

INVESTIGATOR'S SUMMARY¹

Nomination 2007-22
Investigator: Ihab Ismail²

SPINNING SAW STOPS ON HUMAN CONTACT

The Innovation

How does it work? Identify and describe innovation(s) in SawStop.

:

The SawStop system can tell the difference between cutting wood and cutting an operator. When the system detects that an operator has contacted the blade, it stops the blade within a few thousandths of a second. In most cases, the result is that the operator receives only a small nick instead of potentially losing one or several fingers. The SawStop is very similar to a standard table saw with one exception; it has an innovative accident prevention system that allows the blade to retract and prevent an injury.

There are two major components to the SawStop system – detection and braking. The detection system works by inducing a low voltage high frequency signal on the blade. When an operator contacts the blade, their body absorbs some of that signal, lowering the voltage on the blade. Wood, unlike a human body, does not conduct electricity, so the voltage is unaffected when cutting wood. The voltage on the blade is continuously monitored by a digital signal processor (DSP) and when it detects a voltage drop that is characteristic of human contact, it triggers a very high speed braking system to stop the blade.

The braking system utilizes an aluminum brake pawl that is positioned at the edge of the blade and pushed into contact with the teeth of the blade by a high-speed actuator when contact is detected. The actuator is a spring pre-compressed to about 150 pounds and held by a small stainless steel fuse wire. When contact is detected the charge from a 1000uF capacitor charged to 180V is released to flow through a small portion of the fuse wire. This surge of current severs the fuse wire in about 100 millionths of a second to release the spring to push the brake into the teeth of the blade. This sequence of event is illustrated in Figs. 1-3.

When the aluminum brake engages the blade, a tremendous braking torque is created. The saw is configured to use this braking torque to retract the blade beneath the table as shown in Fig. 3 below. Therefore, in addition to stopping the blade, it is retracted as well.

¹ August 21, 2007

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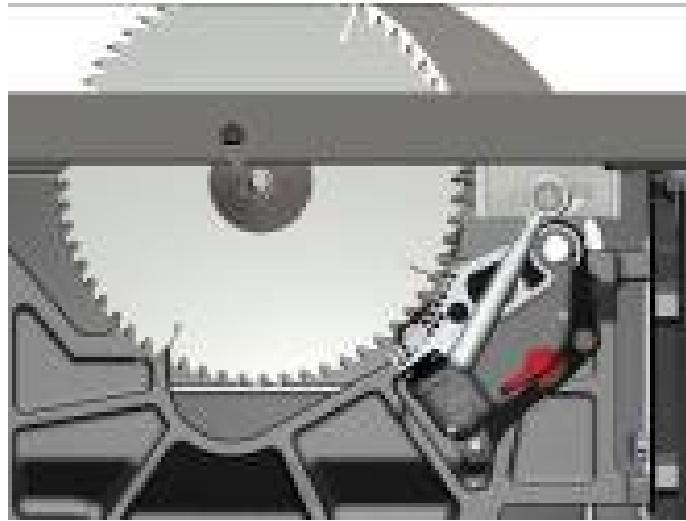


Figure 1

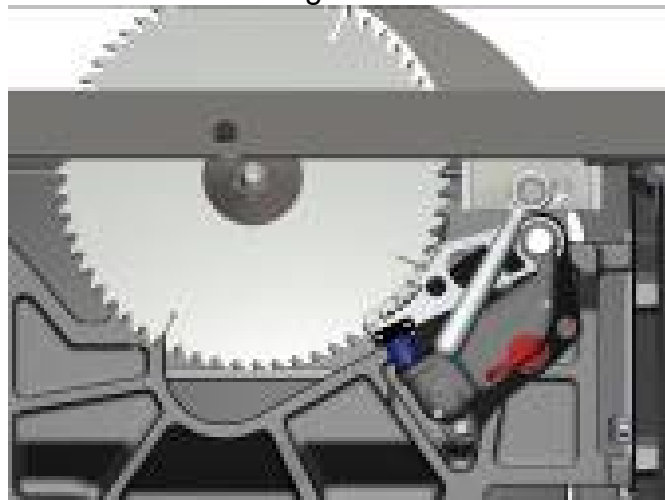


Figure 2

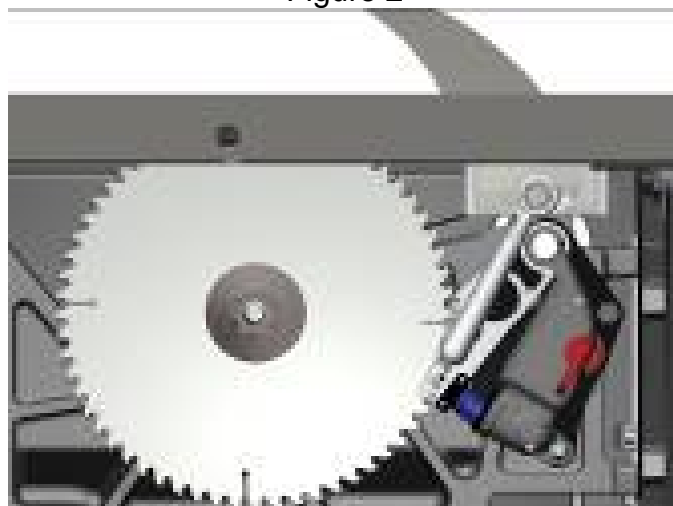


Figure 3

The components of the system are simple (fuse, braking system, and detection system); however, the combination of the three components and engineering them to work as a safety mechanism for table saws is the innovation behind the Saw Stop.

How do SawStop functions, capabilities, quality compare to conventional saws? Do workers, contractors like to use them?

Regardless of the obvious additional safety feature provided by the SawStop, the saw functions, capabilities, quality are comparable to high end table saws. In fact, there were tens of non-sponsored reviews by woodworkers indicating that SawStop is as good if not better than most commercial table saws such as the PM-66 discounting the fact it has the additional safety feature.

In terms of maintenance, there is no special requirement that is different from conventional saws. The system self detects problems with the braking mechanism and indicates that on the LED. The brake cartridge is required to be changed if a significant amount of dust is collected inside the plastic housing which would indicate that the housing seal is damaged, or if the cartridge is used in preventing an accident. The cost of cartridge replacement is around \$60.

Cost and Productivity Comparison

What are the costs of SawStop saws and what are competing costs?

In comparing the SawStop to a conventional table saw, there are two aspects of comparison: direct cost and productivity and indirect costs and productivity.

The direct cost differences are negligible. An average price for a SawStop 5HP with a 10" blade and a 52" fence system and extension table is about \$3,500. Competitive costs for a similarly equipped, high quality table saw (without a brake system) range from \$2,000 to \$3,000. The SawStop user may require additional blades every time the system is triggered to prevent an accident, but the cost of the blade (\$50-\$60) compared to the loss of productivity and other direct costs resulting from accidents such as the OSHA fines. OSHA estimates that the average direct cost of a workplace amputation is approximately \$22,000. Additional direct costs could include increased insurance premiums.

The indirect cost comparison is primarily driven by the safety issues. A safer workplace can significantly reduce the indirect costs for an organization. Several estimates have been provided for the indirect cost savings related to prevented table saw injuries. OSHA estimates the indirect cost saving for amputation prevention to be in excess of \$24,000. The U.S. Consumer Products Safety Commission (CPSC), estimates there are more than 60,000 table saw injuries each year with a total economic cost of over \$2 billion per year. Indirect costs are not easy to quantify, and the estimates may vary significantly; however, there is a significant amount of studies documenting the indirect costs of accidents with

one common conclusion: the cost of indirect it is much higher than any calculated direct cost.

Application and limitations of the Innovation

For what types of saws is it suitable or not suitable?

SawStop can replace any conventional 10" cabinet / table saw. The majority of SawStop saws have been sold to commercial woodworking environments including cabinet shops, door and stair manufacturers, boat builders, modular home builders and the like.

Under what ranges of conditions does it work/not work with regard to material sawed, worker body part contacted, hand orientation, hand covering (such as gloves)?

The SawStop system works to cut all non-conductive materials, including virtually all wood products and plastics. The system detects contact independent of the position or orientation of the body part contacting the blade. If a user is wearing gloves, the blade will typically cut through the glove and detect contact and stop when the blade reaches the operator's skin.

When cutting conductive materials, such as aluminum or some chemically-treated wet wood, the system can be temporarily disabled or bypassed. Even when the system is disabled, it still monitors whether contact was detected and indicates this to the operators so that the operator can determine whether or not it was necessary to operate the saw in the bypass mode when cutting a particular material

The technology is viable for virtually all types of woodworking equipment. At this time, the technology has only been commercially implemented on a table saw. SawStop has developed prototypes for other types of machines, band saws and hand held circular saws and SawStop Engineers are currently exploring ways to adapt the technology to woodworking machinery with cutting heads such as a jointer or router.

Competing technologies and/or Systems

Identify and describe any competing technologies and/or products and how SawStop differs from and improves on them?

Apparently the safety of table saws was always a concern and several attempts have been made to decrease the accident potential resulting from using the table saws. One of the primary concerns of the investigation was to try to identify any potential competing technologies. Indeed, there are competing safety mechanisms that attempted to improve the safety of table saws; however, none was as successful as the SawStop. The commonly recognized safety innovation in table saws before SawStop was the Saw Knife Guard described in more detail

in the attached exhibits. In summary, the Saw Knife Guards attempts to improve the safety of using table saws by trying to direct the operator's hand's away from the blade knife by using a barrier (the knife guard). Different versions of the mechanism include also attachments to reduce the dust collection and/or reduce the possibility of loose wood particles hitting the blade and getting dispersed in the air which may result in an injury to the operator.

In the search for competing technologies, there existed nothing that improves the safety by actually protecting the operator if, and when, a contact with the blade occurs. The blade guards are certainly useful, but several reviews indicated that they are often not used in commercial workshops because they restrict the sawing operation. Even when used, they do not eliminate the possibility of contact between the blade and the operator's hand's. In this regards, SawStop is an addition to the safety of saws, regardless of whether a blade knife guard is used or not.

Background of the Innovation

SawStop was founded in 2000 in Steve Gass' woodshop in Wilsonville, Oregon. Steve Gass was the original inventor of the technology. In 1999, Steve, an amateur woodworker, was in his woodshop and as he was about to use his table saw, a thought occurred to him - "I wonder if I could invent something for my table saw that would prevent a serious injury if I accidentally came in contact with the spinning blade." After concluding that it might be possible, he starting to build the first prototype and 30 days later he had a working model. After building the first prototype, Steve Gass was joined by David Fanning, David Fulmer and David D'Ascenzo, three of his fellow patent attorneys from his law firm in Portland, to form SawStop. The four of them further developed the technology as working prototypes to demonstrate at the International Woodworking Fair in August of 2000. After the show, Gass, Fanning and Fulmer left their jobs as patent attorneys to pursue SawStop full time and over the next several years developed the commercial implementation of the technology in the SawStop table saw. The chronology of events behind the SawStop is summarized below:

- 1999 – Steve Gass creates the idea behind SawStop
- 2000 – The prototypes are developed and tested for tradeshow demonstrations.
- 2001-2002 – Attempts to license the technology to saw manufacturers.
- 2003 – SawStop begins designing its own table saw.
- 2004 – In November the first saws roll off of the assembly line.
- 2005 – SawStop sells 1000 table saws by mid-year.

- 2007 – SawStop has sold more than 7,500 saws through 180 authorized dealers in North America.

Responsibility for the Innovation

The Stephen F. Gass, Ph.D. – Inventor and SawStop President

Paul Carter – SawStop Executive Vice President of Sales & Marketing

Investigator’s Comments

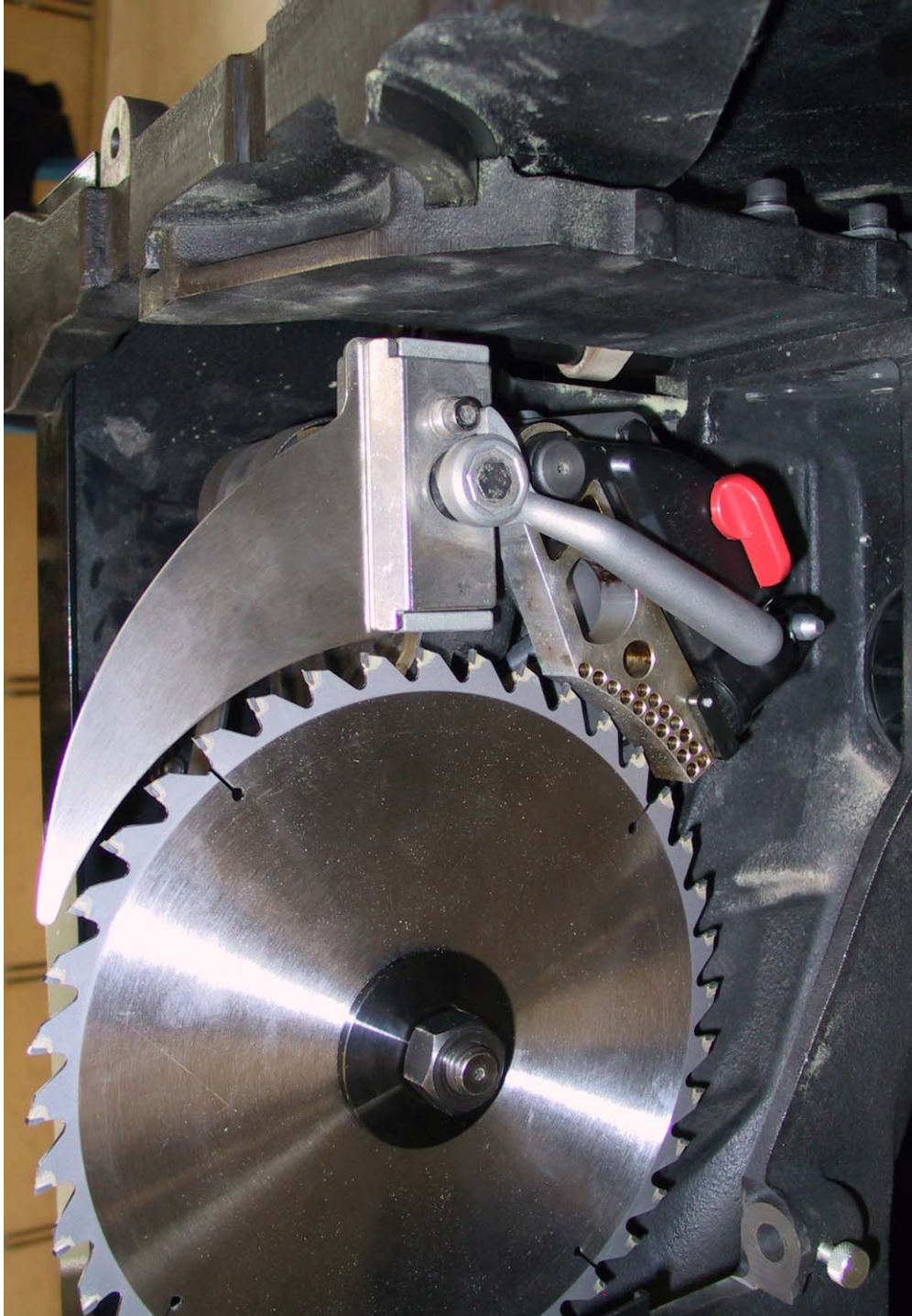
The SawStop innovation is very simple in concept yet very effective.

Similar concept is applied in Ground Fault Circuit Interrupters (GFCI) which protects against electric shock should someone come in contact with a live wire and a path to ground which would result in a current through his/her body. The GFCI operates by sensing the difference between the currents in the Hot and Neutral conductors. Under normal conditions, these should be equal. However, if someone touches the Hot and a Ground such as a plumbing fixture or they are standing in water, these currents will not be equal as the path is to Ground - a ground fault - and not to the Neutral. The GFCI will trip in a fraction of a second at currents (a few mA) well below those that are considered dangerous. This is very similar to the mechanism that detects the contact with the human hand. The challenge, however, is unlike GFCI, the fault detection shall stop a blade knife with very high inertia in a split second to avoid the accident. This challenge is overcome by the second assembly; the braking system, which is triggered through a capacitor and a fuse controlling the spring release of a braking pad.

I believe the system to be very effective in reducing table saw accidents, and the application of the technology components into the table saws will probably drive its applications in many other tools. The simplicity of the mechanism without the need for complicated and expensive electronic parts and devices makes it very suitable for applications in a work environment such as commercial woodworking shops, and construction operations.

SUPPORTING EXHIBITS

1. Large Scale Photo
2. Bosch Guard System
3. Industry Testimonials



Review of the Bosch Guard System

<http://blogs.popularwoodworking.com/editorsblog/Bosch+Riving+Knife++No+More+Excuses+For+Woodworkers.aspx>



The guard consists of three components – the riving knife/splitter, the anti-kickback pawls and the blade cover. The best thing about this guard is the engineering that makes it the most user-friendly system I have seen. The reasons many woodworkers don't regularly use guards are 1) it takes too long to remove, replace and realign the guard, and 2) it gets in the way when you're setting up for a cut, or when the fence is close to the blade. The two plastic side shields on this guard lift up and out of the way and there is a catch to hold the guard up until you want to lower it.



The blade cover attaches to the riving knife/splitter by clamping into place. The lever in my hand releases the guard and it then is easily removed from the saw. Elapsed time for this operation is about five seconds.



The anti-kickback pawls release in a similar fashion. Squeezing a button disengages a pin and the pawls lift out of the way. This also only takes a few seconds, and you can leave the blade cover in place and remove the pawls independently.

After removing the table insert, another lever releases the riving knife/splitter. This doesn't come out of the machine, but it slides in an arced slot and locks in one of three positions. The lever clamps the splitter against a flat piece that is part of the arbor assembly, so it is always in line with the blade. In the top position, it comes up above the top of the blade to allow the blade cover and pawls to attach.



The middle position brings the top of the knife just below the top of the saw blade. If you're making a non-through cut (like a rabbet or a groove) the knife is still acting as a splitter by keeping material against the fence, and by keeping it from binding on the blade. The lowest position drops the knife completely below the blade, out of the way for changing blades.



The riving knife stays in this position when you raise, lower, or tilt the blade. It shields the teeth at the back of the blade to prevent the piece you're cutting from coming in contact with the saw blade. If you look at the picture, you can see that these teeth are the ones most likely to grab something and throw it up and back.



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Industry Testimonials

Rev. 07/6/07



"I can't believe anyone would use anything but this saw. Having used it first hand now, knowing my finger would be gone, nothing can speak more than that. Being a PGA Golf Professional in addition to woodworking, I can't thank SawStop enough for having all of my fingers."

Woodworker – Door Manufacturer – Fremont, California

SawStop save #66... right index finger.

"The pass was quick and the blade stopped immediately. I've heard how a blade can pull fingers and hands down [into the spinning blade] but with SawStop, the blade stopped before I even realized I had touched the blade. I received no injury whatsoever. I really was amazed at how quickly and safely the blade was stopped!"

Timothy A. – Industrial Woodworker, Salt Lake City, Utah

"I think SawStop is the best made saw since saws were ever made."

Michael V., Production Manager, Texas

"I was cutting wood for my boss and my middle finger came in contact with the saw blade. In the blink of an eye the blade was gone. I didn't know what I did; I didn't even think that I touched the blade. All I had was a little blood blister on the end of my finger. Thanks to SawStop."

Kameron N. – Door Manufacturer Employee, Texas – 5/24/07



"We are pleased (and one of us EXTREMELY relieved) to tell you that we had our first "save" yesterday after a year of having two SawStop saws in our shop. The guy that was using it came to let me know how much he appreciated my investment in that saw. Once I figured out what he was talking about, I immediately wanted to see the damage. He was very pleased to show me that it was not much worse than a utility knife cut. He was able to put on a band-aid and go back to work. That single "save" just paid for both saws that we bought with the savings in workers comp premiums that would have resulted. Thanks SawStop!!"

Jason Hall – Owner, Woodcraft Mill & Cabinet - Salt Lake City, Utah



Carl Seymore "C-MO" of Cabinet Door Shop immediately after his thumb came in contact with the blade while using a SawStop Cabinet Saw. March 2006

"Look at this picture - I rest my case! I Praise God for having a product that not only is the best on the market in function but also is, without comparison, the safest!"

Gerald Wayne Wheeler - Cabinet Door Shop, Hot Springs, Arkansas



Robert right after his thumb came in contact with the blade while using a SawStop Industrial Grade cabinet saw in July 2006.

“Pretty amazing that I only had to put on a band-aid. The Saw reacted so quickly that I didn’t even know what had happened. Saved my thumb from a serious injury and saved my company lots of money.”

Robert S. – Cabinet Maker, McMinnville, Oregon

Finger save #55... right thumb

“I didn’t even know I touched the blade until it was all over. Thanks to SawStop, there wasn’t even a scratch. I’ve been cut before by a table saw and it’s amazing how fast it cuts you. I would recommend SawStop to anyone.”

Chris L. – Industrial Woodworker, Salt Lake City, Utah

“I bought two SawStop saws to replace my Unisaws. The saws are first rate, well made and stout. Yesterday, one of my longest serving employees, who has been with the company for almost twenty years, with no accidents, ran his thumb into the blade. If he had been using a conventional saw he would have destroyed his hand. He’s still shaking his head. So there you have it. I can say my money is well spent.”

Rick T., President, Millwork Company, New Mexico

“In my opinion Delta, Powermatic and General have lost considerable ground to SawStop. Thanks for the excellent customer service and product.”

Clark T., North Carolina

“Edgar Noyola just nicked his finger while using the saw. The blade did EXACTLY what you designed it to do. Edgar wants me to thank you for your invention. Thanks for a product that adds value to our business.”

Terry R., Wood Products Manufacturer, Washington

“A true sign of the worth of a company is the value it places in its employees. As a responsible employer, we need to have safety as a number one priority. Every so often some forward thinking individual creates a solution to a safety issue that we as employers need to have and can simply buy.

“Over the years we have had several severe injuries on table saws. When we became aware of the Saw Stop technology, we couldn’t buy it quickly enough. Thanks to SawStop we have already saved what would have been total amputation of most of a thumb.

“You can have all the safety meetings you want and try to instill a conscious thought process in employees working around hazardous machines, but the bottom line is usually a distracted moment that results in injury. The usual comment is how dumb the moment was, but you can’t fix dumb, and the last time we went looking for an amputated thumb to send to a hospital it had gone up the vacuum. All of us at Pacific Pine Products, Inc. are your biggest fans-keep up the good work. Sincerely,”

Roger L., President, Door Manufacturer, Oregon

“Save”

The technology truly works, as Lowell, Arkansas saw operator John Stroud recently found out. On March 15, Stroud was building cabinets for Collins Custom Cabinets when his hand slipped and came in contact with the blade. Luckily for him, the saw was equipped with SawStop and the blade gave him just a slight nick, saving his finger. Owners Sharon and Don Viers are grateful.

“Having John walk away nearly unscathed was not only a blessing to him, but a huge sigh of relief for us. We know that we made the right decision to buy SawStop saws for our employees, and it has obviously paid off for John and for our business.”

Sharon V., Arkansas

“The saw is easy to assemble and adjust, and appears to be manufactured with quality materials to close tolerances. SawStop understands that safety alone does not sell saws, and they took the opportunity to reconsider and improve on many aspects of cabinet saw design... The saw is solid and smooth running. I particularly recommend this saw for schools and commercial shops, but think that dedicated private woodworkers might enjoy working with it as well.”

Dave Wright - WoodCentral, SawStop Cabinet Saw Review

“You've truly put out a product that will change the industry. Even without the safety system, this saw is the best I've ever used, and I've used Powermatic 66's, Unisaws, and Jets....”

Brian G., Ohio

“I wanted the best North American style 10 inch saw on the market. Sorry Powermatic and Delta, even with out the technology the SawStop has them beat. The controls alone are akin to spinning the wheel of a bank safe, smooth and effortless. This saw screams quality. Out of the box alignment...perfect. Table and cast iron wings, ditto. Folks if I could find fault somewhere, I wouldn't hesitate to let you know.”

Per Swenson – Swenson & Swenson, Denville, New Jersey

“It can happen to anyone...even us experienced guys.”

“I was cutting some 1 ¼” oak on my new SawStop cabinet saw. At the same time, I was keeping an eye on a new employee who was working on the planer. After cutting part way through, I realized the blade wasn't set high enough and I pushed down on the wood to make the blade go through. Because I was still watching the guy on the planer, I didn't even notice when the blade popped through the wood and my finger ran right into it. I wasn't paying attention and I made a mistake. Fortunately, the SawStop safety system did its job and it barely cut into a callous on my finger. I didn't even need a bandage. SawStop saved my finger!”

Joel B., Furniture Maker, Illinois

“Five years ago, one of my employees, a kid, mangled three of his fingers while working on our table saw. The dado set chewed through his fingers like a hamburger grinder and crushed his bones. Two years later, another employee was working on table saw and some stacked material fell over and pushed his hand into the blade and cut off one of his fingers.”

“The worst part isn't the fact that my worker's comp premiums doubled from \$18,000 to \$36,000 in a two year period, or the fact that OSHA can come by anytime they want, or that work productivity goes down and business suffers. The worst part is the guilt of knowing that you sent a kid to the hospital. The guilt that you feel knowing that this kid's life has changed, that he is suffering and that you have sent him out into the world without the use of three fingers for the rest of his life. I don't want people working for me with stubs.”

“When I saw your cabinet saw demonstration I bought one. It is awesome!

Jerry K., Custom Cabinetry, California

“My SawStop purchase just paid for itself today, thanks for providing this product!”

Ron Huisinga - Phoenix, Arizona

Ron Huisinga’s finger immediately after accidentally touching the dado set on his SawStop saw.



“I personally believe in this product. I have seen it demonstrated, both live and on video. I now have personal first-hand experience with this revolutionary safety device. I purchased my saws because I believe in safety – after all, exactly how much is a severed finger (or worse) worth in today’s litigious society? Certainly several times the cost of a SawStop brand table saw. I replaced 2 perfectly serviceable, well known name brand saws, all in the interest of safety and corporate responsibility.”

“My question is: When is the rest of the industry going to wake up? How many more disfigurements, amputations or worse, are going to happen for the sake of saving a few dollars? Thanks, SawStop. Your product should be a requirement, not an afterthought. Keep up the good work, guys!”

Vic Nesheim, President, Nescon, Inc.

“I have had your saw now for about 4 months. To attempt to explain the level of comfort that I now experience in the shop is difficult. Gone is the threat of someone obtaining a severe injury while operating the table saw. The removal of the threat makes the whole experience much more enjoyable and relaxing.

This is the best saw I have ever operated. Probably the best purchase I have ever made. I would like to point out that the quality that is built into this saw and many of the safety features put it in a class where there is no equal. Congratulations on making such a fine product.”

Joe T., Windsor Locks, Connecticut

2 Finger Saves!

“(Our company) recently purchased a SawStop table saw and I am pleased to inform you that we have had great success with your product. Without this amazing technology, we would have suffered not only one but two potentially serious injuries. Thanks to the SawStop, neither of the incidents was severe and no injuries were rendered. Our company just wanted to take the time to thank you for manufacturing safer equipment, in turn reducing the risk of serious injury at our facility. Thank you.”

Nathan F., Lead Fabricator, Vermont

“Without the (SawStop), our operator would have lost part of his finger and possibly a lot worse. The injury would have cost our company several thousand dollars as well as increasing our workers’ comp premiums and most importantly the loss our operator would have sustained for the rest of his life. It’s amazing how a \$69 cartridge saved a person’s life as he knows it not mention thousands of dollars to our company. Since the accident, our company has decided to replace all standard table saws on our shop floor with SawStop.”

John G., Elk Grove, California

“The saw had been set up for less than two week before the operator did his own ‘hot dog test’ with his thumb. In addition to (saving) his fingers, it potentially saved us tens of thousands of dollars in lost wages, workers’ compensation, insurance premiums and possibly even litigation. Instead, it cost us one glove and one bad-aid. We hope to never test the SawStop technology again (but we’re sure glad to know it’s there. I cannot express our gratitude enough.”

Todd Virts – Vice President, P.A. Portner, Inc., Gaithersburg, Maryland

“I just wanted to let you know I love my table saw. The saw is well made and functions flawlessly. The safety features are a bonus but the saw itself is awesome!”

Brett A. – Woodworker, Wyoming

“SawStop is, without a doubt, the best investment we have ever made!! The cost/value of body parts is priceless. Our operators couldn’t be happier. A real winner!!”

Bill R. – Chair Manufacturer, Utah



“I just wanted to write and say thanks for your great product! It saved a thumb today in our shop!! We are very grateful!”

“I am attaching a picture so you can see...his thumb barely got nicked.”

Paul – Countertop Manufacturer, Utah

“Since we started using SawStop (cabinet saws), we have had two minor injuries that could have been much more severe. I am impressed with the technology and would recommend the SawStop to anyone”

Jack W. – Chair Manufacturer, Wisconsin

“Amazing! It’s hard to imagine how fast the cartridge activates. The injury sustained from the accident, which would have resulted in the loss of a digit, was no more severe than a small splinter (wound). Thanks!”

Phillip W. – Cabinet Shop, Tennessee

“We had our first saw [brake] trigger on skin a few weeks ago. Attached is photo of the guy’s hand. The cut was less than your average paper cut, which is especially amazing because his hand passed over the blade as the result of a kickback. We had a similar kickback [incident] about ten years ago which caused three severed fingers and thumb which was left hanging by very little. The SawStop saws work better than our old Powermatics even without the brake. The [SawStops] have basically paid for themselves by avoiding medical bills and costly litigation. Thanks for creating such a great product.”



Matt K. – Cabinet Manufacturer, Minnesota

“This is the second incident that we have had involving the SawStop and it is the reason that we installed the second (SawStop) to replace another old saw. We can only estimate the cost savings (workers’ comp and production loss) but what we are sure is that it would have been in the high \$1000’s...not to mention the three fingers saved.”

Rodney C. – Furniture Manufacturer, Utah

“This is a very inexpensive saw for what it does. It saved a finger in our shop which makes it well worth it. If this saw were double the price I paid and I needed another one, I would still buy it in a snap. If you are thinking about buying (a SawStop) it would be the best thing you could do for your shop. Don’t wait, BUY NOW!”

Eric W. – Owner, Woodworking Shop, South Dakota – 5/24/07