

Decision Trees Using TreePlan

16

16.1 TREEPLAN OVERVIEW

TreePlan is a decision tree add-in for Windows Excel 2010 & 2013 & 2016 & 2019 & 365 and Mac Excel 2016 & 2019 & 365.

TreePlan helps you build a decision tree diagram in an Excel worksheet using dialog boxes. Decision trees are useful for analyzing sequential decision problems under uncertainty. Your decision tree model may include various controllable alternatives (e.g., whether to introduce a new product, whether to bid on a new project) and uncontrollable uncertainties (e.g., possible demand for a product, whether you're awarded a contract), arranged in chronological order. TreePlan automatically includes formulas for summing cash flows to obtain outcome values and for calculating rollback values for determining the optimal strategy.

To use TreePlan, you

- (1) open a new worksheet,
- (2) choose TreePlan > TreePlan to build a new decision tree diagram,
- (3) select a node to change the structure of your decision tree,
- (4) enter branch names, cash flows, and probabilities, and
- (5) determine the optimal strategy from TreePlan's results.

All of TreePlan's functionality, including its built-in help, is a part of the TreePlan XLAM file. There is no separate setup file or help file. When you use TreePlan on a Windows computer, TreePlan does not create any Windows Registry entries (although Excel may use such entries to keep track of its add-ins).

16.2 BUILDING A DECISION TREE IN TREEPLAN

With Windows Excel or Mac Excel, you can start TreePlan by choosing the TreePlan ribbon and clicking the TreePlan button. In these instructions we write "TreePlan > TreePlan."

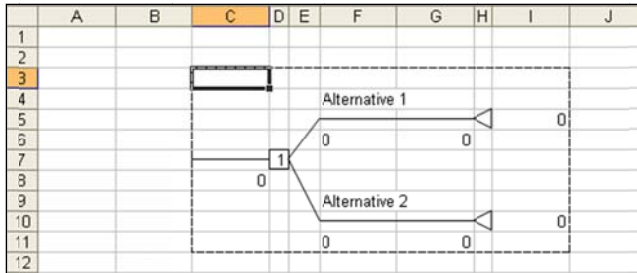
An alternative is to use the shortcut key: Control+Shift+T on Windows Excel, or Option+Command+t on Mac Excel.

If the worksheet doesn't have a decision tree, TreePlan prompts you with a dialog box with three options; choose **New Tree** to begin a new tree. TreePlan draws a default initial decision tree with its upper left corner at the selected cell. For example, the figure below shows the initial tree when cell C3 is selected before creating the new tree.

TreePlan writes over existing values in the spreadsheet, so begin your tree to the right of the area where your data is stored.

It is very important that you **do not add or delete rows or columns in the tree-diagram area**. If you do, you will not be able to modify the structure of your decision tree.

Figure 16.1 TreePlan Initial Default Decision Tree



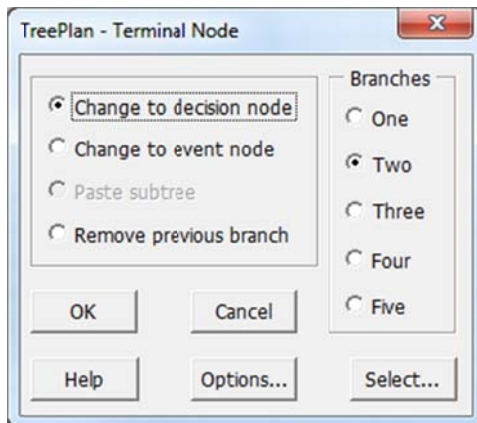
Build your tree by using TreePlan to add or modify branches or nodes in the default tree.

To change the branch labels or probabilities, click on the cell containing the label or probability and type the new label or probability.

To modify the structure of the tree (for example, to add or delete branches or nodes in the tree), select the node (or the cell containing the node) in the tree you want to modify, and choose TreePlan > TreePlan. TreePlan will then present a dialog box showing the available commands.

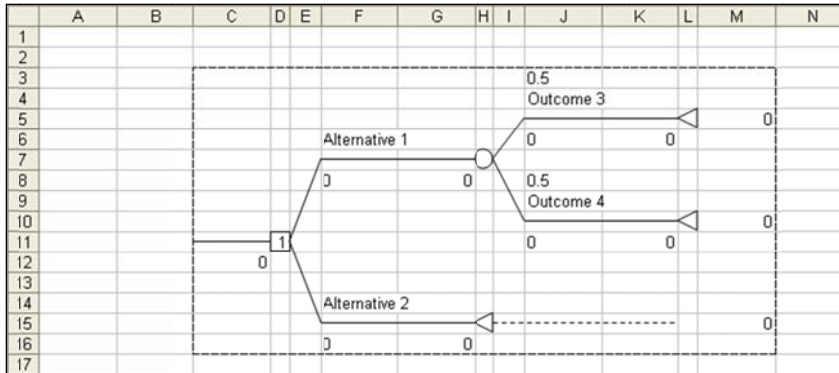
For example, to add an event node to the top branch of the tree shown above, select cell H5 or select the triangle shape, and choose TreePlan > TreePlan. TreePlan then presents this dialog box.

Figure 16.2 TreePlan Terminal Node Dialog Box



To add an event node to the branch, we change the selected terminal node to an event node by selecting **Change to event node** in the dialog box, selecting the number of branches (here two), and pressing **OK**. TreePlan then redraws the tree with a chance node in place of the terminal node.

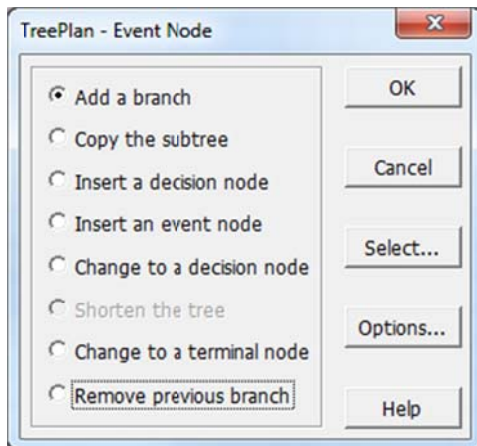
Figure 16.3 Initial Decision Tree Diagram



The dialog boxes presented by TreePlan vary depending on what you have selected when you choose TreePlan > TreePlan.

With an event node selected, the dialog box shown below is presented when you choose TreePlan > TreePlan. A similar dialog box is presented when you select a decision node. If you want to add a branch to the selected node, choose **Add branch** and press **OK**. If you want to insert a decision or event node before the selected node, choose **Insert decision** or **Insert event** and press **OK**. To get a description of the available commands, click on the **Help** button.

Figure 16.4 TreePlan Event Dialog Box



The **Copy subtree** command is particularly useful when building large trees. If two or more parts of the tree are similar, you can copy and paste "subtrees" rather than building up each part separately. To copy a subtree, select the node at the root of the subtree and choose **Copy subtree**. This tells TreePlan to copy the selected node and everything to the right of it in the tree. To paste this subtree, select a terminal node and choose **Paste subtree**. TreePlan then duplicates the specified subtree at the selected terminal node.

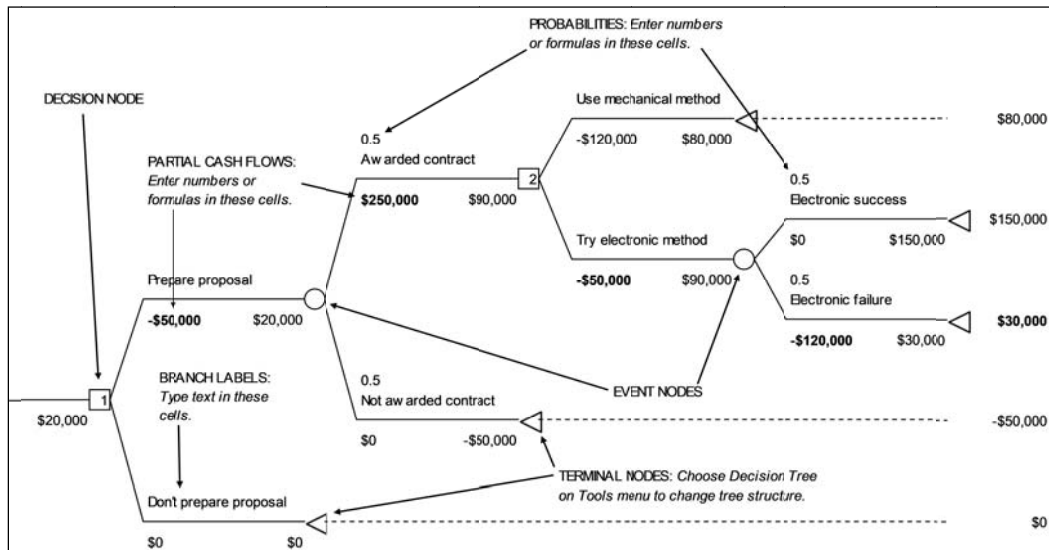
Since TreePlan decision trees are built directly in Excel, you can use Excel's commands to format your tree. For example, you can use bold or italic fonts for branch labels. Select the cells you want to format and change them using Excel's formatting commands. To help you, TreePlan provides a

Select dialog box that appears when you choose TreePlan > TreePlan without a node selected. You can also bring up this dialog box by pressing the **Select** button on the **Node** dialog box. From here, you can select all items of a particular type in the tree. For example, if you choose **Probabilities** and press **OK**, TreePlan selects all cells containing probabilities in the tree. You can then format all of the probabilities simultaneously using Excel's formatting commands.

16.3 ANATOMY OF A TREEPLAN DECISION TREE

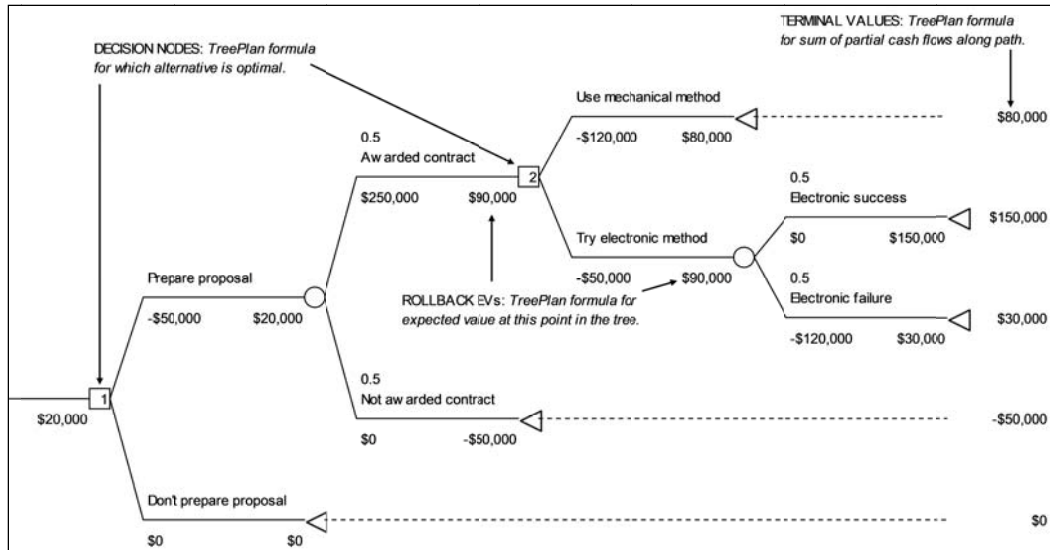
An example of a TreePlan decision tree is shown below. In the example, a firm must decide (1) whether to prepare a proposal for a possible contract and (2) which method to use to satisfy the contract. The tree consists of decision nodes, event nodes and terminal nodes connected by branches. Each branch is surrounded by cells containing formulas, cell references, or labels pertaining to that branch. You may edit the labels, probabilities, and partial cash flows associated with each branch. The partial cash flows are the amount the firm "gets paid" to go down that branch. For the scenario with terminal value \$30,000, the firm pays \$50,000 if it decides to prepare the proposal, receives \$250,000 up front if awarded the contract, spends \$50,000 to try the electronic method, and spends \$120,000 on the mechanical method if the electronic method fails.

Figure 16.5 Nodes, Labels, Cash Flows, and Probabilities



The trees are "solved" using formulas embedded in the spreadsheet. The *terminal values* sum all the partial cash flows along the path leading to that terminal node. The tree is then "rolled back" by computing expected values at event nodes and by maximizing at decision nodes; the *rollback EVs* appear next to each node and show the expected value at that point in the tree. The numbers in the decision nodes indicate which alternative is optimal for that decision. In the example, the "1" in the first decision node indicates that it is optimal to prepare the proposal, and the "2" in the second decision node indicates the firm should try the electronic method because that alternative leads to a higher expected value, \$90,000, than the mechanical method, \$80,000.

Figure 16.6 Terminal Values, Rollback EVs, and Choice Indicators



TreePlan has a few options that control the way calculations are done in the tree. To select these options, press the **Options** button in any of TreePlan's dialog boxes. The first choice is whether to **Use Expected Values** or **Use Exponential Utility Function** for computing certain equivalents. The default is to rollback the tree using expected values. If you choose to use exponential utilities, TreePlan will compute utilities of endpoint cash flows at the terminal nodes and compute expected utilities instead of expected values at event nodes. Expected utilities are calculated in the cell below the certain equivalents. You may also choose to **Maximize (profits)** or **Minimize (costs)** at decision nodes; the default is to maximize profits. If you choose to minimize costs instead, the cash flows are interpreted as costs, and decisions are made by choosing the minimum expected value or certain equivalent rather than the maximum. See the Help file for details on these options.

When you choose to change the tree structure or select a TreePlan option (e.g., min/max), TreePlan first saves the values in the branch name cell, the partial cash flow cell, and the probability cell.

When TreePlan redraws the tree, it enters those saved values and it re-enters formulas for terminal values (sum of partial cash flows), rollback certainty equivalents, and decision node choice indicators.

If you are not using the sum-of-cash-flows formulas for terminal values and if you want to retain your own specific terminal values when TreePlan redraws the tree, enter your terminal value in the partial cash flow cell immediately prior to each terminal node.

16.4 TREEPLAN INPUTS AND FORMULAS

Figure 16.7 Influence Chart of TreePlan Inputs and Formulas

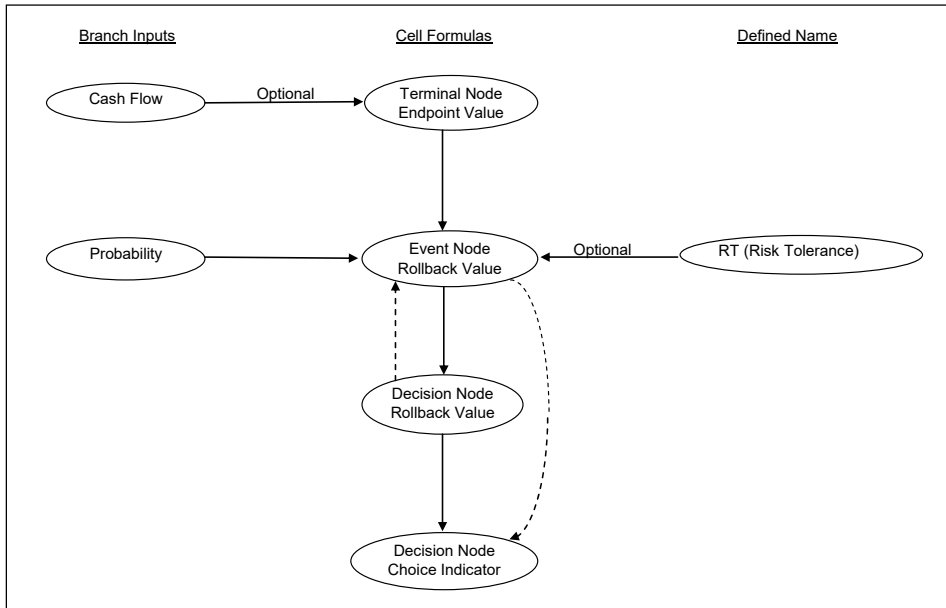


Figure 16.8 Explanation of Formulas

<u>Location</u>	<u>Formula</u>
Endpoint Value at Terminal Node	SUM of branch cash flows
Rollback Value at Event Node	IF probabilities SUM to approximately one, then SUM the products of probabilities times subsequent rollback values
Rollback Value at Decision Node	MAX or MIN of subsequent rollback values
Choice Indicator at Decision Node	Nested IF functions

16.5 STEP-BY-STEP TREEPLAN TUTORIAL

A decision tree can be used as a model for a sequential decision problem under uncertainty. A decision tree describes graphically the decisions to be made, the events that may occur, and the outcomes associated with combinations of decisions and events. Probabilities are assigned to the events, and values are determined for each outcome. A major goal of the analysis is to determine the best decisions.

Decision tree models include such concepts as nodes, branches, terminal values, strategy, payoff distribution, certain equivalent, and the rollback method. The following problem illustrates the basic concepts.

DriveTek Problem

DriveTek Research Institute discovers that a computer company wants a new storage device for a proposed new computer system. Since the computer company does not have research people available to develop the new storage device, it will subcontract the development to an independent research firm. The computer company has offered a fee of \$250,000 for the best proposal for developing the new storage device. The contract will go to the firm with the best technical plan and the highest reputation for technical competence.

DriveTek Research Institute wants to enter the competition. Management estimates a cost of \$50,000 to prepare a proposal with a fifty-fifty chance of winning the contract.

However, DriveTek's engineers are not sure about how they will develop the storage device if they are awarded the contract. Three alternative approaches can be tried. The first approach is a mechanical method with a cost of \$120,000, and the engineers are certain they can develop a successful model with this approach. A second approach involves electronic components. The engineers estimate that the electronic approach will cost only \$50,000 to develop a model of the storage device, but with only a 50 percent chance of satisfactory results. A third approach uses magnetic components; this costs \$80,000, with a 70 percent chance of success.

DriveTek Research can work on only one approach at a time and has time to try only two approaches. If it tries either the magnetic or electronic method and the attempt fails, the second choice must be the mechanical method to guarantee a successful model.

The management of DriveTek Research needs help in incorporating this information into a decision to proceed or not.

[Source: The storage device example is adapted from Spurr and Bonini, *Statistical Analysis for Business Decisions*, Irwin.]

Nodes and Branches

Decision trees have three kinds of nodes and two kinds of branches. A decision node is a point where a choice must be made; it is shown as a square. The branches extending from a decision node are decision branches, each branch representing one of the possible alternatives or courses of action available at that point. The set of alternatives must be mutually exclusive (if one is chosen, the others cannot be chosen) and collectively exhaustive (all possible alternatives must be included in the set).

There are two major decisions in the DriveTek problem. First, the company must decide whether or not to prepare a proposal. Second, if it prepares a proposal and is awarded the contract, it must decide which of the three approaches to try to satisfy the contract.

An event node is a point where uncertainty is resolved (a point where the decision maker learns about the occurrence of an event). An event node, sometimes called a "chance node," is shown as a circle. The event set consists of the event branches extending from an event node, each branch representing one of the possible events that may occur at that point. The set of events must be mutually exclusive (if one occurs, the others cannot occur) and collectively exhaustive (all possible events must be included in the set). Each event is assigned a subjective probability; the sum of probabilities for the events in a set must equal one.

The three sources of uncertainty in the DriveTek problem are: whether it is awarded the contract or not, whether the electronic approach succeeds or fails, and whether the magnetic approach succeeds or fails.

In general, decision nodes and branches represent the controllable factors in a decision problem; event nodes and branches represent uncontrollable factors.

Decision nodes and event nodes are arranged in order of subjective chronology. For example, the position of an event node corresponds to the time when the decision maker learns the outcome of the event (not necessarily when the event occurs).

The third kind of node is a terminal node, representing the final result of a combination of decisions and events. Terminal nodes are the endpoints of a decision tree, shown as the end of a branch on hand-drawn diagrams and as a triangle on computer-generated diagrams.

The following table shows the three kinds of nodes and two kinds of branches used to represent a decision tree.

Figure 16.9 Nodes and Symbols

<u>Type of Node</u>	<u>Written Symbol</u>	<u>Computer Symbol</u>	<u>Node Successor</u>
Decision	square	square	decision branches
Event	circle	circle	event branches
Terminal	endpoint	triangle or bar	terminal value

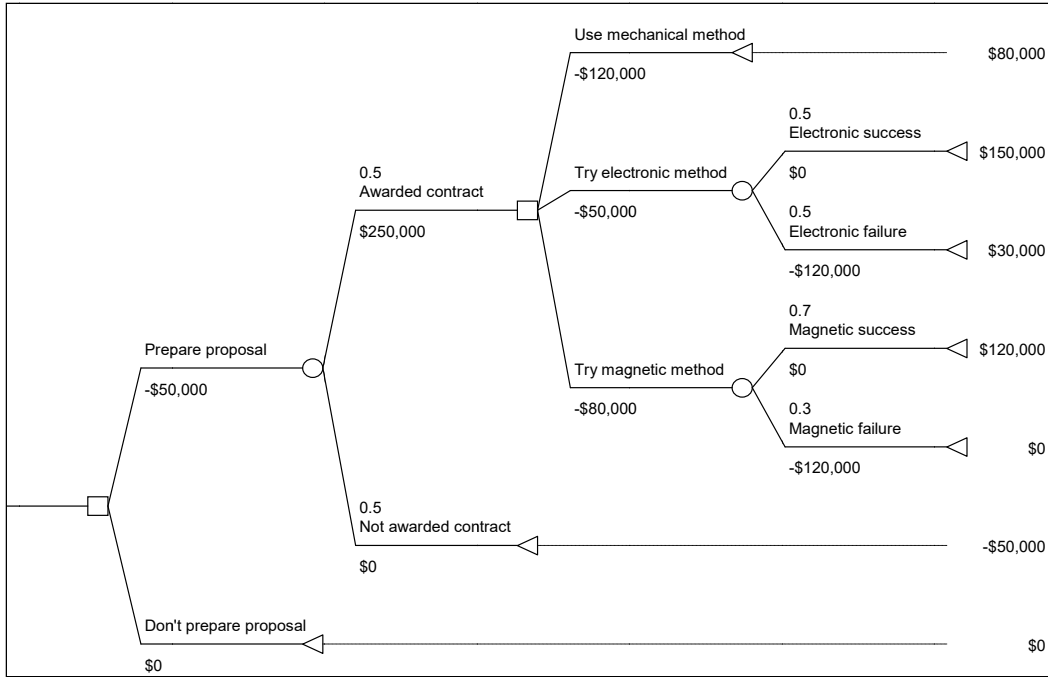
Terminal Values

Each terminal node has an associated terminal value, sometimes called a payoff value, outcome value, or endpoint value. Each terminal value measures the result of a *scenario*: the sequence of decisions and events on a unique path leading from the initial decision node to a specific terminal node.

To determine the terminal value, one approach assigns a cash flow value to each decision branch and event branch and then sum the cash flow values on the branches leading to a terminal node to determine the terminal value. In the DriveTek problem, there are distinct cash flows associated with many of the decision and event branches. Some problems require a more elaborate value model to determine the terminal values.

The following diagram shows the arrangement of branch names, probabilities, and cash flow values on an unsolved tree.

Figure 16.10 DriveTek Decision Tree Diagram



To build the decision tree, you use TreePlan’s dialog boxes to develop the structure. You enter a branch name, branch cash flow, and branch probability (for an event) in the cells above and below the left side of each branch. As you build the tree diagram, TreePlan enters formulas in other cells.

Building the Tree Diagram

1. Start with a new blank worksheet.
2. Select cell A1. Choose TreePlan > TreePlan. In the TreePlan New Tree dialog box, click the New Tree button. A decision node with two branches appears.

Figure 16.11 TreePlan New Tree Dialog Box

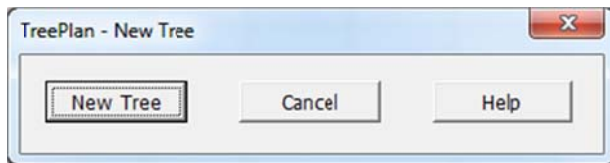


Figure 16.12 Initial Decision Tree Diagram

	A	B	C	D	E	F	G
1							
2				Alternative 1			
3						0	
4			1	0	0		
5							
6		0					
7				Alternative 2			
8						0	
9				0	0		

3. Select cell D2, and enter **Prepare proposal**. Select cell D4, and enter **-50000**. Select cell D7, and enter **Don't prepare proposal**.

Figure 16.13 Branch Names and Cash Flow

	A	B	C	D	E	F	G
1							
2				Prepare proposal			
3						-50000	
4				-50000	-50000		
5			2				
6		0					
7				Don't prepare proposal			
8						0	
9				0	0		

4. Select cell F3. Choose TreePlan > TreePlan. In the TreePlan Terminal Node dialog box, select Change To Event Node, select Two Branches, and click OK. The tree is redrawn.

Figure 16.14 TreePlan Terminal Node Dialog Box

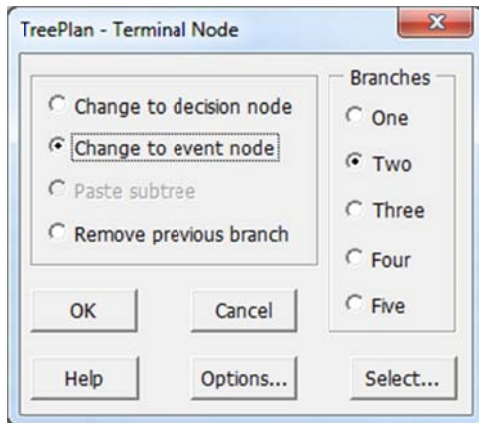


Figure 16.15 Initial Event Branches

	A	B	C	D	E	F	G	H	I	J	K	
1								0.5				
2								Outcome 3				
3										◁	-50000	
4				Prepare proposal				0	-50000			
5												
6				-50000	-50000			0.5				
7								Outcome 4				
8										◁	-50000	
9			2					0	-50000			
10	0											
11												
12				Don't prepare proposal								
13											◁	0
14				0	0							

5. Select cell H2, and enter **Awarded contract**. Select cell H4, and enter **250000**. Select cell H7, and enter **Not awarded contract**.

Figure 16.16 Event Branches With Names and Cash Flow

	A	B	C	D	E	F	G	H	I	J	K	
1								0.5				
2								Awarded contract				
3										◁	200000	
4				Prepare proposal				250000	200000			
5												
6				-50000	75000			0.5				
7								Not awarded contract				
8										◁	-50000	
9			1					0	-50000			
10	75000											
11												
12				Don't prepare proposal								
13											◁	0
14				0	0							

6. Select cell J3. Choose TreePlan > TreePlan. In the TreePlan Terminal Node dialog box, select Change To Decision Node, select Three Branches, and click OK. The tree is redrawn.

Figure 16.17 Subsequent Decision Branches

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2												Alternative 5			
3															200000
4												0	200000		
5															
6								0.5							
7								Awarded contract				Alternative 6			
8											1				200000
9								250000	200000			0	200000		
10															
11															
12								Prepare proposal				Alternative 7			
13															200000
14								-50000	75000			0	200000		
15															
16															
17								0.5							
18								Not awarded contract							-50000
19															
20								0	-50000						
21															
22								Don't prepare proposal							
23															0
24								0	0						

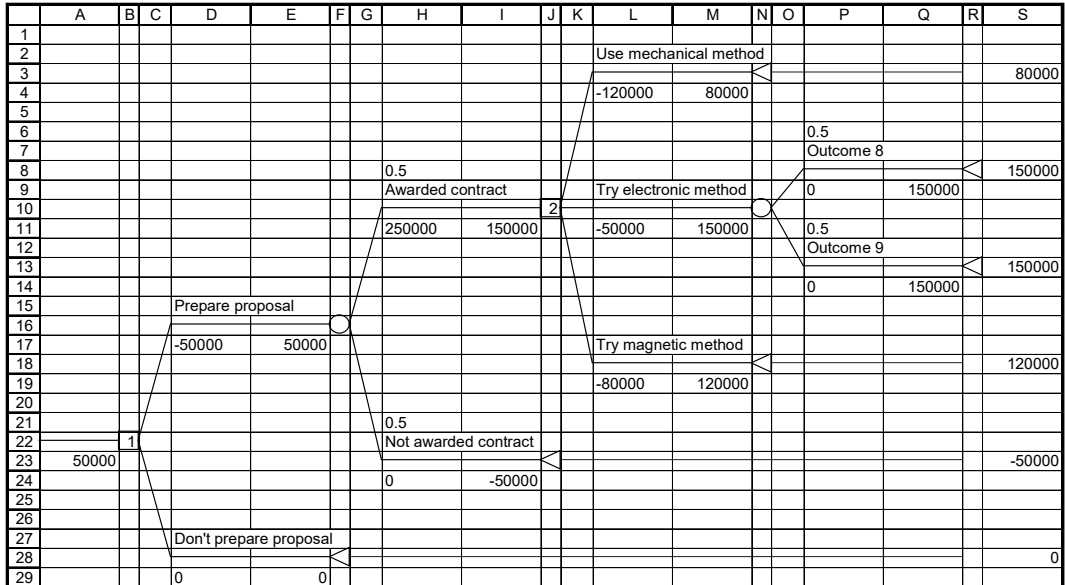
7. Select cell L2, and enter **Use mechanical method**. Select cell L4, and enter **-120000**. Select cell L7, and enter **Try electronic method**. Select cell L9, and enter **-50000**. Select cell L12, and enter **Try magnetic method**. Select cell L14, and enter **-80000**.

Figure 16.18 Subsequent Decision Branches With Names and Cash Flows

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2												Use mechanical method			
3															80000
4												-120000	80000		
5															
6								0.5							
7								Awarded contract				Try electronic method			
8											2				150000
9								250000	150000			-50000	150000		
10															
11															
12								Prepare proposal				Try magnetic method			
13															120000
14								-50000	50000			-80000	120000		
15															
16															
17								0.5							
18								Not awarded contract							-50000
19															
20								0	-50000						
21															
22								Don't prepare proposal							
23															0
24								0	0						

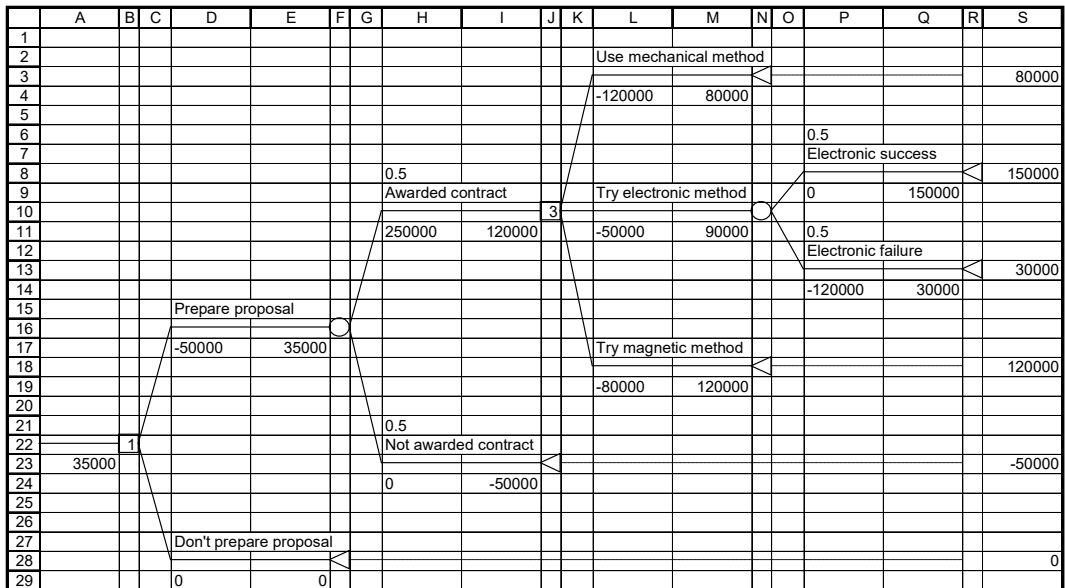
8. Select cell N8. Choose TreePlan > TreePlan. In the TreePlan Terminal Node dialog box, select Change To Event Node, select Two Branches, and click OK. The tree is redrawn.

Figure 16.19 Branches for Electronic Method Uncertainty



9. Select cell P7, and enter **Electronic success**. Select cell P12, and enter **Electronic failure**. Select cell P14, and enter **-120000**.

Figure 16.20 Branch Names and Cash Flows for Electronic Method Uncertainty



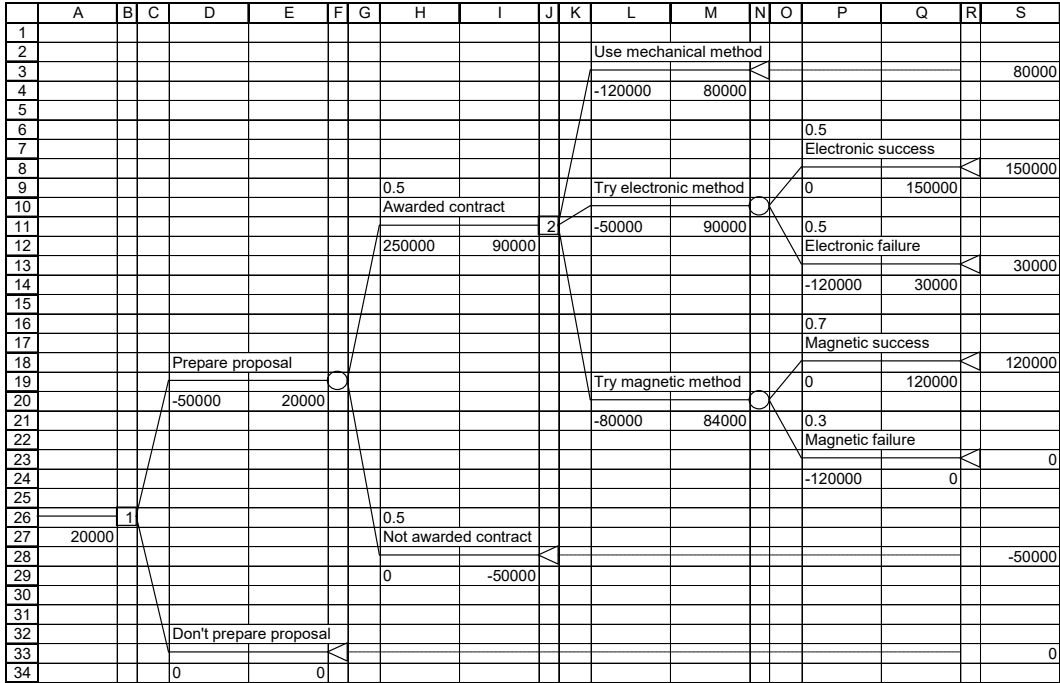
10. Select cell N18. Choose TreePlan > TreePlan. In the TreePlan Terminal Node dialog box, select Change To Event Node, select Two Branches, and click OK. The tree is redrawn.

Figure 16.21 Branches for Magnetic Method Uncertainty

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
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11. Select cell P16, and enter .7. Select cell P17, and enter **Magnetic success**. Select cell P21, and enter .3. Select cell P22, and enter **Magnetic failure**. Select cell P24, and enter **-120000**.

Figure 16.22 Complete Diagram Before Formatting



12. Rename the sheet tab **Original**. Save the workbook.

Interpreting the Results

The \$30,000 terminal value on the far right of the diagram in cell S13 is associated with the following scenario:

Figure 16.23 Evaluation of a Scenario

<u>Branch Type</u>	<u>Branch Name</u>	<u>Cash Flow</u>
Decision	Prepare proposal	-\$50,000
Event	Awarded contract	\$250,000
Decision	Try electronic method	-\$50,000
Event	Electronic failure (Use mechanical method)	-\$120,000
	Terminal value	\$30,000

TreePlan put the formula =SUM(P14,L11,H12,D20) into cell S13 for determining the terminal value.

Other formulas, called rollback formulas, are in cells below and to the left of each node. These formulas are used to determine the optimal choice at each decision node.

In cell B26, a formula displays 1, indicating that the first branch is the optimal choice. Thus, the initial choice is to prepare the proposal. In cell J11, a formula displays 2, indicating that the second branch (numbered 1, 2, and 3, from top to bottom) is the optimal choice. If awarded the

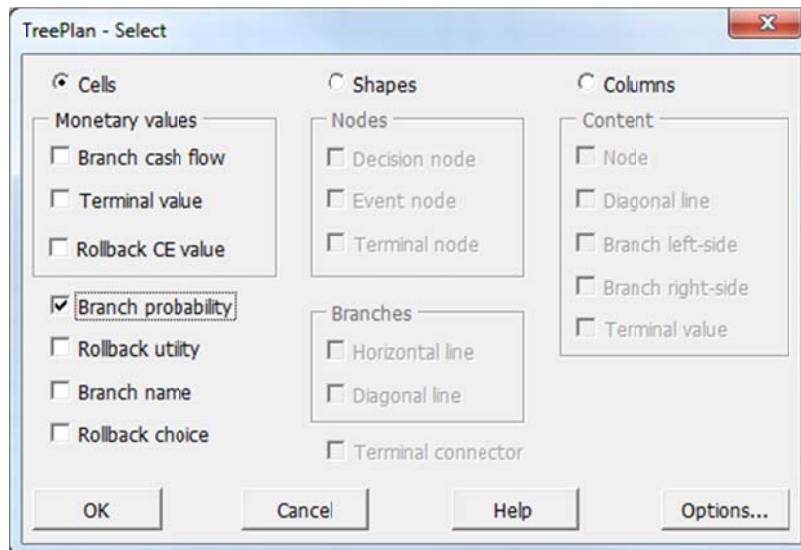
contract, DriveTek should try the electronic method. A subsequent chapter provides more details about interpretation.

Formatting the Tree Diagram

The following steps show how to use TreePlan and Excel features to format the tree diagram. You may choose to use other formats for your own tree diagrams.

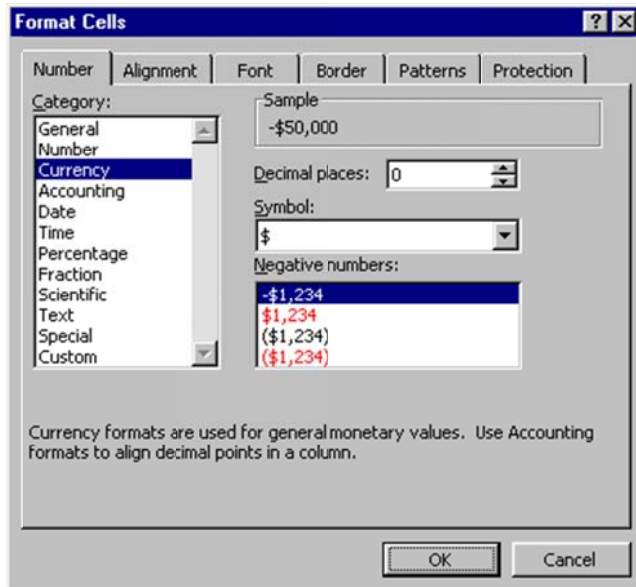
13. Right-click the sheet tab, and choose Move Or Copy from the shortcut menu. In the lower left corner of the Move Or Copy dialog box, check the Create A Copy box, and click OK.
14. On sheet Original (2), if the probabilities are not left-aligned, select cell H9. Choose TreePlan > TreePlan. In the TreePlan Select dialog box, verify that the option button for Cells and the Branch Probability checkbox are selected, and click OK. With all probability cells selected, click the Align Left button.

Figure 16.24 TreePlan Select Dialog Box



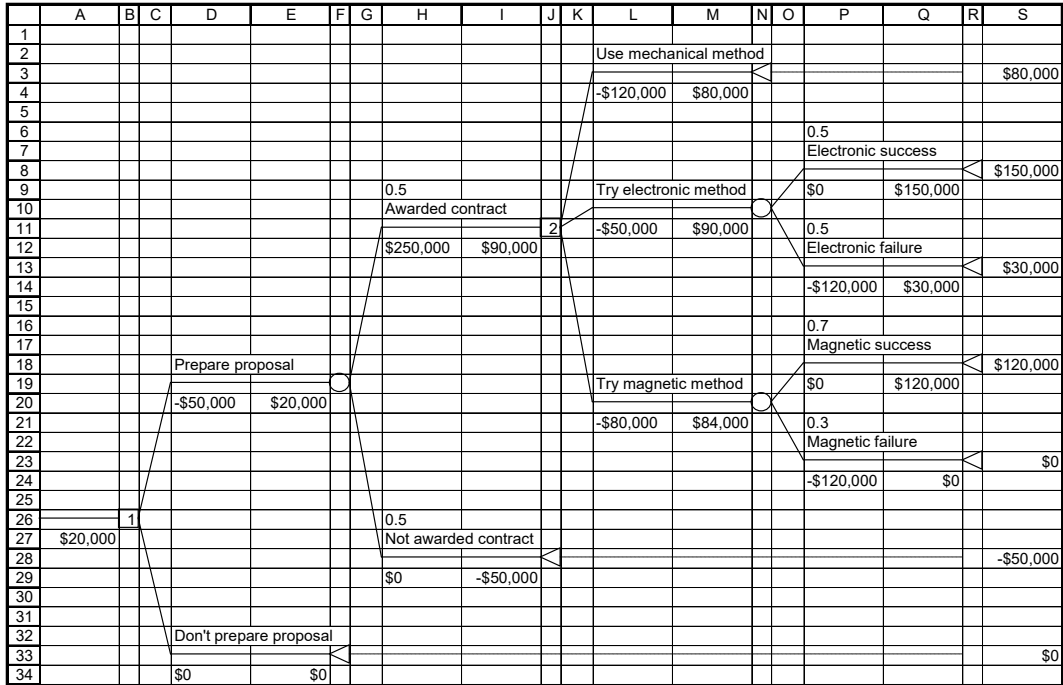
15. Select cell H12. Choose TreePlan > TreePlan. In the TreePlan Select dialog box, verify that the option button for Cells and Branch Cash Flow checkbox are selected, and click OK. With all branch cash flow cells selected, if the cash flows are not left-aligned, click the Align Left button. With those cells still selected, choose Home > Format > Format Cells. In the Format Cells dialog box, click the Number tab. In the Category list box, choose Currency; type 0 (zero) for Decimal Places; select \$ in the Symbol list box; select -\$1,234 for Negative Numbers. Click OK.

Figure 16.25 Excel Format Cells Dialog Box



16. Select cell I12. Choose TreePlan > TreePlan. In the TreePlan Select dialog box, verify that the option button for Cells and the Rollback CE checkbox are selected, and click OK. With all rollback cells selected, choose Format > Cells. Repeat the Currency formatting of step 16 above.
17. Select cell S3. Choose TreePlan > TreePlan. In the TreePlan Select dialog box, verify that the option button for Cells and the Terminal Value checkbox are selected, and click OK. With all terminal value cells selected, choose Format > Cells. Repeat the Currency formatting of step 16 above.

Figure 16.26 Complete DriveTek Decision Tree



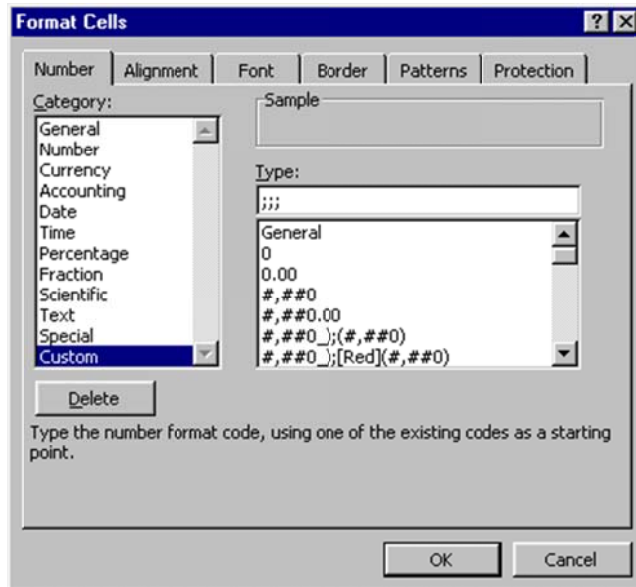
- Right-click the sheet tab, choose Rename from the shortcut menu, and enter **Formatted**. Save the workbook.

Displaying Model Inputs

When you build a decision tree model, you may want to discuss the model and its assumptions with co-workers or a client. For such communication it may be preferable to hide the results of formulas that show rollback values and decision node choices. The following steps show how to display only the model inputs.

- Right-click the sheet tab, and choose Move Or Copy from the shortcut menu. In the lower left corner of the Move Or Copy dialog box, check the Create A Copy box, and click OK.
- On sheet Formatted (2), select cell B1. Choose TreePlan > TreePlan. In the TreePlan Select dialog box, verify that the option button for Columns and the Node checkbox are selected, and click OK. With all node columns selected, choose Home > Format > Format Cells > Number. In the Category list box, select Custom. Select the entry in the Type edit box, and type ;;; (three semicolons). Click OK.

Figure 16.27 Excel Format Cells Dialog Box



Explanation: A custom number format has four sections of format codes. The sections are separated by semicolons, and they define the formats for positive numbers, negative numbers, zero values, and text, in that order. When you specify three semicolons without format codes, Excel does not display positive numbers, negative numbers, zero values, or text. The formula remains in the cell, but its result is not displayed. Later, if you want to display the result, you can change the format without having to enter the formula again. Editing an existing format does not delete it. All formats are saved with the workbook unless you explicitly delete a format.

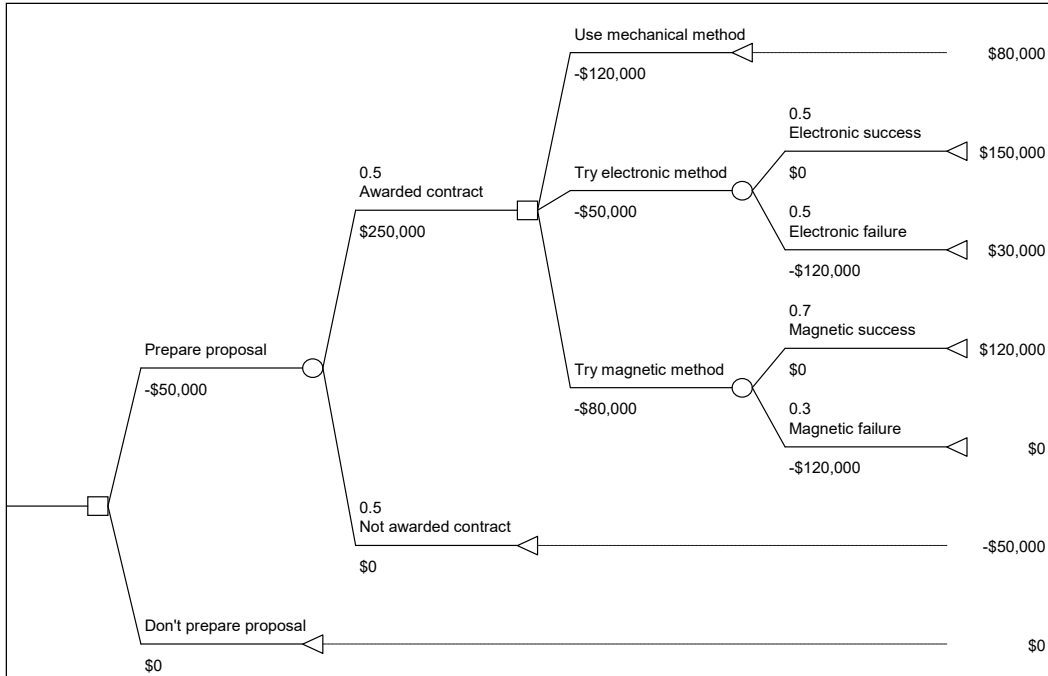
21. Select cell A27. Choose TreePlan > TreePlan. In the TreePlan Select dialog box, verify that the option button for Cells and the Rollback CE Value checkbox are selected, and click OK. With all rollback values selected, choose Home > Format > Format Cells > Number. In the Category list box, select Custom. Scroll to the bottom of the Type list box, and select the three-semicolon entry. Click OK.
22. Right-click the sheet tab, choose Rename from the shortcut menu, and enter **Model Inputs**. Save the workbook.

Printing the Tree Diagram

23. The Name Box list box is located just above cell A1. Click the Name Box, and select TreeDiagram.
24. To print the tree diagram from Excel, choose Page Layout, and clear the checkbox for Gridlines View. With the tree diagram range selected, choose Page Layout > Print Area > Set Print Area. Then choose File > Print. For this diagram set Landscape Orientation click the option button for Landscape. For Windows, use No Scaling; for Mac, uncheck Scale To Fit. Click the Sheet tab; clear the check box for Gridlines. Click the Print button.

25. To print the tree diagram from Word, in Excel select the tree diagram range. On Excel's Page Layout ribbon, uncheck Gridlines View. On Excel's Home ribbon, click (Clipboard) Copy. In Word, select the insertion point, and on Word's Home ribbon, click the (Clipboard) Paste dropdown arrow, and click Paste as Picture.

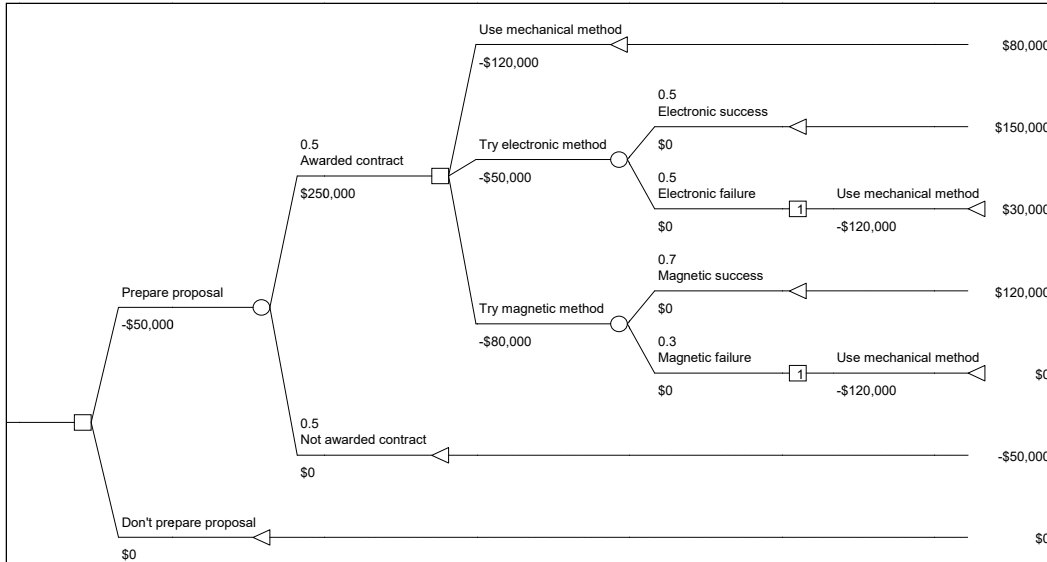
Figure 16.28 DriveTek Without Rollback Values



Alternative Model

If you want to emphasize that the time constraint forces DriveTek to use the mechanical approach if they try either of the uncertain approaches and experience a failure, you can change the terminal nodes in cells R13 and R23 to decision nodes, each with a single branch.

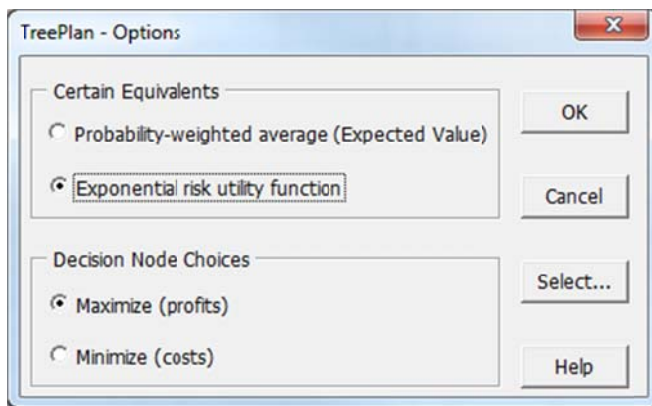
Figure 16.29 Alternative DriveTek Decision Tree



16.6 EXPONENTIAL UTILITY AND TREEPLAN

TreePlan's default is to rollback the tree using expected value (probability-weighted average) at an event node and maximum of successor values at a decision node. If you choose to use exponential utilities in TreePlan's Options dialog box, TreePlan will redraw the decision tree diagram with formulas for computing the utility and certain equivalent at each node.

Figure 16.30 TreePlan Options Dialog Box



For the Maximize option with exponential utility, the rollback formulas are $U = A - B * \text{EXP}(-X/RT)$ and $CE = -\text{LN}((A - EU)/B) * RT$, where X and EU are cell references.

For the Minimize option with exponential utility, the formulas are $U = A - B * \text{EXP}(X/RT)$ and $CE = \text{LN}((A - EU)/B) * RT$.

TreePlan uses the name RT to represent the risk tolerance parameter of the exponential utility function. The names A and B determine scaling. When you choose to use exponential utility, if the names A, B, and RT do not already exist in the worksheet or workbook, they are initially defined as A=1, B=1, and RT=999999999999.

In Windows Excel you can change the values of defined names using Formulas > Name Manager > Edit.

In Mac Excel you can change the values of defined names by choosing (from the topmost menu) Insert > Name > Define Name or by choosing Formulas > Define Name. In the Define Name dialog box, after you select a name in the “Names in workbook” list box, enter a new value in the “Select the range of cells” edit box, and click the OK button.

16.7 ACKNOWLEDGEMENT

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