are settle or go to trial. The criteria for deciding between those alternatives include benefit items such as (1) the average sentence in similar cases if defendants are found guilty, (2) the proportion of similar cases in which defendants are found guilty, and (3) the average sentence awarded which is discounted or multiplied by the probability of a sentence being received. The criteria also include such cost items as (1) the number of hours likely to be consumed by each alternative, (2) the hourly cost for each alternative, and (3) the hours multiplied by the hourly cost.

Within the cells of Table 6 are shown hypothetical figures indicating how each alternative scores on each criterion. Reading across the settlement row, an offer to plead guilty with a two year sentence has been made. The number of hours to consummate the settlement or plea bargain would be twelve hours at twenty dollars an hour for a salaried assistant state's attorney, for a total cost of $240. Reading across the trial row, cases of this type average five year sentences where the defendant is found guilty, which is seventy percent of the time. The average or expected value is thus three and one-half years. The number of hours (if the case has to be tried) would be about thirty-six at twenty dollars an hour for a total cost of $720.

The client of the prosecutor is the state. There normally is no conflict between the prosecutor and the state. The prosecutor is a salaried employee of the state, and they are both interested in obtaining good convictions at low cost. The last column of Table 6 shows the benefits minus costs from the victim's perspectives which may conflict with the prosecutor's perspective. The victim is generally only interested in increasing the sentence length, and not especially in reducing the hourly cost.

2. Handling Criteria Measured On Different Dimensions

Unlike Table 3, where $300 in cost can be subtracted from $1,000 in benefits, there is no way of directly subtracting $240 in cost from two years in benefits. There is likewise no direct way of subtracting $720 in cost from three and one-half years in benefits on the trial row. One can, however, meaningfully subtract downward and note that the increment of trial over settlement is one and one-half years in benefits and $480 in costs. The problem thus could reduce to answering the question of which is more desired by the prosecutor, an incremental one and one-half years or a saving of $480. If one and one-half years is preferred, then go to trial since doing so gives the incremental one and one-half years. If saving $480 is preferred, then settle since doing so saves the $480.

That approach of comparing increments becomes too complicated where multiple options and/or multiple benefits are involved. It is also too complicated to allow for sensitivity analysis for the calculation of tie-causing values. A generally better approach is to compare the two years with the three and one-half years by expressing both of them as percentages of their sum, as is shown on Column 3. Likewise, one can compare the $240 with the $720 by expressing them as percentages of their sum, as is shown in Column 6. One can then subtract the percentage costs from the percentage benefits in order to obtain the difference shown in Column 7. Differences and sums are shown only for the total benefits column and the total cost column because the object is to choose the alternative that is better on benefits minus costs, rather than better on sentence length, probability of victory, number of hours, or cost per hour.

Column 7 indicates that if the sentence is given equal weight or importance along with the total hourly cost, then settling is the better alternative. Its net benefits are a positive 11 percentage points, as contrasted to a negative eleven percentage points for going to trial. If, however, one considers the sentence obtained to be at least twice as important as total hourly cost, then going to trial is the better alternative. This is shown by the algebra in the lower-right corner of Table 5. One could also say that if one would rather achieve an extra year of sentencing than save the prosecutor's office $320, then going to trial is the better alternative. This is shown by the algebra in the lower-left corner. That information, however, is the same as asking which is preferred between an extra 1.5 years and an extra $480.

3. Tie-causing Values

TABLE 7

Tie-causing Values in the Criminal Case from the Prosecutor's Perspective[13]

Goals / *Options*	*Benefit Items*			*Cost Items*			*Net Items*
	(1) Average Sentence if Awarded (Years)	(2) Probability of a Sentence	(3) Average Sentence or Expected Value (Years)	(4) Number of Hours	(5) Cost Per Hour	(6) Total Hourly Cost	(7) Prosecutor %B-%C
Settle	1.17 Years	.58 Probability	1.17 Years	20.25 Hours	$32.75	$405.00	0%
Go to Trial	8.57 Years	1.20 Probability	6.00 Years	21.33 Hours	$11.85	$426.67	0%

[13]Notes:

a. If any information item in Table 6 changes to its tie-causing value in the above Table 7, then the %B-%C (from settling) will drop from +11% to 0%, and the %B-%C (from going to trial) will rise from -11% to 0%.

b. See notes 2 and 3 of Table 4.

Table 7 shows the tie-causing values for all the information items in Table 6. For example, if the settlement offer goes down from two years to 1.17 years, then there would be a tie. This is so because 1.17 years as a settlement offer in Table 4 added to three and one-half years as an average trial result in Table 5 adds to 4.67. If those numbers are converted into part/whole percentages, the 1.17 becomes twenty-five percent of 4.67, and the 3.5 becomes seventy-five percent of 4.67. If we then add twenty-five percent as a benefit score to twenty-five percent as a cost score, settling receives a %B-%C score of zero percent. Likewise, if we add seventy-five percent as a trial benefits score to seventy-five percent as a trial cost score, we also receive a %B-%C score for going to trial of zero percent. This means that any offer below 1.17 years should be rejected if one gives equal weight to the sentence obtained and the total hourly cost.

One could likewise determine that any of the numbers shown in Table 6 (If substituted for the corresponding numbers in Table 5) will generate a tie between settling and going to trial on the bottom line of %B-%C. That is the bottom line in this context (rather than $B-$C), since the benefits and costs are measured on the different dimensions of years and dollars. All the amounts shown in Table 6 can be calculated by the algebraic approach shown in the lower-right corner of Table 5 which is analogous to the algebraic approach used for calculating the tie-causing values in Table 4. Fortunately, the Policy/Goal Percentaging microcomputer program will soon be available. It will calculate the tie-causing values for any table like Table 5 with equal or unequal weights for each benefit goal and each cost goal. One can also by hand or with the microcomputer program determine the tie-causing values (1) from a defense perspective where sentences are additional costs rather than benefits, (2) from a victim perspective where B-C is determined just by the sentence obtained as a benefit, and (3) a defendant perspective where B-C is determined just by the sentence received as a cost.[14]

C. *Using a Microcomputer For The Sensitivity Analysis*

Tables 8 and 9 show some output for the newly developed personal computer program that can handle most of the sensitivity analysis described in Tables 1 through 7.

Table 8A shows that a jury trial has a higher expected value by 200 monetary units for the lawyer. The four rows of Table 8B show that a tie between the alternatives would occur:

1. If the $10,000 predicted damages were only $9,167, or if the combination of the victory probability and the percentage fee were to drop from twenty-four to twenty-two.

[14]For literature describing part/whole percentaging as a means of evaluating alternative decisions which are measured on different dimensions, *see* S. NAGEL, PUBLIC POLICY: GOALS, MEANS, AND METHODS 343-54 (1984).

2. If the $5,000 settlement offer were to rise to $6,000, or if the twenty percent fee were to rise to twenty-four percent.
3. If the sixty dollar hourly litigation cost were sixty-eight dollars, or if the twenty-five hours were twenty-eight hours.
4. If the thirty dollars hourly settlement cost were only ten dollars, or if the ten hours were only three hours.

Table 8C shows that a jury trial has a lower expected value by 400 monetary units for the client. The two rows of Table 8D show that a tie between the alternatives would occur:

1. If the jury damages were to rise from $10,000 to $11,111, or if the combination of the victory probability and the percentage fee were to rise from twenty-four to forty percent.
2. If the $5,000 settlement offer were to go down to $4,500.

Table 9A shows that a settlement has a higher value than going to trial for the prosecutor. The two rows of Table 9B show a tie between the two alternatives would occur:

1. If the settlement offer were to drop from two years to 1.17 years, or if the trial sentence were to rise from five to six years. The top row also shows that if sentencing were considered almost twice as important as saving litigation costs, then there would be a tie.
2. If the settlement cost were to rise from $240 to $411, or if the trial cost were to fall from $720 to $420. Likewise, if saving litigation costs were only considered about half as important as sentencing, then there would be a tie.

TABLE 8

Using A Microcomputer For The Civil Cases[15]

A. The Bottom Line For The Lawyer

Alternative	Combined Rawscores
2 Jury	900.00
3 Settle	700.00

B. Tie-causing Values For The Lawyer

	Threshold Analysis Jury	Settle	Weight
Jury Damages	9166.67		0.220
Settlement		6000.00	0.240
Litigation Costs	68.00		-28.333
Settlement Costs		10.00	-3.333

C. The Bottom Line For The Client

Alternative	Combined Rawscores
2 Jury	3600.00
3 Settle	4000.00

D. Tie-causing Values For The Client

	Threshold Analysis Jury	Settle	Weight
Jury Damages	11111.11		0.400
Settlement		4500.00	0.720

[15]Notes:

a. The relations between the main tables in the article and the sub-tables of Table 8 are:
   (1) Table 8A corresponds to the bottom line of Table 3 for the lawyer.
   (2) Table 8B corresponds to the main threshold values of Table 4.
   (3) Table 8C corresponds to the bottom line of Table 3 for the client.
   (4) Table 8D corresponds to the main threshold values of Table 4.

b. Irrelevant information has been removed from Table 8 such as indicating that a $700 settlement constitutes 44% of the total of the damages awarded ($900) plus the settlement ($700). Likewise if one settles, there can be no jury damages or litigation costs, and if one goes through a jury trial, there can be no settlement or settlement costs. Nothing, however, has been added to the above computer displays.

TABLE 9

Using A Microcomputer For The Criminal Cases[16]

A. The Bottom Line For The Prosecutor

Alternative	Combined W P/W
1 Settle	11.36
2 Trial	-11.36

B. Tie-causing Values For The Prosecutor

	Threshold Analysis Settle	Trial	Weight
Avg. Sentence	1.17	6.00	1.833
Total Cost	411.43	420.00	-0.545

[16]Notes:

a. The relations between the main tables in the article and the sub-tables of Table 9 are:
   (1) Table 9A corresponds to the bottom line of Table 6.
   (2) Table 9B corresponds to the main threshold values of Table 7.

b. Irrelevant information has been removed from Table 7 such as indicating that a combined weighted part/whole percentage of +11% is 50% of the sum of the two combined absolute percentages.

To obtain the bottom-line values for the lawyer in Table 8A one inserts into the computer for the trial alternative (1) $10,000 in trial damages weighted by .60 times .40, and (2) sixty dollars in litigation cost per hour weighted by twenty-five hours. For the settlement alternative, one inserts (1) $5,000 in settlement amount weighted by .20, and (2) thirty dollars in settlement cost per hour weighted by ten hours. To obtain the bottom-line values for the client in Table 8C one inserts for the trial alternative $10,000 in trial damages weighted by .60 times .60. Likewise, one inserts for the settlement alternative $5,000 in settlement value weighted by .80. Once that data has been inserted, then asking the computer for a sensitivity analysis will yield the tie-causing values of Table 8A or 8D.

To obtain the bottom-line values for the prosecutor in Table 9A one inserts into the computer for the trial alternative (1) five years weighted by the .70 probability, and (2) twenty dollars in litigation cost per hour weighted by thirty-six hours. For the settlement alternative, one inserts (1) two years weighted by the 1.00 probability, and (2) twenty dollars in litigation cost per hour weighted by twelve hours. Once that data has been inserted, then asking the computer for a sensitivity analysis will yield the tie-causing values of Table 9B provided that one has previously indicated that part/whole percentaging should be used to deal with the multi-dimensionality of combining years and dollars.

Thus to obtain the initial results or bottom-lines, one just has to remember that the probabilities or other multipliers are treated as weights on the dollar-award columns or the dollar-cost columns. This is a much easier method for inputting the information needed for the initial analysis than is the method of decision trees. The trees may look aesthetic, but they are much more complicated to communicate to the computer, and they are generally incapable of doing a comprehensive sensitivity analysis.[17]

III. DECISION TREES AND LITIGATION STRATEGY

Joyce Kilmer in his famous poem said that "Only God can make a tree." He was, however, not talking about decision trees. God does not make decision trees for at least two reasons.

First, decision trees are for people who think of case outcomes or events in terms of probabilities of occurring, such as seventy percent, one in four, or

[17]For literature describing the new microcomputer program for doing sensitivity analysis in litigation strategy, see Nagel, *P/G% Analysis: An Evaluation Aiding Program* 9 EVALUATION REV. 209 (1985); S. NAGEL, DECISION MAKING WITH MULTIPLE OBJECTIVES (Haimes & Chankong ed. 1985) (Policy/Goal Percentaging as a Form of Multi-Criteria Decision-Making). The microcomputer program can also calculate the present value for the trial damages, taking into consideration the length of predicted delay and the prevailing interest and inflation rates. The program can also deal with multiple probabilities of victory, but a single holistic or gestalt probability may be more meaningful than disaggregated probabilities that do not capture the total picture.

highly probable. Since God is an omniscient being, He thinks of events in terms of either happening or not happening, with nothing in between.

More important for our purposes, even if God did think probabilistically, He would probably not make decision trees to analyze probabilistic events. Since He is an omniscient being, He would use a more insightful tool similar to a policies/goals table or a PG table. Such a table shows options on the rows, goals on the columns, relations between the options and the goals in the cells, and a bottom line at the right indicating which option is best on benefits minus costs. That is the subject of this article.

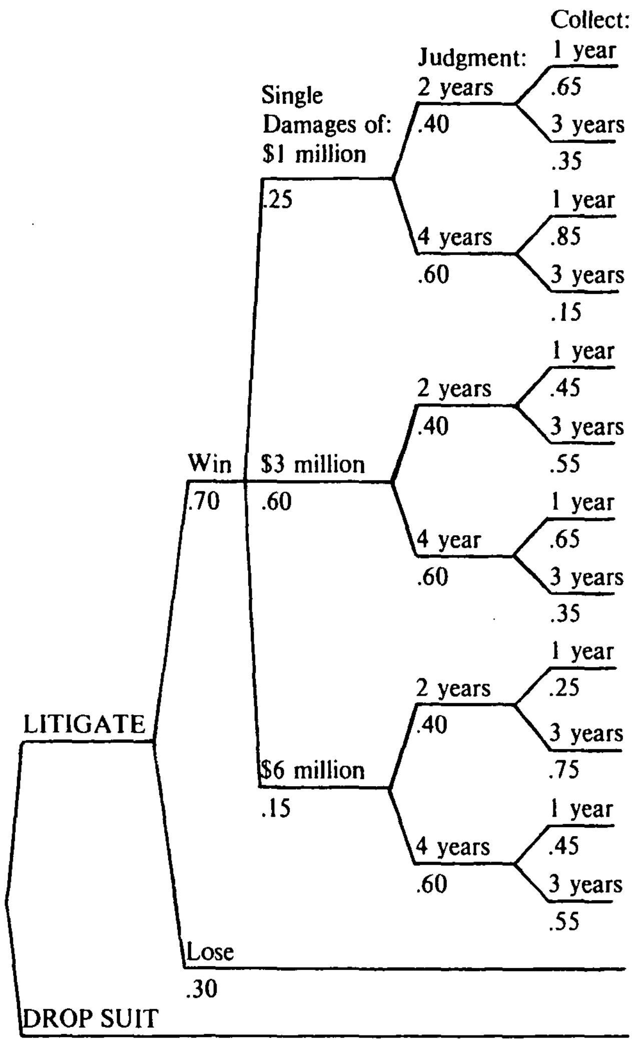
A. *A Decision Tree In Need Of Being Cut Down*

Figure 1 shows an impressive decision tree relevant to deciding whether to sue or not to sue. This tree contains two trunks labeled "Litigate" and "Drop Suit." The litigate trunk branches into win or lose. The win branch sub-branches into damages of one, three, and six million dollars. Each of those branches sub-branch into judgments within two or four years, and each of those sub-branches into collecting within one year or three years on the judgments. That adds up to fourteen impressive branches or fourteen scenarios.

Akron Law Review, Vol. 19 [1986], Iss. 1, Art. 2

FIGURE 1

A Decision Tree Approach To Deciding Whether To Sue Or Not Sue[18]



Scenario	*Probability*	*Present Value*
1	4.6%	$ 2.0M
2	2.4%	$ 1.4
3	8.9%	$ 1.7
4	1.6%	$ 1.2
5	7.6%	$ 6.1
6	9.2%	$ 4.2
7	16.4%	$ 5.0
8	8.8%	$ 3.5
9	1.0%	$12.2
10	3.2%	$ 8.4
11	2.8%	$10.1
12	3.5%	$ 6.9
13	30.0%	$ 0.0
	100.0%	
		Save $ 1.0

[18]Notes:

a. The above figure is based on the recommendations of Marc Victor as to how to draw a decision tree. See Marc Victor, "Litigation Risk Analysis" (Paper presented at ABA annual meeting, 1982). The above data, however, is purely hypothetical and not meant to reflect any specific case of Marc Victor's or anyone else.

b. The probability for each scenario is the product of the four probabilities along the decision-tree branches of the scenario. Thus, .046 equals .70 x .25 x .40 x .65.

c. The present value for each scenario is equal to 3 times the damages, multiplied by .90 for a 1-year collection (10% collection fee) and by .75 for a 3-year collection (25% collection fee). One then discounts or multiples that figure by $1/(1.10)^t$ where .10 is the discount rate, and t is the years of delay for judgment and collection. Thus, \$2.0 equals \$1 x 3 x .90 x $1/(1.10)^3$.

To calculate the probability of any of the fourteen scenarios, one multiplies the four probabilities along the decision tree branches of the scenario. For example, the .046 probability of the first scenario equals .70 x .25 x .40 x .65. To calculate the present value of any of the fourteen scenarios, one multiplies three times the damages by ninety percent for a one year collection (ten percent collection fee) and by seventy-five percent for a three year collection (twenty-five percent collection fee). One then discounts or multiplies that figure by $1/(1.10)^t$ where .10 is the discount rate, and t is the years of delay for judgment and collection. For example, the two million dollars of the first scenario equals \$1 x 3 x .90 x $1/(1.10)^3$.

B. *Using The Wood Of The Shaky Decision Tree To Make A Sturdy PG Table*

Table 10 analyzes the same data from the perspective of averaging rather than probabilities, and from the perspective of a PG table rather than a decision tree.

TABLE 10

Replacing A Decision Tree With Averaging And A PG Table[19]

Goals	*Benefit Items*				*Cost*	*Net*
Options	(1) Average Damages	(2) Average Delay to Damages	(3) Damages Discounted for Collection	(4) Damages Discounted for Delay	(5) Litigation Cost	(6) Benefits Minus Cost (4)-(5)
Not Sue	$0	0 years	$0 ($0 x 1.00)	$0 [$0/(1.10)^0]	$0	$0
Sue	$6.12 (2.04 x 3)	5.00 years	$5.14 ($6.12 x .84)	$3.19 [$5.14/(1.10)^5]	$1	$2.19

[19]Notes:

a. Average damages (column 1) are calculated by noting that a sample of 100 cases shows:
   (1) 30 cases resulted in $0 damages.
   (2) 18 (or .25 x 70) resulted in $1 damages, or $18 in total.
   (3) 42 (or .60 x 70) resulted in $3 damages, or $126 in total.
   (4) 10 (or .15 x 70) resulted in $6 damages, or $60 in total.
   (5) Thus, the 100 cases resulted in $204 in damages for an average of $2.04 apiece.

b. Average delay to damages (column 2) is calculated by noting that in the 70 cases in which damages were awarded:
   (1) 28 cases (or .40 x 70) took 2 years to judgment, or 56 years in total.
   (2) 42 cases (or .60 x 70) took 4 years to judgment, or 168 years in total.
   (3) Thus, the 70 cases took 224 years for an average of 3.2 years to judgment, or 224/70.
   (4) 42 cases took 1 year to collect, or 42 years in total.
   (5) 28 cases took 3 years to collect, or 84 years in total.
   (6) Thus, the 70 cases took 126 years for an average of 1.80 years to collect, or 126/70.
   (7) Thus, the 70 cases took 5.00 years apiece for judgment and collection, or 3.20 + 1.80.

c. The collection-fee multiplier (column 3) is 1.00 minus the collection fee expressed as a decimal. Thus, if the collection fee is 10%, the collection-fee multiplier is .90. The average collection-fee multiplier is calculated by noting that the 70 winning cases show:
   (1) 42 cases had a .90 multiplier, or 37.8 in total.
   (2) 28 cases had a .75 multiplier, or 21.0 in total.
   (3) Thus, the 70 cases had 58.8 in grand total for an average of .84 as a multiplier.

d. Damages discounted for delay (column 4) equal average damages multiplied by $1/(1.10)^t$ where t is the average delay to damages.

e. The numbers which appear in Table 10 and the above notes are all derived from Figure 1.

1. Advantages Of The Averaging Approach

On the matter of averaging, one should note that people (including lawyers) have a great deal of difficulty working with probabilities. They do not, however, have much trouble understanding the related concept of an average. A lawyer can easily understand the idea of listing the damages awarded for ten cases (including cases in which no damages are awarded) and then dividing by ten to get the average damages awarded, which may be $3,200. That is easier than thinking that the damages awarded are $4,000 in cases in which liability is found and that $4,000 has to be discounted by eighty percent in order to arrive at an expected value of $3,200. The eighty percent probability is especially confusing if the lawyer is irrelevantly told that such a probability represents four to one odds and a ninety percent probability represents nine to one odds. Table 10 only talks in terms of averages. It avoids the word probability.

Other advantages of using an averaging approach rather than a probability approach in addition to avoiding confusion include:

1. The averaging approach emphasizes empirical data-processing to arriving at average damages, whereas a probability approach tends to overemphasize mathematical probability calculations with independent probabilities or Bayesian conditional probabilities.
2. The data-processing emphasis is also a welcome improvement over the possible overemphasis on subjective intuition of the probability approach.
3. In order to use data-processing to get relevant averages, one has to have a big database that will cover lots of possible types of cases. This may now be possible by using the Westlaw or Lexis database for calculating empirical probabilities by way of quantitative content analysis programs that are now being developed.
4. Where no data is available, lawyers can probably generate educated estimates concerning average damages and other averages better than they can generate probabilities. I was recently thinking about the expected value of robbing a grocery store in terms of the monetary crime benefits discounted by the probability of success. I came up with a figure that seemed quite unrealistic in comparison to what I generated when I thought in terms of the average monetary crime benefits across a set of ten average grocery store robberies, some of which are unsuccessful.

Because lawyers often think in terms of probabilities does not mean doing so is the best way to analyze litigation. The best way is the way that (1) maximizes accuracy in consistently arriving at decisions that maximize benefits minus costs, and that (2) minimizes the difficulty in quickly arriving at a decision. Thinking in probabilities is not inconsistent with also thinking in terms of averages. The two perspectives may be better than either one alone. My own previous work has used probabilities.[20] Observing decision trees like the one in Figure 1 has convinced me there must be an easier way to do it. My previous examples using probabilities were overly simple. The seventy cases that won out of one hundred cases averaged about two years to collect after the judgment was awarded. That is simpler to recognize and work with than saying cases with various probabilities took one year and cases with various other probabilities took three years.

2. Advantages Of The Policies/Goals Table Format

The second main way in which Table 1 differs from Figure 1 (besides using averages rather than probabilities) is the use of the PG table format which lists options along the rows, goals along the columns, and relations in the cells. Here the options are to sue or not sue which is a simple go/no-go decision. The bottom line at the right side of a PG table should always be (1) benefits minus costs, (2) total benefits if all the effects are stated positively, (3) total costs if all the effects are stated negatively, or (4) some indirect measure of benefits minus costs.

The advantages of a PG table over a decision tree include:

1. Far easier to type without the artwork of a decision tree.
2. Far simpler in terms of the number of rows since there are only as many rows as there are options.
3. More consistent with common-sense business practice of picking the option that is most profitable, or that is positively profitable in a go/no-go situation.
4. Eliminates virtually all rounding errors.
5. Far easier to read.
6. Allows for an infinite number of degrees of damages, not just one, three, and six million dollars. In calculating an average, the damages can be any amount.
7. Allows for an infinite number of degrees of delay, not just two or four years on judgment, or one and three years on collection. In calculating average delay, the time periods can be any amount.
8. Easily allows for more plaintiff choices than just suing or not suing, such as sue with a jury trial, sue with a bench trial, settle with a structured settlement, settle with a flat payoff, or reject the case altogether.
9. Easily allows for a defendant perspective of defending with a jury trial request, defending with no jury trial request, offering various structured settlements, or offering various flat payoffs.
10. Easily allows for sensitivity analysis whereby any of the benefit or cost items can be expressed in terms of a threshold value that would

[20] Nagel, *Applying Decision Science to the Practice of Law*, 30 PRAC. LAW 13-22 (1984).

make for a tie between suing and not suing at the bottom line.

11. Easily allows for sensitivity analysis whereby any of the benefit or cost items can be expressed as a range between minimum and maximum values.
12. Easily allows for nonmonetary benefits and nonmonetary costs which would be involved in criminal cases and possibly civil cases that do not involve damages.
13. The arithmetic is much simpler.
14. There is no unnecessary disaggregation into so many pieces like fourteen scenarios. The PG table disaggregates the decision-making into benefit items, cost items, and B-C net items. The PG table thus forces the decision-maker to think about each of those goal components in order to decide between the two options available. Delay and collection can be considered costs, negative benefits, or simply items that are relevant to determining the true benefits.
15. A PG table could show the degree of risk adverseness as a cost of suing, or show the degree of risk preference as a benefit of suing. Being risk adverse is, however, a non-monetary cost, and being a risk preferer is a non-monetary benefit. PG tables can deal with a mix of monetary and non-monetary variables by methods described in the references at the end of this article.
16. Easily allows for making allocation decisions as to how much time or money should be invested in alternative case activities or cases.
17. Decision trees tend to encourage lots of branches concerning relatively trivial matters at the ending branches such as how long it takes to collect on a judgment that is already awarded, and a slighting of more important matters like the diversity of factors that influence winning and losing at the initial branches.
18. The PG table can be easily handled with a microcomputer program which provides for prompting and sensitivity analysis.
19. The decision matrix or PG table can easily handle multiple alternatives, not just two alternatives.
20. The decision matrix can handle non-monetary criteria, not just monetary ones.
21. The decision matrix can add and subtract alternatives, criteria, and relations, and make other sensitivity changes with relative ease in order to see how they affect the bottom-line conclusions.

C. *Spreading PG Tables To Every Lawyer's Office*

What may be needed to implement the above ideas and related ideas are entrepreneurial activities like the following:

1. A Judicial Prediction Service — This could be a service charging so many dollars per hour of microcomputer time on a telephone modem

or hookup offering systematic predictions of damages, non-damage judgments, averages, and probabilities drawing on Westlaw, Lexis, Jury Verdict Research Service and/or other databases.

2. A Lawyer Decision-Making Service — This could also be a service charging so many dollars per hour of microcomputer time on a telephone modem, but offering an analysis in the form of PG tables. Relevant decision-making problems could include:
   (1) Choosing among alternative clients, plaintiffs, defendants, firms, or other entities to represent, prosecute, or sue.
   (2) Deciding whether to go to trial or accept a settlement where tort, contract, or property damages, or other remedies are involved.
   (3) Deciding on an optimum level of time to spend on big cases, or how to allocate one's time resources among many cases.
3. A series of training workshops across various U.S. cities each year designed to train lawyers in the use of the Judicial Prediction Service and the Lawyer Decision-Making Service. Those workshops would deal with decision analysis methods involving mutually exclusive alternatives, combinations of alternatives, decision-making under conditions of risk, decisions where doing too much or too little is undesirable, and decisions that involve allocating scarce resources among people, activities, and places.

The above ideas would have sounded like science fiction a few years ago, but not now. Seventy percent of all law offices in the country now have at least one data-processing or word-processing terminal and TV monitor which could be made capable of taking a telephone modem or hookup.[21] To the extent that these kinds of developments would make both lawyers and clients better off, the developments would probably be approved by whatever entities are both omniscient and omnibenevolent.[22]

D. *Using A Microcomputer For Processing A PG Table Or Decision Matrix*

Tables 11, 12 and 13 show how the same data from Figure 1 can be more meaningfully analyzed by the microcomputer program called Policy/Goal Percentaging than by a decision-tree approach.

The program is called Policy-Goal Percentaging because it relates policies, decisions, or other alternatives to goals or criteria in order to decide which decision or combination is best in light of the alternatives, goals, and relations. The program uses percentaging to deal with the fact that the goals may often be measured on different dimensions like time, distance, attitude scales, or dollars, which can be converted to dimensionless part/whole percentages in order to allow for meaningful addition across goals. In this example, however, only dollars are involved.

[21] Keeffe, *How to Shop for Your Firm's Computer*, 10 A.B.A. J. 161 (May 1984).

[22] The author thanks Marc Victor for having partly inspired this article by his stimulating work on litigation risk analysis.

1. Alternatives And Criteria

Each table shows one or more computer displays. All the data comes from Figure 1. Table 11A shows the two alternatives of either litigate or drop the suit.

TABLE 11

The Alternatives and the Criteria[23]

A. The Alternatives Or Available Decisions			
		Budgets	
	Alternative	Minimum	Actual
1	Litigate	0.00	0.00
2	Drop Suit	0.00	0.00
B. The Criteria (Damages And Costs)			
	Criterion	Meas. Unit	Weight
1	*Scenario 1	$	0.05
2	*S 2		0.02
3	*S 3		0.09
4	*S 4		0.02
5	*S 5		0.08
6	*S 6		0.09
7	*S 7		0.16
8	*S 8		0.09
9	*S 9		0.01
10	*S 10		0.03
11	*S 11		0.03
12	*S 12		0.04
13	*Litigation Costs		-1.00

[23]Notes:

a. There is no minimum budget per decision or past actual budget, since this is a choosing problem, rather than a budget-allocation problem.

b. The measurement unit is millions of dollars for all the criteria. Each criterion is weighted by the probability of its occurring.

It could easily expand to more than two alternatives such as (1) litigate via a jury trial, (2) litigate via a bench trial, (3) numerous forms of settlement, and (4) drop the suit. Columns 2 and 3 of Table 11A indicate this is not a budget allocation problem. Thus it does not have any minimum budget for each alternative or previous actual budget.

Table 11B shows the criteria for judging between the alternatives. In this context, the criteria refer to damages and costs. There are twelve different ways of arriving at different damage levels. Damages 1 or Scenario 1 involves (1) litigating, rathen dropping the suit, (2) winning, rather than losing, (3) obtaining damages of one million dollars, rather than three million or six million dollars, (4) obtaining the judgment within two years of winning, rather than four years, and (5) collecting within one year from the time the judgment was awarded, rather than three years. The probabilities of the occurrence of events 2, 3, 4, and 5 are seventy, twenty-five, forty, and sixty-five percent, respectively. Multiplying those independent probabilities together gives the probability of Damages 1 or Scenario 1 occurring. That probability is .0455 or five percent rounded to two decimal places, which is the figure shown in the "Weight" column. The measurement-unit column indicates that for this problem, all the criteria are measured in dollars. The litigation costs are not discounted by a probability. They are given a negative weight because being high on cost is undesirable, whereas being high on each of the twelve damage amounts is desirable from a plaintiff's perspective.

2. Relations And Transformations

Table 12A shows the relations between the alternatives and the twelve damages criteria and one cost criteria. Scenario 1, for example, says the damages with that set of events will be two million dollars. That figure is arrived at by tripling the one million dollars in single damages to consider treble damages. The three million dollars is then multiplied by ninety percent to consider the ten percent collection fee. That figure is then multiplied by $1/(1.10)^3$ to consider the ten percent interest or discount rate and the three year waiting period. A similar interpretation should be given to each figure in Table 12A. The litigation costs are one million dollars.

TABLE 12

The Relations Between The Alternatives And The Criteria[24]

A. The Relations

Alternative/Criteria Scoring

	Scenario	S 2	S 3	S 4	S 5
Litigate	2.00	1.40	1.70	1.20	6.10
Drop Suit	0.00	0.00	0.00	0.00	0.00
	S 6	S 7	S 8	S 9	S 10
Litigate	4.20	5.00	3.50	12.20	8.40
Drop Suit	0.00	0.00	0.00	0.00	0.00
	S 11	S 12	Litigation Costs		
Litigate	10.10	6.90	1.00		
Drop Suit	0.00	0.00	0.00		

B. Transforming The Relations

$X^2 = X\ 1$

$X = X^2/0.908$

Present value : rate = 0.10

Actual value : term = 3.00

[24]Notes:

a. The relations are in millions of dollars, as the measurement unit in Table 11B should indicate.

b. The commands in Table 12B allow the raw scores of Table 12A to be multiplied or divided by any factor. They also enable the present value or future value of any amount in Table 12A to be calculated.

Table 12B shows how the program can transform the original relations or raw scores. The top line of those transformation commands enables the raw score to be multiplied. This could include multiplying the one milion dollar by three, or by ninety percent. The second line allows the raw score to be divided by any number. The third line specifies the discount rate for calculating present or future values. The fourth line specifies the term or time period. By exercising appropriate options, one can calculate the present value of an amount to be received in the future, or calculate the future value of an amount received in the present. Those calculations take into consideration the interest rate, the term, and having the interest remain in the account or the firm to draw compound interest. The amounts shown in Table 12A have already been discounted for the collection fee and for the delay in being received.

3. Initial Analysis And Sensitivity

Table 13A shows the initial decision by asking the computer what is the best decision in light of the alternatives available (Table 11A), the criteria for judging the alternatives and the weights of the criteria (Table 11B), and the relations between the alternatives and the criteria (Table 12A). The answer is that the total expected value for litigating is $4.19 million. That represents $3.19 million in damages minus the one million dollar in litigation costs. If the suit is dropped, there are no benefits and no costs. The combined raw score for dropping the suit is thus zero.

TABLE 13

The Initial Decision And The Sensitivity Analysis[25]

A. The Initial Decision Or Analysis

Alternative	Combined Rawscores
1 Litigate	2.19
2 Drop Suit	0.00

B. The Sensitivity Analyses

	Threshold Analysis		
	Litigate	Drop Suit	Weight
Scenario 1	-45.59	47.59	-1.049
S 2	-89.82	91.22	-1.540
S 3	-22.90	24.60	-1.199
S 4	-135.62	136.82	-1.808
S 5	-22.71	28.81	-0.283
S 6	-19.60	23.80	-0.429
S 7	-8.35	13.35	-0.274
S 8	-21.38	24.88	-0.537
S 9	-206.72	218.92	-0.169
S 10	-60.01	68.41	-0.229
S 11	-68.09	78.19	-0.189
S 12	-55.65	62.55	-0.282
Litigation Costs	3.19	-2.19	-3.189

[25]Notes:

a. The combined raw scores in Table 13A are calculated by multiplying the probability weights of Table 11B against the relation scores of Table 12A and then adding the products.

b. The threshold values in Table 13B are calculated by setting up a threshold equation in which the sum of the above-mentioned litigating products are set equal to the sum of the above-mentioned suit-dropping products. The equation has 26 terms on each side, including 13 relation scores and 13 weights for litigating, and 13 relation scores and 13 weights for dropping the suit.

c. One then treats each of the 39 inputs as an unknown and asks the question, "To what value would that input have to change in order to make for a perfect equality between the profitability of litigating and the profitability of dropping the suit."

Table 13B provides especially useful information. It shows what the raw scores in Table 12A would have to change to in order for the second place alternative (of dropping the suit) to become tied with the first place alternative (of litigating). There are thirteen criteria and two alternatives. That means there are twenty-six input scores in Table 12A and 13 probabilities in Table 11B that could change to enable dropping the suit to become as profitable as litigating. Of those thirty-nine values, only one is numerically possible because the gap between litigating and dropping the suit is so large. In a more realistic example where the two alternatives might be closer in their combined raw scores, any of the thirty-nine or so input values could conceivably change enough to cause the initial best alternative to become second best.

Examples of impossible changes include the impossibility of (1) a scenario bringing in negative damages through litigation, which is what it would take for any one scenario to make a tie between the alternatives in Table 4A, (2) a scenario bringing in positive damages through dropping the suit, which is equally meaningless, or (3) a scenario having a negative probability, which is impossible since probabilities only go from 0 to 1.00. The only room for eliminating the greater profitability of litigating by way of one input change would be if the litigation costs were to rise from one million dollars to $3.19 million. Litigating would then be as profitable or unprofitable as dropping the suit. Thus the decision to litigate can be considered firmly in first place, unless there is a possibility that the litigation costs are being so badly misestimated that they may be more than three times the one million dollars predicted. One can easily test to see that any of these threshold values will result in a tie between litigating and dropping the suit by inserting any one threshold value in place of its original input value back in either Table 12A or 11B and then asking for a new initial analysis.

Threshold values can be quite useful in probability analysis with or without decision trees, especially in deciding litigation strategies. They can indicate to what figure the settlement value has to increase in order for a settlement to be as profitable as going to trial. They can indicate the threshold value for any probability so as to convert questions of the form "What is the probability?" into questions of the form "Is the probability likely to be higher or lower than the threshold value?" The latter type of question is much easier for lawyers and others to handle. If an input score is very close to its threshold score, that tells the decision-maker that he or she should probably seek additional information to be sure the input score is correct since a small change could affect which alternative is best. If all the input values are substantially different than their threshold values, then one can feel more confidence in accepting an initial decision like that shown in Table 13A.

E. *Comparing Decision Matrices And Decision Trees*

Going from Figure 1 to Tables 11, 12, and 13 requires approximately five minutes or less of key strokes. There is no question that a decision matrix approach like that shown in Tables 11, 12, and 13 is much faster to input and manipulate than a decision-tree approach with or without the aid of computers. There are microcomputer decision-tree programs such as the Arborist developed by Texas Instruments. It requires considerable time and patience to be able to input the information from Figure 1. More important, it is almost psychologically impossible to do the algebra needed for calculating a set of threshold values, break-even values, or indifference points for thirty-nine input items by hand. At the present time, no other existing microcomputer program seems capable of calculating those useful threshold values.

IV. SOME CONCLUSIONS

The idea of sensitivity analysis includes more than just the calculation of tie-causing values, but that is the most important part of analyzing the effects on decisions of changing items of input information. Other forms of sensitivity analysis that are discussed elsewhere include (1) insensitivity ranges within which scores can vary without affecting the best alternative; (2) change slopes, which show how much the gap between the two leading alternatives is influenced by a one unit change in each input; (3) best and worst case scenario analysis whereby one does a version of Table 1 that is most favorable toward settling and a version that is least favorable in order to obtain insights into whether one should settle or go to trial, and (4) convergence analysis whereby one determines how low a figure the weight for a goal can be and yet the goal will dominate the other goals in determining the best alternative.

The idea of sensitivity analysis and tie-causing values can be a highly useful tool in decision-making. It can be more valuable than the "what-if" analysis that is associated with spreadsheet programs like Lotus 1-2-3. Lotus does what-if analysis whereby one asks what would be the effect of changing a cell or information item in Table 3 or 4 on the bottom profit for settling versus going to trial. In Table 3, there are sixteen information items that lead to the two profit figures. Each item may be reasonably capable of taking five different values. That means if one wants to do a comprehensive what-if analysis, then one would have to make approximately eighty changes, and observe the effect of each of the separate changes on the profit figures.

The sensitivity analysis of Table 4, however, tells us instantly that any offer greater than $6,000 will make settling more profitable, and any offer less than $6,000 will make going to trial more profitable if all the other numbers are held constant. One does not have to experiment with offers of $4,000, $5,500, $6,500, $7,000, and so on in order to determine their effects. The same is true of the sensitivity analysis or tie-causing values of the other fifteen information items. The what-if system of spreadsheet analysis is totally inapplicable to Table 5 dealing with benefits measured in years and costs measured in dollars, since the two profit figures are not arrived at by simply adding and subtracting across the rows. The computerized sensitivity analysis, however, has no trouble calculating tie-causing values under such circumstances.

There are other microcomputer procedures that are useful as decision-making tools for trial lawyers. These include procedures designed to predict the probabilities of victory in civil or criminal cases, or to predict damages or sentences likely to be received. The outputs of those programs can be the inputs to the kind of decision-making analysis shown in Tables 3 and 6, which in turn are the inputs to the sensitivity analysis shown in Tables 4, 5 and 7. There are also systematic procedures designed to enable attorneys to sequence cases and allocate time to cases in order to maximize benefits minus costs.[26] The most useful methodology may, however, be the methodology of calculating tie-causing values in order to make choices between conflicting alternatives, especially whether to go to trial or accept a settlement.[27]

[26] For literature describing microcomputer procedures for judicial prediction and attorney-time allocation, *see* Nagel, *Using Microcomputers and P/G% to Predict Court Cases* 18 AKRON L. REV. 541 (1985).

[27] For further details concerning the subject matter of this article and the broader context of decision science applied to law, *see* S. NAGEL, USING PERSONAL COMPUTERS FOR DECISION MAKING AIDS IN LAW PRACTICE (American Law Institute-American Bar Association, 1985).