**New Guitar Case (guitar + amplifier):**

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**BACKGROUND**

Nowadays, people are playing the guitar to relieve their stress. They also play to express their feelings. The common case for guitar can only fit the guitar. In that case, when people carry both a guitar and an amplifier, they have to carry them in both hands. For convenience it would be more useful to have a case that accommodates both guitar and amplifier. The purpose of the project is to determine the materials and processing to be used for this new type of case.

**OBJECTIVE**

The objectives for the new guitar case are

- It has to be light weight.
  This is because people are making light guitars and amplifiers nowadays; therefore, when a lightweight guitars and amplifiers are available, people will need a light guitar case that can fit both their guitar and amplifier.

- It has to be cheap.
  If the case is expensive, people are not going to buy it.

- It has to be wear resistant
  Since the case has to be able to fit both guitar and amplifier, it needs to be wear resistant so it can last a long time.

- It must be strong.
  If for some reasons the guitar case drops, it will not affect the sound of the guitar
REQUIREMENTS
The requirements are relate directly from the material selection objectives. They are supplied for the student’s use in completing this material selection project. The requirements are as follows:

- Light
- Cheap
- Wear resistance
- Strong

CES Selector properties to use:

**Limit stage**
- Good wear resistance
- Good flammability resistance

**Graph Stage**
- Price (USD$/lb) vs. Density (lb/ft$^3$)
- Wear resistance versus Flammability

Using the CES software, choose the appropriate material that might be used for this new guitar case. Follow the steps from the CES guide/tutorial to help you through the material selection process. You may also decide on some of your own requirements for your own personal guitar case, as you will.
NOTES FOR INSTRUCTOR

In order to determine the best material for the specific product, there are several steps that needed to be done using the Cambridge Engineering Software (CES).

First is using the limiting stage. Considering the criteria and the users that have been set above, the guitar case has to have good wear resistance and very poor flammability. When those properties are inputted in the CES software, the materials selection selects only 6 out of 67 materials available. They are Butyl Rubber, EVA, Isoprene (IR), Natural Rubber (NR), Polycholoroprene (Neoprene, CR), and Polyurethane.

Figure 1 below shows the window image of the software of the limiting stage. In stage 1, the good wear resistance and very poor flammability are ticked.
Second is using the graph stage. There are two graphs drawn in this stage. First is the price (USD$/lb) versus density (lb/ft$^3$). This graph is chosen because as the criteria that has been set; the guitar case has to be cheap. The bag has to be light as well. The density is given by dividing mass over the volume. The dimension of a guitar and an amplifier is not all the same. Sometimes, they have bigger dimension and on the other hand, they can have smaller dimension. Therefore, the density should be around 100 lb/ft$^3$ or less. The price of a case is around $40. It is not considered the cost to produce, manufacture, and other things. Thus, the price of a faceplate should be less than $7. The first graph stage limits 35 materials out of 67 materials available. And, they are too many to be listed.

Figure 2 below shows the window of the graph stage from the CES software. The graph plots the price (USD$/lb) versus density (lb/ft$^3$).

Figure 2: The density (lb/ft$^3$) vs. price (USD/lb) graph
The second graph stage is a graph of wear resistance versus flammability. As it is already pointed out in the first stage, the materials have to have good wear resistance and very poor flammability. Therefore, the second graph stage limits 6 materials out of 67 materials available. And, they are Butyl Rubber, EVA, Isoprene (IR), Natural Rubber (NR), Polychloroprene (Neoprene, CR), and Polyurethane.

Figure 3: Good wear resistance versus very poor flammability graph

There are 6 materials that are available in the limiting stage and both graph stage. They are Butyl Rubber, EVA, Isoprene (IR), Natural Rubber (NR), Polychloroprene (Neoprene, CR), and Polyurethane. Butyl Rubber costs between $0.4952 and $0.5447 per lb. It has a density between 56.19 and 57.43 lb/ft³. Natural rubber costs between $0.499 and $0.5822 per lb. It has a density between 57.43 and 58.06 lb/ft³. According to
the information on CES, Natural Rubber and Butyl Rubber are excellent, cheap, general purpose elastomer with large stretch capacity and useful properties from -50 to 115°C, but with poor oil, oxidation, ozone, and UV resistance. They have low hysteresis – and thus very bouncy. Bounciness is very good because it will not be too fragile. So, if it drops when being carried, it will not affect the guitar or the amplifier. EVA costs between $0.7047 and $1.217 per lb. It has a density between 58.99 and 59.62 lb/ft³. EVA is available in pastel or deep hues, it has good clarity and gloss. It has good barrier properties, little or no odor, is UV resistance and FDA approval for direct food contact. The toughness and flexibility is retained even at low temperatures and it has good stress-crack resistance and good chemical resistance. EVA can be processed by most normal thermoplastic processes: co-extrusion for films, blow molding, rotational molding, injection molding and transfer molding. EVA costs between $0.8317 and $2.495 per lb. It has a density between 76.79 and 78.04 lb/ft³. Beside giving flexibility and stretching, Chlorinated hydrocarbons are characterized by exceptional chemical resistance, and ability to be colored, and useful properties up to 175°C. Some have low gas permeability and low hysteresis, minimize heating when cyclically loaded, and resist burning. Polyurethane costs between $1.663 and $3.78 per lb. It has a density between 63.68 and 78.04 lb/ft³. Urethanes have exceptional strength (up to 48 MPa) and abrasion resistance, low compression set and good fuel resistance. They have useful properties from -55 to 90°C. Isoprene costs between $0.499 and $0.5822 per lb. It has a density between 58.06 and 58.68 lb/ft³. Isoprene has low hysteresis and high tear resistance, making it bouncy and tough. Also, all of them have very good castability, very good mouldability, and good machinability.