Dodecatimer

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Design Impact Statement

Public health, safety, and welfare summary

In their current state, wireless charging is considered to be safer than wired charging due to less interaction between the device and the person operating it [1]. Wireless charging, as convenient as it is, does come with a health hazard that seems to be ignored: Electric and Magnetic Field (EMF) radiation. A typical wireless charger emits around 3mg of EMF radiation and 1mg is considered harmful to the human body [2]. However, the radiation significantly drops after a few inches away from the charger, so it would cause real harm if someone were using their phone while charging.

Cultural and social impacts summary

The Dodecatimer was made specifically not to connect to a person's phone because if a person has to use a phone to use the Dodecatimer, why not just use the phone to set-up a timer? The average person spends over three hours on their phone per day [3]. People don't need another reason to pick up their phones and stare at a screen. The Dodecatimer would mitigate this by a small degree. The client wished for this project to be used in a classroom setting for younger students, which would help students who suffer from time blindness, again without the use of a distracting phone.

Environmental impacts summary

Due to wireless charging's slow rate of charge, it lacks the power efficiency that wired charging has. Compared to a normal plug-and-charge cable, wireless charging used 47% more power [4]. The internal frame of the dodecatimer is currently made with a 3-D printer. 3-D printed materials are not recycled by current commercial recycling companies because the materials are not marked.

Economic factors summary

The Dodecatimer is built with wood chosen by the customer but unfortunately the price of wood is on the rise. Lumber per thousand board feet, in early 2017, cost between $300 and $400, but this year it is sitting at over $1000 [5].

Conclusion

Our project, while small, has potential impacts that need to be addressed. We have already worked to circumvent possible risks to the health, safety, and welfare of our customers, and while there are not large impacts on society or culture, we do need to consider the effect we have on the environment as we manufacture our timers. Economically, our goal is to create something that is accessible to a maximum number of people while still remaining profitable. These factors in mind, we are moving forward with the hope that we can create a fun and unique product that people will be excited to own. For the risk factors we have not been able to fix, we have ways to potentially minimize them. Our group can create a PCB with minimal components that will therefore create less pollution to produce. We can also provide information on the website (Dodecatimer.com) that tells people how to properly dispose of their timer. With negative impacts either fixed or addressed, we are happy with the state of the project.

Project Timeline

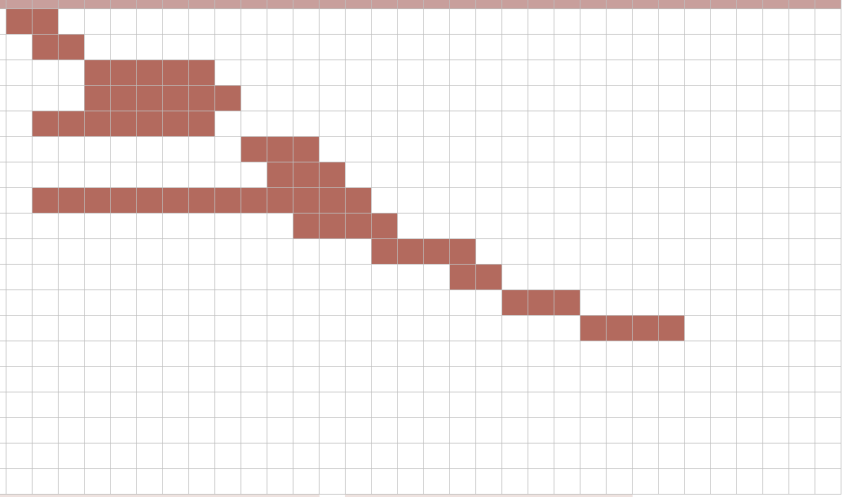
Dodecatimer
PROJECT NAME

9/7/2020
START DATE

6/1/2021
END DATE

5/17/2021
LAST UPDATE DATE

Task ID	Task Name	Due Date (Week)	% Completed
1	Team Protocols and Standards	3	100%
2	Risk Registers	4	100%
3	Block Diagram	9	100%
4	Block Validation	10	100%
5	Engineering Requirements	9	100%
6	First Block Check-offs	13	100%
7	Design Reviews	14	100%
8	Engineering Requirements Lock	15	100%
9	Second Block Check-offs	16	100%
10	Final Block Check-offs	19	100%
11	System Review 1	20	100%
12	System Review 2	23	100%
13	Final System Review	27	100%



Notes:
Most of the items listed are undetermined due to not knowing when the due date is.

Approved By

Mark van der Pol
PROJECT MANAGER

10/10/2020
DATE

Scope and Engineering Requirements

The goal of this project is to develop the Dodecatimer idea into a minimum viable product (MVP). We would like to build upon this MVP and develop the product beyond its minimum acceptable standards if possible, however. By the end of this project, we will have accomplished each of our requirements, and we would like to leave the project in a place where further development will be straightforward. The requirements are as follows:

1. The system will have 12 discernible faces for 12 different timing values.
2. The system will be checked off as aesthetically pleasing by the project partner and one or more course instructors.
3. The system will emit a preset noise when timing is completed.
4. The system will vibrate when the timing starts or is reset.
5. The system is capable of recharging its internal batteries and will have a battery life of 24 hours with 12 hours of use and 12 hours of idle time.
6. System has edges within +0.5in/-0.25in tolerance of 1in.
7. The system will be able to correctly register timer start and reset behavior.
8. The system will time down from a given number to zero with plus/minus 1 second tolerance based on the side that is facing up.

The Dodecatimer will have a different timing value for each of its twelve faces from which it will be able to count down from. The system will be overall aesthetically pleasing. The size will be reasonable so that the timer will fit in a person's hand easily. It will have vibration and audio feedback for the user, and the input to the system will be basic gesture controls. These will include changing the orientation of the device to start the timer and shaking the device to reset the timer. Finally, our device will have a battery life that will let it be used throughout the day and charge overnight.

Risk Register

ID	Description	Category	Probability	Impact	Performance Indicator	Responsible Party	Action Plan
R1	Shipping Delays	Timeline	30%	H	Parts not in stock	All	Retain
R2	Component Costs	Cost	25%	M	Cost nearing $100	All	Reduce
R3	Manufacturability	Technical	20%	M	Product takes too long to build ("too long" TBD)	Shane	Avoid
R4	Battery Style	Technical	15%	H	Battery cannot power unit for 24 hours	Omar	Reduce
R5	Control Bugs	Technical	10%	M	User input and feedback are incorrect more than 1/10 times	Christian	Reduce

The three biggest risks we have assessed are R1, R2, and R4. R3 will not affect the minimum viable product as much as these three, and the class requirements can be satisfied even if this risk is not eliminated. R5 would cause issues, but if this risk does become a problem, it can be fixed with code adjustments. R1 and R2 are bigger issues because they are not in our control like our other risks are. We can select online resources with faster shipping, but that may lead to higher costs. Inversely, cheaper parts are often found on websites with slower shipping rates. These issues could cause problems with deadlines and budgeting, and because we cannot fully control them, they are two of our biggest risks. Our third bigger risk is the battery. While Omar has done the research and math to select a battery that is sufficient for the system, there is a chance that something was not properly accounted for when the group was selecting parts. This would affect the draw on the battery and hence could negatively affect battery life and performance. The reason this is one of our top three risks is because the battery has an effect on the entire system. If we cannot supply enough current, then we will have issues with the timer that cannot be fixed in code. We would also fail to fulfill the battery engineering requirement. Having to change the battery down the line would mean changing the enclosure and other components, so this is something we need to pay close attention to.

Future Recommendations

1. Improvements to manufacturing
   Production time for these timers is a consideration moving forward. We have to print the skeletons right now, but this can take 6+ hours to print for each one. Finishing and assembling the wooden tiles is also a time sink. Possible solutions would be to use a molding method to create the skeletons, adjusting the skeleton to make it faster to print, and creating a jig that could help speed up the finishing process for the tiles. The downside to using molding is that the skeleton edge lengths would no longer be customizable to match the tile edge lengths. We recommend using 3D printing for the skeletons until such a point that the sanding for the tiles can be done more precisely and uniformly.

2. Improvement to audio functionality
   Currently, we are limited in the sounds that can be played. With the class D audio amplifier being driven by a PWM (pulse width modulation) signal, we can emit tones at varying frequencies, but we cannot play more intricate sound clips (i.e. with voice). An sd card connection could be included into the arduino to make use of the arduino's innate libraries to .mp3 sound clips.

3. Improvement to environmental impact
   Every skeleton must be 3D printed, as of right now, from plastic. There are also circuit boards with metals that are bad for the environment. This means that when the system is eventually disposed of, there will be some negative effect on the environment. We recommend providing information to each customer on how to return the Dodecatimers rather than throwing them in the trash. In this way, the components could be disposed of properly or reused where possible. Both of these options would lower the negative impacts.

4. Improvement to battery life
   In its current state, the timer has a battery life above the original goal of 24 hours. However, potential future improvements and versions could have a higher power drain. Furthermore, maximizing battery life is beneficial because it will reduce the effect of battery life degradation that Li-Ion batteries are prone to. The device currently polls every half-second. If there were a way to implement an interrupt with a custom threshold value, then this would drastically improve the battery life of the device.

5. Further customization
   While surveying potential customers, it became apparent that customization was of interest to people. Right now, there is a plan to allow people to choose the wood that their timer is made from, and there is an ability to customize the timing values. We would suggest adding the ability to add details like names, dates, logos, etc. to the wooden tiles. This could be most easily done with the default 0 time face.

6. Assessment of PCB (Printed Circuit Board)
   Currently, most of the circuit blocks have been integrated onto the PCB. Depending on the number of devices sold, using pre-purchased modules and minimizing the contacts and components on the custom board could lower cost of production. The largest cost with the custom PCB is the part placement. Placing everything by hand with a stencil is very time intensive and prone to errors while ordering the PCB with assembly done increases the price significantly. Reviewing production cost of the system with the premade modules could help reduce overhead and thus increase profit.

7. Future improvements and modifications
   The project as of right now functions as intended; it is a timer with 12 preset values that can be started and reset by manipulating the device. The aesthetics and application of the device are appealing to people according to the market research we did, but we believe that the concept for this system could be built upon to create devices that appeal to different demographics. If there was a way to integrate the wireless charging and gesture control functionality with a smart system, the people who like more modern devices would be new potential customers. An example would be using a polyhedron of some size to select different colors for a smart LED.

8. Possible “simple” version
   Right now, the timer is made from a wooden shell. This shell is made by laser cutting and engraving 12 individual tiles that are then hand sanded and glued together with the skeleton. The personalized wooden timer is at a price point that younger demographics may not want to pay. In our research, we found that many of the college students we talked to were willing to pay a price point under what these would need to be sold for. If a simpler version could be created for a lower price, younger people who are interested in the concept of the Dodecatimer would be able to purchase one. Possible simplifications could be to remove the vibration aspect and only use sound or to create the shell out of plastic to lower material costs. A charging port could also be added that takes a standard USB plug to remove the need for the person to also buy a Qi pad if they do not have one.

References

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[3] D. J. Spajic, “How Much Time Does the Average Person Spend on Their Phone?,” *KommandoTech*, 14-Dec-2020. [Online]. Available: https://kommandotech.com/statistics/how-much-time-does-the-average-person-spend-on-their-phone/. [Accessed: 12-Apr-2021].

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