Riving Guard

CHS Team 1:

Keertik Bacon
Carlos Montemayor
Matthew Zhang

Daleth Sendin
Centennial High School
4300 Centennial Lane, Ellicott City, MD
2019 - 2020

Table Of Contents

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

Table Of Contents

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

Abstract

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

Table saws are a favorite tool of carpenters worldwide. They allow quick cuts through large pieces of stock, and are thus essential for any woodworking operation.

Conversely, however, these **saws are quite dangerous**. Unlike most other saws, the user directs the stock, rather than the blade, and this creates opportunities for catastrophic accidents when the user is not completely focused.

The US Consumer Product Safety Commission in 2017 reported that **table saws caused 27,000 emergency room injuries annually**, representing **62.1%** of all saw-related injuries. Our research revealed that while solutions exist on the market, they are either **impractical** for some carpenters or are **restrictive** in the cuts that can be made.

To solve this issue, we developed the Riving Guard, which is a saw guard and riving knife combination that offers **protection from accidental contact** with the blade and **mitigates kickback**, while also allowing a large **variety of cuts**. The guard mounts onto existing riving knife mounting hardware, and is **easy to install and remove**.

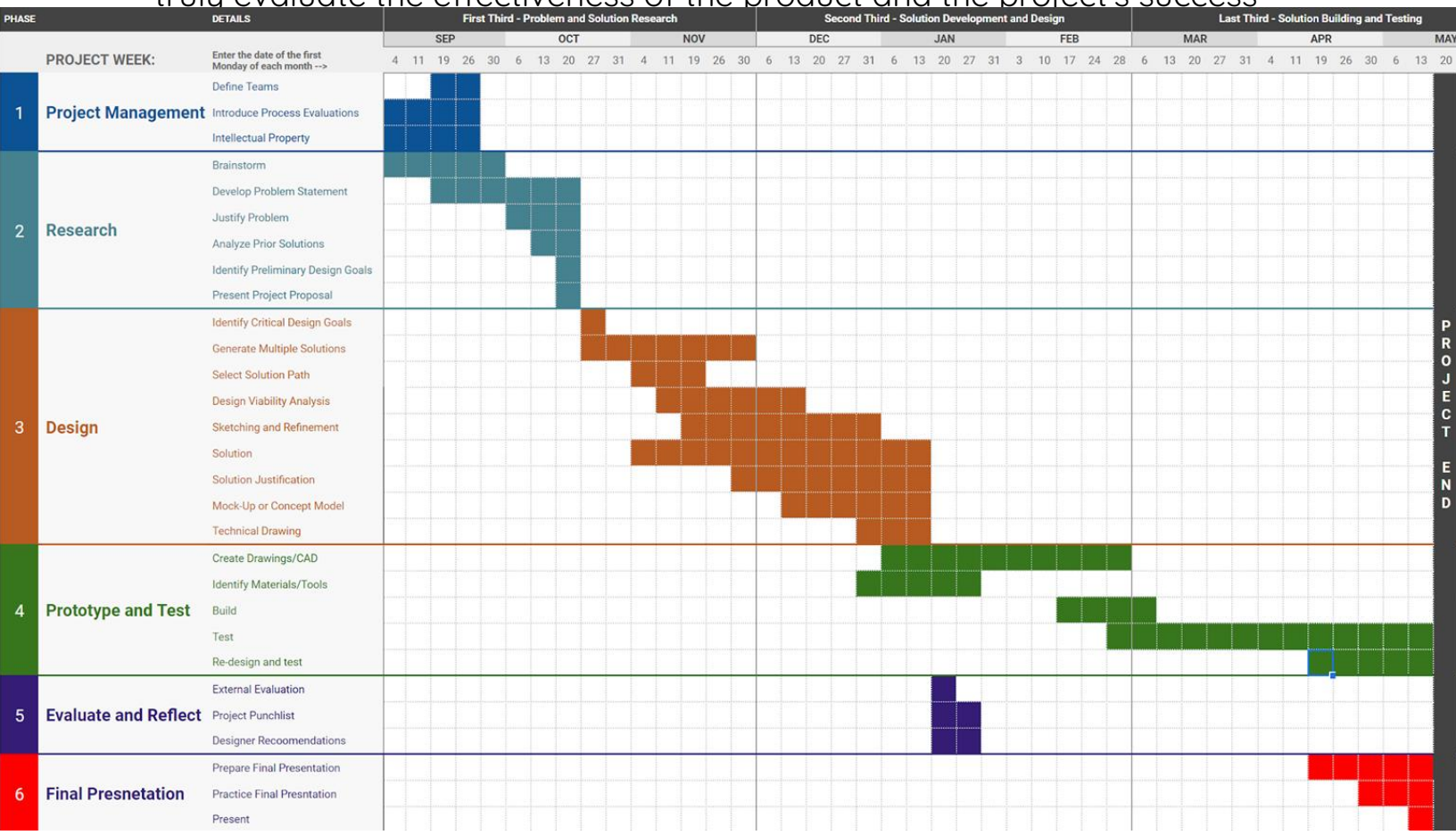
Because of school closures and lockdowns resulting from the COVID-19 pandemic, we were unable to conduct much of our product's testing and design revisions. As a result, we are not able to present a final product in this portfolio.

Timeline

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

In order to make sure the project ran smoothly and kept on track, we devised a **Gantt Chart** that we used to schedule the activities of the year. The phases of the project were clearly labelled and split into general subtasks that we could palpably focus on. The year was split into these six sections:

- **Project Management:** Work out the logistics of the group and set a structure for the group to work within
- **Research:** Look for problems and evaluate their potential for a successful product
- **Design:** Focus on one problem and develop a custom solution
- **Prototype and Test:** Create a working model of the solution and hold it against criteria
- **Evaluate and Reflect:** Think about how the project was approached and executed, reflect on how it could have been done better
- **Final Presentation:** Wrap up the project and consolidate the findings in order to truly evaluate the effectiveness of the product and the project's success



Section 1: The Problem

Problem Statement

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

The US Consumer Product Safety Commission in 2017 reported that **table saws caused 27,000 emergency room injuries** annually. A survey of handymen found that the vast majority of these accidents, **around 85-90%, could be attributed to human error**, such as **distraction, inexperience, or negligence.**

Problem Generation

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

Before arriving at our final problem of table saw safety, we first considered several other problems. Here, we present some of our problem ideas from early on that we rejected in favor of table saw safety.

Water Leakage

- Leakages in water infrastructure can cause large amounts of water to be lost
  - **50% water loss** in urban distribution networks is not uncommon
  - EPA estimates the average family wastes **180 gallons per week** of water due to household leaks

Unsanitary Surfaces

- High touch surfaces are unsanitary, causing problems particularly in hospital situations
  - The National Institute of Health estimates that **50%** of high-touch surfaces in hospitals are **missed in disinfection**, and **40%** are **not adequately disinfected**

Snow Removal

- Snow piles up during the winter time and can be a struggle to remove
  - Shoveling can pose **health risks**
  - Snow **blocks roads**, and makes them icy
  - Heavy snow can **collapse roofs**

Problem Decision Matrix

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

To choose the problem we would focus on for the year, we evaluated our four ideas in a decision matrix, assigning each one a score of 1-10 (1 being the worst and 10 being the best) in each of these five criteria:

- **Practicality:** whether we would be able to build a meaningful solution, giving our knowledge, financial, and time constraints
- **Scope:** how many people this problem affects, and whether developing and marketing a solution would be financially viable
- **Originality:** whether this problem already has some solutions on the market
- **Interest:** how much working on a solution to his problem interests us, and how much we want to see a solution
- **Researchability:** how much data there is available to justify the problem and developing a solution

Evaluating the four problems with the decision matrix resulted in Table Saw Safety coming in 1st place. And thus we chose to pursue that topic, keeping the 2nd place problem of Snow Removal as a backup.

Ideas	Practicality	Scope	Originality	Interest	Researchability	**Totals**
Power Tool Safety	9	6	6	7	7	**35**
Water Leakage	6	8	3	5	7	**29**
Unsanitary Surfaces	3	7	8	3	5	**26**
Snow Removal	9	7	4	6	4	**30**

Problem Validation: Interviews/Surveys

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

After selecting Table Saw Safety as our problem, we conducted research to learn about the specific problems that carpenters face with table saws, and to see where we can offer a solution. To achieve a balance of both quantity and quality of data, we employed various methods of research, surveying handymen and carpenters on online woodworking forums as well as visiting local carpenters and interviewing them.

In-person Interviews

Nelson Laur, CEO of Peak Carpentry

- Dislikes saw guards, finding them restrictive and obtrusive
- Suggested focusing on portable contractor table saws
    - Pointed out that while workshops can afford expensive saw safety systems, freelance contractors often cannot

Brian Michael, CHS Teacher/Hobbyist Carpenter

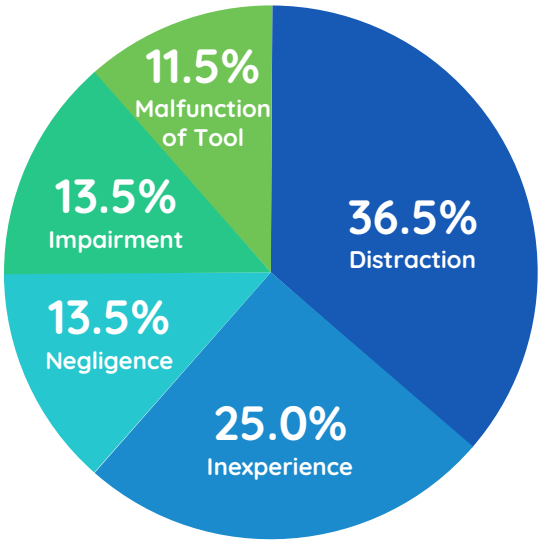
- Related how easy it is to be injured by a table saw
    - Emphasized that even experienced carpenters can be injured if they are inattentive
- Shared that he never uses saw guards, also finding them obtrusive

Online Survey

Conducted on Reddit, at r/woodworking, r/DIY, and r/AskEngineers

Cause of Saw Injuries

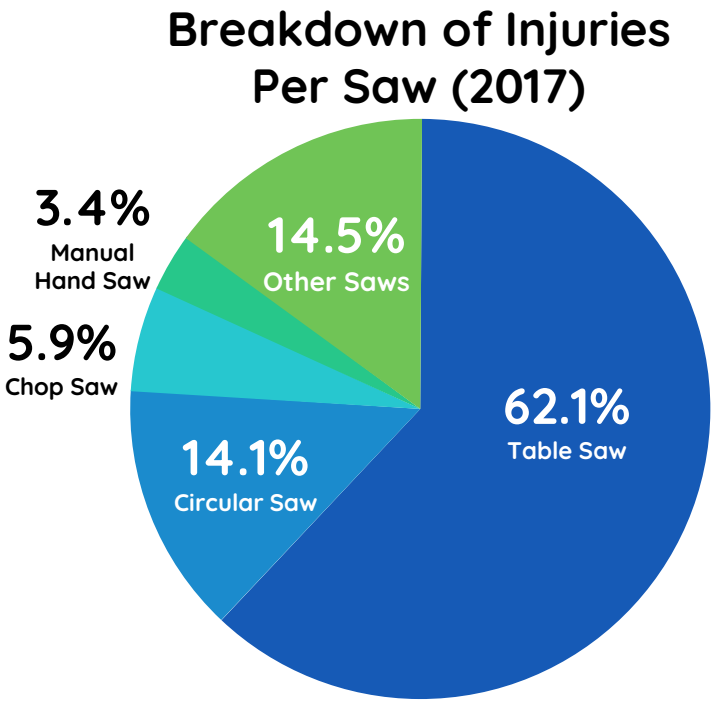
52 responses

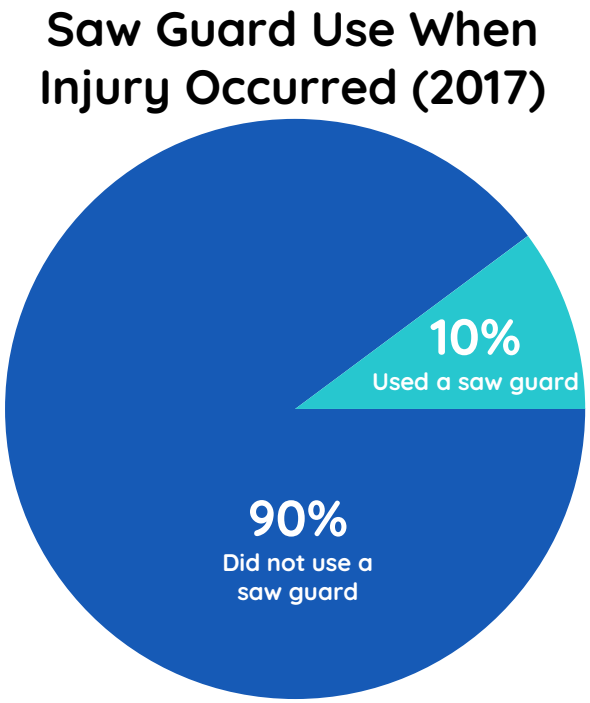


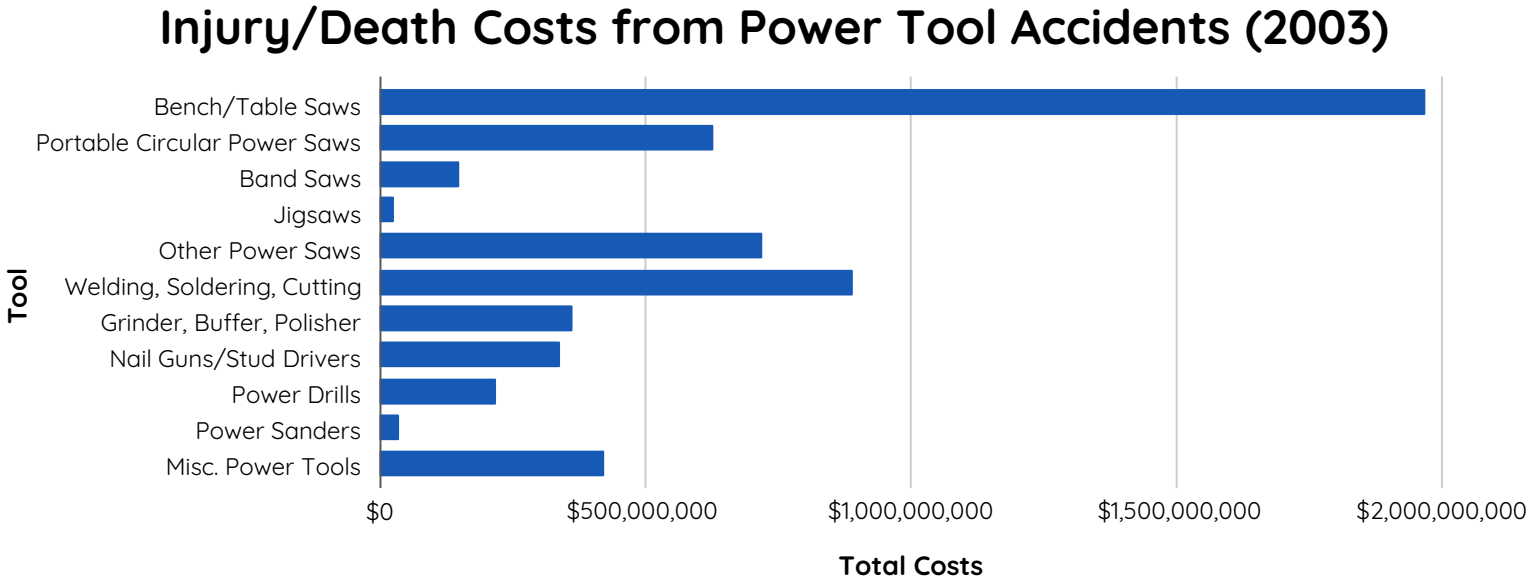
Problem Validation: Studies

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

In addition to our own data-gathering, we also consulted various power tool safety studies published by the United States Consumer Product Safety Commission over the period 2001 - 2017. To account for changes in the statistics since the publication of the older studies, we tried to corroborate the data in them with the more recent studies.







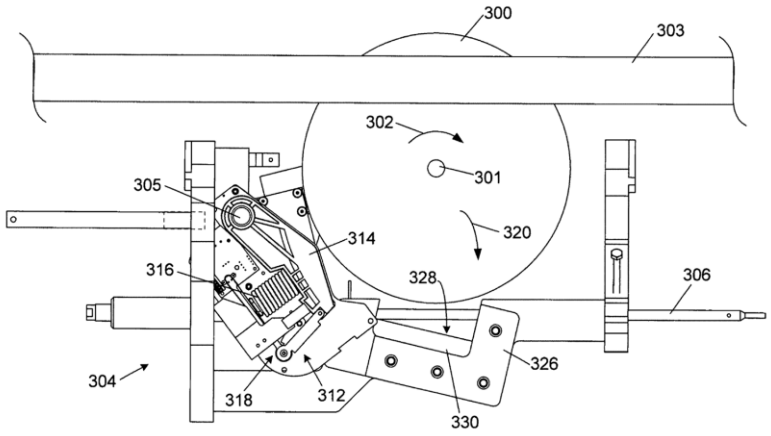
Section 2: The Solution

Current and Past Solutions

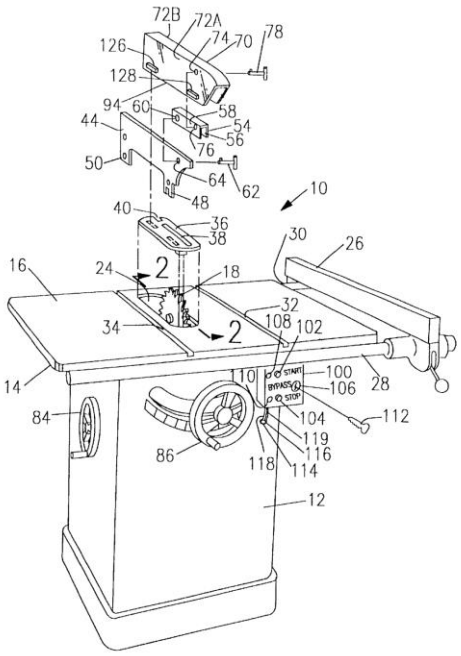
Matthew Zhang, Keertik Bacon, and Carlos Montemayor

- **Riving Knife**
  - Creates a physical barrier between the two cut pieces, so that they do not catch on the end of the spinning blade and get kicked back
  - **Drawback:** Doesn't provide much protection other than that
- **Anti-Kickback Pawls**
  - Small plates that are designed to dig into workpiece to prevent violent kickback
  - **Drawback:** Can get in the way, cannot be used with non through cuts.
- **Regular Saw Guards**
  - Blocks access to the blade to prevent accidental touch
  - **Drawback:** Gets in the way of working, cannot do non-through cuts
- **SawStop**
  - Stops the blade immediately when detecting a touch
  - **Drawback:** Expensive to replace (thus not practical for freelance carpenters), proprietary
- **Saw Guard Detection**
  - Only turns on the saw if a guard is detected
  - **Drawback:** Forces guard use, which is inconvenient and restrictive

Fig. 3



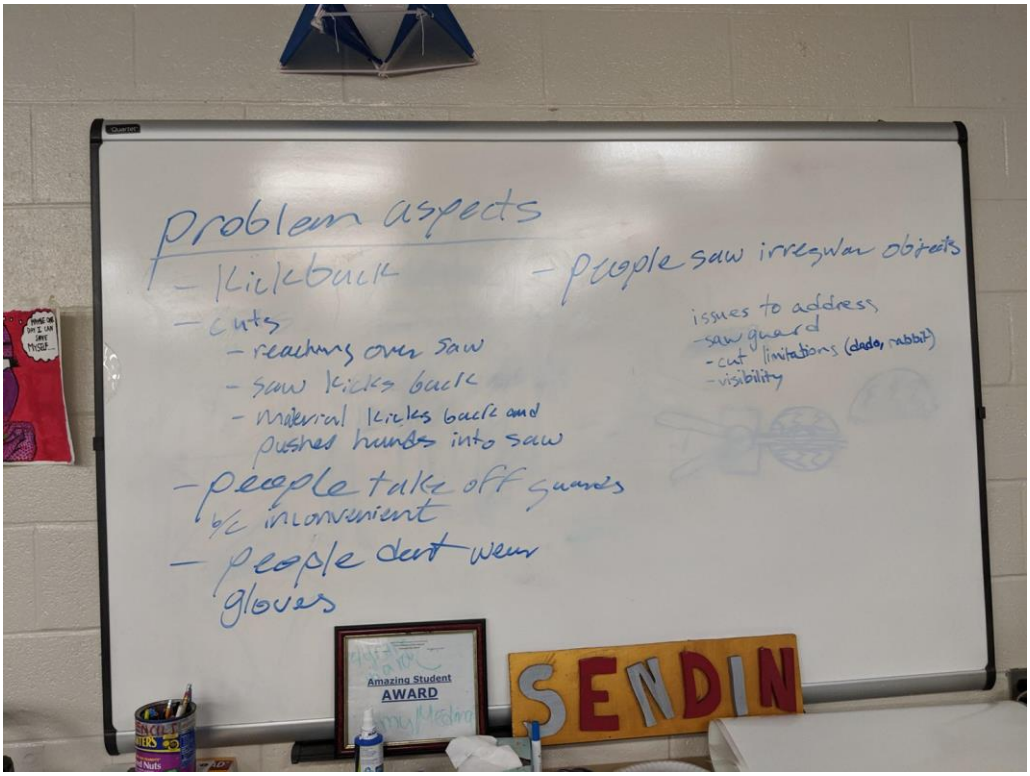
SawStop detects electrical contact with ground though the blade via touch and brakes the saw immediately (albeit breaks the blade)

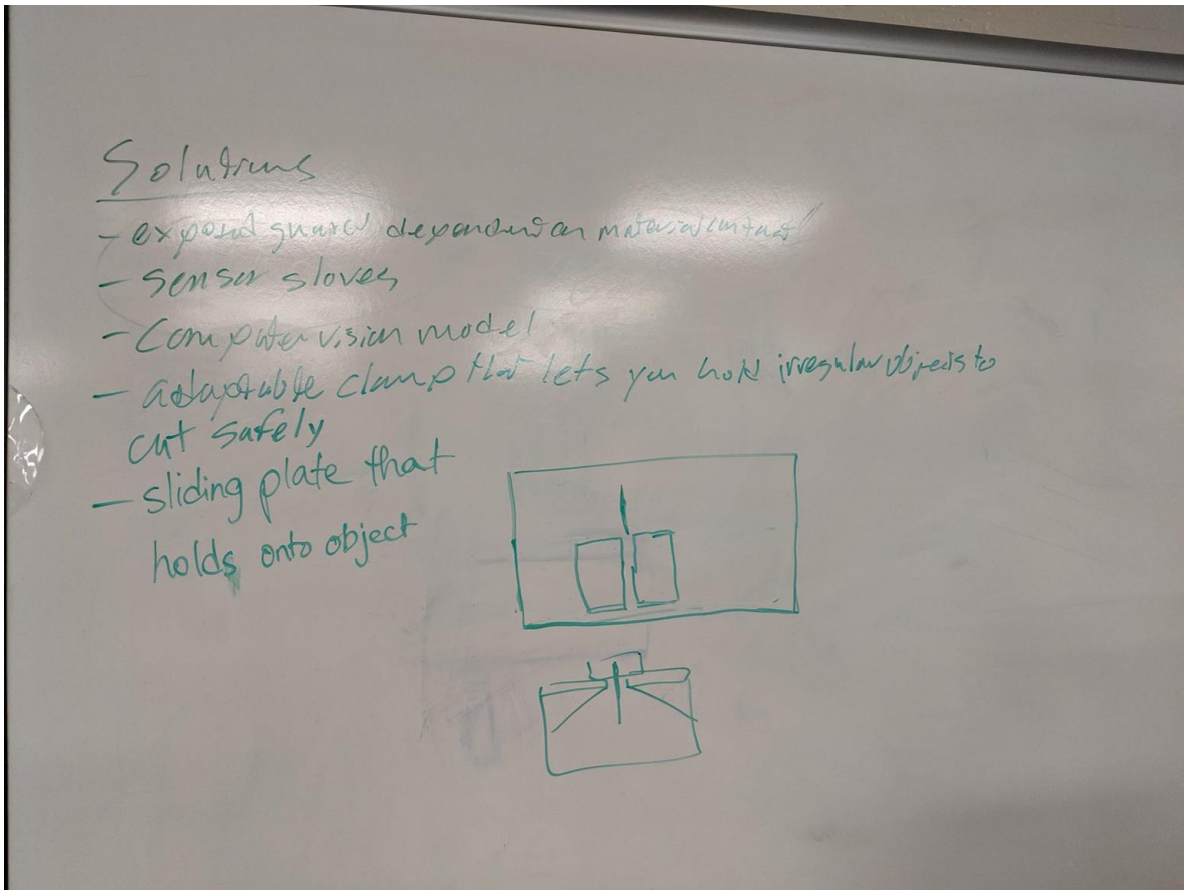


Sensor controlled saw prevents saw from being run if guard is not in place, as well as detecting proximity of user

Brainstorming

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

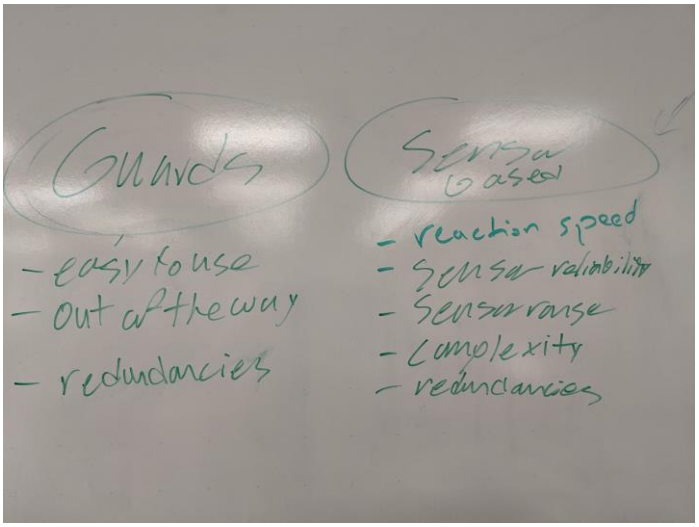




Brainstorming

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

In the process of designing our product, we first had to **determine the approach** we wanted to take in solving the problem. We could make a saw guard, something to assist in feeding the stock, or even a sensor-based saw stop. We evaluated these approaches in a decision matrix, judging each one on whether it was practical, cost effective, adequately sophisticated, effective, and original. To ensure that we had plenty of ideas to choose from later, we picked the top two finishers from the decision matrix, which were **guards** and **feeding mechanisms**.



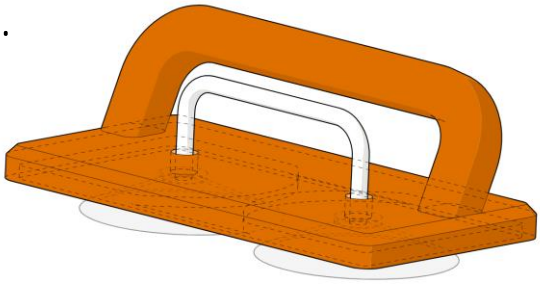
Ideas	Practicality	Cost	Sophistication	Effectiveness	Originality	Totals
Guards	10	9	5	6	5	**34**
Sensor based sawstop	4	6	8	7	5	**30**
Clamps / Feeding	8	8	6	5	6	**33**
Anti-kickback	9	8	6	6	2	**31**
Braking Mechanism	5	5	7	9	3	**29**

Product Ideas

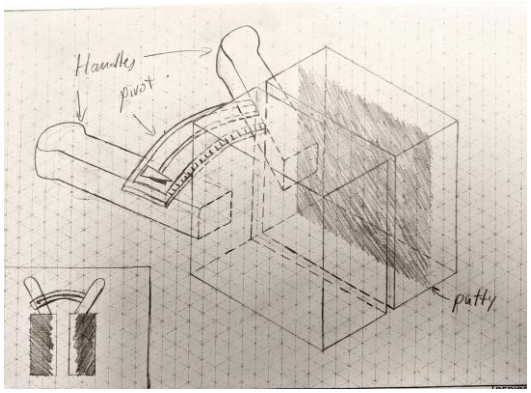
Matthew Zhang, Keertik Bacon, and Carlos Montemayor

1. **SuckBlock**
   The SuckBlock will be a regular push block with a handle and flat bottom surface, but instead of a grippy bottom, there will be a suction cup to grip the material. To adjust the suction, there will be an extra latch, similar to a gas pump nozzle, that the user can grip. This would help users not lose control of material.
1. **Malleable Clamp**
   A clamp with an adaptive surface for the clamp that allows you to saw irregular-shaped objects. Aims to help hold irregular shaped objects better.
1. **Material Adaptive Guard**
   The guard is made of many small spring tensioned pieces that move up and down. The point is that they would be designed to allow the material to be slid under them horizontally but not expose any part of the blade. This would ensure maximum protection from the blade
1. **Guard/Riving Knife combo (Riving Guard)**
   A riving knife that also functions as a saw guard, rotating over the blade and blocking the cutting edge. This acts to protect from accidental touch and prevent kickback.
1. **Magnifying Glass/Illuminated Guard**
   A LED light that is mounted inside of a guard to improve visibility along with a magnifying lens built into the front of it, right where the user would look through the guard at the material. This would help solve the issue that saw guards can be hard to see through.

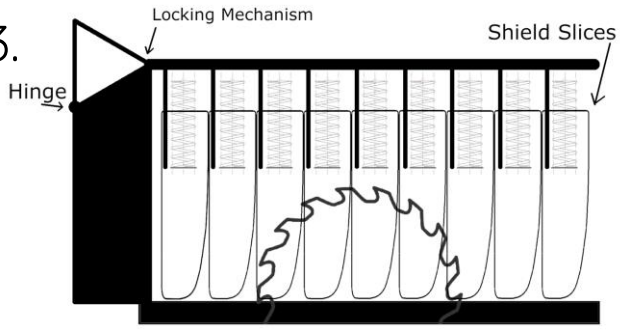
1.



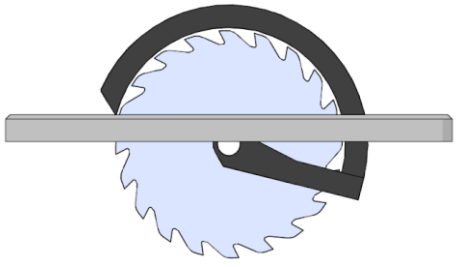
2.



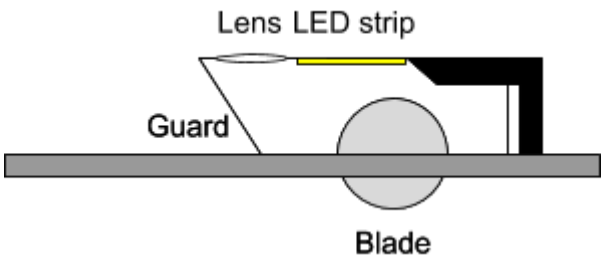
3.



4.



5.



For more details on these product concepts, consult Appendix E.

Product Decision Matrix

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

To choose our solution, we evaluated our five ideas in a decision matrix, assigning each one a score of 1-10 (1 being the worst and 10 being the best) in each of these six criteria:

- **Convenience:** how easy and convenient the product is to use
- **Price:** whether this product would be cheap to produce and sell, and thus financially viable
- **Flexibility:** how flexible this product is in allowing different types of cuts
- **Effectiveness:** whether the product actually offers protection from injury
- **Feasibility:** whether we could reasonably create the product with the time, skills, and budget that we have
- **Professional Opinion:** how highly the carpenters that we consulted viewed the product
    - For exact opinions, consult Appendix A

The riving guard was the highest-ranked by the decision matrix, and so that is what we chose to develop.

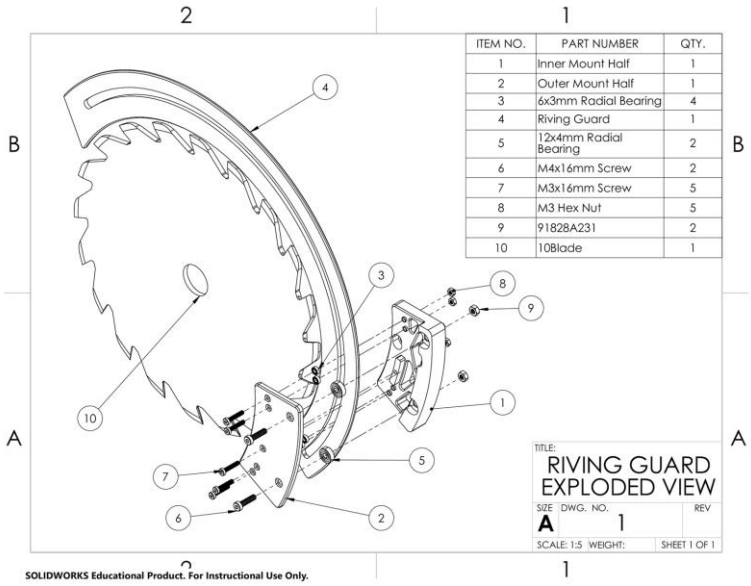
Ideas	Convenience	Price	Flexibility	Effectiveness	Feasibility	Professional Opinion	Totals
Malleable Clamp	6	7	6	8	9	6	**42**
Riving Guard	8	8	6	7	10	9	**48**
Illuminated Guard	6	7	6	8	10	4	**43**
SuckBlock	9	8	8	7	9	5	**46**
Material Adaptive Guard	5	5	6	6	6	3	**31**

Proposed Solution

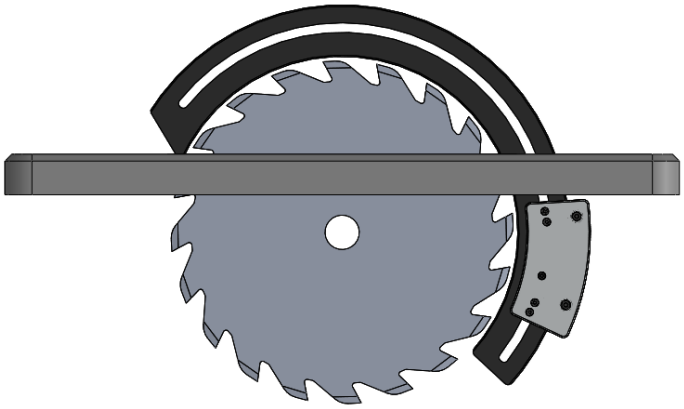
Matthew Zhang, Keertik Bacon, and Carlos Montemayor

Riving Guard

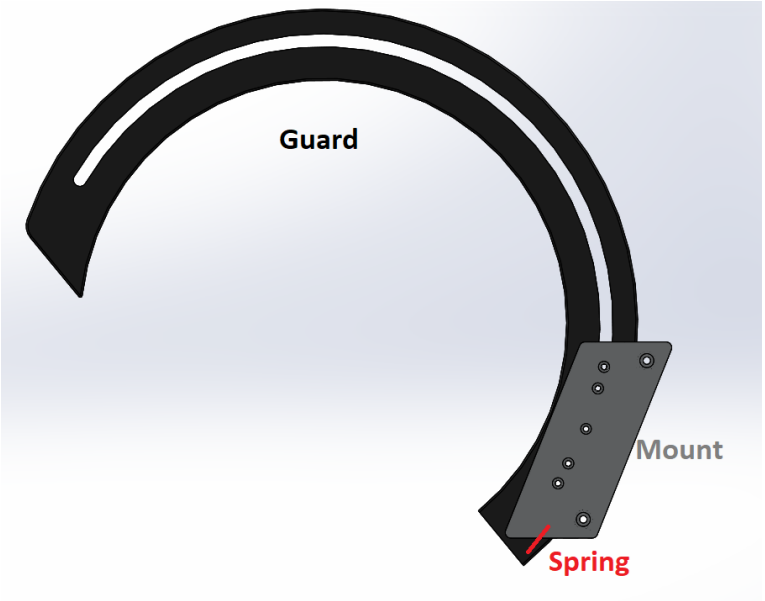
- Combines the functionality of a saw guard, while maintaining the **anti-kickback** and **low profile** features of a riving knife
- Wraps around the blade edge to cover the cutting edge
- **Spring loaded** in order to always cover as much of the blade as possible
- Designed to use **existing** riving knife **mounting hardware**
- **Works for non-through cuts**, which existing saw guards cannot do
  - Refer to Appendix B for diagrams on how the riving guard works with through and non-through cuts



Exploded view of final design



Latest CAD model including finalized mount and guard

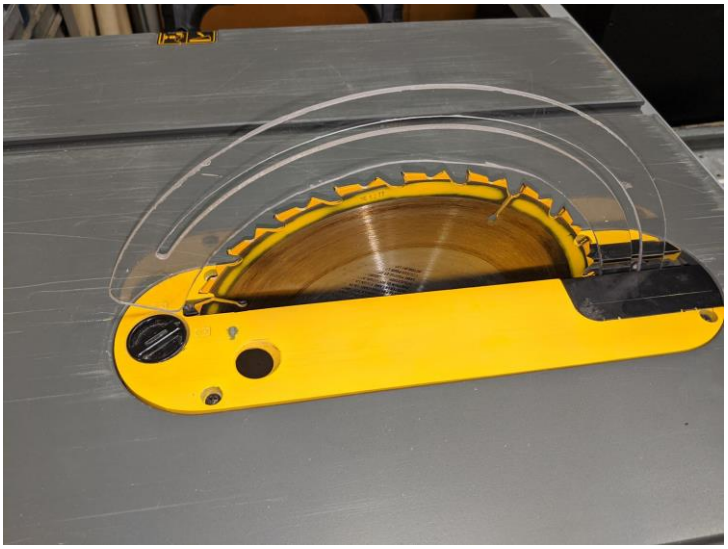


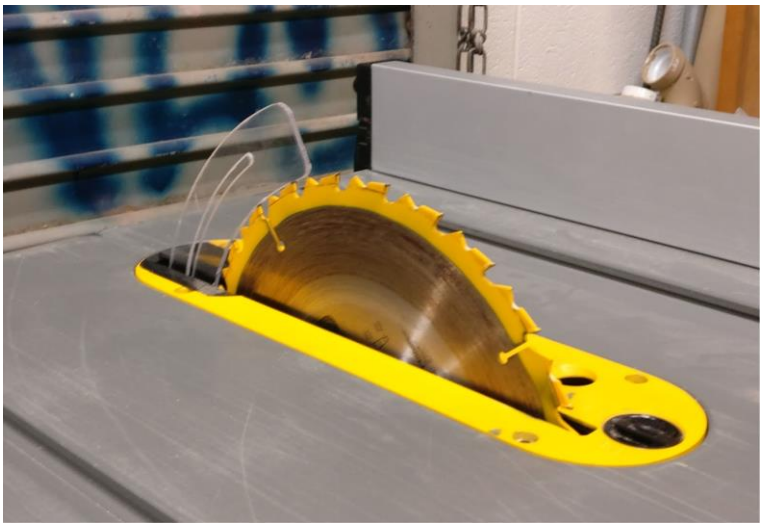
Labeled side view of design proposal

Prototype

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

- **CAD and drafting done in SOLIDWORKS**
- **Mounting pieces FDM printed in PLA plastic**
  - Rapid Prototyping for fast iteration
  - Loads appropriate for 3D Printing
- **Prototype guard CNC machined out of polycarbonate plastic**
  - CAM Developed in Fusion 360
  - Cheap and quick to machine for prototyping
- **M4 and M3 hardware used for assembly**
  - Standard metric hardware is cheap and accessible
- **Movement of guard supported by radial ball bearings**
  - Ensure smooth and even movement throughout
- **Designed to mount using existing riving knife mounting holes and screws**
  - Does not require extra hardware extra modification to use
- **Mounting slots instead of holes in order to allow fine tuning of riving guard height**





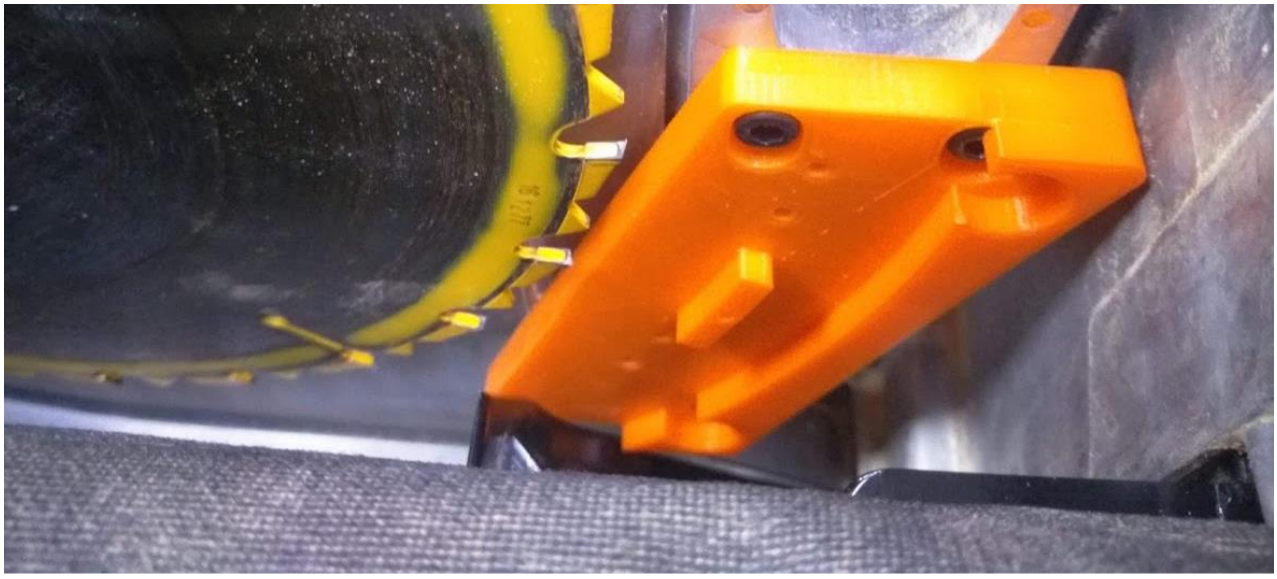
Section 3: Testing

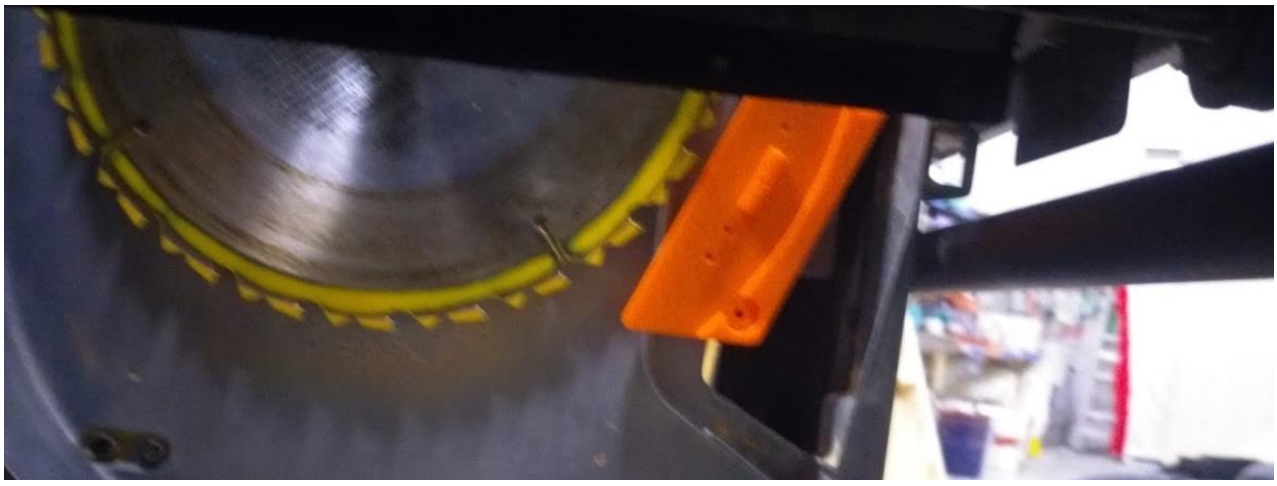
Testing and Evaluation

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

Already Performed Tests

- Preliminary Mounting Test
  - Tested a **preliminary design for the riving guard mount**. The mount replaced the existing riving knife.
  - Conclusions:
    - The mount can **stick out on the bottom less**, and instead have more vertical upwards height
      - This will allow the mount to not occupy as much space
    - There was a **ridge that the mount had trouble clearing**
      - We can solve the issue by adding a cutaway area where the mount is thinner
    - The actual guard could be optimized by **removing some excess material** on the ends so as to not get as caught in the saw enclosure





Testing and Evaluation

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

Tests Planned

- Clearance and Spacing Test with a running saw
  - Test a new **prototype polycarbonate guard** with a **cardboard saw blade**
    - Would be conducted multiple times to alleviate problems with movement and to refine the design
  - **No tensioning**, simply checking to see if the guard is manufactured to specifications to be able to operate properly
- Springing/Tensioning Test with a running saw
  - Test the polycarbonate guard prototype with cardboard saw blade, but **add in the tensioning mechanism**
  - Check with pieces of pre-cut material to see if the guard would retract easily and properly with material being cut
  - Check if the guard stays in place and can still mount properly
- Final Build Materials Test
  - Test the **final guard prototype**, made with the finalized materials and with a **real saw blade**
  - Check if the device behaves properly while moving material through the saw blade
  - Check the deflection of the guard under reasonable stresses to the material
  - Check that the guard does not interfere with the cutting operation

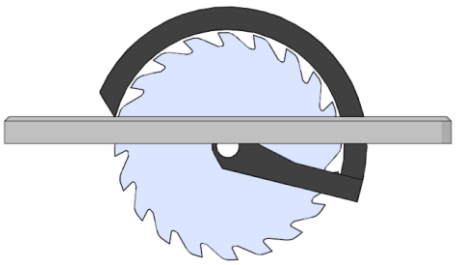
Guard Design Evolution

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

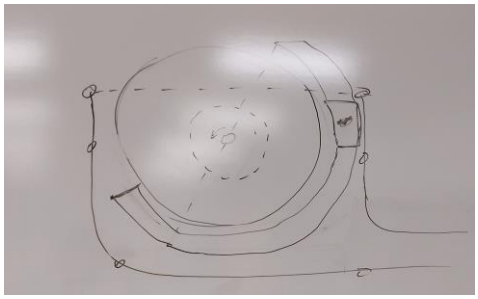
In response to more detailed design concepts and testing, the riving guard underwent changes from its original design, which are detailed below.

Mounting

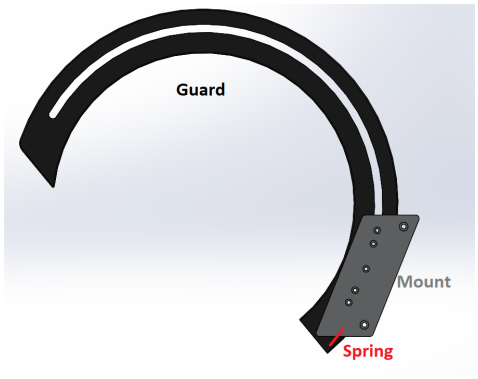
- Original version had guard mounting onto the saw motor's drive shaft
- A bearing would connect the guard to the axle, so that the guard does not rotate with the axle
- Decided not to use this design, as mounting onto a rapidly spinning axle would possibly be dangerous
    - Furthermore, there was little room with most saw models, and would complicate the manufacturing of the "guard" piece
- Guard was redesigned to mount to the riving knife mounting hardware
    - Radial mounting extension removed
    - Slot added along guard circumference to allow movement through the new mount



The original drive-shaft mounted riving guard



Original sketch of revised design



Revised guard design

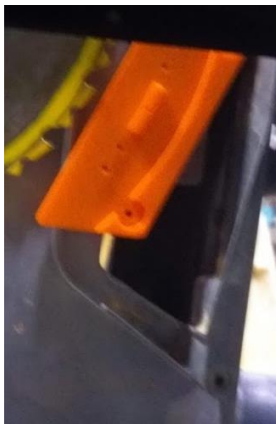
Mount Design Evolution

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

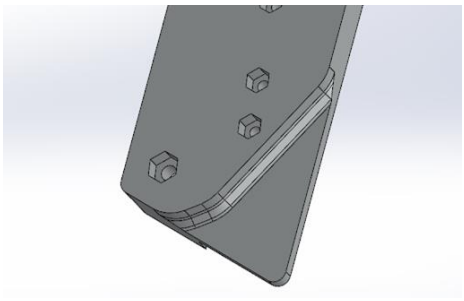
In response to more detailed design concepts and testing, the riving guard mount underwent changes from its original design, which are detailed below.

Blade Enclosure Clearance

- The original mounting piece, when installed into the riving knife mount, collided with a ridge on the blade enclosure
- A proposed design change was to incorporate a cutaway on the mount, to allow clearance



Interference with ridge



Proposed design for mount cutaway

Mounting Screw Accessibility

- A screw to attach the mount to the saw was hidden behind one of the bearing holes
- Would present a problem for assembly/disassembly later, especially once the bearing was in

Screw/bearing overlap

Design Fix

- Both problems were fixed with a new mount design
  - Ridge interference was solved by moving the screw holes down, and thus moving the mount up when it is installed
  - Bearing hole was relocated to be higher, to not overlap with the screw hole

New mount design

Section 4: Summary

Summary

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

- Determined an existing problem in the field of tool safety
  - Identified Table Saws as particularly dangerous
- Researched many existing solutions
  - All had their own drawbacks in one way or another
  - None completely solved the issue
- Brainstormed many different concepts and ways to attack the problem
  - Figured out which aspects of table saws are dangerous, and how most people get hurt
  - Looked at multiple generated solutions and determined which would be most practical to implement
- Created the Riving Guard concept
  - Aims to combine the features of a guard and riving knife
  - Prevents kickback while also covering the blade
  - Stays out of the way of the user as much as possible
- Generated initial Riving Guard prototypes
  - CAD modeled a mount and guard assembly
  - 3D Printed and CNC machined parts
- Tested Riving Guard prototypes
  - Noted multiple improvements that could be made, specifically to the mounting piece
  - Incorporated these improvements into a second version of the mounting piece
- Left unfinished due to COVID-19 closures
  - Was not able to thoroughly test new mounting piece
  - Was not able to test bearings in the new mounting
  - Was not able to develop springing
  - Was not able to test metal guard
- What did we gain?
  - Experience
    - Reaching out to experts
    - Researching a specific topic and justifying a decision
    - Collecting data
    - Designing experiments
    - Product design and fabrication
  - Knowledge
    - Pre-existing products for power tool safety
    - Most likely causes of injury from saws
    - What experts in the field consider most important for safe and effective power tools
  - Evidence that we can commit ourselves to a long and difficult project

References

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

Borlase, G. A., & Paul, C. (2018, November). *2017 Table Saw Special Study BP*. Retrieved from U.S. Consumer Product Safety Commission website: https://www.cpsc.gov/s3fs-public/2017%20Table%20Saw%20Special%20Study%20BP.PDF?qQr.xwg9UOS50O7Tx52PFf7QqRUYA6my

Marcy, N., Rutherford, G., & Mills, A. (2003, June). *Hazard Screening Report - Power Tools and Workshop Equipment*. Retrieved from U.S. Consumer Product Safety Commission website: https://www.cpsc.gov/s3fs-public/pdfs/2003h054.pdf

Smith, T. P. (2011, July). *Human Factors Evaluation of Technology Intended to Address Blade-Contact Injuries with Table Saws, July 2011 (0841)*. Retrieved from U.S. Consumer Product Safety Commission website: https://www.cpsc.gov/s3fs-public/hftablesaw072011.pdf

United States Government U.S. Consumer Product Safety Commission. (2011, March). *Survey of Injuries Involving Stationary Saws; Table and Bench Saws, 2007-2008, March 2011* (S. R. Chowdhury & C. Paul, Authors). Retrieved from U.S. Consumer Product Safety Commission website: https://www.cpsc.gov/s3fs-public/statsaws.pdf

Section 5: Appendices

Appendix A

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

Interview Notes

On December 27, 2019, we visited Nelson Laur, CEO of Peak Carpentry. We toured his workshop, and talked with him and his father (Nelson Laur Sr.). Below is a transcription of notes taken during the visit.

Tools to Consider

- Jointer
- Chop saw
  - If not paying attention, could accidentally bring the blade down onto fingers
- Band saw
  - Hazardous if cannot hold onto material well
  - If material gets caught on blade, it could pin the finger between it and the table due to the downward-moving blade
- Cabinet saw
  - Since cabinet saws are almost always part of a larger workshop, money is not as big of an issue
  - Workshops are usually willing to pay extra for a SawStop saw
- Jobsite table saw
  - Independent contractors usually cannot afford the more expensive SawStop brand saws
  - These saws are more dangerous, because they are not used in controlled workshop conditions
    - They are set up in front lawns, carried in trucks, and are set up and packed up frequently

Companies to Contact

- SawStop
- JET
- Unisaw

Opinions on our Product Concepts

- Riving Guard
  - Neat idea, but would need to be built of a strong material (like titanium) to resist bending
- Suck Block
  - Could be potentially useful, but might have issues sticking to wood surfaces
- Malleable Clamp
  - Residue from the clamping surface might stick to the workpiece

Appendix B

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

Other Technical Drawings

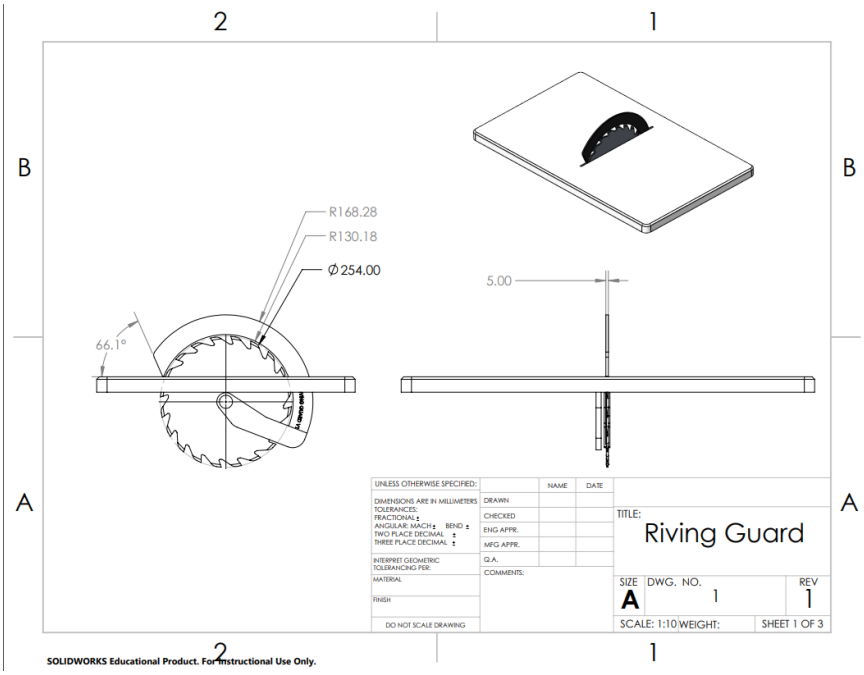


Figure 1. Technical drawing of the original drive shaft-mounted riving guard, showing measurements.

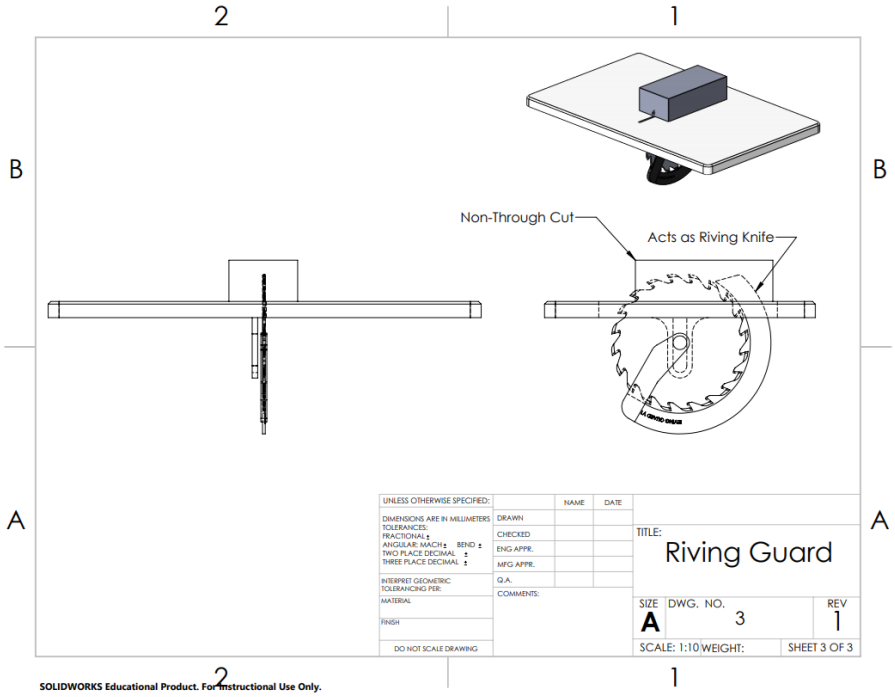


Figure 2. Technical drawing of the original drive shaft-mounted riving guard, displaying how the guard acts with a non-through cut.

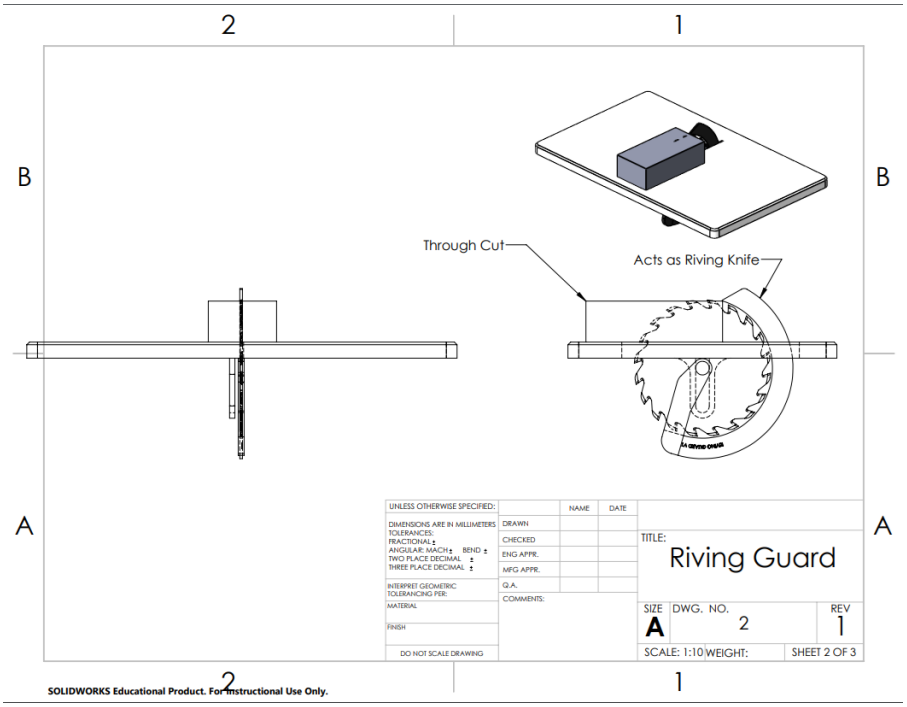


Figure 3. Technical drawing of the original drive shaft-mounted riving guard, displaying how the guard acts with through cuts.

Appendix C

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

Presentation 1 (10/22/2019) Slideshow

Power Tool Safety

Keertik Bacon, Matthew Zhang, and Carlos Montemayor

Have you ever encountered a murderous power tool?

Problem

Power tools pose many risks:

- Cuts
- Kickback
- Amputation

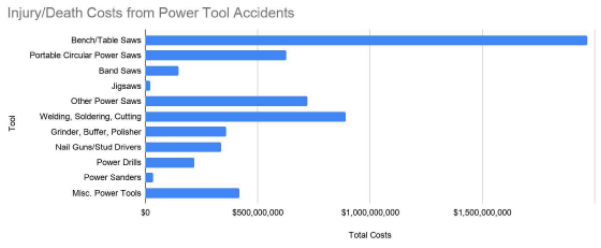
Caused by:

- Distraction
- Inexperience
- Negligence
- Tool Failure

Problem Statement:

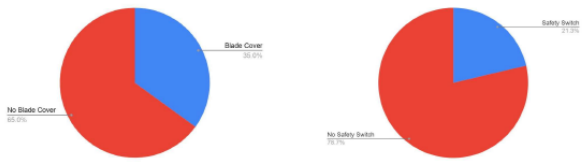
The US Consumer Product Safety Commission in 2008 reported that **stationary saws caused 101,900 hospital-treated injuries** annually. A survey of handymen found that the vast majority of these accidents, **around 85-90%, could be attributed to human error**, such as **distraction, inexperience, or negligence.**

Tool Injury Distribution



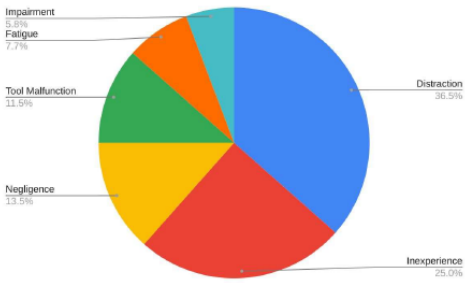
Source: US Consumer Product Safety Commission

Safety Features Statistics



In addition, only 14.5% of saws involved in accidents had any sort of safety label, and only 24.5% of saws involved in accidents had an anti-kickback pawl.

Causes of Injury



Potential Problems

Water Leakage

- Leakages in water infrastructure can cause large amounts of water to be lost
  - **50% water loss** in urban distribution networks is not uncommon
  - EPA estimates the average family wastes **180 gallons per week** of water due to household leaks

Unsanitary Surfaces

- High touch surfaces are unsanitary, causing problems particularly in hospital situations
  - National Institute of Health estimates that **50% of high-touch surfaces in hospitals are missed in disinfection and 40% are not adequately disinfected**

Snow Removal

- Snow piles up during the winter time and can be a struggle to remove
  - Can pose health risks
  - Snow blocks roads
    - Icy roads dangerous
  - Heavy snow can collapse roofs

Problem Criteria (How?)

- Practicality in Implementation
- Scope
- Originality
- Interest
- Researchability

Decision Matrix

Ideas	Criteria and Constraints: Practicality	Scope	Originality	Interest	Researchability	Totals
Water Leakage	6	8	3	5	7	29
Unsanitary Surfaces	3	7	8	3	5	26
Snow Removal	9	7	4	6	4	30
Power Tool Safety	9	6	6	7	7	35

Personal Interest (Why?)

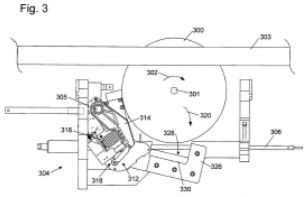
- Often use power tools
  - Robotics Club
  - Engineering Classes
- Would personally aid us in our work
- Have felt anxious being new to dangerous tools

Pre-existing Solutions

Saw Stop

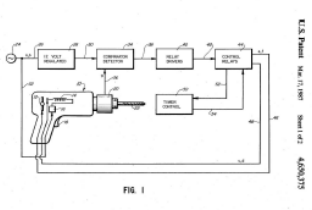
- Blade is slightly charged to detect contact
- Brake mechanism grabs blade teeth
- Pros:
  - Saw stops almost immediately
- Cons:
  - Destroys blade and brake
  - Cannot cut some conductive material
  - Mechanism complex/expensive
  - Does not work if operator wears gloves
- Patent #: US7908950B2

Fig. 3



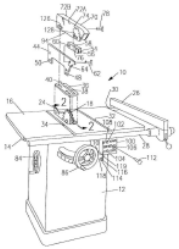
Drill Braking System

- Drill bit is slightly charged to detect contact
- Runs reverse voltage to stop bit
- Pros:
  - Reusable
  - Reduces injury on contact
- Cons:
  - Cannot drill conductive material
  - Does not work if operator wears gloves
  - May not stop instantaneously
- Patent #: US4650375A



Saw Guard Detection

- Uses proximity sensor to detect safety guard engagement
- Prevents tool from starting unless guard is on, or key-activated bypass is activated
- Pros:
  - Prevents accidents from forgetting to reinstall guard
- Cons:
  - Only makes sure guard is on; doesn't make tool safer
- Patent #: US6418829B1



A Solution

Aim:

- Reduce ER/common injuries from power tools

Primary approaches:

- Mechanical aspects that are most likely to cause power tool injuries
- Common impairments and symptoms
- Compromises of pre-existing solutions

Questions?

Appendix D

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

Presentation 2 (1/15/2020) Slideshow

TABLE SAW SAFETY

Keertik Bacon, Carlos Montemayor,
Matthew Zhang

The Problem

Table Saws and their Dangers

The US Consumer Product Safety Commission in 2017 reported that **table saws caused 27,000 emergency room injuries** annually. A survey of handymen found that the vast majority of these accidents, **around 85-90%, could be attributed to human error**, such as **distraction, inexperience, or negligence.**

Table Saw Dangers

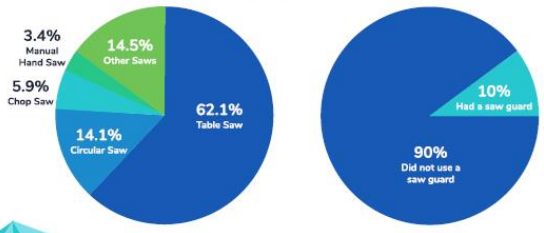
Kickback
- Material catches on blade and is thrown back
- Usually remedied by a riving knife

Accidental Touch
- Reaching over the blade
- Grabbing loose material
- Not minding where both hands are
- Usually remedied by a saw guard

27,000

Emergency room-level injuries caused by table saws annually

Saw Accident Statistics



> "I hate saw guards."
>
> *Nelson Laur*
> *CEO of Peak Carpentry*

Current Saw Guards

Clumsy
- Decreased Visibility
  - Harder to see the blade and cut
- Decreased Access
  - Hard to make thin cuts

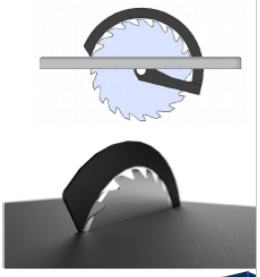
Inconvenient
- Must be removed for certain cuts
  - Non-Through cuts
  - Thin cuts
- May not work with some push blocks

Our Solution

Fixing Table Saws and their Dangers

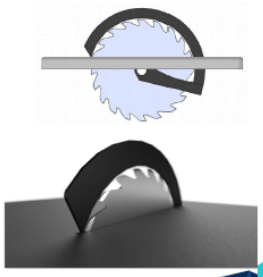
Riving Guard

- **Combines Riving Knife and Guard functionality**
- **Spring loaded & rotates around the saw blade**
  - Moves out of the way for material
- **Thin enough so that the guard can ride within the kerf of a cut**
  - Reduces kickback



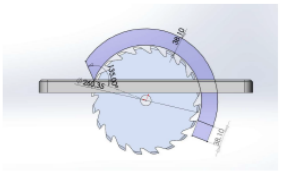
Riving Guard

- **Accessible and Non-Intrusive**
  - Does not inhibit alignment
- **Provides Protection from Accidental Touch**
  - Covers cutting edge
- **Reduces Risk of Kickback**
  - Functions as riving knife
- **Functional for through and non-through cuts**
  - Rotates out of the way

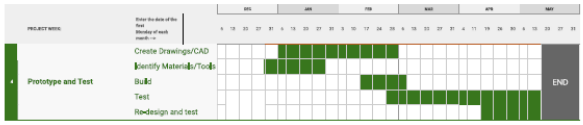


Riving Guard Design

- **Wraps around the blade and leaves a tight clearance**
- **Pivots around the center of the blade**
  - Possibly with a bearing around the saw shaft
- **Sprung to keep riving guard covering blade**
- **Sloped edge at front for material to push guard out of the way**



Our Process



Solution Path Decision Matrix

Ideas	Practicality	Cost	Sophistication	Effectiveness	Originality	Totals
Guards	10	9	5	6	5	34
Sensor based sawstop	4	6	8	7	5	30
Clamps / Feeding	8	8	6	5	6	33
Anti-kickback	9	8	6	6	2	31
Braking Mechanism	5	5	7	9	3	29

Product Concept Decision Matrix

Ideas	Convenience	Price	Flexibility	Effectiveness	Feasibility	Professional Opinion	Totals
Malleable Clamp	6	7	6	8	9	6	42
Riving Guard	8	8	6	7	10	9	48
Illuminated Guard	6	7	6	8	10	4	43
Suck Block	9	8	8	7	9	5	46
Material Adaptive Guard	7	6	8	6	8	4	39

Expert Opinion

Nelson Laur, CEO of Peak Carpentry
- Liked the concept over existing polycarbonate guard designs
- Suggested use of titanium to mitigate bending

Brian Michael, CHS Teacher/Hobbyist Carpenter
- Called it a "neat idea"
- Recommended rounding leading edges of riving guard to prevent edges from catching on workpiece

Building Materials & Tools

Prototype Materials

- Cardboard/Wood
- Rubber Bands
- Plastic 3D printed caps

Prototype Tools

- 3D printer
- CNC Router
- Bandsaw
- Scrollsaw
- Wood Glue/Strong Adhesive
- Duct Tape

Final Build Materials

- CNC Machined Aluminum/Steel
- Torsion Spring
- Machined aluminum caps
- Bearings

Final Build Tools

- CNC Router
- Welder

Thanks!

Any questions?

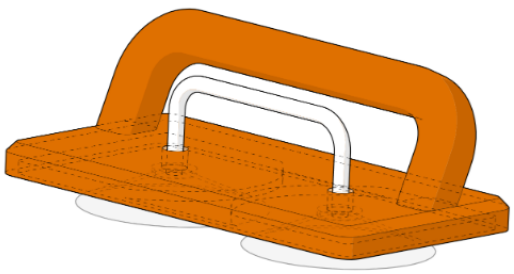
Appendix E

Matthew Zhang, Keertik Bacon, and Carlos Montemayor

SuckBlock Concept

PLTW | Engineering

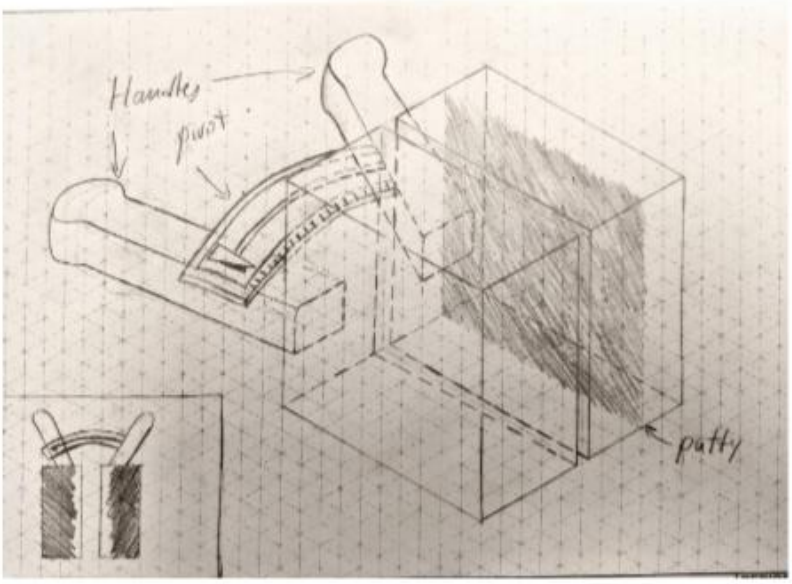
PLTW EDD Product Concept

Product Name:	SuccBlocc®
Brief Description:	Push blocks are regularly used to push material when using a saw guard. This push block will feature a suction device to keep it attached and prevent it from losing grip
How it works (Operation):	The SuckBlock will be a regular push block with a handle and flat bottom surface, but instead of a grippy bottom, there will be a suction cup to grip the material. The suction cup will have a dial attached to a lead screw in order to adjust the suction.
How this addresses the problem (Justification):	It holds on more securely to the work piece, meaning that the work piece will not slip out of your grip, which could potentially lead to kickback when the material is loose.
Sketch/Model	

Malleable Clamp Concept

PLTW | Engineering

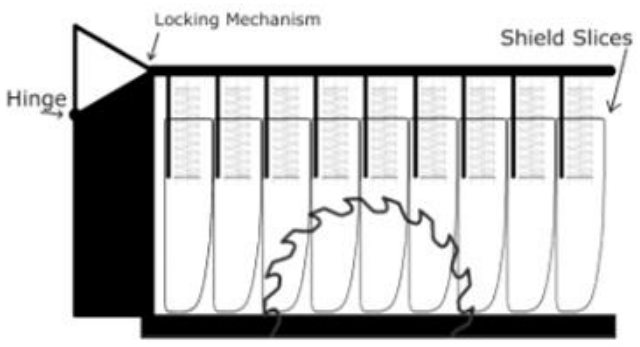
PLTW EDD Product Concept

Product Name:	Malleable Clamp
Brief Description:	A clamp with an adaptive surface for the clamp that allows you to saw irregular object
How it works (Operation):	The surface has very high friction, and the clamp can attack to guides in order to safely slide into the table saw.
How this addresses the problem (Justification):	There are a series of injuries that come from people trying to cut materials that were not made for sawing, or have materials that are difficult to clamp down kickback.
Sketch/Model	

Adaptive Guard Concept

PLTW | Engineering

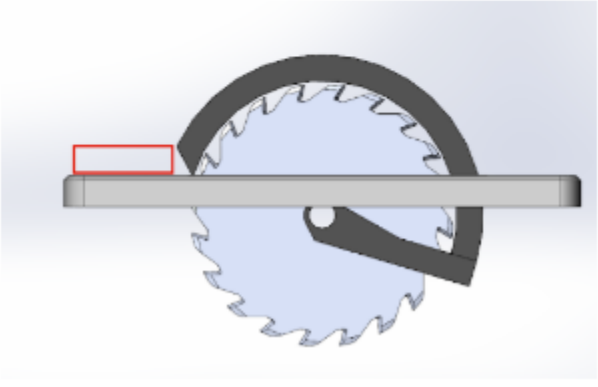
PLTW EDD Product Concept

Product Name:	Material Adaptive Guard
Brief Description:	A guard made from small sliding parts that adapts to the material being cut
How it works (Operation):	The guard is made of many small spring tensioned pieces that move up and down. The point is that they would be designed to allow the material to be slid under them horizontally but not expose any part of the blade.
How this addresses the problem (Justification):	None or minimal amounts of the blade will be exposed at one point, reducing the possibility that someone will accidentally push their hands into the blade.
Sketch/Model	

Riving Guard Concept

PLTW Engineering

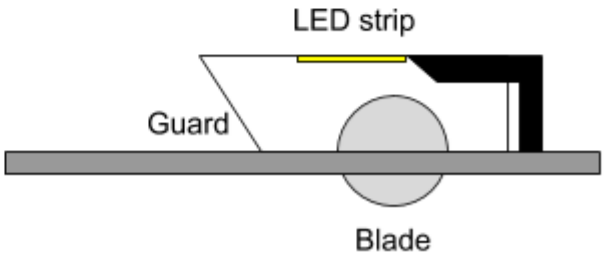
PLTW EDD Product Concept

Product Name:	Riving Guard
Brief Description:	A riving knife that also functions as a saw guard, it rotates over the blade and blocks the cutting edge
How it works (Operation):	A circular profile that goes around the blade lifts up when the piece passes, due to a small slope on the front. It is sprung to always make contact with the table/workpiece.
How this addresses the problem (Justification):	It protects the user from head-on collisions with the blade, without too much vision obstruction. It also functions as a riving knife, preventing the materials from catching on at the back of the blade.
Sketch/Model	

Illuminated Guard Concept

PLTW | Engineering

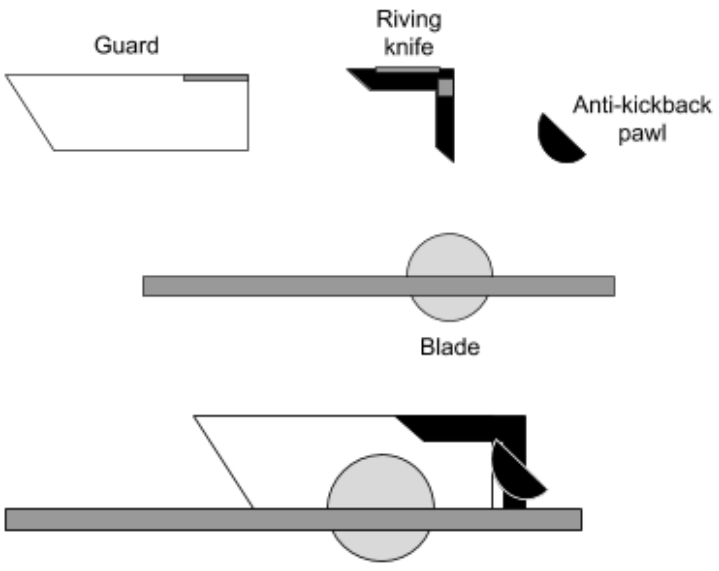
PLTW EDD Product Concept

Product Name:	Guard-Lite
Brief Description:	A LED light that is mounted inside of a guard to improve visibility
How it works (Operation):	A guard which mounts to an existing table saw and has an LED inside, illuminating the work. The guard will have small cable that eventually plugs into the wall to provide power.
How this addresses the problem (Justification):	One issue is that many people find blade guards inconvenient because it is hard to see the workpiece through them. Having an illuminated interior would allow people to see it gooder
Sketch/Model	

Modular Guard Concept

PLTW | Engineering

PLTW EDD Product Concept

Product Name:	Modular Riving Knife/Saw Guard
Brief Description:	A riving knife that mounts to a saw that has modular attachment points for saw guards and other accessories like anti-kickback pawls
How it works (Operation):	The riving knife will have a variety of modular attachment methods. One of which is a magnetic attachment system, in which the guard will be able to be removed/attached with a pull/placement
How this addresses the problem (Justification):	Many people remove safety features of their saw blades such as the guard because there are certain cuts or operations that cannot be completed with the guard on. However, some do not put them back on because they are hard to remove/attach An easy to remove modular design will, somewhat counter intuitively, encourage saw guard use, as it will be easy to reattach.
Sketch/Model	

Magnetic Clamp Concept

PLTW | Engineering

PLTW EDD Product Concept

Product Name:	Electromagnetic clamp
Brief Description:	Magnetic chunk that rests on the edge of the material, has other magnets attracting it onto table and guide
How it works (Operation):	One magnetic piece of material is rested on an edge of the material and placed on the table flush with a guide. Under the table and on the other side of the guide are strong magnets that create an attractive force with the magnetic chunk on the material edge, and thus push it into the guide and table. The second and third magnets are attached to a common sliding mechanism that can push the material through the saw blade
How this addresses the problem (Justification):	This eliminates the need for clunky and spacious clamps, and it's very easy to set up.
Sketch/Model