CV Approval Cover Sheet

Complete this sheet and place it atop your completed forms before you scan and submit them.

Name: Dev Lochan

Email: lochand@hotmail.com

Building: CVHS **Grade:** 11

Sponsor: Mr. Floreck **Email:** mfloreck@cvschools.org

Required forms: *These forms must be completed for ALL projects.*

Sponsor initials

_____ **1: Adult Sponsor Checklist** - Checklist and Sponsor Signature

_____ **1A: Student Checklist** – Student and Project Details, plus the separate type-written **Research plan (i.e. title, problem, hypothesis, materials, procedure, and analysis) with five-source Bibliography.**

_____ **1B: Approval form** - Signatures of student and parent/guardian, as well as signatures of SRC or IRB if required.

_____ **3: Risk Assessment form** - required by the CV IRB in order to determine if the project involves hazardous chemicals (not found in a typical high school chemistry laboratory setting), hazardous activities or devices (i.e. weapons), and microorganism that are not exempt from pre-approval.

Potential forms: *Determined with your sponsor by using the Form Wizard.*

_____ **1C: Regulated Research / Institution setting** - for projects not completed at home or school.

_____ **2: Qualified Scientist form** - may be needed for projects that have human participants, vertebrate animals, potentially hazardous biological agents (including microbes) and DEA-controlled substances.

_____ **4: Human Participants form** - ALL projects that use human participants.
Human Informed Consent - required for each actively participating humans.

_____ **5A: Vertebrate Animal** - ALL non-exempt vertebrate projects conducted at home/school/field site

_____ **5B: Vertebrate Animal** - for vertebrate projects conducted in a Regulated Research Institution

_____ **6A: Potentially Hazardous Biological Agents Risk Assessment** - needed for microorganisms, rDNA, fresh/frozen tissues (including primary cell lines, human and other primate established cell lines and tissue cultures, blood, blood products and body fluids.

_____ **6B: Human and Vertebrate Animal Tissue** - for projects that use fresh/frozen tissues (including primary cell lines, human and other primate established cell lines and tissue cultures), blood, blood products and body fluids

_____ **7: Continuation/Research Progression** - Required for projects that are a continuation/progression in the same field of study as a previous project for this student. NOTE: The previous year's abstract and research plan must be included with the form.

Checklist for Adult Sponsor (1)

This completed form is required for ALL projects.

To be completed by the Adult Sponsor in collaboration with the student researcher(s):

Student's Name(s): Dev Lochan

Project Title: A Step Towards Solving Foot Pain: A Revolutionary Shoe with Magnetic Levitation to Reduce Ground Reaction Forces | Year 2

1. ☑ I have reviewed the ISEF Rules and Guidelines.

2. ☑ I have reviewed the student's completed Student Checklist (1A) and Research Plan/Project Summary.

3. ☑ I have worked with the student and we have discussed the possible risks involved in the project.

4. ☐ The project involves one or more of the following and requires prior approval by an SRC, IRB, IACUC or IBC:
   - ☐ Humans
   - ☐ Vertebrate Animals
   - ☐ Potentially Hazardous Biological Agents
   - ☐ Microorganisms ☐ rDNA ☐ Tissues

5. ☑ Items to be completed for **ALL PROJECTS**
   - ☑ Adult Sponsor Checklist (1)
   - ☑ Student Checklist (1A)
   - ☑ Research Plan/Project Summary
   - ☑ Approval Form (1B)
   - ☐ Regulated Research Institutional/Industrial Setting Form (1C) (when applicable; after completed experiment)
   - ☑ Continuation/Research Progression Form (7) (when applicable)

Additional forms required if the project includes the use of one or more of the following (check all that apply):

☑ **Humans**, including student designed inventions/prototypes. (Requires prior approval by an Institutional Review Board (IRB); see full text of the rules.)
- ☑ Human Participants Form (4) or appropriate Institutional IRB documentation
- ☑ Sample of Informed Consent Form (when applicable and/or required by the IRB)
- ☑ Qualified Scientist Form (2) (when applicable and/or required by the IRB)

☐ **Vertebrate Animals** (Requires prior approval, see full text of the rules.)
- ☐ Vertebrate Animal Form (5A) - for projects conducted in a school/home/field research site (SRC prior approval required.)
- ☐ Vertebrate Animal Form (5B) - for projects conducted at a Regulated Research Institution. (Institutional Animal Care and Use Committee (IACUC) approval required prior experimentation.)
- ☐ Qualified Scientist Form (2) (Required for all vertebrate animal projects at a regulated research site or when applicable)

☐ **Potentially Hazardous Biological Agents** (Requires prior approval by SRC, IACUC or IBC, see full text of the rules.)
- ☐ Potentially Hazardous Biological Agents Risk Assessment Form (6A)
- ☐ Human and Vertebrate Animal Tissue Form (6B) - to be completed in addition to Form 6A when project involves the use of fresh or frozen tissue, primary cell cultures, blood, blood products and body fluids.
- ☐ Qualified Scientist Form (2) (when applicable)
- ☐ The following are exempt from prior review but require a Risk Assessment Form 3: projects involving protists, archae and similar microorganisms, for projects using manure for composting, fuel production or other non-culturing experiments, projects using color change coliform water test kits, microbial fuel cells, and projects involving decomposing vertebrate organisms.

☐ **Hazardous Chemicals, Activities and Devices** (No SRC prior approval required, see full text of the rules.)
- ☐ Risk Assessment Form (3)
- ☐ Qualified Scientist Form (2) (required for projects involving DEA-controlled substances or when applicable)

☑ **Other**
- ☑ Risk Assessment Form (3)

Mike Floreck		07/25/19
Adult Sponsor's Printed Name	Signature	Date of Review (mm/dd/yy)
717-506-3413	mfloreck@cvschools.org	
Phone	Email	

Student Checklist (1A)

This form is required for ALL projects.

1. a. Student/Team Leader: Dev Lochan Grade: 11

   Email: lochand@hotmail.com Phone: 717-888-0188

   b. Team Member: _____ c. Team Member: _____

2. Title of Project:

   A Step Towards Solving Foot Pain: A Revolutionary Shoe with Magnetic Levitation to Reduce Ground Reaction Forces | Year 2

3. School: Cumberland Valley High School School Phone: 717-506-3413

   School Address: 6746 Carlisle Pike, Mechanicsburg, PA 17050

4. Adult Sponsor: Mike Floreck Phone/Email: mfloreck@cvschools.org

5. Does this project need SRC/IRB/IACUC or other pre-approval? ☑ Yes ☐ No Tentative start date: 07/25/19

6. Is this a continuation/progression from a previous year? ☑ Yes ☐ No
   If Yes:
   a. Attach the previous year's ☑ Abstract **and** ☑ Research Plan/Project Summary
   b. Explain how this project is new and different from previous years on
   ☑☐ Continuation/Research Progression Form (7)

7. This year's laboratory experiment/data collection:

   07/24/19 (Actual Start Date: (mm/dd/yy))

   03/01/20 (End Date: (mm/dd/yy))

8. Where will you conduct your experimentation? (check all that apply)
   ☑ Research Institution ☑ School ☐ Field ☑ Home ☐ Other: _____

9. List name and address of all non-home and non-school work site(s):

   Name: Harrisburg Foot & Ankle

   Address: 4033 Linglestown Rd # 1, Harrisburg, PA 17112

   Phone/email: (717) 651-0000

10. **Complete a Research Plan/Project Summary following the Research Plan/Project Summary instructions and attach to this form.**

11. **An abstract is required for all projects after experimentation.**

Research Plan/Project Summary Instructions

A complete Research Plan/Project Summary is required for ALL projects and must accompany Student Checklist (1A).

1. All projects must have a Research Plan/Project Summary
   a. Written prior to experimentation following the instructions below to detail the rationale, research question(s), methodology, and risk assessment of the proposed research.
   b. If changes are made during the research, such changes can be added to the original research plan as an addendum, recognizing that some changes may require returning to the IRB or SRC for appropriate review and approvals. If no additional approvals are required, this addendum serves as a project summary to explain research that was conducted.
   c. If no changes are made from the original research plan, no project summary is required.

2. Some studies, such as an engineering design or mathematics projects, will be less detailed in the initial project plan and will change through the course of research. If such changes occur, a project summary that explains what was done is required and can be appended to the original research plan.

3. The Research Plan/Project Summary should include the following:
   a. **RATIONALE:** Include a brief synopsis of the background that supports your research problem and explain why this research is important and if applicable, explain any societal impact of your research.
   b. **RESEARCH QUESTION(S), HYPOTHESIS(ES), ENGINEERING GOAL(S), EXPECTED OUTCOMES:** How is this based on the rationale described above?
   c. Describe the following in detail:

- **Procedures:** Detail all procedures and experimental design including methods for data collection. Describe only your project. Do not include work done by mentor or others.
- **Risk and Safety:** Identify any potential risks and safety precautions needed.
- **Data Analysis:** Describe the procedures you will use to analyze the data/results.

   d. **BIBLIOGRAPHY:** List major references (e.g. science journal articles, books, internet sites) from your literature review. If you plan to use vertebrate animals, one of these references must be an animal care reference.

Items 1–4 below are subject-specific guidelines for additional items to be included in your research plan/project summary as applicable.

1. **Human participants research:**
   a. **Participants:** Describe age range, gender, racial/ethnic composition of participants. Identify vulnerable populations (minors, pregnant women, prisoners, mentally disabled or economically disadvantaged).
   b. **Recruitment:** Where will you find your participants? How will they be invited to participate?
   c. **Methods:** What will participants be asked to do? Will you use any surveys, questionnaires or tests? If yes and not your own, how did you obtain? Did it require permissions? If so, explain. What is the frequency and length of time involved for each subject?
   d. **Risk Assessment:** What are the risks or potential discomforts (physical, psychological, time involved, social, legal, etc.) to participants? How will you minimize risks? List any benefits to society or participants.
   e. **Protection of Privacy:** Will identifiable information (e.g., names, telephone numbers, birth dates, email addresses) be collected? Will data be confidential/anonymous? If anonymous, describe how the data will be collected. If not anonymous, what procedures are in place for safeguarding confidentiality? Where will data be stored? Who will have access to the data? What will you do with the data after the study?
   f. **Informed Consent Process:** Describe how you will inform participants about the purpose of the study, what they will be asked to do, that their participation is voluntary and they have the right to stop at any time.

2. **Vertebrate animal research:**
   a. Discuss potential ALTERNATIVES to vertebrate animal use and present justification for use of vertebrates.
   b. Explain potential impact or contribution of this research.
   c. Detail all procedures to be used, including methods used to minimize potential discomfort, distress, pain and injury to the animals and detailed chemical concentrations and drug dosages.
   d. Detail animal numbers, species, strain, sex, age, source, etc., include justification of the numbers planned.
   e. Describe housing and oversight of daily care.
   f. Discuss disposition of the animals at the end of the study.

3. **Potentially hazardous biological agents research:**
   a. Give source of the organism and describe BSL assessment process and BSL determination.
   b. Detail safety precautions and discuss methods of disposal.

4. **Hazardous chemicals, activities & devices:**
   - Describe Risk Assessment process, supervision, safety precautions and methods of disposal.
   - Material Safety Data Sheets are not necessary to submit with paperwork.

A Step Towards Solving Foot Pain:

A Revolutionary Shoe with Magnetic Levitation to Reduce Ground Reaction Forces

Year 2

Dev Lochan | 11th Grade
Research Plan 2019-20

Table of Contents

Introduction

Foot pain has become a major issue among humans as a population. My mom has recently developed Plantar Fasciitis, which puts her in an immense amount of discomfort at points, discomfort that current shoes can't help enough. To address this growing problem, the shoe sole needs to be reinvented and this magnetic levitation is the answer to people's problems.

Engineering Goal

To create a cheap, soft, and light shoe sole using Halbach array-based magnetic levitation. Constraints include a budget of $20 dollars, 12 oz of weight, and access to regular machine available in a common workshop.

Research

Halbach Array Design Considerations

- Operational Gap
    1. Between the work-piece and magnet array for a Planar design
    2. In the ID of a Halbach Cylinder
    3. Between a Halbach Rotor and the stator
- Operational Environment
    1. Temperature
    2. Rotational speeds
    3. Liquids/ gasses
- External Demagnetizing Fields
    - This is important especially in Halbach Arrays used for Rotors.
- Cost
- Required Lifetime in Service
- Available Room or Volume that Can Be Allotted to the Array
- Size of the Array Assembly
    - Halbach Arrays depend on the assemblage of magnets, which by their nature attract and repel each other. The size of the array complicates its construction.

Halbach Array Benefits

The most obvious benefit of a Halbach-style Array is that the field produced is very strong when compared to other arrays having the same amount of the magnet alloy. The arrangement essentially increases the efficiency of the magnetic circuit.

The by-product of the design is that there is only one working surface or "working face." The one working-face, where the magnetic field resides, is very strong; and the non-working face has essentially no field. In essence, the magnetic field, which would normally be present on the non-working face, is rerouted to the working-face. This is true for both Circular and Planar style Arrays.

Disadvantages of Halbach Arrays

The primary disadvantage of the Halbach Array geometry is that it is difficult to put together, resulting in potentially higher manufacturing costs than other potential solutions. This is because all of the magnet elements are repelling each other in a Halbach Array. This can create a variety of assembly issues including: needing to assemble the magnets magnetized,

combating the forces during assembly, and ensuring the assembly will "hold together" during its use.

Another disadvantage is that Halbach Arrays may have an issue in high heat applications because the array elements apply a demagnetizing field on each other. As the operating temperature increases, a magnet is more susceptible to demagnetizing, and the neighboring magnet demagnetization is exacerbated.

Timeline and Construction Plan

- **Timeline**
  - Understanding Halbach Arrays and building some for an extended period of time to understand the forces behind it
    - Total time expected: 3 weeks
  - Design the Shoe and Build various prototypes to perfect the design
    - Total time expected: 2 ½ months
  - Test on humans and gather input
    - Total time expected: 1 month
- **Plan for construction**
  - Utilize the engineering lab to create a small working prototype out of rubber or a scratch material.
  - The magnetic hub will be based on Halbach Arrays.
  - A whole new kind of shoe design will allow freedom in my design and create fewer limitations on weight

Risk and Precautions

There aren't very many risks involved with this experiment but since I will be dealing with human trials, I will be under the supervision of a physiotherapist. I will also wear the proper personal protection equipment, along with providing it for the participants. This will help avoid any risk or danger involved with this project. I won't collect any identifying information either in order to maintain privacy.

Testing

Just like the prior year, I will drop a weight onto the shoe to test declaration but the majority of my data will come from human participants to get real-world data that can be applied to the further development of the shoe.

Works Cited

A., A., R., & Y. (2012, July 23). Foot Plantar Pressure Measurement System: A Review. Retrieved December 9, 2018, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3444133/

Bonsor, K. (2000, October 13). How Maglev Trains Work. Retrieved September 20, 2017, from http://science.howstuffworks.com/transport/engines-equipment/maglev-train.htm

Effects of shoe inserts and heel height on foot pressure, impact force, and perceived comfort during walking. (2005, March 05). Retrieved from https://www.sciencedirect.com/science/article/pii/S0003687005000050

Halbach Arrays - Planar & Circular Magnet Halbach Arrays: Dura Magnetics USA. (n.d.). Retrieved from https://www.duramag.com/magnet-applications/halbach-arrays/.

How Maglev Works. (n.d.). Retrieved from https://www.energy.gov/articles/how-maglev-works

Mary Josephine Hessert, Mitul Vyas, Jason Leach, Kun Hu, Lewis A Lipsitz, & Vera Novak. (2005, May 19). Foot pressure distribution during walking in young and old adults. Retrieved from https://bmcgeriatr.biomedcentral.com/articles/10.1186/1471-2318-5-8

Approval Form (1B)

A completed form is required for each student, including all team members.

1. To Be Completed by Student and Parent

a. **Student Acknowledgment:**

- I understand the risks and possible dangers to me of the proposed research plan.
- I have read the ISEF Rules and Guidelines and will adhere to all International Rules when conducting this research.
- I have read and will abide by the following Ethics statement

Student researchers are expected to maintain the highest standards of honesty and integrity. Scientific fraud and misconduct are not condoned at any level of research or competition. Such practices include but are not limited to plagiarism, forgery, use or presentation of other researcher's work as one's own, and fabrication of data. Fraudulent projects will fail to qualify for competition in affiliated fairs and ISEF.

Dev Lochan		07/24/19
Student's Printed Name	Signature	Date Acknowledged (mm/dd/yy) (Must be prior to experimentation.)

b. **Parent/Guardian Approval:** I have read and understand the risks and possible dangers involved in the **Research Plan/Project Summary**. I consent to my child participating in this research.

Punit Lochan		07/24/19
Parent/Guardian's Printed Name	Signature	Date Acknowledged (mm/dd/yy) (Must be prior to experimentation.)

2. To be completed by the local or affiliated Fair SRC

(Required for projects requiring prior SRC/IRB APPROVAL. Sign 2a or 2b as appropriate.)

a. **Required for projects that need prior SRC/IRB approval BEFORE experimentation** (humans, vertebrates or potentially hazardous biological agents).

The SRC/IRB has carefully studied this project's **Research Plan/ Project Summary** and all the required forms are included. My signature indicates approval of the **Research Plan/Project Summary** before the student begins experimentation.

Mike Flaherty	
SRC/IRB Chair's Printed Name	
	10/30/19
Signature	Date of Approval (mm/dd/yy) (Must be prior to experimentation.)

OR

b. **Required for research conducted at all Regulated Research Institutions with no prior fair SRC/IRB approval.**

This project was conducted at a regulated research institution (**not home or high school, etc.**), was reviewed and approved by the proper institutional board before experimentation and complies with the ISEF Rules. **Attach (1C) and any required institutional approvals (e.g. IACUC, IRB).**

SRC Chair's Printed Name	
Signature	Date of Signature (mm/dd/yy) (May be after experimentation)

3. Final ISEF Affiliated Fair SRC Approval (Required for ALL Projects)

SRC Approval After Experimentation and Before Competition at Regional/State/National Fair

I certify that this project adheres to the approved **Research Plan/Project Summary** and complies with all ISEF Rules.

Regional SRC Chair's Printed Name	Signature	Date of Approval (mm/dd/yy)
State/National SRC Chair's Printed Name *(where applicable)*	Signature	Date of Approval (mm/dd/yy)

Risk Assessment Form (3)

Must be completed before experimentation.

Student's Name(s) Dev Lochan

Title of Project A Step Towards Solving Foot Pain: A Revolutionary Shoe with Magnetic Levitation to Reduce Ground Reaction Forces | Year 2

To be completed by the Student Researcher(s) in collaboration with Designated Supervisor/Qualified Scientist:
(All questions must be answered; additional page(s) may be attached.)

1. List all hazardous chemicals, activities, or devices that will be used; identify microorganisms exempt from pre-approval (see Potentially Hazardous Biological Agent rules).
   N/A

2. Identify and assess the risks involved in this project.
   The shoe that was created last year will be modified slighty and placed on the feet of many people to gain additional data and feedback to improve the shoe

3. Describe the safety precautions and procedures that will be used to reduce the risks.
   The shoe will only be given for a limited time and will be observed and approved by a phycial therapist or an orthopedic surgeon prior to distribution.

4. Describe the disposal procedures that will be used (when applicable).
   N/A

5. List the source(s) of safety information.
   Doctors and researchers

To be completed and signed by the Designated Supervisor (or Qualified Scientist, when applicable):
I agree with the risk assessment and safety precautions and procedures described above. I certify that I have reviewed the Research Plan/Project Summary and will provide direct supervision.

Dhaval Pandya — Designated Supervisor's Printed Name

Signature

07/24/19 — Date of Review (mm/dd/yy)

Physiotherapist — Position & Institution

717-460-1531 — Phone or email contact information

Knowledge of the lower extremities and body — Experience/Training as relates to the student's area of research

Qualified Scientist Form (2)

May be required for research involving human participants, vertebrate animals, potentially hazardous biological agents, and hazardous substances and devices. Must be completed and signed before the start of student experimentation.

Student's Name(s): Dev Lochan

Title of Project: A Step Towards Solving Foot Pain: A Revolutionary Shoe with Magnetic Levitation to Reduce Ground Reaction Forces | Year 2

To be completed by the Qualified Scientist:

Scientist Name: Dhaval Pandya

Educational Background: Physiotherapist

Degree(s): Doctor Of Physical Therapy degree + Masters

Experience/Training as relates to the student's area of research: Knowledge of physical therapy and the lower extrememties

Physiotherapist
Position:

~~Harrisburg Foot & Ankle~~ Select Medical
Institution:

4033 Linglestown Rd # 1, Harrisburg, PA 17112
Address:

717-651-0000
Email/Phone:

1. Have you reviewed the ISEF rules relevant to this project? ☑ Yes ☐ No
2. Will any of the following be used?
   a. Human participants ☑ Yes ☐ No
   b. Vertebrate animals ☐ Yes ☑ No
   c. Potentially hazardous biological agents (microorganisms, rDNA and tissues, including blood and blood products) ☐ Yes ☑ No
   d. Hazardous substances and devices ☐ Yes ☑ No
3. Will this study be a sub-set of a larger study? ☐ Yes ☑ No
4. Will you directly supervise the student? ☑ Yes ☐ No
   a. If no, who will directly supervise and serve as the Designated Supervisor?
   b. Experience/Training of the Designated Supervisor:

To be completed by the Qualified Scientist:

I certify that I have reviewed and approved the Research Plan/ Project Summary prior to the start of the experimentation. If the student or Designated Supervisor is not trained in the necessary procedures, I will ensure her/his training. I will provide advice and supervision during the research. I have a working knowledge of the techniques to be used by the student in the Research Plan/Project Summary. I understand that a Designated Supervisor is required when the student is not conducting experimentation under my direct supervision.

Dhaval Pandya
Qualified Scientist's Printed Name

Signature

7/24/19
Date of Approval (mm/dd/yy)

To be completed by the Designated Supervisor when the Qualified Scientist cannot directly supervise.

I certify that I have reviewed the Research Plan/Project Summary and have been trained in the techniques to be used by this student, and I will provide direct supervision.

Mike Floreck
Designated Supervisor's Printed Name

Signature

7/25/19
Date of Approval (mm/dd/yy)

717-506-3413
Phone

mfloreck@cvschools.org
Email

Human Participants Form (4)

Required for all research involving human participants not at a Regulated Research Institution. If at a Regulated Research Institution, use institutional approval forms for documentation of prior review and approval.
(IRB approval required before recruitment or data collection.)

Dev Lochan	A Step Towards Solving Foot Pain.A Revolutionary Shoe with Magnetic Levitation to Reduce Ground Reaction Forces Year 2
Student's Name(s)	Title of Project
Mike Floreck	lochand@hotmail.com
Adult Sponsor	Phone/Email

Must be completed by Student Researcher(s) in collaboration with the Adult Sponsor/Designated Supervisor/Qualified Scientist:

1. ☑ I have submitted my Research Plan/Project Summary which addresses ALL areas indicated in the Human Participants Section of the Research Plan/Project Summary Instructions.
2. ☑ I have attached any surveys or questionnaires I will be using in my project or other documents provided to human participants.
   ☑ Any published instrument(s) used was/were legally obtained.
3. ☑ I have attached an informed consent that I would use if required by the IRB.
4. ☑ Yes ☐ No Are you working with a Qualified Scientist? If yes, attach the Qualified Scientist Form 2.

BELOW - IRB USE ONLY

Must be completed by Institutional Review Board (IRB) after review of the research plan. All questions must be answered for the approval to be valid. (If not approved, return paperwork to the student with instructions for modifications.)

☐ Approved with Full Committee Review (3 signatures required) and the following conditions: **(All 6 must be answered)**

1. Risk Level (check one) : ☐ Minimal Risk ☐ More than Minimal Risk
2. Qualified Scientist (QS) Required (Form 2): ☐ Yes ☐ No
3. Designated Supervisor (DS) Required (Form 3): ☐ Yes ☐ No
4. Written Minor Assent required for minor participants:
   ☐ Yes ☐ No ☐ Not applicable (No minors in this study)
5. Written Parental Permission required for minor participants:
   ☐ Yes ☐ No ☐ Not applicable (No minors in this study)
6. Written Informed Consent required for participants 18 years or older:
   ☐ Yes ☐ No ☐ Not applicable (No participants 18 yrs or older in this study)

IRB SIGNATURES (All 3 signatures required) None of these individuals may be the adult sponsor, designated supervisor, qualified scientist or related to (e.g., mother, father of) the student (conflict of interest).

I attest that I have reviewed the student's project, that the checkboxes above have been completed to indicate the IRB determination and that I agree with the decisions above.

Medical or Mental Health Professional (a psychologist, medical doctor, licensed social worker, licensed clinical professional counselor, physician's assistant, doctor of pharmacy, or registered nurse) with expertise related to this project.

Printed Name	Degree/Professional License
Dhaval Pandya	Doctor of Physical Therapy
Signature	Date of Approval (Must be prior to experimentation.) (mm/dd/yy)
Dhaval Pandya	07/24/19

Educator

Printed Name	Degree/Professional License
Roy Stanley	AP Physics Teacher - CVHS
Signature	Date of Approval (Must be prior to experimentation.) (mm/dd/yy)
Roy Stanley	10/30/19

School Administrator

Printed Name	Degree/Professional License
Dr Michael Jones	Board principal CVHS
Signature	Date of Approval (Must be prior to experimentation.) (mm/dd/yy)
Dr Michael Jones	10/30/19

Human Informed Consent Form

Instructions to the Student Researcher(s): An informed consent/assent/permission form should be developed in consultation with the Adult Sponsor, Designated Supervisor or Qualified Scientist.
This form is used to provide information to the research participant (or parent/guardian) and to document written informed consent, minor assent, and/or parental permission.

- When written documentation is required, the researcher keeps the original, signed form.
- Students may use this sample form or may copy ALL elements of it into a new document.

If the form is serving to document parental permission, a copy of any survey or questionnaire must be attached.

Student Researcher(s): Dev Lochan

Title of Project: A Step Towards Solving Foot Pain:A Revolutionary Shoe with Magnetic Levitation to Reduce Ground Reaction Forces Year 2

I am asking for your voluntary participation in my science fair project. Please read the following information about the project. If you would like to participate, please sign in the appropriate area below.

Purpose of the project:
To create a novel shoe using magnetic levitation for a much softer feel

If you participate, you will be asked to:
Wear a trial shoe for some time and complete a small survey afterward

Time required for participation:
5 Minutes
Potential Risks of Study:
The shoe may feel different and has the possiblity of walking differently while wearing it

Benefits:
The shoe was developed to be extremely soft as opposed to the rest of the shoes in the market

How confidentiality will be maintained:
No identifying information will be taken

If you have any questions about this study, feel free to contact:

Adult Sponsor/QS/DS: Mike Floreck Phone/email: mfloreck@cvschools.org

Voluntary Participation:

Participation in this study is completely voluntary. If you decide not to participate there will not be negative consequences. Please be aware that if you decide to participate, you may stop participating at any time and you may decide not to answer any specific question.

By signing this form I am attesting that I have read and understand the information above and I freely give my consent/assent to participate or permission for my child to participate.

Adult Informed Consent or Minor Assent Date Reviewed & Signed: (mm/dd/yy) _____

_____ _____

Research Participant Printed Name: Signature:

Parental/Guardian Permission (if applicable) Date Reviewed & Signed: (mm/dd/yy) _____

_____ _____

Parent/Guardian Printed Name: Signature:

Continuation/Research Progression Projects Form (7)

Required for projects that are a continuation/progression in the same field of study as a previous project.
This form must be accompanied by the previous year's abstract and Research Plan/Project Summary.

Student's Name(s) Dev Lochan

To be completed by Student Researcher: List all components of the current project that make it new and different from previous research. The information must be on the form; use an additional form for previous year and earlier projects.

Components	Current Research Project	Previous Research Project: Year: 2018-19
1. Title	A Step Towards Solving Foot Pain: A Revolutionary Shoe with Magnetic Levitation to Reduce Ground Reaction Forces | Year 2	Taking a Step Towards Solving the Foot Crisis: Reducing Joint Impact with Magnetic Levitation
2. Change in goal/ purpose/objective	To optimize the shoe from the previous year to make it a viable product	To make a light, cheap, and practical shoe
3. Changes in methodology	Addition of a new magnetic system using Halbach Arrays, as well as some electronic components to track information (along with the needed software development)	Use of simple magnetics embedded into the sole of a shoe to place forces in the right area
4. Variable studied	Deceleration with an Arduino Accelerometer	Human testing and force analysis using special machinery found in a podatric clinic
5. Additional changes	Development of a new type of shoe sole to embed the magnets in more effectively	Used a simple premade sole

Attached are:

☑ Abstract and Research Plan/Project Summary, Year 2018-19

I hereby certify that the above information is correct and that the current year Abstract & Certification and project display board properly reflect work done only in the current year.

Dev Lochan — Student's Printed Name(s)

Signature

10/27/19 — Date of Signature (mm/dd/yy)

Abstract 2018-19

216,262,500. That's the number of steps an average human takes over their lifetime, yet the shoes that humans use to take those steps have not evolved over time and are found to have major flaws causing severe foot pain. My project is about designing and developing the first of a kind shoe with Magnetic Levitation that could change shoes as we know them. The new magnetic levitation shoe solves the problems of joint pain using a generic, less expensive shoe with supplemental technology. As part of my design, I added magnets between small pockets in 3 strategic areas of the sole and the insole according to a layout determined through clinical gait data, medical research, and consultations with 5 different doctors. The levitation's efficiency was then compared to the current technology through a set of rigorous testing using a crutch (simulated leg), 32 kg of weight which is an average weight of a normal leg, and an accelerometer to measure the deceleration of the foot. The deceleration is a measure of the efficiency of the cushioning and a lower number indicates a lower force. After over 120 trials, 4 different shoes, 198 data points, the modified shoe was found 19% more efficient in walking, 65% cheaper and 11% lighter than an average unmodified shoe. The results show that this is an invention that can change the rapidly growing $246.07 billion footwear industry forever and revolutionize a necessity in our life: shoes.

Dev Lochan

Research Plan 2018-19

Taking a Step Towards Solving the Foot Crisis:

Reducing Joint Impact with Magnetic Levitation

Table of Contents

Research and Concept Review

Magnetic Principles

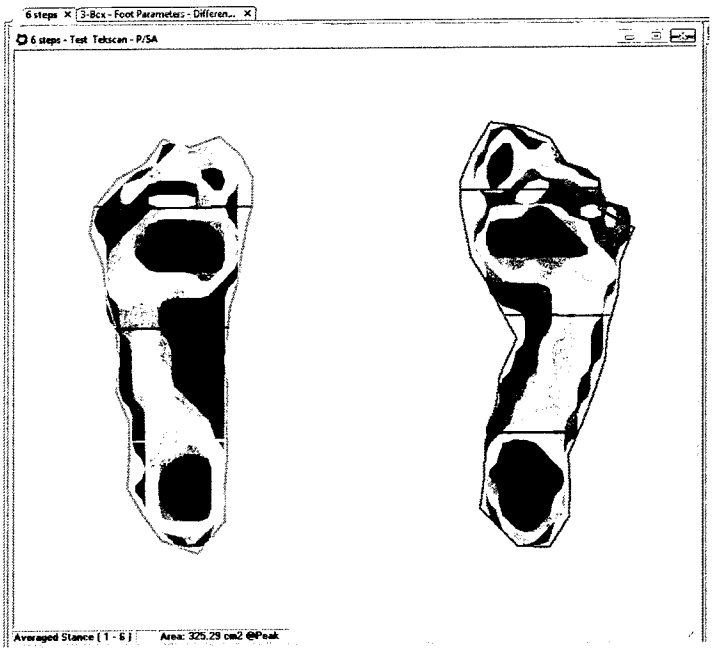
- **Law of Magnetism**: Opposite poles attract each other and similar poles repel
    - Basis of magnetic suspension: repulsive properties
        - Magnetic Repulsion will provide a contactless suspended turbine for better efficiency

Current Technology

- **Variations of Foam**: Can be soft and supportive but can tend to not provide the degree of softness desired by most people.

Foot Pressure Map

- This image represents the map of a foot and the various places magnets can be implemented into to reduce the pressure (shown in red).



Engineering Goal

To create a **cheap**, **soft, and flexible** shoe sole using magnetic levitation **without to much extra weight**. **Constraints** include a budget of $20 dollars, 12 oz of weight, and access to regular machine available in a common workshop.

Rationale

Foot pain has become a major issue among humans as a population. My mom has recently developed Plantar Fasciitis, which puts her in an immense amount of discomfort at points, discomfort that current shoes can't help enough. To address this growing problem, the shoe sole needs to be reinvented and this magnetic levitation is the answer to people's problems.

Timeline and Construction Plan

- **Timeline**
  - Playing with the magnets for an extended period of time to understand the forces behind it
    - Total time expected: 2 weeks
  - Design the Shoe and Build various prototypes to perfect the design
    - Total time expected: 3 ½ months
- **Plan for construction**
  - Utilize the engineering lab to create a small working prototype out of an old pair of shoes.
  - The magnetic hub can be made from neodymium magnets to support the massive weight.
  - To create a hole in the shoe, a hole saw bit can be used.
  - The teardown of the shoe revealed a hard layer that represents a woven nylon midsole that might hold things together.
    - Might be difficult to work with due to its rigidity.

Risk and Precautions

There aren't very many risks involved with this experiment but since I will be dealing with several saws and workshop machines, I will be under the supervision of a trained adult. I will also wear the proper and necessary safety gear, such as goggles. This will help avoid any risk or danger involved with this project.

Testing

By dropping an 18.7 lbs weight (average weight of a footstep) attached to a force sensor onto the shoe sole with the magnets, the force placed on the joint scan be measured.

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