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1. Introduction:

We have been designated to build a battery state-of-charge meter that indicates the amount of charge that is remaining in a battery. The only guidelines given to complete this task are as follows:

- Design may be analog or digital
- Must consume as little energy as possible as not to drain the battery it is testing.
- Tester should have appeal in global market place as well as usefulness in the developing world.
- Display showing amount of charge remaining in the battery.
- Must stay below a fifty dollar ceiling

We first did some research to discover the needs for a battery meter. This allowed us to try and develop a potential market place for our product. We also did some research on what types of batteries have the greatest appeal in both the modern world and the developing world. This made us lean towards developing the battery meter for a 12 volt battery. The in-depth research completed assures us that our product will be popular in the modern world as well as in the developing world. The developing world requires the 12 volt battery as a source of power. However, these batteries are expensive and people in developing countries obviously do not have a tremendous amount of money. Therefore, it will be beneficial for individuals to know the state-of-charge of their battery so that it won’t be damaged by overcharging or being used below a harmful percentage. The modern world has so many uses for the 12 volt battery that our product should be of great convenience to many potential buyers as well. In particular, 12 volt batteries are used to power boats. A meter would be greatly beneficial to boat owners because they certainly do not want to risk their battery malfunctioning while they are out in the water.

2. Market Research:

The first step in the design of our potential product was to determine who could use our product. In particular, we needed to establish what type of battery has universal appeal in the modern and developing world. In order to answer this question, we examined a wide array of sources, ranging from internet websites to actual business experts.

2.1 Process of Research:

The best way to design a product is to examine the faults of similarly designed products. We started out our research by searching the WEB for original designs of current battery meters. After coming up with a basic idea on how a typical battery meter appears we tried to determine some of the best features from each and applied them to our own design. The next step to take was to determine some of the uses of a battery meter. To go about this, we again used the WEB and searched for how batteries are used. In particular we examined the need for batteries in third world countries. After
determining which battery had the most use in the third world, we then used the internet again to determine if and how this type of battery can be used in the modern world.

Our research was then concluded by conducting interviews with two individuals who are experts in the battery field. Firstly, by consulting with the president of Micro-tech, Ted Jasiewicz, we discovered that a battery may not hold its charge as well when it drops below eighty percent of its capacity. Then we were given vital information about the need for battery meters from a representative of Design that Matters.

2.2 Research Analysis:

After looking through a wide array of online catalogs, we found a general pattern of what a battery meter might look like and the qualities that it might have. One of the most common types of testers can be seen in Figure 1. This tester works on 12 volt batteries and, by using four LEDs, it either states that the battery is fully charged, two-thirds of the way charged, one-third of the way charged or not charged at all. Furthermore, this item is small, durable and affordable, as it is only valued at $12.99.

Yet another common battery meter can be seen in Figure 2. Again, this meter measures a 12-volt battery and provides four LEDs, each representing a given state of charge, which display the charge left in the battery. A chief selling point for this product was that it is small and compact enough to fit in someone’s pocket. Again this product is cheap as its retail value is only $9.98.

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1 http://www.thesportsauthority.com/product/index.jsp?productId=841278
Lastly, a third type of meter, depicted in Figure 3, was found to be of particular interest. The described meter has a retail value of $39.99 and works on both 6V and 12V batteries. Unlike other testers, this tester provides a display that not only indicates whether the tester is moderately charged or fully charged, but it also displays the actual voltage in the battery as well. The use of alligator clips also makes it easier to obtain a reading on batteries that may have awkward shaped terminals.

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2 http://www.basspro-shops.com/servlet/catalog.Textld?hvarTextId=45203&hvarTarget=search&hvarAID=inktomi&cm_ven=Performics&cm_cat=Search&cm_pla=DDI%20Link&cm_ite=Inktomi%20%28Position%20Tech%29

3 http://www.northerntool.com/webapp/wcs/stores/servlet/ProductDisplay?catalogId=4006970&storeId=6970&langId=-1&productId=19846&cm_tli=auto&cm_partner=tl
Our researches also lead us to determine what a battery meter is actually needed for in the developing world. According to the Design that Matters website, batteries are vital in the developing world. One country that is apart of the developing world and manifests the need for batteries is Mali. The lack of energy in Mali is perfectly seen with some rather startling statistics from the CIA’s official webpage. In the year 2001, Mali produced 480.2 million kWh of electricity with a population of 11.62 million people. Cuba, which in the same period had a population of 11.26 million people, produced 14.38 billion kWh of electricity. Clearly, Mali is lacking the necessary means to produce electricity as a country that has fewer inhabitants is producing vastly greater amounts of electricity. The primary reason for this lack of power in Mali is that no centralized power grid exists. As a result, people in third world countries such as Mali must use batteries to power their homes and appliances.

According to a representative from Design that Matters, a company that has provided us with this given product task, there is a substantial problem in countries such as Mali that use batteries. When the representative talked to us on March 19, 2004, he told us that batteries are consumed at a staggering amount and when they stop working, people merely discard the batteries in their village community. This is truly not a positive thing. Batteries contain potentially harmful chemicals. When these batteries are discarded the soil and surrounding water supplies are contaminated with these hazardous materials that are found in batteries. Also, little children sometimes play with these batteries and expose themselves to these dangerous chemicals as well.

Therefore, it is vital that batteries that are used in the third world can potentially be recharged. Not only will this save the inhabitants of these countries money, since they will not have to buy as many batteries, but it also will help to preserve the environment. The representative then went on to exclaim that 12 volt batteries, in particular car batteries, are the type of batteries that have the greatest wide-range appeal in these areas that are lacking electricity. Professor Vaz reaffirmed this statement when we consulted him as a group. For instance, there are charging stations located throughout these developing nations where people bring their car batteries and recharge them. However, the chief problem in this process is that there is no readily available product that people can use to see if their car battery actually needs to be charged. People who own these batteries sometimes must wait for their battery to entirely drain. With stations spread out across the country side, this can cause families to lose their source of power for quite sometime. On the opposite end of the spectrum, people can overcharge their battery. This can cause the battery to be permanently damaged. In countries where citizens are low on funds one can not risk destroying their only source of power and merely buying a new one. Also, overcharging of a battery can lead to it possibly exploding and harming the individual who is charging it. As a result, there is a wide need for a battery meter in these developing countries. They provide a convenience for inhabitants in developing countries because they would know exactly when they have to charge their battery. The inhabitants would not longer need to purely guess. The product will also provide a measure of safety because the batteries will no longer be overcharged in these areas.

While we found that are product has great appeal in the developing world, we also did research to find how a 12 volt battery tester can be used in the modern world as well.
By doing a search on the internet, we discovered that 12 volt batteries are used for cars, communication equipment, medical equipment, farm equipment and even camping equipment. While a battery meter can be used for all of these types of products, we feel that our design will have the most appeal for boat owners. Most boats operate on 12 volt batteries. The state-of-charge of a boat battery is vital for all boat owners. It will be disastrous if a boat’s battery stops functioning when a person is in the middle of a body of water. Consequently, this meter will allow boaters to find out how much energy is left in their battery and will prevent any disastrous situations in the water. Figure 3 shows how big the boating market is. These numbers show that targeting this market will be worth while.

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2001</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>People Participating in Recreational Boating</td>
<td>71,644,000</td>
<td>67,973,000</td>
<td>69,820,000</td>
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<tr>
<td>Water Skiers</td>
<td>5,458,000</td>
<td>5,921,000</td>
<td>6,736,000</td>
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<tr>
<td>All Boats in Use</td>
<td>17,353,400</td>
<td>17,191,600</td>
<td>17,032,400</td>
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<tr>
<td>Outboard Boats Owned</td>
<td>8,381,100</td>
<td>8,335,700</td>
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<tr>
<td>Inboard Boats Owned</td>
<td>1,705,700</td>
<td>1,681,700</td>
<td>1,662,500</td>
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<tr>
<td>Sterndrive Boats Owned</td>
<td>1,767,100</td>
<td>1,740,700</td>
<td>1,708,700</td>
</tr>
<tr>
<td>Personal Watercraft</td>
<td>1,353,700</td>
<td>1,293,900</td>
<td>1,239,400</td>
</tr>
<tr>
<td>Sailboats Owned</td>
<td>1,612,800</td>
<td>1,625,000</td>
<td>1,637,200</td>
</tr>
<tr>
<td>Misc. Craft Owned (Canoes, rowboats, dinghies, and other craft registered by the states)</td>
<td>960,000</td>
<td>953,000</td>
<td>946,000</td>
</tr>
<tr>
<td>Other (Estimated canoes, rowboats etc. not registered by the states)</td>
<td>1,573,000</td>
<td>1,561,600</td>
<td>1,550,200</td>
</tr>
<tr>
<td>Outboard Motors Owned</td>
<td>8,976,500</td>
<td>8,759,400</td>
<td>8,702,800</td>
</tr>
<tr>
<td>Inboard Engines Owned (Includes gasoline, diesel, and jet drive marine engines)</td>
<td>2,216,800</td>
<td>2,207,000</td>
<td>2,185,000</td>
</tr>
</tbody>
</table>

Figure 4: 2002 boat population estimates

Furthermore, our research extended to consulting with the president of Micro-tech. When talking to this expert in the battery-field, he exclaimed to us that a battery should not fall below eighty-percent of its total charge. The reason is that the longevity of the battery is greatly decreased when the battery falls below this level. Since we are considering the developing world as a consumer, it is important that they are given information that will allow their battery to have the longest lifespan. Consequently, this allowed us to determine that our battery-meter should provide a warning once the battery falls below this threshold.

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3. Customer Requirements

Realizing where our product will be used and who will be using our product, a list of customer requirements has been compiled. The results from the market research helped create a guideline for the following requirements:
- Durable
- Lasts a long time
- Water and Heat resistant
- Affordable
- Relatively small/Portable
- Easy to use and understand
- Accurate
- Efficient

Besides the above requirements, it is obvious that the market has some implied expectations as well. The consumer will assume that the product that they are using is safe. Lastly, the product should look appealing. One certainly does not want to purchase something that is not visually satisfying or stylish.

4. Product Requirements

The list of customer requirements gave us everything we needed to recognize what our product requirements should be. Firstly, the product needs to be durable and have a long life span. When our product is used in a boat, the chances of it getting knocked around are high. The developing world also needs the product to have a long life span. If components need to be replaced they will not be able to obtain them and this will make the product seemingly useless. Also, because people in developing countries make little money, they cannot afford to keep buying our product when it malfunctions.

Next, the product needs to be water resistant because one of its primary uses will be on a boat. If water gets on the product, it must still be functional. People in the developing world need the product to operate in hot temperatures. The maximum temperature in Mali, one country we would target, is over one hundred degrees Fahrenheit between the months of February and May.

As mentioned earlier, people in the developing word need their battery to last as long as possible. This leads to the fact that the product needs to be efficient. The product must use as little power as possible so it does not drain the battery it is testing.

The product also has to be affordable. The people in the developing world make very little money and would never be able to buy the product if it was too much money. We need to compete with our competitors in the battery meter industry as well. As can be seen earlier in the market report, a cheap battery meter costs approximately ten dollars. Our product must be able to operate at a higher quality then these low-cost detectors while still remaining competitive price-wise.

The people using the product in the developing world will have little education at best, so it has to be easy to use and understand. It is not a guarantee that everyone using our product will even be able to recognize our number system. Therefore, providing
LEDs that will clearly indicate when the battery needs to be charged will be crucial to ensure its global appeal.

Moreover, people using the product will be dependant on its accuracy. The people in the developing world need their batteries to last as long as possible, ergo, our product’s aid in helping them requires it to be accurate in indicating when their battery should be charged.

5. Product Specifications

The following list of product specifications was formulated from our customer and product requirements:

- Alligator clips to attach to battery terminals
- Low power circuit that will read in voltage
- Low power circuit that will compare voltages
- 2 LEDs (one to signify “Substantially Charged” the other to signify “Needs to be Charged”)
- LCD screen to display actual voltage

Appearance and durability issues are primarily covered by the outer casing for this product. The casing should be lightweight and robust. Furthermore, this casing should seal the developed circuitry and prevent water, temperature and humidity from affecting its functionality. The idea of outer elements not affecting the performance of the product will also be taken into consideration when we chose components for circuit design.

Noticeably, our product will not have an actual ON button. Instead, the meter will be turned on when a battery is actually hooked up to the product. This is particularly beneficial because it makes the product easy to operate. The manner in which the battery will be hooked to the meter will be through the use of alligator clips. The type of alligator clips that will be used can be seen in Figure 5. The user must simply connect one terminal of the twelve volt battery to each clip. We will design the device so polarity will not affect the output. Also, no additional batteries will be needed to power this device. We find this particularly useful because there already are not enough sources of power in the developing world that it would be counter-productive to introduce a product that is helping to conserve battery usage that will be causing for greater battery usage.
The low power circuit that will actually read in the voltage will be designed at a later date. The same can be said for the low powered circuit that will compare voltages. The purpose of this circuit will be to compare the voltage of the battery to 11.66 volts, a value that was determined through our market research. If the read voltage is greater than ten volts an LED will be turned on that will indicate that the battery is adequately charged. If the read voltage is less than ten volts an LED will be turned on that will indicate that the battery needs to be charged up. The type of LED used can be seen in Figure 6. It is possible that more LEDs will be used to indicate other possible states of charge of the battery in question. Lastly, an LCD screen will be used to actually display the voltage. Prior battery meters did not clearly display the voltage of a battery. Therefore, we have decided to use an LCD screen that will clearly display the voltage of the 12 volt battery. The type of LCD screen that will be used can be viewed in Figure 7. A block diagram for how our product components will interact can be seen in Appendix A.

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5 http://www.oselectronics.com/ose_p8.htm

6 http://www.allelectronics.com/cgi-bin/category.cgi?category=340&item=LED-1&type=store

7 http://www.logosunlimited.co.uk/lcdScreens.htm
6. Product Parts:

From our product specification, we are able to establish an artist concept drawing of our design. While this design will possibly change over time, this initial drawing provides an accurate portrayal of the type of product we are attempting to create. This drawing can be seen in Figure 8. The main body of the product is a square shaped casing. Within this casing is a rectangular LCD screen. This screen will display the actual voltage in a numerical readout. This will give the user a qualitative figure for the charge of their meter in case they so need the information for another application. Also, within the drawing are two circles. These circles each represent a LED. One of these LEDs will serve to signify that the battery is accurately charged while the other serves to signify that the battery needs to be charged. Lastly, the two lines projecting out of the bottom of the square casing signify the alligator clips that were previously described. Again, these alligator clips will be attached to each terminal of the battery in order for a reading to take place.
7. Conclusion

Through our research, we have concluded that there is a great need for battery meters throughout the world. In particular, most developing countries do not have power grids that provide electricity for all of their people. These people are left to use batteries as their only source of electricity. The 12-volt car battery is the type of battery that is widely used throughout the developing world. In fact there are stations set up in many countries where people can bring their car battery and recharge it.

However, as we have found out, car batteries can be damaged when they are overcharged. An overcharged battery can possibly explode, leak environmentally hazardous chemicals or simply cease to work. Consequently, it is vital for inhabitants of the third world to know how much charge is left in their car batteries.

Furthermore our product has wide appeal in the developed world as well. Most boats operate on 12-volt batteries. It is vital for these boat-owners to realize that their boat’s battery is indeed in working order or else they could be potentially stranded in a body of water. Also, 12-volt batteries are used for farming equipment, camping equipment, communication equipment and cars as well. In all instances, it is important to know that a battery is actually in working order. Also, charging a battery takes times and individuals do not want to actually charge their battery unless it is necessary.

Lastly, and perhaps most importantly, the cost of our product will be competitive with the average market value of current battery-testers. Most battery testers that we observed are under fifty dollars and some lesser quality testers can be found below twenty dollars. It is possible for us to make a quality tester that works efficiently and competes with current products on the market. Hence, it is apparent that our product will have wide appeal and can sell well.
Appendix A: System Block Diagram

SAME ISSUES HERE...

This is a bad example of a block diagram.

A block diagram should contain blocks that represent physical parts of your system (ie. NOUNS).

A Flow Chart is a diagram containing blocks indicating your decision making strategy (ie. VERBS).

Don't confuse the two!
References:

http://www.trojanbattery.com/customercare_batterymaint4.html