Capacitor Gun

DESIGN DOCUMENT

Team 15
Client: Max Balzer
Adviser: Mani Mina
Bret Tomoson
Max Balzer
Grant Larson
Brett Nelson
Mark Fowler
Zachee Saleng
sdmay19-15@iastate.edu
sdmay19-15.sd.ece.iastate.edu

Revised: October 12, 2018/Version 1

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List of figures/tables/symbols/definitions (This should be the similar to the project plan)

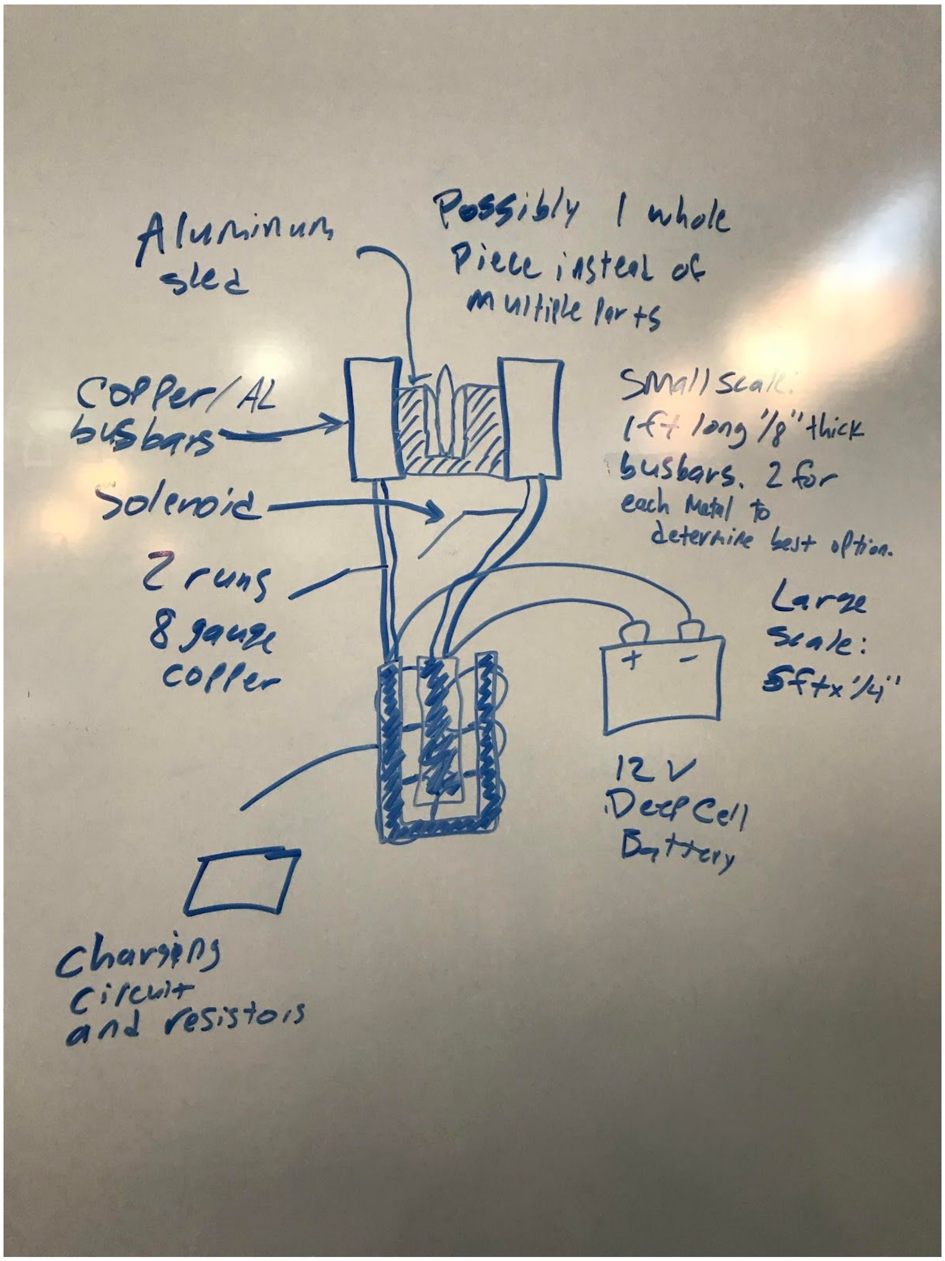


Figure 1: Overall design for small and large scale project with proposed materials.

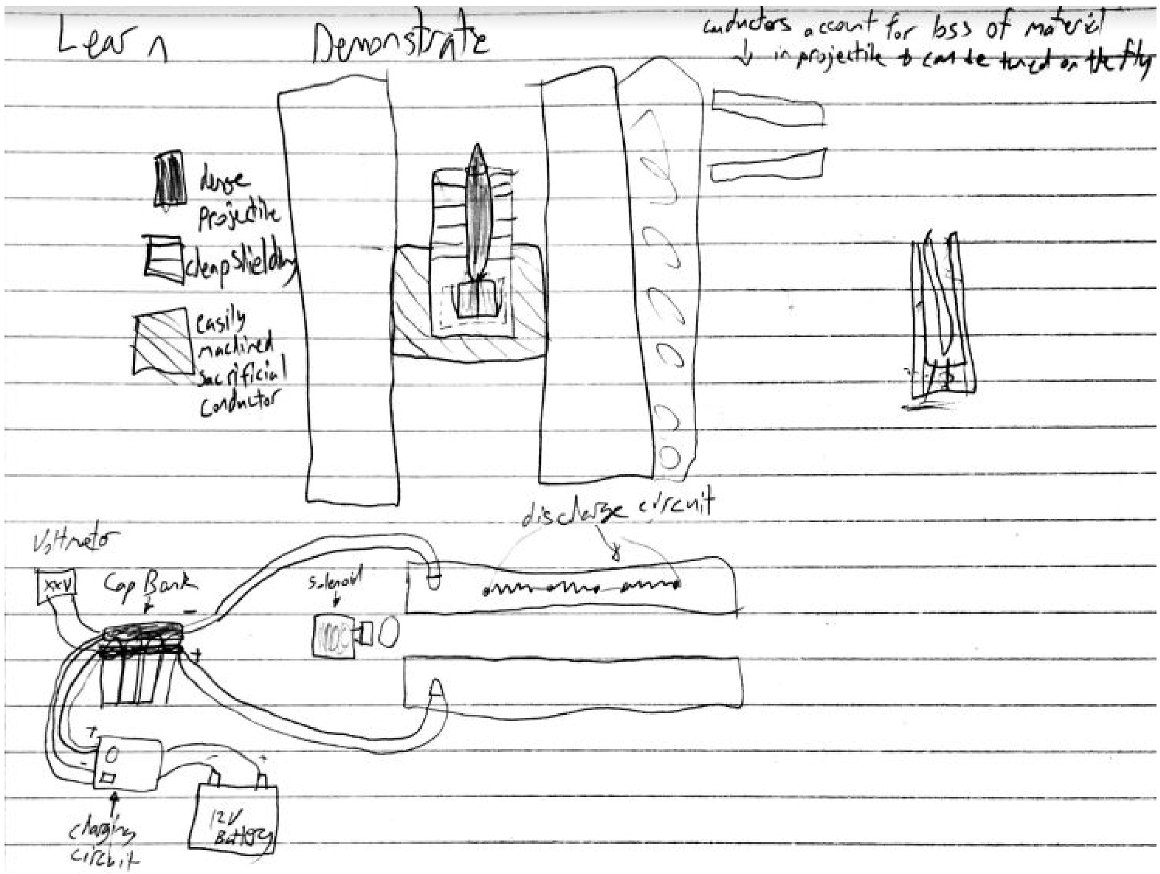


Figure 2: Projectile Early Model with General Layout

NOTE: This template is a work in progress. When in doubt, please consult the project plan assignment document and associated grading rubric.

1 Introduction

1.1 Acknowledgement

The Rail Gun Project team would like to thank Iowa State University and the Professors of the College of Engineering for their help and support through this process. Also, thank you to Professor Mani Mina for his mentorship and sharing of his expertise in electromagnetics.

If a client, an organization, or an individual has contributed or will contribute significant assistance in the form of technical advice, equipment, financial aid, etc, an acknowledgement of this contribution shall be included in a separate section of the project plan.

1.2 Problem and Project Statement

This goal of this project is to show that using electromagnetics, in a railgun, one can create a firearm that can compete with a comparable conventional firearm in price and useability. The main issue will be creating a railgun that will be affordable, reliable, and reusable. The railgun we are building is also being used in the military and is scheduled to be fitted into new class of warship in the near future, so this concept is being used in the "real world".

The solution being worked towards is calculating the optimal amount of material and correct material to get a good energy output close to a similar caliber bullet without overheating. We will first create a small scale prototype that will allow for testing and then use the information gathered from that to create our end product. Researching and developing equations that will work in our case will be difficult as the more established equations that are out there do not pertain to our specific situation. Also creating a product that is affordable is another problem we are solving, finding parts that are powerful enough for the project but are affordable enough is another issue that is being solved in this project. This project will hopefully yield a working railgun that can be used reliably and and be reusable at an affordable price.

– This is included so that the reader will have the correct conception of the problem and the solution approach upfront. Each shall be written in a non-technical manner that a lay person would understand.

– Consists of two components, each separated and clearly identified:

-General problem statement – defines the general problem area

-General solution approach – defines the proposed solution approach

-This section should also highlight the purpose of the project, what you are trying to do.

Explain what is driving this project. Why is it important?

Explain what the project is.

Explain what you hope to accomplish. What are the outputs of the project?

1.3 Operational Environment

The product could be used in a variety of environments, it will have to be used at a gun range so the conditions will vary. The end product will be enclosed in an enclosure to reduce the risk of shock. Depending on the environment the product may have to be modified to make sure performance is not affected.

– For any end product other than simply a calculation or simulation, it is essential to know the environment in which the end product will be used or to which it is expected to be exposed or experience. For example, will the end product be exposed to dusty conditions, extreme temperatures, or rain or other weather elements?

– This information is necessary in order to design an end product that can withstand the hazards that it is expected to encounter.

1.4 Intended Users and Uses

The intended users of this product are those who are enthusiastic about electromagnetics and want to learn more or show the capabilities of an electromagnetic gun. The apparatus will have to be fairly entuitive so that it can be used by anyone with some instructions and a safety talk. Safety is also another aspect that is going to be a part of the design.

– To properly design an end product that will provide the maximum satisfaction and perform in the most efficient manner, it is essential to understand the end user and the associated end uses.

1.5 Assumptions and Limitations

Assumptions:

The railgun will be able to fire x times per x

The first use will have x amount of energy

The product will be 5 feet long

It will launch a projectile x feet

Limitations:

The railgun will take x minutes to charge

It can be shot x times before it overheats

The rails will last x shots

Requires a 12 volt deep-cell battery to charge

– Two separate lists, with a short justification as needed.

– Extremely important, as it can be one of the primary places where the client can go to determine if the end product will meet their needs.

– Examples of assumptions: The maximum number of simultaneous users/customers will be ten; Blue is the best background color and will be used; The end product will not be used outside the United States.

– Example of limitations: The end product shall be no larger than 5"x8"x3" (client requirement); The cost to produce the end product shall not exceed one hundred dollars (a market survey result); The system must operate at 120 or 220 volts and 50 or 60 Hertz (the most common household voltages worldwide).

– For limitations, include tests not performed, classes of users not included, budget/schedule limitations, geographical constraints, etc.

1.6 Expected End Product and Deliverables

The end product will be a railgun that will be able to launch a projectile in a similar manner to an equivalent caliber firearm. The product will require a power supply to operate and if someone with experience in electronics is not available then it will also require a manual so that users can operate the railgun safely and effectively.

These tie in with the goals. What deliverables are necessary to meet the goals outlined in the introduction?

List the end product and any other items, along with a brief description, that will be delivered to the client prior to the end of the project.

– If the end product is to be commercialized, the description shall be of the commercialized end product.

– It shall be in the form of a technical product announcement, as opposed to a product advertisement, and shall not include a list of technical specifications.

– Any other items that will be delivered to the client shall also be included and described unless their definition and description are obvious.

– Examples might include a household power supply to eliminate the need for batteries, a user's manual, or other project reports.

– There shall be at least a one-paragraph description for each item to be delivered.

– Delivery dates shall also be specified.

2. Specifications and Analysis

2.1 Proposed Design

The group has been researching equations and materials to use in the project. Researching a proper formula that will give specific values for current, temperature, etc. has been the main focus and has taken up most of the groups time. Finding the proper materials has also been an issue, deciding which conductor to use and what material to use as the enclosure has involved weighing the pros and cons of each. It mainly comes down to the price point of each material and if it can be machined in a way that will be useful.

We have a schematic for the capacitor bank and the rails, we know we are connecting them in series. The group is also working on the charging circuit for the capacitors as well as a discharging circuit. The capacitors have been picked and the group is using the specifications from it's spec sheet to calculate the parameters of the railgun.

Include any/all possible methods of approach to solving the problem:

– Discuss what you have done so far – what have you tried/implemented/tested, etc?

– We want to know what you have done

• Approach methods should be inclusive of **functional and non-functional requirements** of the project, which can be repeated or just referred to in this section

If your project is relevant to any **standards** (e.g. IEEE standards, NIST standards) discuss the applicability of those standards here

2.2 Design Analysis

The small scale prototype has not been built as of the writing of this document. As we have researched we have changed some of the aspects of the railgun due to financial constraints and the feasibility of the initial idea, which was a railgun with the same output as a .50 caliber projectile.

– Discuss what you did so far

Draw the schematic design and this gives the explanation that we can use Lorentz force. The formula of Lorentz force will help to propel the projection out of the rail. we discussed on how the current will help us to make the circuit a reality. We talked about the copper and we did some research on the material to see if it would be used for the rail. All the informations that we calculate have been recorded. We designed the actuators and talked about the type that will best fit our project. We drew the schematic design of the rail and in between the rail there is a little piece of material that we need to put in there. Knowing the length, the current, and the height. we have determined the size of the material to define different cross-sections and the material that will be used (copper or aluminum). We are still doing calculations to be able to define the value of the capacitor that we need to use.

– Did it work? Why or why not?

– What are your observations, thoughts, and ideas to modify or continue?

– If you have key results they may be included here or in the separate “Results” section

We want to show the advantage of the microcontroller use, the voltage, and the current and how it will create a magnetic field. This is a diagram that we will use to build small scale, and from the small we will a large one. Also some modification will be brought on it as far we are working on.

-Highlight the **strengths, weakness**, and your observations made on the proposed solution.

3 Testing and Implementation

Testing is an **extremely** important component of most projects, whether it involves a circuit, a process, or a software library

Although the tooling is usually significantly different, the testing process is typically quite similar regardless of CprE, EE, or SE themed project:

1. Define the needed types of tests
2. Define the individual items to be tested
3. Define, design, and develop the actual test cases
4. Determine the anticipated test results for each test case 5. Perform the actual tests
6. Evaluate the actual test results
7. Make the necessary changes to the product being tested 8. Perform any necessary retesting
9. Document the entire testing process and its results

Include Functional and Non-Functional Testing, Modeling and Simulations, challenges you've determined.

3.1 Interface Specifications

We will not be using any hardware or software interface for this project.

– Discuss any hardware/software interfacing that you are working on for testing your project

3.2 Hardware and software

Lab equipment located in Coover Hall will be used for preliminary testing of the small scale prototype. We will be using the voltage source in the labs to help design the charging circuit for the capacitors and the discharging circuit.

– Indicate any hardware and/or software used in the testing phase

– Provide brief, sample introductions for each to explain the usefulness of each

3.3 Functional Testing

Have not done any functional testing.

Examples include unit, integration, system, acceptance testing

3.4 Non-Functional Testing

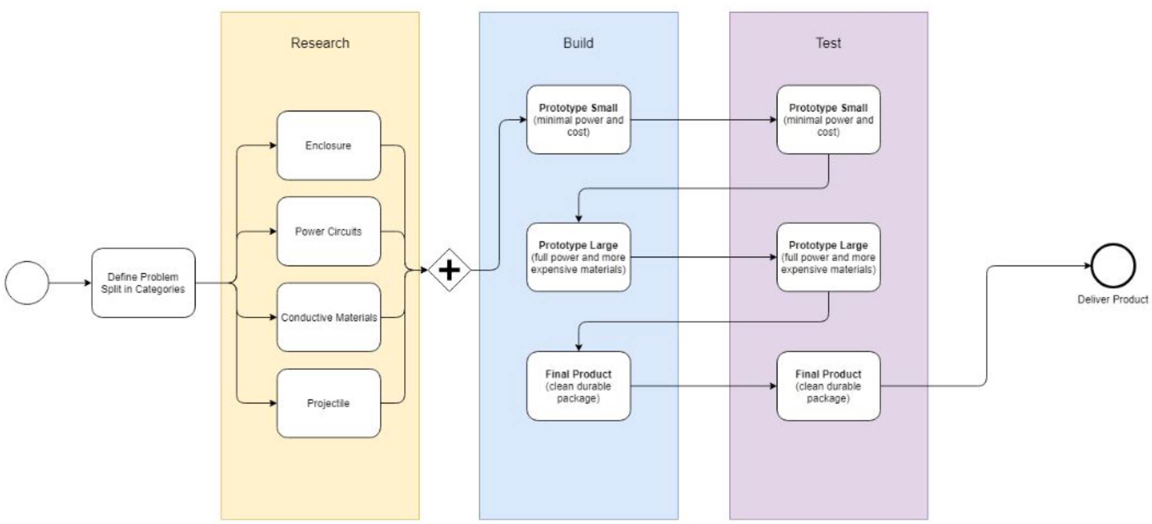
Besides testing of the actual railgun launching the projectile testing of the structural integrity of the enclosure as a whole will be necessary. Usability is slightly important as a user who has understanding of electronics and electromagnetics is the only one who should be using the product.

Testing for performance, security, usability, compatibility

3.5 Process

– Explain how each method indicated in Section 2 was tested

– Flow diagram of the process



3.6 Results

No testing has been conducted thus far.

– List and explain any and all results obtained so far during the testing phase

- – Include failures and successes
- – Explain what you learned and how you are planning to change it as you progress with your project
- – If you are including figures, please include captions and cite it in the text

  • This part will likely need to be refined in your 492 semester where the majority of the implementation and testing work will take place

-**Modeling and Simulation**: This could be logic analyzation, waveform outputs, block testing. 3D model renders, modeling graphs.

-List the **implementation Issues and Challenges**.

4 Closing Material

4.1 Conclusion

So far this project has been primarily focused on researching to get proper equations and materials to get a small scale prototype up and running. Our goal for this semester is to get the prototype working so we can test various materials and values to observe their impact on the railgun performance. The plan is to do the math now so we can get as much use out of the material we buy in the future and get as much useful data back from the prototype phase so that when the final product is being developed we have enough data to create the best possible end product.

Summarize the work you have done so far. Briefly re-iterate your goals. Then, re-iterate the best plan of action (or solution) to achieving your goals and indicate why this surpasses all other possible solutions tested.

4.2 References

No references at this time.

This will likely be different than in project plan, since these will be technical references versus related work / market survey references. Do professional citation style(ex. IEEE).

4.3 Appendices

No additional information at this current time.

Any additional information that would be helpful to the evaluation of your design document.

If you have any large graphs, tables, or similar that does not directly pertain to the problem but helps support it, include that here. This would also be a good area to include hardware/software manuals used. May include CAD files, circuit schematics, layout etc. PCB testing issues etc. Software bugs etc.