Concussion Alert - Rohit Mahesh

Invention Log

What is an invention?

An invention is something new that enables us to solve a problem or do something better or easier.

The purpose of this Invention Log

All stories have an ending. In this case, the ending of what you are doing is your invention. But all stories also have a beginning and middle. The purpose of this Invention Log is to tell the entire story of your invention. In it, during every step you take in making your invention, you will record what you did, why you did it, and how you did it. This Invention Log is an important part of the invention process and is a complete and accurate record of the ideas, plans, and processes by which the invention was created. Invention Logs can be used by students to prove they came up with the idea and invention. Oftentimes, they are used as part of the patenting process.

How to use this Invention Log

The Invention Log is not a book report that is created after you are done. Rather, it is a diary that is continuously filled in as you work on your invention. Follow the steps of the invention process and fill out the various pages as you work on them. When you are done with a page, print your name and the date at the bottom. If you need extra space for any section, make copies of the Blank Page (Page 17) and use that for any purpose. Once you are done, put the pages in the order in which you did them and staple them to make a complete Invention Log. This log will also be used as part of the final presentation and needs to be filled in using complete sentences (except for things like a list of materials). Teams share one Invention Log and should attach signatures of all inventors.

The name of the invention: Concussion Alert

The problem that it solves: Concussions are a significant problem. About 1.6 to 3.8 million sports and recreation-related concussions occur each year. 10% of all contact sport athletes sustain concussions yearly in the US. Less than 50% are reported and less than 30% are identified. Concussion has serious symptoms and dangerous health impacts, some being long term. Risk of death increases exponentially if another concussion occurs before the first is properly healed.

Statement of Originality

I promise that the ideas in this Invention Log are my own. (If a team, all should complete.)

Inventor Name(s):

Rohit Mahesh

Signature(s):

Rohit Mahesh

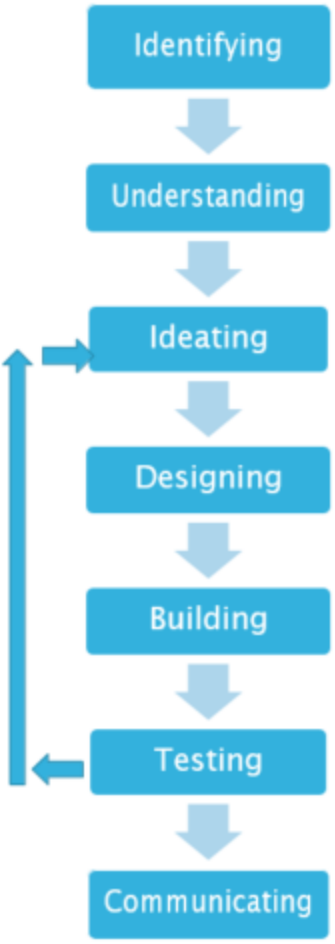
Date:

Grade: 8th grade

School: Pioneer Middle School

Town: Canton, Michigan

Invention Process Overview



Identifying a problem means brainstorming and using research to discover problems and who might have these problems. You might uncover these problems at home, at your school, with your sports team, listening to the news, or somewhere else entirely.

Understanding the problem means you know what is causing the problem and exactly what you want to happen when the problem is solved. The better you understand the problem, the better your solution will be.

Ideating means thinking about the problem: brainstorming and researching different ideas and options to solve the problem.

Designing means deciding what your invention solution will be made of, what it will look like, and how it will work.

Building means assembling your invention based on your solution design using the materials and the process you have decided to use.

Testing your solution is how you find what works and what doesn't. You will modify or change your design, build in those changes, and test the changes. Testing also includes an analysis of the pros and cons of the invention, its impact on society and the environment, its marketability, and its social value. You keep repeating this process until your invention or prototype works and works well.

Communicating means explaining the problem and your research, how your invention solution solves the problem, who might use your invention, your process in creating this invention, and how you might make it even better.

Terms to Explore

These are terms that have to do with inventing. Some of these terms are used in this Invention Log, and some may be terms that you will want to use to describe your process. Please read over these terms before you get started.

advertise – the act or practice of calling public attention to one's product, service, need, etc., especially by paid announcements in newspapers and magazines, over radio or television, in social media, on billboards, etc.

brainstorm – to produce an idea or way of solving a problem by holding a spontaneous group discussion or individual thinking session.

data collection – the process of gathering and measuring information of different variables, in a systematic way that helps one to answer research questions, test hypotheses, and evaluate outcomes.

design – to plan and make decisions about something that is being built or created. To create the plans, drawings, etc. that show how something will be made.

durable – able to withstand wear, pressure, or damage.

engineer – people who invent, design, analyze, build, and test machines, systems, structures, and materials to fulfill objectives and requirements while considering the limitations imposed by practicality, regulation, safety, and cost.

entrepreneur – a person who organizes and operates a business or businesses, taking on greater than normal financial risks to do so.

experiment – a scientific procedure undertaken to make a discovery, test a hypothesis, or demonstrate a fact.

hypothesis – a proposed explanation using previous knowledge, but made based on limited evidence; a starting point for further investigation.

improvements – the act or process of making something better; the quality of being better than before.

interview – a formal discussion to establish needs or requirements; a report or reproduction of information is obtained.

inventor – a person who invented a particular process or device or who invents things as an occupation.

invest – to put (money) to use, by purchase or expenditure, in something offering potential profitable returns.

market – to advertise and offer a product for sale; to present something in a particular way and make people want to buy the product.

marketable – able or fit to be sold or marketed; meets enough market needs to be able to be sold.

original – created directly and personally by a particular artist; not a copy or imitation.

operational – in or ready for use.

patent – a government authority or license conferring a right or title for a set period, especially the sole right to exclude others from making, using, or selling an invention.

perseverance – continued effort to do or achieve something despite difficulties, failure, or opposition.

pitch – promotion using an argument and demonstration; a short verbal dialogue that tells the story and benefits of a product.

problem – a matter regarded as unwelcome or harmful and needing to be dealt with and overcome.

product – something that is made or grown to be sold or used.

profit – money that is made in a business, through investing, etc., after all the costs and expenses are paid; a financial gain.

profitable – yielding advantageous returns or results; yielding a financial profit or gain.

prototype – an original or first model of something from which other forms are copied or developed; an early version of a product that helps the inventor consider different options for design before finalizing a go-to-market design.

publication – the act or process of producing or printing a book, magazine, newspaper, etc., and making it available to the public.

research – the study of materials and sources to establish facts and reach new conclusions.

seek – to search for something or someone; ask for help to achieve something.

solution – something that is done to deal with a problem; something that solves a problem.

source – the point or place which something starts; a place, person, or thing from which something originates.

substantially – to a great or significant extent.

test – a procedure intended to establish the quality, performance, or reliability of something, especially before it is taken into widespread use.

testimonial – a written or spoken statement in which you say that you used a product or service and liked it.

Requirements and Restrictions

To participate in the STEMIE National Invention Convention and Entrepreneurship Expo (NICEE) in the Spring, there are certain restrictions and requirements.

- Your teacher must sign off on your solution/invention before you begin building your design.
- Remember that animals are not allowed at NICEE, so if your invention is for animals, you must demonstrate it in pictures or on a stuffed toy. Demonstrations/presentations may not include human beings or other living creatures.
- Your display board must be no wider than 24"' with the 12" wings folded in.
- You must have a COMPLETED, SIGNED Invention Log with each page signed by you.
- Your prototype/invention should be no more than 2 feet high and 2 feet wide and be able to set on a tabletop.
- Your invention does not have to be a working model, but you need to be able to explain how it would work. If it can be operational, it should be.
- Wall outlet electricity (120 VAC) may NOT be used at NICEE. Battery-powered devices are fine.
- Inventors may not use lighters, matches, candles, or any other open flame or heat source nor any material or liquid considered combustible.
- Inventions may not contain biohazards or utilize any materials that are or could become, dangerous.
- Other restrictions include electric stun guns, martial arts weapons, guns, replica guns, ammunition, fireworks, knives of any size, mace, pepper spray, razors, box cutters, or balloons.
- If your invention cannot be demonstrated at NICEE due to issues with size, electricity, or hazardous materials, a video of the device in action can be shown.

Originality

It is very important that your solution is original and does not already exist or is substantially different from any other invention. These are great places to research to find out if your idea already exists:

- Libraries (ask a librarian for advice on where to look!)
- The internet (e.g., www.google.com, www.bing.com)
- Stores (e.g., www.amazon.com, www.bestbuy.com, www.walmart.com, www.target.com)
- Books about your topic(s) (look up at www.bn.com or www.amazon.com)
- Professionals in the industry (check out www.linkedin.com for possible people to interview)
- Trade/industry-specific publications (each industry has topical magazines and websites)
- The United States Patent and Trademark Office (visit www.uspto.gov to search for patents and trademarks)
- Domain registrars (e.g, www.GoDaddy.com to see if your product name .com is taken)

The Steps You Will Take

As you work on your invention, follow these steps and check them off as you complete them. Don't write your ideas here – use the appropriate space in the following pages to complete each of the sections.

1. What problem are you trying to solve?
2. What is the result you are trying to achieve?
3. What are some possible solutions and which one did you choose to do?
4. Has this solution been done before?
5. Make a model (drawing) of the invention.
6. What problems might you encounter with this design?
7. How will you fix those problems?
8. Repeat steps 5 to 7 until you have a design that you think will work.
9. What parts and materials will you need to make the invention?
10. Where will you get those parts and materials?
11. What additional skills will you need to make the invention?
12. Who can help you do those activities?
13. Get the parts and materials and build the invention. Get any help you need to build it.
14. Test and evaluate the invention.
15. Identify any problems with the invention.
16. Repeat steps 5 to 15 until the invention works as planned.
17. Name the invention.
18. Plan and create the Invention Display Board.
19. Practice what you will say about your invention in the Judging Circle.
20. Be proud of what you have done!!!!

Explaining the Problem and Identifying a Solution (Identifying and Understanding)

1. What problem are you trying to solve? The more specific you are in describing the problem, the better your solution will be. How did you come up with the problem?

Hidden concussions are a big problem while playing a sport. There are many ways that this could happen: they could get hit in the head with a ball hit/kicked by another player, they could attempt a header incorrectly and get injured in the process, or they could run into another player by mistake. The most common occurrence is when players run into each other by accident. If a player is hit in the head with a ball and receives a concussion more than one time, their brain takes much longer to heal. Playing sports right after a concussion is not advised because if another head wound occurs before the brain fully heals, the injured player might die. I came across this problem when I read an article about the severity of concussions. What shocked me was the number of people per sport that get concussions. I looked at a data set from HS RIO (National High School Sports-Related Injury Surveillance Study database) and information from CDC as well as university publications to compile data below:

1. 3,800,000 concussions reported in 2012, double what was reported in 2002
2. 33% of all sports concussions happen at practice
3. 39% — the amount by which cumulative concussions are shown to increase catastrophic head injury leading to permanent neurologic disability
4. 47% of all reported sports concussions occur during a high school football
5. 1 in 5 high school athletes will sustain a sports concussion during the season
6. 33% of high school athletes who have a sports concussion report two or more in the same year
7. 4 to 5 million concussions occur annually, with rising numbers among middle school athletes
8. 90% of most diagnosed concussions do not involve a loss of consciousness
9. An estimated 5.3 million Americans live with a traumatic brain injury-related disability (CDC)
10. 999 cyclists who completed the questionnaire, 23.8% had experienced a concussion

2. What is the result you are trying to achieve? The more specific you are in describing the result you want, the better your solution will be.

My solution to this problem is to create an invention that can detect concussions based on somebody's gait; or way of walking. This invention will likely be a shoe sole with numerous sensors on it. The sensors will find the gait velocity and step length of a person. These are necessary to detect a concussion because a concussed person's gait velocity is much slower than that of a non-concussed patient. The step length of a concussed person will also be smaller than that of a healthy person. After discovering the gait velocity and step length, the invention will send an alert to the coach, letting them know if the player has a potential concussion. The coach will then decide what to do with the player. This invention will not diagnose a concussion, only be able to identify the signs of one. The user will benefit from this invention because if a head injury is missed, then there is a risk of a second injury to the head, which may cause the player to die.

Players that have a concussion might go back to playing rather than staying out and letting their wound heal. My ideal result would be to reduce the number of repeated head injuries.

3. What are some possible solutions? Which one did you choose to pursue? How did you decide which solution to try? The more specific you are in describing the solution you will create, the better your invention will be. How did you come up with the solution?

I found many possible solutions; helmets, balls, or even drones. The way I narrowed it down to the perfect solution, was by establishing my criteria.

CRITERIA:

1. The product will not injure the wearer (Another product has an impact sensor inside a mask–this is dangerous because if something hits you in the mouth hard enough, it might injure you more than just a concussion).
2. It should be lightweight
3. cost-effective
4. It should not touch the wearers' skin–sometimes it can emit radiation, and it might be uncomfortable.
5. It should not make noise–sometimes motors will make a lot of noise
6. It should be able to alert someone–sometimes concussions can go undetected
7. It should have multiple usabilities–gait-based concussion detection can be used in all cases.
8. It should not be harmful to health

Next, I made a table comparing my ideas and existing solutions to figure out what would allow me to get the best result. I highlighted my ideas in orange so that I would not get mixed up.

Criteria	Headband Ex: HijiBand	Face Mask Ex: HijiBand	Gait Shoe (concept)	Human Judgement	Bluetooth soccer ball	Sonar drone	Biking helmet with GPS
The product will not injure the wearer	✗	✗	✓	✓	✓	✓	✓
It should be lightweight	✓	✓	✓	?	✓	✓	✓
cost-effective	✗	✗	?	✓	?	✗	✓
It should not cause discomfort	✗	✗	✓	✓	✓	✓	✗

It should not make noise	✓	✓	✓	✓	✓	✓	✓
It should be able to alert someone	✓	✓	?	?	?	?	✓
It should have multiple usabilities	✓	✓	?	✓	✓	✓	✓
It should work every time	✓	✓	?	✗	?	?	✓
Should not be harmful to health	✗	✗	✓	✗	?	?	?

After that, I explored how my ideas would work:
For the Bluetooth solution, I thought that we could have a device mounted inside a ball that would judge its velocity. Then I would use existing measurements of speeds and weights that would be able to cause a concussion and determine if the blow would be hard enough to cause one.
For the sonar solution, I thought that there would be a drone above the playing field and a sensor on the soccer ball. Using an accelerometer on the drone can judge the speed of a ball. Then, using AI and sonar, it can see if the ball is getting near someone's head. Then, it tracks the speed and sends it to the coach's phone before the collision happens.
For the helmet solution, I was planning to have three GPS trackers–one on a bike, and the others on the front and back of a helmet. The way this works is by finding the movement of someone's head using the two GPS sensors. Then, when the person's head starts moving, it starts a timer and finds the speed of somebody's head. The third GPS tracker checks how far away from the bike someone is.

4. Has this solution been done before? If it exists, how is your approach different and better? What research did you do to see if this invention had been done before? Who did you talk to? Where did you look? What website did you search for? You should show 4 pieces of evidence of different types of research – talking with experts, searching the internet, interviewing friends and family as to how useful this would be, etc.

Where I looked to see if my idea is new:

A. Amazon
B. Google
C. Youtube
D. Google Scholar
E. Talked to experts

Teacher Signature - REQUIRED FOR ALL PARTICIPANTS

principle of sustainability? Who did you talk to about this design (another student, parent, teacher, etc.)? What were their comments about your design?

6. What problems did you encounter?

I had many problems throughout building my concussion detection shoe. The first one I faced was that I had no actual data for the rate of change in the stride length, and stride time of a person when they get a concussion. My second problem was that there is no way to exactly calculate the step length of a person without actually measuring by hand. My third issue occurred after I found papers to help calculate the rate of change. It was that the error rate was too small, and there was a possibility of false positives when I calculated the stride length, step width, and stride time. My fourth problem occurred when I was 3d modeling my shoe and sensors. I had minimal experience in fusion 360 CAD design, and I didn't know where to start. My fifth problem happened when I was thinking through the algorithm for detecting a concussion. The problem was that the data I had measured was taken from college-age people, and it would be impossible to test with that data.

7. How can you fix those problems or address those issues?
   For the first problem that I faced, I had to use sources that I wouldn't normally use. I checked for gait before and after a concussion, and I got promising results. I had a few more questions about that topic (question 3), but after emailing one of the authors, I was able to understand. The way I worked out the second problem was that I looked at a complex way to calculate the stride length using accelerometers. For problem number four, I was able to find instructional videos on how to 3d model online, and I slowly got the hang of it. For the fifth problem, I figured out that the average was proportional for all demographics.

8. Repeat steps 5 to 7 until you have a design that you think will work. You may have to make multiple copies of a blank page until you have a good design.

Building the Invention or Prototype (Designing, Building, Testing)

9. What parts, materials, and tools will you need to make the invention and how much will they cost?

   To build my concussion detection shoe, I will need an IMU (inertial measurement unit), an FSR (force sensitive resistor) a raspberry pi 4, two connection wires, and a 5.1-volt battery. This costs about $120.

10. Where will you get those parts and materials?
    To get the materials necessary to build my invention, I will buy some of them from amazon, and some from Adafruit.

11. What additional skills or abilities will you need to make the invention?
    To build my invention, I will need to know how to wire a raspberry pi, and I will also need to be able to solder the wires in the correct places. I also need to know how to code my algorithm.

12. Who can help you build the invention?

    I think I can build most of my invention on my own (with online help), but I will need some help from adults with some aspects of the building.

13. Get the parts and materials and build the invention (with help).

14. Test and evaluate the invention. What did you do to test the invention?

My invention cannot be directly tested because I don't have a concussed person to test it on. I looked at different ways to simulate a concussion, but none would apply to me. However, because my invention works as expected, based on the data from different research papers, it should be able to identify a concussion.

15. Identify any problems with the invention. What will you change to make it better?

    Some problems I have with my invention are that the raspberry pi model I picked was too large, and it might interfere with people's activities. Also, I wanted to have all my sensors inside the shoe, but that did not work because of the size of the sensors.

16. Repeat steps 5 to 15 until the invention works as planned. You may have to copy and make multiple copies of this blank page until you have an invention that works the way you want.

Naming the Invention (Communicating)

17. Naming your invention is important.

- What words describe your invention?

  Some words that describe my invention are real time concussion alert, detect gait variance, head injury detection

- Think in terms of words that will help you name your invention.

I want to name my invention “concussion alert” because it accurately describes what my invention can do.

- What is the function of your invention?
  My invention is used to figure out if someone has a concussion by analyzing their gait.

- Think in terms of marketing it. How will it solve the problem? How will it help others?
  My invention solves the problem by bringing awareness to a concussion that may otherwise be undetected to reduce the risk of a second concussion. It will help others by keeping them safe from further damage.

- How is your invention different from others that may already be on the market? If it is similar, what did you do to make it better? How is it different?
  My invention is different from other inventions on the market for two reasons. My invention uses a different method, and my invention can be used at all times.

- Who is your target audience? Who would use your invention?
  My target audience for this product is contact sports players, athletes, or people with a risk of falls, but my invention can be used by anyone that is wearing shoes.

Some creative attention-getting techniques you can use are:

- Alliteration (using the same first letters or sounds): “Kit Kat”
- Rhyming: “Light Bright”
- Alternative spelling: “Sno Bal”
- Using numbers in the name: “Super Clean 3000”
- Describing the function of the invention: “Hydro-Blast”

- Based on this analysis, what are some good names for your invention?

  Some good names for my product are concussion monitor, concussion aware, and concussion alert

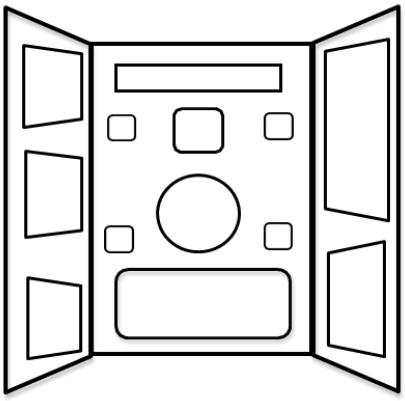
- Which name do you like best and why?
  I like the name “concussion alert” because there are websites for the other names, and concussion alert was the only one that wasn’t taken.

Planning and Creating the Invention Display Board (Communicating)

18. Create your display board. This is an example of what a Display Board might look like, but you can make it look however you want. This is your invention and your display, so use your creativity to tell the story of your invention the way you want.

Be sure you use:

- Readable fonts (style, size, color)
- Colors that look good together
- Shapes that are the right size
- Correct grammar and spelling
- Proper punctuation



Maximum size: With the wings folded in, the Display Board can only take 24" of table space. However, you are allowed to open up the wings during your Judging Circle presentation.

Your Display Board MUST contain the following information in one consolidated place on the poster:

Student(s) Name(s)
Project Name
Student(s) Grade(s)
Student(s) School
School City, State
Preferred Industry-Focused Award Category (e.g. Telecommunications)
Patent Status (three options: None, Under Counsel, or Patent Pending)

Students should note "Patent Pending" on their posters for Patent Status **only** if a provisional or non-provisional patent application has been officially filed with the USPTO. If you are currently represented by an attorney or patent agent (pro bono or otherwise), then mark "Under Counsel." It is possible to be both "Under Counsel" and "Patent Pending", or just "Under Counsel", or just "Patent Pending" (if you did the filing yourself).

You might also want to add this information:

- Images showing you building or testing
- How the invention was made
- How the invention is used
- The biography of the inventor
- The text supports and explains any pictures, drawings, charts, etc.
- What scientific principles were used in your invention? (e.g. buoyancy, heat transfer)
- What engineering disciplines were used in your invention? (e.g. electronics, optics)
- Testimonials from users, research results
- Any other information about the invention that will help explain it, what it does, or why it is good

Practicing What You Will Say About Your Invention (Communicating)

19. Be prepared to answer questions. Here are some questions that you might be asked in the Judging Circle by the judges or fellow students. To help you prepare, you might want to write down some of the important parts of your answers so that you have them when you practice giving your presentation.

- How did you come up with the idea for this invention?

  I got the idea for this invention from an experience I had when I was playing soccer in fourth grade. One of the players on my team collided with another player, and he said that he was okay. However, after the game, her fell to the ground and did not wake up. Several days later, we found out that he had a concussion and that his running and playing again after the concussion made the symptoms worse. Later, I read about how sometimes if the brain swells after a concussion, it can cause damage to the brain stem, which might cause death. I realized that this could have happened to the person on my team.

- What people, situations, or conditions does this problem affect?

  My problem affects everyone because everyone who is walking, climbing stairs, doing work, playing sports or engaging in recreational activities is at risk for concussions.

- How did you think up your solution to the problem?

  I came up with the solution to my problem by asking experts in the field such as University professors, athletic trainers, coaches, sports rehab specialists about what was the biggest change after a concussion. After I reviewed the results, I saw that changes in a person's gait would be the best thing to look at.

- Where did you get the materials for the invention?
  I got the materials for the invention from amazon.

- Who helped you build the invention and what did they help you do?
  Professors Vivek and Ahmed helped me by telling me what processes I would need to learn and do.

- Are there other, better materials you could have used that would improve the invention?

  I used cardboard for my inertial measurement unit casing, but I would have liked to 3d print it if I had access to a 3D printer and the necessary materials.

- Who has used your invention and what did they think about it?

  I have not had the chance to have others use my invention due to Covid restrictions and quarantine. But I tested it with my parents and my sister. They all had positive feedback and said it will be very useful to everyone.

- What changes might you want to make to your invention?

  - I will try to make the product smaller to fit better in the shoe.
  - The biggest size is the battery. So I will try to find an alternative source to power the raspberry Pi.
  - I will also try to work with a shoe manufacturer to place it inside the shoe heel so it is not externally visible.
  - I would try to test it out in a real world situation.

20. **Be proud of what you have done. You will use the problem-solving and communication skills you have gained here throughout your life and career. Congratulations on what you've done!**

Blank Page(s)

These blank pages are available for you to add anything to your Invention Log that will help explain what you did, how you did it, and what the results were. This could include drawings, calculations, descriptions, test results, etc. Multiple copies of this page can be inserted anywhere you want in the Invention Log.