EML2322L Decision Matrix Example - Bad

MOBILE PLAFTORM			Design 1			Design 2			Design 3			Design 4			Design 5		
Objective	Weighting Factor	Parameter	Mag.	Score	Value	Mag.	Score	Value	Mag.	Score	Value	Mag.	Score	Value	Mag.	Score	Value
Speed	0.20	feet	2.30	0.0	0.0	3.10	6.7	1.3	2.60	2.5	0.5	3.50	10.0	2.0	2.30	0.0	0.0
Controllability	0.30	experience	fair	4.0	1.2	good	8.0	2.4	great	9.0	2.7	poor	2.0	0.60	great	10.0	3.0
Manufacturing Time	0.20	hours	6.5	4.23	0.8	8.0	6.40	1.3	10.0	10.00	2.0	6.0	3.60	0.7	6.0	3.60	0.7
Modularity	0.20	fasteners	2	10	2.0	3	7	1.3	4	5	1.0	2	10	2.0	2	10	2.0
Material Cost	0.10	experience	okay	6	0.6	okay	6	0.6	okay	6	0.6	okay	6	0.6	okay	6	0.6
Overall value					**4.65**			**6.9**			**6.8**			**5.9**			**6.3**

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BALL HOPPER / SORTER			Design 1			Design 2			Design 3			Design 4		
Objective	Weighting Factor	Parameter	Mag.	Score	Value	Mag.	Scoer	Value	Mag.	Score	Value	Mag.	Score	Value
Spead	0.30	…	…	…	…	…	…	…	…	…	…	…	…	…
Controlability	0.30	…	…	…	…	…	…	…	…	…	…	…	…	…
Manufacturing Time	0.30	…	…	…	…	…	…	…	…	…	…	…	…	…
Overall value					**…**			**…**			**…**			**…**

Qualitative Score Assignments:	
great	10
good	8.6
okay	6
fair	4
poor	2

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Errors in the Decision Matrix Example – Bad

1. **Are separate matrices used for different parts of the design?**
    a. Two matrices (rather than the required 3+) are used.
2. **Does each matrix contain an appropriate number of objectives?**
    a. Matrix 2 does not contain sufficient objectives to compare ball hopper / sorter designs. Thus, matrix 2 does not contain an appropriate number of objectives.
3. **Are different objectives used for different matrices?**
    a. The objectives in matrix 2 are just copied from matrix 1 and not thought through.
4. **Do weighting factors for each matrix sum to one (or 100%)?**
    a. Matrix 2 has weighting factors that sum to 0.9.
    b. Matrix 1 has speed parameterized by feet which is wrong.
5. **Do quantitative objectives use quantitative assessments?**
    a. Matrix 1 material cost will never be qualitative since a quantitative magnitude can be determined using the material cost sheets and online pricing.
6. **Do all quantitative assessments include clear calculations and results summaries in tabular format?**
    a. No clear calculations.
    b. Result summaries are not in tabular format.
    c. Significant figures are not used properly.
    d. All information should be justified from material provided to the students (i.e. motor speeds, material costs, and manufacturing time estimates) or from reliable online sources (for example: McMaster-Carr).
7. **Do qualitative objectives use qualitative assessments?**
    a. Matrix 1 Controllability: Designs 3 and 5 have the same magnitude but different scores.
    b. Matrix 1 Material Cost: Since all magnitudes are the same, this objective is not contributing to the comparison of the designs and another objective should be added.
8. **Does every magnitude assessment use linear score assignments?**
    a. Matrix 1 Speed: Scores should be assigned as a linear ratio.
    b. Matrix 1 Manufacturing Time: Score should be assigned as a linear ratio.
9. **Are quantitative magnitude assessments correct?**
    a. Matrix 1 – Manufacturing Time: The score assignments are inverted. The lowest magnitude should result in the highest score on objectives like material cost, manufacturing time, and modularity (as defined here).
10. **Is the design with the highest composite score selected?**
    a. Matrix 1 does not have the highest scoring design (Design 2) selected.

11. **Are reasonable and consistent significant figures reported in the matrices?**
    a. Matrix 1 – Speed: Speed cannot be estimated with an accuracy of one-hundredth of a foot per second. Report speeds to a tenth of a foot per second.
    b. Matrix 1 – Controllability: Qualitative evaluations should never be shown with a decimal place since doing so implies that there is a (distinguishable) difference between scores of 7.0 and 7.5. If this level of precision exists, then the objective should be evaluated quantitatively.
    c. Matrix 1 – Design 4: The value column should contain consistent sig figs.
    d. Matrix 1 – Manufacturing Time: Scores should be reported to one decimal place since the magnitudes are reported as such.
    e. Matrix 1 – Overall value: Overall values should be reported to one decimal place unless reporting a second decimal place distinguishes two designs tied for first place.
    f. Qualitative Score Assignments: A qualitative score assignment of 8.6 is wrong as it implies there is a difference between a score of 8.6 and 8.5. If this level of precision exists, then the objective should be evaluated quantitatively.

12. **Are grammar and formatting at a collegiate level?**
    a. Grammar & Spelling
        i. Matrix 1: Mobile Platform is misspelled.
        ii. Matrix 2: Speed is misspelled.
        iii. Matrix 2: Controllability is misspelled.
        iv. Matrix 2 – Design 2: Score is misspelled.
    b. Formatting
        i. If possible, matrices should be printed on a single page.
        ii. Matrix 1: Table borders should be shown as in the template.
        iii. Matrix 1 – Design 5: The ‘value’ column has been resized.
        iv. Matrix 2: Winning design must be highlighted.
        v. Matrix 2: Manufacturing time is erroneously in bold.
        vi. Matrix 2: Manufacturing time is too large to fit in the column and is cut off.

Errors in the Decision Matrix Example Objectives – Bad

Mobile Platform

Objective Definitions & Weighting Factor Justifications:

Speed

Speed is a measurement of how the maximum speed the robot can travel. The competition has a time limit, so having a high top speed will be beneficial to the design. However, having too high a top speed will make the robot unstable when going over ramps and making precise movements. For this reason, we have decided to set a target speed of 2.5 ft/sec, because that is the average top speed of all designs we are evaluating. Because this objective directly influences the ability of the robot to complete the objective within the time limit, we have assigned a relatively high weighting factor of 0.3. All designs will be scored linearly in both directions from 2.5 ft/sec.

Errors: There is no explanation of how target speed was determined. The purpose of using target is speed is to quantify a balance between speed and controllability, so they are both being assessed in the same objective. As a result, the following controllability objective is redundant and unnecessary.

Controllability

Controllability is the measure of how controllable a robot will be. To do this, the robot was driven over a ramp, around a bucket, and back around a ramp. A detailed description of the testing procedure can be found in Appendix A. Each run was timed, and the robot with the quickest time scored the highest score for controllability. Because the ability to precisely control the robot is critical to its success picking up buckets and going over ramps, we have assigned a high weighting factor of 0.25. All designs will be scored linearly from the best scoring design, which will receive a 10.

Errors: The purpose of this objective is to assess the ability of each design to make precise movements easily. The testing procedure as stated does not seem to be a good indicator of this characteristic, because it is entirely dependent on the speed and not consistent with the objective at hand. It can be improved upon by designing a course that prevents each platform from reaching its top speed, while also penalizing platforms that collide with the buckets. It is also redundant, as stated above.

Manufacturing Time

Error: Manufacturing Time is evaluated in the matrix but there is no discussion of it in the report body.

Modularity

Modularity is the measure of how many fasteners are in the mobile platform. This is important because the robot needs to be put back into a box after each week. So the robot with the fewest number of fasteners will be the easiest to place back into the box. Since this objective is important in that it ensures the group will not be penalized, but not critical to the success of the robot in competition, it has been assigned a relatively low weighting factor of 0.15. The design with the lowest number of fasteners will receive a 10 out of 10, with all other designs scored linearly from this point.

Errors: Modularity should only be defined as the number of fasteners that need to be removed in order for the mechanism to fit in the storage box. Many fasteners can remain on each mechanism while in storage, which has not impact on whether or not the mechanism will fit in the box which is the purpose of this objective.

Volume

Volume is a measure of how much room the robot takes up. The smaller the robot will be easy to build and maneuver, although it will be slightly less stable. The smaller volume a robot takes up the shorter time it will take to build also. Because we think this will be strongly correlated with the success of the robot in competition, we have assigned a weighting factor of 0.25. The design with the smallest volume will be awarded 10 out of 10 points, and all other designs will be scored linearly from there.

Errors: The assumptions made about the objective are not necessarily true. This flawed logic is not justified, and a more meaningful definition and justification should be made. This objective should be replaced with a meaningful objective. In addition, this objective doesn't even appear in the Mobile Platform matrix ☺.

Material Cost

Cost is a measure of how much the robot costs to build. Cost is important because of the $50 dollar budget detailed in the project description. Hence, a lower material cost will be beneficial because it frees up more of the budget to be used on other parts of the robot. Because this objective serves to ensure that the group does not incur a penalty, not influence the success of the design on competition day, we have decided to assign a relatively low weighting factor of 0.1. The design with the lowest material cost will receive 10 out of 10 points, with other designs scored linearly from there. Cost estimates for each design are detailed in Appendix A.

Errors: None.

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Score Assignments:

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Bucket Manipulator [more examples or poor definitions not shown in the above matrix]

Controllability

Controllability is a measure of how easy it is to align the manipulator with the bucket. Each design resembles a forked gripper, so this objective will be evaluated by measuring the distance between each prong. Since the bucket needs to fit in between the prongs to be lifted, it will be easier to align the manipulator with the bucket if there is a larger distance between the prongs. Therefore, the design with the largest distance will score a 10 out of 10, with all other designs scored linearly from there. Because this objective will be important in decreasing the time spent picking up the bucket, we have chosen to weight it highly at 0.25.

Errors: The evaluation of this objective is flawed. A prong distance of 100in will not be able to pick up the bucket, and would fail during the competition. There are better ways to evaluate this objective through experimental testing.

Reliability

Reliability is a measure of how well the manipulator can deposit tennis balls into the hopper without dropping them. This is important so balls will not be dropped and wasted during manipulation. Reliability will be measured by attaching each manipulator to the same mobile platform then lifting a bucket with 5 tennis balls 3 times. Every time a tennis ball falls out of a bucket, the design will lose 10 percent of its score. Because it is vital that all balls are successfully deposited into the hopper, we have assigned a weighting factor of 0.30. A detailed testing procedure and results for each design are found in the Appendix.

Errors: The testing in this objective is valid; however, each design should be linearly scored from the best scoring design, not how it is described above. This guarantees that the best scoring design receives a score of 10. Ensure that control variables are consistent across each test, such as the hopper/mobile platform.

Modularity

Modularity is the measure of how many fasteners need to be removed to fit bucket manipulator back in the box. This is important so the team will not incur a penalty. Since it is difficult to tell how this particular assembly will fit with others in the box and which exact fasteners will need to be removed, we will assume that the number of fasteners that need to be removed each week correlates with the total number of fasteners on the design. Therefore, this objective will be measured by tallying the total number of fasteners on each design. The design with the lowest number of fasteners will receive a 10 out of 10, with all other designs scored linearly from this point. Since this objective is important in that it ensures the group will not be penalized, but not

critical to the success of the robot in competition, it has been assigned a relatively low weighting factor of 0.15.

Errors: None; this is a good alternative to the first modularity objective above.

Cost

Cost is a measure of how much the total material needed to build the design costs. Cost is important because of the $50 dollar budget detailed in the project description. Hence, a lower material cost will be beneficial because it frees up more of the budget to be used on other parts of the robot. Because this objective serves to ensure that the group does not incur a penalty, not influence the success of the design on competition day, we have decided to assign a relatively low weighting factor of 0.1. The design with the lowest material cost will receive 10 out of 10 points, with other designs scored linearly from there.

Errors: None.

Manufacturing Time

Manufacturing Time is an assessment of how long it will take to fabricate and assemble each design. It is important because there are a finite number of lab periods before competition day, and it is imperative that the robot be completed before competition. The less time that it will take to manufacture the bucket manipulator, the more time will be available for work on other systems or for testing the robot. The estimated manufacturing times are detailed for each design in *Appendix A.* The design with the lowest manufacturing time will be awarded 10 out of 10 points, with higher designs scored linearly from there. Because we foresee testing time being an important factor towards success in the competition, we have decided to weight this objective highly at 0.20.

Errors: Manufacturing time is important for all matrices, so if it appears in one matrix, it should appear in all matrices. (It is not present in the Mobile Platform objectives above)

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Score Assignments:

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<u>Ball Hopper / Sorter</u>

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