APPLYING MULTI-CRITERIA DECISION MAKING TO THE SELECTION OF PAVEMENT MARKINGS

USER'S GUIDE

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16. Abstract

This is a User's Guide for applying multi-criteria decision making to the selection of pavement markings.

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SUMMARY OF COMMON LDW COMMANDS

FILE:: OPEN — Allows the user to access a selected LDW model (c:\PAVEMARK.ldw, OR c:\EXAMPLE.ldw).

SAVE — Saves the updated version of the LDW file as the current name.

SAVEAS — Saves the updated file as a new file name, so that the original file is preserved.

PRINT — Sends selected results outputs to the printer

EDIT:: ADD — Allows the user to add alternatives to the matrix.

DELETE — Allows for a selected alternative to be deleted.

VIEW::MATRIX — Brings up the matrix which shows the alternatives and the scores for each alternative for each measure. Use this view to:

- Add or Delete an existing alternative
- Edit data for an alternative
- Input new data for an added alternative

RESULTS::

RANK ALTERNATIVES

Gives output on how the alternatives ranked under a given goal. For overall results, select the Best Pavement Marking Goal.

COMPARE ALTERNATIVES

Provides analysis of what caused the major differences in utility between two alternatives.

SENSITIVITY GRAPH

Displays a graph showing how changing the weight of a selected goal or measure affects the overall ranking of the alternatives.

SENSITIVITY TABLE

Gives resultant utility values for all alternatives for a specific change in weight for a selected goal or measure.

GRAPH ALTERNATIVES

Displays a chart showing the component utilities which made up an overall utility for a selected goal.

INTRODUCTION:

The Connecticut Department of Transportation (ConnDOT) currently uses various marking systems to provide guidance to motorists. Each of these systems has unique placement and performance requirements, as well as a wide range of costs. To help assist in deciding which systems will be the most useful and cost effective under given conditions, a decision support system (DSS) based on multi-criteria decision making has been developed utilizing "Logical Decisions for Windows" (LDW) software.

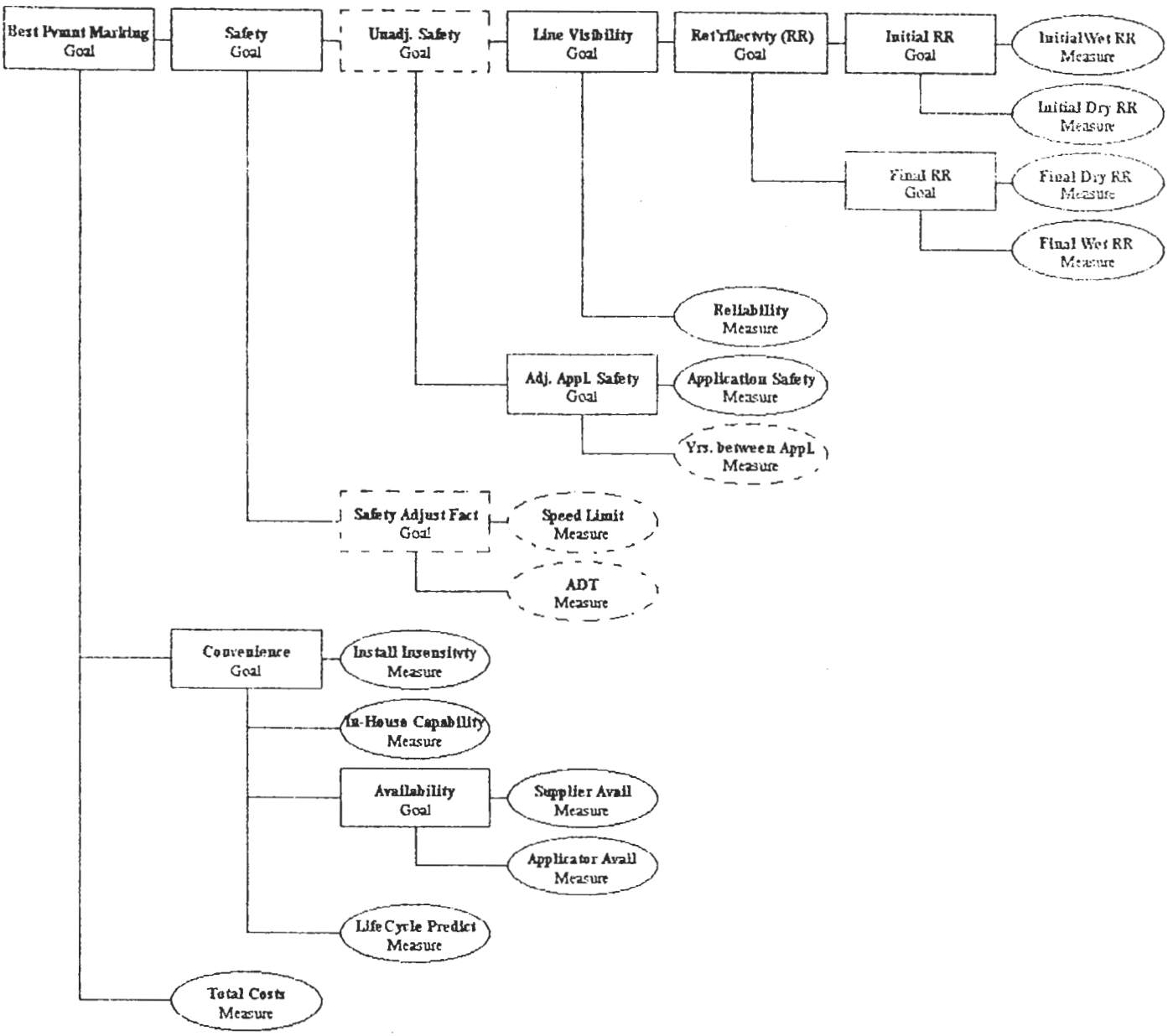
The software has been programmed with all of the background information to create a model which LDW can use to analyze which alternative, or pavement marking system, will suit a specific application the best. The main intent of this manual is to illustrate to the user how to input new alternatives into the software, and view the results of the analysis. It is not intended to facilitate changes to the model itself.

GETTING STARTED:

First make sure that LDW is properly installed on your machine. See Section 2 (page 7) of your Logical Decisions software manual [1] for hardware requirements and installation. Once the program is running, the pavement marking model must be loaded into the software. The model is titled PAVEMARK. This file should be saved onto the hard drives of any machines which will be utilizing the software under the LDW subdirectory prior to use. This may easily be done by loading the model in from drive A by choosing *OPEN* from the file menu, and then specifying the filename A:PAVEMARK. This file may then be saved to the hard drive by selecting *SAVEAS* from the file menu and saving the model as PAVEMARK.ldw, making sure that the C drive is the current drive

The hierarchy of goals that has been set up for the model is illustrated in Figure 1. The Best Pavement Marking goal is the overall goal to be satisfied from the analysis. Beneath it are three subgoals Safety, Convenience, and Total Costs. Moving to the right notice that the final item on each line is a measure (oval shaped). These measures are the

FIGURE 1: Goals Hierarchy



inputs that are required for each alternative by the user. Also notice that "dummy" goals and measures appear in the hierarchy using dotted lines. These dummy measures and goals allow the software to take into account various adjustment factors that have been included in the model. These adjustment factors are described in Section IV of the Working Report by Campbell and Davis[2]. Note that the software does not distinguish between dummy measures and goals and regular ones, so no dotted lines will appear in the goal hierarchy displayed by the software.

When the model is first loaded into the software, the screen will show a small window with a portion of the goals hierarchy as shown in Figure 1. This window should be closed, because this view is not necessary from a user standpoint. Double click the mouse on the upper left corner of the box to close this window. If you do wish to view the goals hierarchy within the software, use the *VIEW::GOALS HIERARCHY* option. When this option is selected a dialogue box will appear. Select the starting goal to be Best Pavement Marking, and then click on *OK*. This will give a full screen window showing the goals hierarchy as in Figure 1 without dotted lines. If you would like to see more of the goals on the screen at one time, use the *WINDOW::ZOOM* command. When the menu appears, type a new zoom value as a percent. Decreasing the zoom percentage value will show more of the goals.

ADDING ALTERNATIVES:

An alternative is one particular pavement marking type applied at a specified frequency (e.g., epoxy paint applied every two years). All alternatives that are under consideration for a given application must have their measurement values inputted into the software. Appendix B of the Working Report[2] contains the checklist which must be completed for each alternative prior to utilization of the DSS.

Throughout this user manual, we will look at an example of three pavement markings alternatives, including Preformed Plastic every four years, Epoxy once a year,

and Epoxy every two years. Figure 2 contains the checklist form from Appendix B completely filled out for the alternative Epoxy every two years. Figure 3 shows a matrix similar to that which will show up on the screen once you are in the Logical Decisions program. Figure 4 is a completed matrix showing the example data for the three alternatives, ready for input into Logical Decisions (these data may or may not resemble realistic data about these markings).

To input the alternatives, select the *VIEW::MATRIX* option. This matrix is a "spreadsheet-like" table of the alternatives and their measures. . The cursor (or green highlight) may be moved around the matrix using the arrows, or by using the mouse. Notice that there is already one alternative in the matrix labeled "NEW ALTERNATIVE". This alternative has default values that are the best in all categories. Any time a new alternative is added, the default value for each measure will be the value that represents the highest utility. To add two additional alternatives for a total of three, follow these steps:

- Click on the cell labeled "NEW ALTERNATIVE" on the left of the matrix
- Select the *EDIT::ADD* option
- Choose *ALTERNATIVE* from the next menu, and then *OK*
- Copy from an existing alternative?, select *NO*
- At the dialogue box labeled NEW ALTERNATIVE, select *OK*

When a new alternative is added , it will automatically be labeled "NEW ALTERNATIVE1". Repeat this step so that three alternatives are now shown on the matrix, labeled NEW ALTERNATIVE, NEW ALTERNATIVE1, and NEW ALTERNATIVE2.

APPENDIX B. PAVEMENT MARKING EVALUATION CHECKLIST

Description of Application
(i.e., the stretch of roadway to be marked)

Roadway label and location: Example

Speed limit: 55 ADT: 85,000

Pavement type: class 1 surface

Description of Pavement Marking Alternative

marking type: Epoxy
(e.g. epoxy)

expected number of years between applications: 2

Measurement Values for Pavement Marking Alternative

Measure 1. Initial dry-pavement retroreflectivity (based on when the marking is initially applied).

225 mcd./sq.m./lux

Measure 2. Initial wet-pavement retroreflectivity.

Under moderate rainfall conditions, the retroreflectivity of the newly-applied pavement marking is:

Circle one:

1) Barely visible.
2) Below average.
(3) Average.
4) Above average.
5) Excellent.

Measure 3. Final-month dry-pavement retroreflectivity (based on the final month of the marking's specified life-span).

50 mcd./sq.m./lux

Measure 4. Final-month wet-pavement retroreflectivity.

Under moderate rainfall conditions, the retroreflectivity of the pavement marking during the final month of its specified life-span is:

Circle one:

(1) Barely visible.
2) Below average.
3) Average.
4) Above average.
5) Excellent.

Measure 5. Reliability. Circle one:

1) ConnDOT has had experience with or strong reason to suspect premature failure.
2) ConnDOT has some reason to suspect that there could be premature failure.
(3) There is little reason to suspect premature failure.
4) Evidence suggests that the material has a high probability of lasting for its specified life.
5) There is strong evidence that the material has a high probability of lasting for its specified life.

Measure 6. Application safety. Circle one.

1) Characterized by a combination of two or more constraints of long duration and/or unattached devices, and/or more than one normal lane occupied, and/or application time constraints.
2) One major constraint, either long road duration or unattached devices.
3) One or more moderate constraints.
(4) Two or fewer minor constraints of duration, devices, lanes occupied or time constraints.
5) Characterized by short duration, no unattached devices, no more than one lane occupied, and no time constraints.

FIGURE 2: Completed checklist form for TWO YEAR EPOXY alternative

Total costs (based on a ten year time horizon and considering the funding available for this application)

A. cost of materials and installation ($/lin.ft.) for each application: .25 A.

B. expected number of applications in 10 years: 5 B.

C. maintenance costs over 10 years ($/lin.ft.): _____ C.

D. cost of each eradication ($/lin.ft.): _____ D.

E. expected number of eradications over 10 years: ____ E.

F. other costs incurred over 10 yrs. ($/lin.ft.): _____ F.

Measure 7. = [(AxB) + C + (DxE) + F] / 10 = .125 ($/lin.ft./year)

Measure 8. Installation insensitivity. Circle one:

1) characterized by being sensitive enough to substantially limit application to controlled conditions.
2) characterized by being sensitive to the extent that significant caution must be exercised prior to the application.
3) average sensitivity when compared with other materials and only ordinary care need be exercised prior to application.
(4) slightly sensitive with minor caution required prior to application.
5) characterized by being relatively insensitive.

Measure 9. In-house capability. Can ConnDOT apply this type of pavement marking? Circle one:

(0) No 1) Yes

Measure 10. Life-Cycle Predictability. Circle one:

1) considered unpredictable due to past experience or a lack of experience.
2) considered to have a wide range of life-cycle predictability and/or not presently adequately familiar.
3) considered to have a range to the extent that we are not yet comfortable with the life-cycle's prediction. Based on limited and/or inconclusive experience, unable to rank otherwise.
(4) considered to be predictable but with a few divergent experiences.
5) considered highly predictable.

Measure 11. Number of suppliers of the pavement marking material. Circle one:

1) very limited
(2) somewhat limited
3) average
4) more than average
5) plentiful

Measure 12. Number of applicators of the pavement marking material. Circle one:

1) very limited
2) somewhat limited
3) average
(4) more than average
5) plentiful

FIGURE 2: (continued)

FIGURE 3: Matrix View

ALTERNATIVE	SPEED LIMIT	ADT	YEARS BETWEEN APPLICATIONS	INITIAL DRY RR	INITIAL WET RR	FINAL DRY RR	FINAL WET RR	RELIABILITY

ALTERNATIVE	APPLICATION SAFETY	TOTAL COST	INSTALLATION INSENSITIVITY	IN-HOUSE CAPABILITY	LIFECYCLE PREDICTABILITY	SUPPLIER AVAILABILITY	APPLICATOR AVAILABILITY

FIGURE 4: Completed Matrix

ALTERNATIVE	SPEED LIMIT	ADT	YEARS BETWEEN APPLICATIONS	INITIAL DRY RR	INITIAL WET RR	FINAL DRY RR	FINAL WET RR	RELIABILITY
ONE YEAR EPOXY	55	85000	1	225	3	75	3	3
FOUR YEAR PLASTIC	55	85000	4	590	5	84	4	2
TWO YEAR EPOXY	55	85000	2	225	3	50	1	3

ALTERNATIVE	APPLICATION SAFETY	TOTAL COST	INSTALLATION INSENSITIVITY	IN-HOUSE CAPABILITY	LIFECYCLE PREDICTABILITY	SUPPLIER AVAILABILITY	APPLICATOR AVAILABILITY
ONE YEAR EPOXY	4	0.25	4	0	4	2	4
FOUR YEAR PLASTIC	3	0.575	1	1	3	4	2
TWO YEAR EPOXY	4	0.125	4	0	4	2	4

Now we will change the alternative names to reflect names that are significant to our analysis. *Double* click the mouse on the alternative box labeled NEW ALTERNATIVE in the matrix. A dialogue box then shows up, displaying the name NEW ALTERNATIVE in the box in the upper left corner. Click the mouse on this box, and rename this alternative ONE YEAR EPOXY. Select *OK* after renaming the alternative. Repeat this for the other two alternatives, naming them FOUR YR PLASTIC, AND TWO YEAR EPOXY, as shown in Figure 4. Now the alternatives are properly labeled, and we are ready to input the data from Figure 4.

DATA ENTRY:

To begin inputting data into the matrix, click the mouse on the first cell of the matrix, which is labeled as the measure Speed Limit for the ONE YEAR EPOXY alternative. Type in the corresponding values from Figure 4. Type <ENTER> when the correct value for the cell is completed. Complete entering the data as displayed in Figure 4. Notice that the order of the measures in the Logical Decisions matrix corresponds directly to the order of information on the checklist form shown in Figure 2. . If a mistake is made, move the cursor back to the cell with the error, and type in a new value, hitting <ENTER> when it is complete.

Now you may want to save the information you have inputted. Use the *FILE::SAVEAS* command, and title the data with something other than that of the model, such as MARKING1.LDW. Click *OK* after the new name is entered to complete the save. Now we are ready to see some of the results of the analysis carried out by the model.

VIEWING RESULTS:

RANK ALTERNATIVES

LDW allows several ways to look at the results of the analysis. The first and most direct way is the *RESULTS::RANK ALTERNATIVES* option. This will display the utilities associated with each alternative for any of the specified goals. When the *RANK ALTERNATIVES* option is chosen, a dialogue box appears, asking for what goal or measure should the alternatives be ranked. Any of the goals or measures from the goals hierarchy may be examined. From the dialogue box, choose the Best Pavement Marking goal, and then click *SELECT*. Selecting the overall goal Best Pavement Marking will give you the overall ranking results for the analysis. Figure 5 displays the chart that LDW will create when this option is carried out.

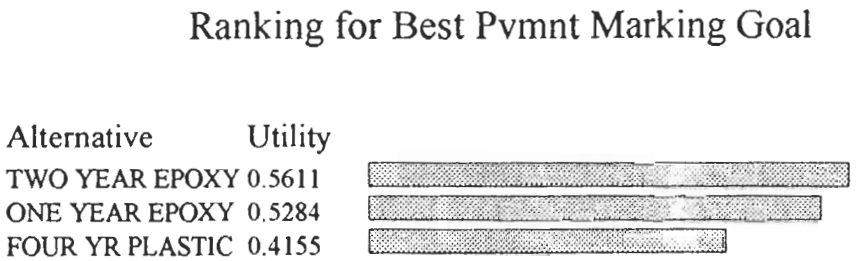


FIGURE 5. *RANK ALTERNATIVES* for overall goal

This bar chart displays the corresponding utility values for each alternative under the chosen goal. If a measure is chosen rather than a goal, LDW will show the measure level as well as the corresponding utility for each alternative. If any of the alternatives has a measure value which is less than the minimum that was specified, LDW will state in the rank alternative section that this alternative failed under the given measure.

When looking at these results from LDW, it is apparent that there is not a large difference in utility between the top two alternatives (.0327). In order to understand the significance of this small difference in utility, and where it has come from, we must take a

closer look at what has caused the differences in utility. To accomplish this, we will use the compare alternatives option in LDW.

COMPARE ALTERNATIVES

This option in LDW allows the user to examine in detail the differences between two alternatives. This is carried out by selecting *RESULTS::COMPARE ALTERNATIVES* . When this option is selected, LDW shows a dialogue box where the two alternatives to be compared must be specified. In order to get a better understanding of where the difference in utility between the top two alternatives comes from, select the TWO YEAR EPOXY alternative and the ONE YEAR EPOXY alternative and then click on *SELECT*. Figure 12 shows what this option would look like in comparing these two alternatives.

In this table LDW compares the alternatives by the measures that make the largest contribution to the difference in overall utility between the alternatives selected. The measures are sorted by largest contributions to one alternative or the other. Negative contributions show that alternative 2, the lower ranked alternative, scored better on the associated measure than the higher ranked alternative.

Overall Utility for TWO YEAR EPOXY (Alt1) = 0.5611

Difference = 0.0327

Measure	Alt1 Level	Alt2 Level	% Contribution to Difference	Total Contribution
Total Costs	0.125	0.25	132.6	0.04333
Final Wet RR	1	3	-28.5	-0.009299
Final Dry RR	50	75	-19.6	-0.006393
Yrs. between Appl.	2	1	15.4	0.005034

FIGURE 12. *COMPARE ALTERNATIVES* option

The Total Contribution is the absolute amount of the difference in overall utility between the two alternatives that is due to the measure. From Figure 12, you can see that the sum

of the total contribution column will equal the difference in utility between the two alternatives, which in this case is 0.0327.

Using the compare alternatives option, you can understand exactly what the difference in utility between the top two alternatives represents. The majority of the difference in utility between the TWO YEAR EPOXY and the ONE YEAR EPOXY alternatives resulted from the decreased cost of the two year, and to a small extent the number of years between applications (which offsets application safety through an adjustment factor). The increase in line visibility, shown in the measure categories Final Wet RR and Final Dry RR, which one gains from repainting every year was not enough to offset the added cost. This analysis shows that the small overall differences in utility have resulted from larger differences that have offset each other.

For the pavement marking analysis, you may wish to examine not only how the alternatives ranked under the overall goal, but also how each ranked under some of the main subgoals, such as Safety, Convenience, and Total Costs. These subgoals may be selected from the dialogue box after the *RANK ALTERNATIVES* option is chosen so that the utilities associated with these other goals may also be examined. For our example, the results of the ranking for these three subgoals are shown in Figures 6, 7, and 8.

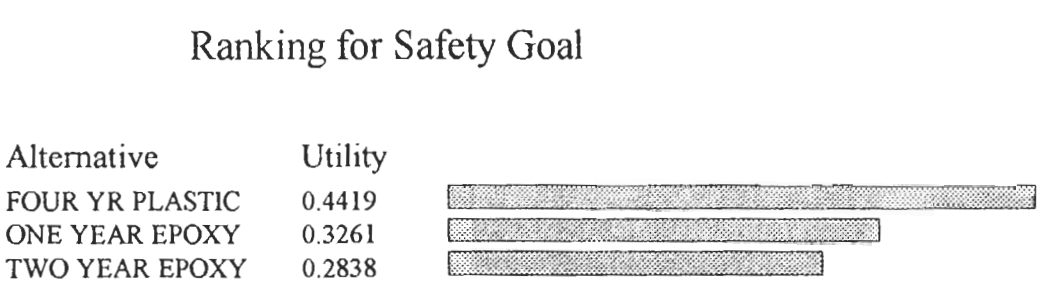


FIGURE 6. *RANK ALTERNATIVES* for Safety Goal

Ranking for Convenience Goal

Alternative	Utility
TWO YEAR EPOXY	0.4985
ONE YEAR EPOXY	0.4985
FOUR YR PLASTIC	0.3387

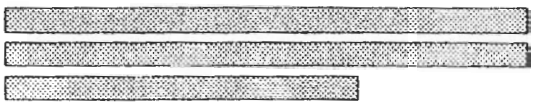


FIGURE 7. *RANK ALTERNATIVES* for Convenience Goal

Ranking for Total Costs Goal
($$/linear foot/year)

Alternative	Utility	Level
TWO YEAR EPOXY	0.875	0.125
ONE YEAR EPOXY	0.75	0.25
FOUR YR PLASTIC	0.425	0.575

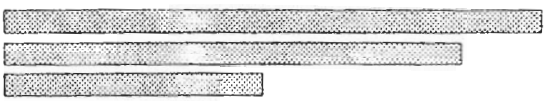


FIGURE 8. *RANK ALTERNATIVES* for Total Costs Goal

GRAPH ALTERNATIVES

Another way to look at the results is through the use of the *RESULTS::GRAPH ALTERNATIVES* option. This option will display a bar graph showing the performance of a single alternative based on the goals and measures under any specified goal . For this bar graph, the width of the bar for a measure or goal is proportional to its weight.

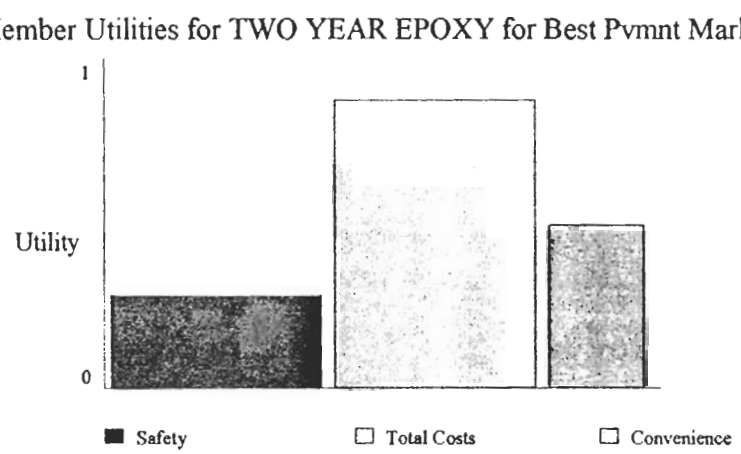


FIGURE 9. *GRAPH ALTERNATIVES* option

When this option is chosen, a dialogue box appears which allows you to customize the graph. The simplest way to complete the dialogue box is to select an alternative and a goal, and then keep the default values for the rest of the items by clicking *OK*. Figure 9 shows what the results of the option would look like for the TWO YEAR EPOXY alternative under the Best Pavement Marking Goal. The bars shown represent how high the alternative scored for each of the three subgoals under the overall goal.

SENSITIVITY GRAPHS

A sensitivity graph allows you to see the effect of varying the weight of a measure or goal from 0 to 100 percent. A sensitivity graph may be viewed by selecting the *RESULTS::SENSITIVITY GRAPH* option.

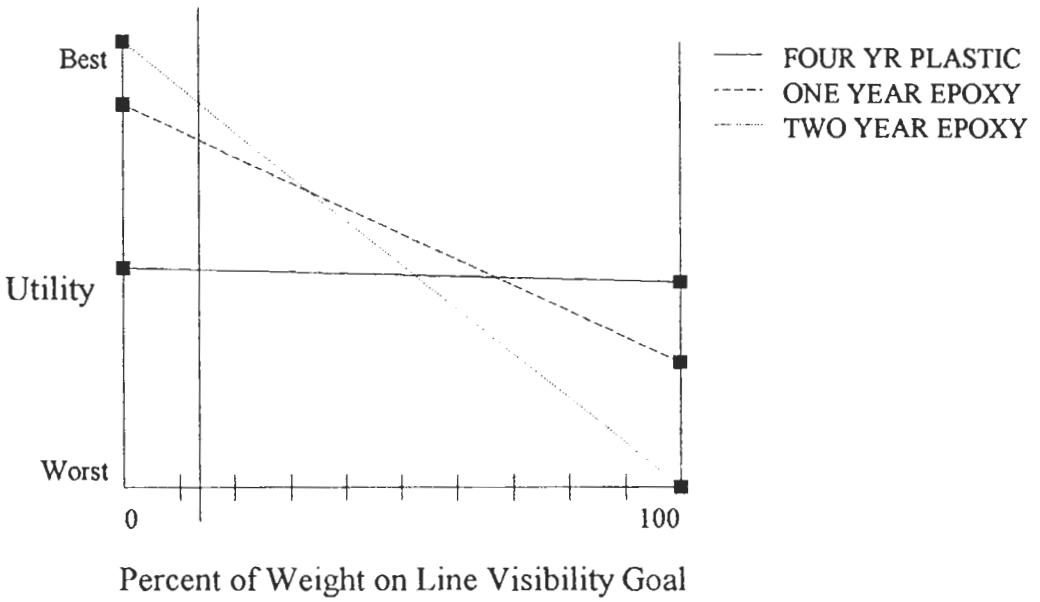


FIGURE 10. *SENSITIVITY GRAPH* option

When this option is selected, LDW shows a dialogue box with a list of goals and measures from the analysis. Select one goal or measure from the menu, and then click on *SELECT*. Figure 10 shows a sensitivity graph for the Line Visibility goal. This graph has

relative utilities as the vertical axis, and the percent of the overall weight as the horizontal axis. The vertical line shows the model's current weight on the goal or measure.

You can see from Figure 10 that the TWO YEAR EPOXY alternative is best when the weight on the Line Visibility goal is between 0 and 33%, ONE YEAR EPOXY is best from 33 to 68%, and FOUR YR PLASTIC is best from 68 to 100%. At the current percentage weight of 13.5%, TWO YEAR EPOXY is the best.

SENSITIVITY TABLE

The sensitivity table option allows you to input a specific new overall percentage weight for any goal or measure, and see the change in overall utility. After selecting the *RESULTS::SENSITIVITY TABLE* option, a dialogue box appears which asks for a new overall weight, with the current weight as a default.

Overall ranking with Line Visibility Goal Weight = 50 %

Alternative	Utility
ONE YEAR EPOXY	0.5934
TWO YEAR EPOXY	0.5587
FOUR YR PLASTIC	0.5482

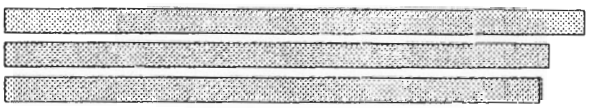


FIGURE 11. *SENSITIVITY TABLE* option

Figure 11 shows the results of changing the weight of line visibility from 13.5% to 50%. This figure shows what the new overall rankings would be under this new scenario. Note that the results shown in Figure 11 are consistent with those displayed in Figure 10 at Percent of Weight equal to 50%.

PRINTING THE RESULTS:

Any of the charts or graphs which LDW creates from the *RESULTS* menu may be printed easily. After LDW displays the chart or graph, from the *FILE* menu select the *PRINT* option. A dialogue box will then show up which provides printing options, including portrait or landscape paper, print quality, and paper size. Select the desired options, and then *OK*. If the printout does not print the items at the desired scale, use the *WINDOW::ZOOM* function to change the size of the chart or graph to be printed.

CONCLUSIONS:

This manual provides instruction for users of the Pavement Marking model that has been set up within LDW. It provides guidance on how to add alternatives, and view and print results. The model that has been set up within LDW may be altered (e.g. weights and utility functions changed), but that is beyond the scope of this manual. Information about this model is provided in the appendix to this manual, including all of the weights for all goals and measures, and the utility functions. The LDW software manual should be consulted if the user wishes to change the model in any way.

REFERENCES CITED

1. Logical Decisions, Golden, Colorado, Logical Decisions Multi-Measure Decision Analysis Software Manual for Windows, 1993.

2. Campbell G.M., and Davis, C.F., Working Report: Applying Multi-Criteria Decision Making to the Selection of Pavement Markings, University of Connecticut, Department of Civil Engineering, JHRAC Project No. 94-2, 1994.

APPENDIX

MODEL INPUTS
AND RESULTING WEIGHTS

Scaling Constants for Preference Set PAVEMARK

Best Pvmnt Marking Goal has K = 0, defined by direct entry and interactions allowed
- Safety Goal weight = 0.4100
- Total Costs Measure weight = 0.4000
- Convenience Goal weight = 0.1900

Safety Goal has K = 9800, defined by direct entry and interactions allowed
- Unadj. Safety Goal weight = 0.0100
- Safety Adjust Fact Goal weight = 0.0100

Convenience Goal has K = 0, defined by direct entry and interactions allowed
- Install Insensitvty Measure weight = 0.3100
- Availability Goal weight = 0.2700
- LifeCycle Predict Measure weight = 0.2400
- In-House Capability Measure weight = 0.1800

Unadj. Safety Goal has K = 0, defined by direct entry and interactions allowed
- Line Visibility Goal weight = 0.6600
- Adj. Appl. Safety Goal weight = 0.3400

Safety Adjust Fact Goal has K = 0, defined by direct entry and interactions allowed
- Speed Limit Measure weight = 0.5000
- ADT Measure weight = 0.5000

Availability Goal has K = 9800, defined by direct entry and interactions allowed
- Supplier Avail Measure weight = 0.0100
- Applicator Avail Measure weight = 0.0100

Line Visibility Goal has K = 0, defined by direct entry and interactions allowed
- Ret'rflectvty (RR) Goal weight = 0.6000
- Reliability Measure weight = 0.4000

Adj. Appl. Safety Goal has K = 9800, defined by direct entry and interactions allowed
- Application Safety Measure weight = 0.0100
- Yrs. between Appl. Measure weight = 0.0100

Ret'rflectvty (RR) Goal has K = 0, defined by direct entry and interactions allowed
- Final RR Goal weight = 0.5900
- Initial RR Goal weight = 0.4100

Final RR Goal has K = 0, defined by direct entry and interactions allowed
- Final Wet RR Measure weight = 0.5600
- Final Dry RR Measure weight = 0.4400

Initial RR Goal has K = 0, defined by direct entry and interactions allowed
- InitialWet RR Measure weight = 0.5600
- Initial Dry RR Measure weight = 0.4400

Additive MUF formula used if K = 0,
Multiplicative MUF formula used otherwise.

SUF Formulas for Preference Set PAVEMARK

Range		Midpoint		SUF Parameters		
Minimum	Maximum	Level	Utility	a	b	c
Speed Limit						
40	55	47.5	0.7	-1.2	0.04	0
30	40	35	0.3	-0.4	0.02	0
0	30	15	0.1	0	0.006667	0
ADT						
0	1e+05	5e+04	0.5	0	1e-05	0
Yrs between Appl.						
0	6	3	0.5	0	0.1667	0
Initial Dry RR						
500	1000	750	0.9	0.6	0.0004	0
400	500	450	0.775	0.55	0.0005	0
300	400	350	0.625	-0.25	0.0025	0
150	300	225	0.25	-0.5	0.003333	0
InitialWet RR						
4	5	4.5	0.9	0	0.2	0
3	4	3.5	0.6	-0.8	0.4	0
2	3	2.5	0.25	-0.5	0.3	0
1	2	1.5	0.05	-0.1	0.1	0
Final Dry RR						
100	500	300	0.85	0.625	0.00075	0
50	100	75	0.35	-0.7	0.014	0
Final Wet RR						
4	5	4.5	0.9	0	0.2	0
3	4	3.5	0.6	-0.8	0.4	0
2	3	2.5	0.25	-0.5	0.3	0
1	2	1.5	0.05	-0.1	0.1	0
Reliability						
4	5	4.5	0.925	0.25	0.15	0
3	4	3.5	0.725	-0.15	0.25	0
2	3	2.5	0.4	-0.6	0.4	0
1	2	1.5	0.1	-0.2	0.2	0
Application Safety						
1	5	3	0.5	-0.25	0.25	0
Total Costs						
0	1	0.5	0.5	1	-1	0
Install Insensitvty						
3	5	4	0.825	0.125	0.175	0
2	3	2.5	0.425	-0.7	0.45	0
1	2	1.5	0.1	-0.2	0.2	0
In-House Capability						
0	1	0.5	0.5	0	1	0
LifeCycle Predict						
3	5	4	0.65	-0.75	0.35	0
2	3	2.5	0.2	-0.3	0.2	0
1	2	1.5	0.05	-0.1	0.1	0
Supplier Avail						
4	5	4.5	0.95	0.5	0.1	0
3	4	3.5	0.8	0.1	0.2	0
1	3	2	0.35	-0.35	0.35	0
Applicator Avail						
4	5	4.5	0.95	0.5	0.1	0
3	4	3.5	0.8	0.1	0.2	0
1	3	2	0.35	-0.35	0.35	0

SUF Parameters: if c = 0, U(x) = a + bx, if c # 0, U(x) = a + b(EXP(-cx))

Percentage Weight for Preference Set PAVEMARK

Measure	Percentage Weight	Effective [3] Weight
Total Costs	40.00	44.33
ADT	10.25	0.00 [4]
Speed Limit	10.25	0.00 [4]
Install Insensitvty	5.89	11.97
Reliability	5.41 [1]	5.33
LifeCycle Predict	4.56	3.93
Application Safety	3.49 [2]	2.15
Yrs. between Appl.	3.49	4.29
In-House Capability	3.42	8.42
Final Wet RR	2.68 [1]	5.29
Applicator Avail	2.57	3.47
Supplier Avail	2.57	3.47
Final Dry RR	2.11 [1]	2.47
InitialWet RR	1.86 [1]	2.75
Initial Dry RR	1.46 [1]	2.11

NOTE: Effects of interactions not included.

FOOTNOTES:

1. The percent weight shown here is 1/2 the actual weight in the model due to the software's treatment of the safety adjustment factor. See tables 2 and 3 in Campbell and Davis (1994) for clarification.

2. The percent weight shown here is 1/4 the actual weight in the model due to the software's treatment of the safety adjustment factor and the years between applications adjustment factor. See tables 2 and 3 in Campbell and Davis (1994) for clarification.

3. Effective weights reflect actual ranges of input measures for alternatives being evaluated, so they will change when measurement values change. In general, when inputs across all alternatives span a greater portion of the available range for a measure, then that measure's effective weight will increase.

4. Effective weights are zero here because all alternatives have the same measurement values for ADT and Speed Limit.