



JUL 2021

DIGITAL ARCHIVE
EDITION

PRECISION ARMS WORKSHOP

AND THE AMERICAN GUNSMITH ARCHIVE

A TECHNICAL JOURNAL OF CRAFT, REPAIR & RESTORATION

07

ARCHIVE ISSUE NUMBER

INSIDE THE ARCHIVE

OPEN SOURCE CNC

FREE GUNSMITH VIDEOS • SHADOW SYSTEMS MR920 • BSD FABRICATION AND WORKS • GUNSMITHING BUSINESS TIPS...

ORIGINAL METHODS. MODERN ACCESS.

ARCHIVE EDITION 211

DIGITAL ARCHIVE EDITION

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FROM THE ARCHIVE

Free Gunsmith Videos

BY AMERICAN GUNSMITH EDITORS JULY 2021

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A number of gunsmiths have free instructional videos on YouTube.com. Search for these channels and check them out before someone decides these videos “violate community standards.” 45 Alfa Charlie Papa Also posting as The Old Singing Gunsmith, American Gunsmith contributor Paul Mazan has great videos along with his son that cover modern guns, black powder, and military surplus firearms.

The Gun Bench Formerly The Shooters Table, this channel is devoted to safety, shooting, and education, including a number of disassembly/assembly videos, parts installations, and repairs. DH Gunworks “Gunsmithing is a great hobby and a rewarding profession. Some people fish, I have my lathe.” DH Gunworks has scores of informative how-to videos. Mark Novak (Anvil) “Many of the old school craftsmen who built and maintained these pieces are long gone, and with them goes their knowledge base.

Since we can no longer ask them how they learnt their craft, we seek to demonstrate the process of acquiring this lost wisdom.” Grumpy Gunsmith of Williamsburg Clay Smith worked at the Colonial Williamsburg gunshop for over two decades and has nearly a half century experience of blackpowder gun building. Yes, his profile picture is him flipping off the camera. Also, check out ClaySmithGuns.com.

Sonoran Desert Institute Sonoran Desert Institute’s School of Firearms Technology gunsmith school has over a hundred informative videos, including featuring Student Builds of the Week where SDI students highlight their work. The Real Gunsmith Randy Selby built rifles for over 52 years and his channel shares some of his knowledge, ideas, opinions, and maybe even a story or two.

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PISTOLS

Shadow Systems MR920

An overview of building highly-customized Glocks.

BY ROBERT K. CAMPBELL JULY 2021

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Many popular handguns have been copied, cloned, and flattered by makers who thought they could either sell the pistol cheaper or make it better. Examples include the Llama pistols on the cheap end of 1911 clones, the middle of the road Kimber, to top-end Les Baer handguns. The new wave of striker fired clones are coming as well. Some are foreign produced and others are domestic designs. Improvements from the factory and from custom makers have come slowly and incrementally to the Glock, now in its fifth generation.

Glock has started offering a retro Glock reissue of the original first generation, a sure sign of a brand's popularity. Aftermarket parts were first offered in the form of sights, then trigger groups, barrels, modified frames, and new production slides. The Glock is among the most popular handguns in the world. The hallmark of the Glock is reliability. Human engineering or ergonomics could stand improvement but reliability is not an issue.

Practically every striker fired polymer frame pistol on the planet shows some type of Glock influence. The Glock design sometimes limits a shooters best efforts at accuracy. Pistols with a steel slide and polymer frame are sometimes slide heavy. Not everyone likes the factory grip design and feel the balance of abrasion and adhesion is far from ideal. Many shooters like the Glock but prefer the 1911 grip

SHADOW SYSTEMS MR920 CONTINUED

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This barrel may be fitted to a Glock 19 as well. angle. I have noticed 1911 shooters once favoring the Browning High Power have now almost universally adopted the Glock. A desire for improvements led to the Shadow Systems MR920, a popular Glock clone the same size as a Glock 19. It could be considered a semi-custom upgrade. Shadow Systems began their manufacturing with Glock upgrade parts like Wilson Combat did with 1911 handguns.

They manufacture slides, barrels, and internal parts and eventually began manufacturing the MR918 as a complete handgun and upgraded to the MR920. The MR920 comes standard with upgrades such as a tritium front sight and a highly modified frame. Shadow Systems pistols feature changeable

grip inserts, including one that closely mimics the 1911. With the addition of an elongated grip frame formed into a beavertail type tang, this is easily the best handling Glock frame I've fired.

The standard Glock frame and slide dimensions allow Glock holsters to fit. The MR920 frame is manufactured from a different type of material than the Glock and it doesn't flex as much. The trigger guard is undercut toward the rear, a trick used by 1911 makes to lower the bore axis. The grip frame finish offers excellent abrasion and adhesion. The slide is a nitride finished steel unit with custom cuts and flats.

The barrel features a standard rifled bore instead of standard Glock polygonal rifling, allowing use of hard cast lead bullets without

difficulty. There have been problems with aftermarket triggers in issue firearms and I am completely against the addition of an aftermarket trigger to a pistol destined for personal defense. Shadow Systems triggers are superior to the Glock in many ways.

Being a factory handgun, this trigger is standard issue from Shadow Systems so there is no concern the pistol has been tampered with. It is superior to the Glock trigger action but not terribly different and certainly not too light for personal defense duty. The Shadow Systems trigger system operates in the same manner as a Glock Safe Action and seems to use the a Generation Three trigger bar with a connector from Taran Tactical. The aluminum trigger shoe has a flatter face and operates



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in the same manner as the Glock. The slide is racked and the striker is only partially cocked. As the trigger is pressed the striker is forced to the rear. The striker breaks and springs forward, firing the pistol. A safety lever in the trigger face prevents the pistol from firing by lateral discharge.

The trigger action broke at 4.9 pounds when I first got it and in the manner of a true custom grade handgun, the trigger has since settled at 4.5 pounds after more than five hundred combined dry fire and live fire repetitions. Glock triggers were once set at 5.5 pounds on average, of late those I have examined tested from 5.8 to 6.0 pounds. Pre-travel of Shadow Systems trigger unit is slightly shorter than the Glock. The MR920 features a standard Glock type rail for mounting optics.

One of the complaints concerning the Glock is the plastic guide rod. The Shadow Systems pistol features a steel guide rod. The rear sight is The lip on the bottom of the grip sometimes may need a bit of modification for maximum comfort. a well-designed ledge-type combat sight. The front sight is a green Tritium night sight. The MR920 is supplied with an optional use magazine well that offers real speed in reloading.

Since the pistol uses magazines with a slight base pad, this magazine well doesn't add to the footprint when carried concealed. The lip on the well may be uncomfortable for some grip styles but the shooter may easily adjust. There was an unwelcome sharp edge on this magazine well; perhaps four minutes of sanding cured it. Since the grip design is different, other makers of aftermarket magazine wells will not adapt to the Shadow Systems pistol.

As you add the features up it would be difficult to modify a stock Glock to this standard at anywhere close to the price of the MR920. If you have these pistols come into the shop there are several differences between the Shadow Systems pistol and the Glock that must be understood. These are not merely modified Glocks, consider them "Americanized" Glocks factory made to tighter tolerances.

MR920 take down is accomplished by the usual Glock-type lever, however, the slide only needs to be slightly moved out of battery to disassemble. Clear the magazine and triple check the chamber first to be certain the pistol isn't loaded. Pull the trigger to decock, pointing the muzzle in a safe direction. Then take the slide out of battery slightly. The levers are pressed down. When the pistol is field stripped you will see a pistol that

SHADOW SYSTEMS MR920 CONTINUED

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resembles the Glock as the parts appear the same. There are no parts interchangeability issues, from the sights, to the barrel, or internal parts, so sustainability will be good in the long run. The maker should prosper with this product, but like the many 1911 clone makers now out of manufacture, the Shadow Systems pistol will be supported by parts, magazines, and barrels for many years to come whether or not the maker continues in business.

This is in contrast as an example to the demise of unique designs such as the Hudson pistol. Break In A difference between the Shadow Systems pistol and the Glock 19 is that the factory tells us the MR920 demands a two hundred round break in. This is a consideration. The sights may be changed out for any Glock aftermarket sight. The one supplied with the pistol is the only choice. The pistol also demands greater lubrication.

The Glock needs only a drop of lubricant on the trigger connector while Shadow Systems recommends lubricating the slide rails and barrel. In the case of my test pistol, it came out of the box running and has never failed to feed, chamber, or eject with standard pressure or +P ammunition. Just the same, you may be asked to examine a pistol that has short cycled or failed to feed. It would be wise to ask if the break in period has been completed.

When I initially opened the Shadow System's box, I found a good quality gun rug, gun lock, cleaning rod, and several back straps. There was also a small bag with a tiny part that did not look like any other internal part I have ever examined and it wasn't. It is the magazine well attachment pin. The MR920 features grip inserts that Shadow Systems refers to as the NPOA (Natural Point Of Aim).

Each backstrap is marked, with the Hinsert for those preferring a muzzle high attitude similar to the Glock, the Ninsert is neutral or mid range, and the Llow insert similar to the 1911 and good for shooters with smaller

hands. I find these backstraps superior to the Glock inserts, especially when the extended tang is taken into consideration. The backstrap is changed by pressing a pin out, either right or left, and pressing the back strap down, then replacing a backstrap and re-inserting the pin.

The magazine well isn't difficult to install. First, choose the preferred backstrap and press it into place without inserting the stabilizing pin. The small metal part with a pin supplied in the plastic bag is the magazine well attachment. Insert the magazine well connector into the grip frame and then attach the magazine well by driving in the standard grip strap pin and the supplied magazine well attachment pin.

I filed the detachable magazine well slightly to make it smoother but some shooters would not have noticed. This is a simple set up that is easily changed out depending on the shooter's preference. The Shadow Systems pistol is very similar but not identical to the Glock so treat it as a unique pistol. AG

MACHINING

BSD Fabrication and Works

The history and how-to of a gunsmith company startup.

BY DEAN MEIER JULY 2021

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Gunsmithing is a specialized art form that focuses on repairing, modifying, designing, and building firearms. Provisions like welding and machining are required in order to properly repair and modify firearms. BSD Fabrication and Works was officially established May 2020 by owner/operator Brice De La Cerda as an independent full-service machine, welding, fabrication, and gunsmithing business.

Starting his professional career as a race mechanic with a passion for automobile tuning/modification, new and developing interests evolved with time. Having been born with a natural artistic talent, Brice developed his skills in the trades of welding, metal working, and machining through practice, local employment opportunities, and online resources. Over time, he saved money to supply his own machine shop along with inherited tools from master machinist Luis Padilla and gunsmith Charlie Shepard.

Starting out with a nineinch Atlas Lathe and a 1950s Series 1 Bridgeport, Brice officially opened up shop. Knowing from the start that production work would never fulfill creative desires, BSD became oriented around custom designs and ideas that clients wanted to create but didn't know how to implement. A large part of this creative flexibility is owed to the versatility of an all-manual machine shop which BSD uses for all of their work to design and handcraft projects in close communication with their clients.

As more requests for work and projects come in, plans are in place to expand services and offer mass production options for popular designs by adding a fleet of CNC machines. The blend of man- This extension tube was machined on the lathe from 7075 aluminum alloy.



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ual machines and tools for bespoke custom work along with automation when needed will allow for lower production costs. Prospective clients can reach the company via email or social media [Facebook.com/BSDFabworkx](https://www.facebook.com/BSDFabworkx), for inquiries. Custom Jobs One unique project BSD tackled was a customer request for a Surefire rail-mounted illumination system. The client wanted to use a 6-Volt illumination head on the original mounting body.

This required using a second battery, which in-turn necessitated design- 5" diameter 4140 steel stock. The part was designed in house by Brice and subsequently machined to the client's required specifications. BSD

states this first attempt was sub-par to their standards due to imperfect knurling caused by tool. Far A custom mandrel was turned and threaded to hold the part concentrically to the bore. Stainless steel was drilled and rethreaded to 14x1mm LH and welded in place. ing an extension tube.

The extension tube was designed, then machined on the lathe from 7075 aluminum alloy. The completed part was elegant, aesthetically pleasing, and allowed the client to achieve height and wearing wheels. Below center: A milling machine and dividing head cut 80 60-degree notches with a dovetail cutter, matching the original barrel nut.

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A36 Steel stock was turned in a lathe to the original part's dimensions. his goal of adding an extra battery for the 6v illumination head. A similar custom mount project involved a SIG QD flash hider mount sent in for are-threading conversion. The client wanted to use the mount on a 14x1mm left hand threaded AK-47 platform. A custom mandrel was turned and threaded to hold the part concentrically to the bore center axis, providing a solid mounting fixture.

The SIG QD mount was originally threaded in 1/2x28, leaving plenty of material to bore as well as a thermal interference to fit a fresh slug of stainless steel. The piece was then drilled and rethreaded to 14x1mm LH. Once the slug was permanently pressed into place, it was TIG welded to fully secure. Once the machining operations were completed on the mount, the fit was checked for concentricity visually with a bore rod when mounted on the rifle.

The final result is a product currently unique to the market and exact per the client's request. There are also a wide variety of muzzle brakes and quick detach mounts on the market that all could be modified similarly. Another unique custom project involved creating a barrel nut cap for a Mini UZI with integrated "D-Cell thread" (1.435x20 TPI) on the front.

Starting out as 1.5" diameter 4140 steel stock, the part was designed in house and machined to client specifications.

Next, the milling machine and dividing head was used to cut 80 60-degree notches with a dovetail cutter to match the original barrel nut and retain its ratcheting characteristics. The part was then sandblasted and oil blackened for rust protection that also provided a matching finish to the original UZI Parkerizing. A similar project involved a customer request to replicate VZ61 Skorpion cocking knobs.

A36 steel stock was mounted into the collet chuck on the lathe and the profile was turned to the original part's dimensions. When the machining operations were completed, the parts were sandblasted and oil blackened, which is BSD's normal procedure for steel parts. The last sample project was an order to have a Beretta Model 81 threaded for a suppressor. The fact the barrels on these pistols barely protrude past the slide presented a design challenge.

Two barrels were threaded identically with a custom thread so as to retain maximum original metal and structural integrity. The corresponding adapters were machined to match these exact outer dimensions while maintaining original slide-to-barrel clearance. Once the adapters were turned and

threaded internally and externally, they went to the milling machine to add low profile wrench flats for easy removal and installation.

The final product added a clean look to the original design while adding the functionality required by the client. The adapters were further refined aesthetically by torch browning and quenching. A pair of steel thread protectors turned from A36 mild steel and oil blackened for rust prevention finalized the project. Gunsmith Takeaways BSD Fabrication and Works provides a wide variety of custom services, serving as a full-service machine, welding and fabrication shop, with a Type 7 FFL.

They also provide a model for how skilled gunsmiths and machinists can build a business. The first and critical part is developing the base skills. As those skills develop, you'll be in a position to serve individual customers by solving their issues. The above projects illustrate bespoke solutions, providing custom solutions to individual customers. Providing those solutions to your customers can also inform what sort of things other future customers may want.

Taking a one-off project may lead to ideas for small batch production of unique items, something that CNC machines can help automate.



The original barrel provided little mounting surface to work with. Above right and This was done to maintain the same slide to barrel clearance as originally designed. It takes skill to make an individual item work and entrepreneurial vision to turn it into a salable

product. It also takes good sense to know when it is better to outsource tasks better tackled elsewhere.

If you run into problems or need a job done that is beyond your current capability, BSD Fabrication and Works [Facebook.com/BSDFabworkx](https://www.facebook.com/BSDFabworkx), can help you out. Thanks to Brice De La Cerda for the stellar example! AG

FROM THE ARCHIVE

Gunsmithing Business Tips, Part 1

A guide to education for the aspiring gunsmith.

BY MARK R. HOLLENSEN JULY 2021

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A couple of years ago, I wrote and published *The Business of Gunsmithing: A Practical Strategic Compendium*. I had been approached a number of times by people considering a career as a full-time gunsmith and those discussions fueled the core content of the book. I have since then received a number of positive responses from people that read it and have likewise received requests for a little more depth or granularity with some of the topics.

To address these requests, I compiled three areas that I felt could be further elaborated on, mainly because I didn't feel that level of granularity was appropriate for a book being published for the general population. The following series has been written for the American Gunsmith audience since it delves much deeper into the journey of becoming a working gunsmith. This three-part series consists of education for the aspiring gunsmith, the gunsmith persona, and working as a gunsmith.

My goal is to help people contemplating a career as a gunsmith with their individual journey and what they will likely face during their pursuit of that career. Learning Considerations Are you considering becoming a full-time gunsmith? Any thoughts on

where to begin the journey? I often have people either tell me that they wish they had become a gunsmith, or are now considering becoming a gunsmith and are wondering how to get started. Where should you actually begin?

I believe like anything else, you should start by seeking out formal, accredited education. Especially if you are just starting out or are not in a position to apprentice with a well-educated and experienced local gunsmith to learn the trade from. Some people may be part of a family-owned gun shop and have the capability to learn from the gunsmith they have hired to do the work for them. But it takes time.

And just like any other career choice, you will want to maximize your education while trying to reduce the time spent getting to where you want to be in the business. Let's look at the person that is either right out of high school and making college plans or the person that is somewhat older and has decided to try out a career in gunsmithing.

In other words, people that are just now considering getting into a career as a full-time gunsmith and don't have a family-

owned shop or other relative or friend to spend time with to learn the trade. Lacking an immediately-available place to learn, there is some debate about proceeding. Based on my experiences, I can see validity to all sides of this question.

Basically, do you simply hire on in a gun shop or outdoor retail store and start there, or attempt to do it on your own at home, or do you make the move towards obtaining a formal education in your new field of choice? The debate is, will formal education really help and prove worthwhile, or is it just a waste of time and money when hands-on experience is the best way? My advice, especially since I took the formal education route, is that education is the better way to go. It proved to be the best choice for me.

Depending upon where you are today, it could be the most obvious choice for you as well. As a full-time working gunsmith, you will quickly learn that time is money and too much time spent on something costs you. This won't be apparent immediately, so take it from those that know to avoid making early decisions that prevent

GUNSMITHING BUSINESS TIPS, PART 1 CONTINUED

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achieving your intended goals or prolong the time that it might take to get where you ultimately want to go. Since there is no single way to become a gunsmith, or one “right” way over another, you really need to think hard before you take your first steps forward. Let’s assume you have graduated from high school or have a General Educational Development equivalent and are in a position to apply to and attend a higher education school.

It doesn’t matter one bit how old you are; you just need to be in a position of being able to apply for and be accepted to the school of your choice. Given multiple options, which one can put you on the right path quickest? And which path can maximize income, output, and physical efforts towards becoming a full-time, working gunsmith? Once you consider all of this, you may quickly see that applying to attend an accredited gunsmith school is really the best all-around option when first starting out. And why not?

If you have the time, ability to pay for such an education, and the drive to see your goal through no matter what, this is probably the best step forward that you could take. Whether any other trade school or a career requiring a college degree, this is commonly recommended. Wouldn’t you like to know as soon as possible that the job either is or isn’t for you? I know I would have wanted to know that so I could save time and move onto something else.

Formal, specialized education in a field provides an immersion into the trade and provides a clearer picture of what you will actually be doing in your new career. And unlike the basic education you have attended all those previous years, this type

of higher education reduces the frills and focuses directly on the intended career choice. What better way to get going than to walk in the door and start doing the work immediately.

This path positions you to learn the absolute core fundamentals of the trade in the beginning while learning your abilities, and how well you work the necessary tasks. To me, learning the fundamentals of the trade are the most valuable as you can always reflect back on that learning experience no matter how far you go in and with your career.

True, there are those that have attended a gunsmith school and complained they didn’t feel they truly learned what was needed for a career and that their education lacked key areas critical to effectively carrying out the job as a working gunsmith. My take is this will always be true for any school education in any career. Any education can involve learning things that you might not use in the future while not covering some needed aspect but where else will you get the opportunity to become educated formally?

Would you rather learn things ad hoc and not have a formal degree? What if you decide you made a mistake and would rather do something else entirely? If you did not attend school and decided to learn on the fly, you might have invested in a career you ultimately don’t want, putting yourself further behind when trying to figure out what it is you want to do, instead of figuring this out as apart of the education process.

And, if you were to have attended and completed your higher education elective with a formal degree, you’re more likely

better positioned than someone that did not. The single-most critical decision that I made many years ago was to apply for, get accepted, and successfully graduate from Gunsmithing School—hands down. Sure, it cost me some loan money that took ten years to pay back but it was smart money spent.

The life-long rewards proved to outweigh the costs incurred during those two school years as I use that education daily. I would have never been able to achieve my goals had I not taken that route. To begin with, school was a direct immersion into the field of gunsmithing while starting at the bottom and learning the core fundamentals of the trade itself.

This meant learning how to use tools, identify tools needed for particular jobs, making those tools by hand, and then making those tools look as good as, if not better, than purchased tools. The education presented me with challenges that I might never have had to face if not for the education. Those challenges tested my abilities, my knowledge, my understanding of how mechanical things work, and how I could think my way through the process of making the repairs possible. That’s just a start.

Attending a fully accredited Gunsmithing School placed me in the same room as other aspiring gunsmiths and very capable instructors. This collaboration enabled each of us to work out problems and solutions with others that may or may not have already known how to correct the issue at hand, and in some cases, we collectively worked to resolve the problems encountered. You will have the opportunity to work with

GUNSMITHING BUSINESS TIPS, PART 1 CONTINUED

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others in your field of choice that are very good at what they do, so you get to see how fine work is done and can be achieved. Those types of opportunities, for me, have never been replicated since leaving school. Sure, I have worked with other gunsmiths along the way, but those relationships were, well, just different. When you attend school with other like-minded people seeking an education to become a talented gunsmith, you all form a camaraderie that bonds you closely together.

There is no scenario like that once you leave school. Trying to obtain an education online or in a virtual environment that leaves you on your own cannot replicate attending a formalized gunsmithing school with your peers. You spend your time learning all-things gunsmithing while there. Being able to learn the absolute core fundamentals of the trade in an immersive environment in the beginning and then building upon that knowledge as you progress through school is the cornerstone to achieving results.

Just like a competitive shooter learns, you always go back to your fundamentals when things start going wrong. Depending on your school of choice, you will learn things about firearms that no book can fully describe and the education that you receive will change your focus from just liking firearms and what they do, to looking at firearms in a much different way. Schooling teaches you how guns work, why they work, why they don't work, and how you can improve on them.

You'll be making them before you are done with your first year, then you'll learn how to make the tools to work on them properly, make parts, multiple nuances of many guns, their differences from one another and from different manufacturers, and how to make them work better. What better way to work on firearms early on in your career than working on your own guns rather than a customer's prized firearms all under the direct supervision of talented gunsmithing instructors?

Clearly the risks of things going wrong or accidentally damaging them while working on them is much more palatable than ruining a gun that doesn't belong to you.

I worked on, rebuilt, and modified a number of my own firearms while attending school for the sole purpose of becoming more knowledgeable about them, learning how to modify and improve them and creating opportunities to fully engage myself with hands-on gun work; from broken screws, to broken or missing parts, making critical changes to the firearm design that is proven to be safe to do, to making new stocks for them and ultimately refinishing them with different refinishing methods.

Yes, you can do this at home but attending school drives you forward at a much faster, more proficient, and more professional approach all while under the helpful and expert eyes of your gunsmithing instructors. You're no longer a hobbyist tinkering with guns when you feel like it; school pushes you to take on and complete projects with deadlines, just like you'll need to do when you're a working gunsmith.

The majority of gunsmithing education needs to be actual, hands-on education, and not just about reading and taking tests, which is something online courses lack. My first year attending Gunsmith School dealt with basic tool making, metallurgy, learning how to heat treat parts, how to forge tools and parts, how to design, fit and polish tools and gun parts so that they work properly. Most of this education was through the use of hand tools only.

Yes, we did make some tools on the lathe, in a milling machine, or on the drill press, but the goal was to educate us on how to work on firearms without power tools at all. Machinery does help and is required for some applications but learning how to work without their assistance is part of the fundamental training. There is just something that enhances learning by making

things with a file, scribe, hacksaw, hammer, some emery cloth, and measuring tools.

And you better not hand that project in if it isn't polished perfectly, is absolutely square, and to the project specifications. You don't want to have that conversation with your metal shop instructor, believe me! As the first year progressed, we were introduced to more machinery for projects, such turning down a barrel blank, cleaning up a Mauser 98 action, truing the bolt face and face of the receiver, threading and fitting the newly contoured barrel to that action, and then chambering it.

After all that, we had to polish, polish, polish, polish! And once that was complete, it was on to building a stock. No, not by purchasing a ninety percent inletted stock for final inletting. No, sir! The class required we purchase a stock blank, make Mauser action templates, draw the stock lines on that block of wood, and then proceeded to remove all excess wood—by hand.

That meant cutting away excess wood with a hand saw one piece at a time and then chiseling other pieces away to work down to the near final stock lines. Then, using stock inletting tools that we also forged, shaped, polished, heat treated, and polished again ourselves, we began to inlet the metal into the stock one chip at a time. Yes, this takes time but it is part of learning fundamentals. No short cuts allowed.

Let me tell you, whittling a finished stock out of stock blank with hand tools you made yourself will for sure tell you if you are all in for this career or not! Paying to be in school where this is your sole focus with other future gunsmiths provides the opportunity to see their work and approach to each project along side your own. Some will have other experiences and can pass along some tricks or solutions to you. And you will more than likely see some fine work from these folks; truly beautiful work.

**SEEING THAT CAN DRIVE YOU
TOWARDS DOING THAT SAME KIND**

GUNSMITHING BUSINESS TIPS, PART 1 CONTINUED

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of fine work for yourself. If you are a perfectionist, you will be like the many that are never satisfied with your own work, mainly because you will know where every mistake you made is on the gun you are building or repairing. But it is the end product that you complete that will define what kind of work you do and what you can do to get better. During our second year, we focused on custom work more so than just simply building or repairing firearms.

This meant taking first year lessons and then applying it towards new projects. Essentially, you became the artist, putting ideas together towards building a firearm with personal touches. Actually, you could build more than one if you had what you needed to do so. We also spent more time on building more difficult-to-make tooling and parts, more time on the machinery aspects of the job, along with the standard course content.

There really were no boundaries as long as you were working on projects that truly developed intended career apprenticeship skills. This could be refurbishing firearms, customizing them, building another bolt action rifle, and/or making tools not listed in the course tool list manual. One of the course requirements was to make an octagon or half-octagon barrel for a firearm build. I ended up making a full octagon barrel fitted up to a Mauser 98 action for my project.

I also built a custom rifle from an 03-A3 action that I had along with rebuilding a Lee Enfield rifle and refurbishing a few other rifles. Student will spend the time could pretty much do as much as they wanted during that year. I completely restored a Stevens Crackshot rifle for a good friend that wanted it like-new to keep as a family heirloom. It turned out really nice even though the initial condition was pretty bad when I started.

This project stands out in my mind as it was the first time I restored a rifle completely—and one that did not belong to me. You quickly find that there are added pressures when working on something that doesn't belong to you. This is necessary to become a working gunsmith. These projects put student in front of nearly every machine tool the school had to offer, as well as quality time at the bluing tanks.

You learn so much so very quickly as long as you are committed to seeing the training through and getting out of it as much as possible. I guess the true motivating factor was simply learning for its own sake. If you stop learning, thinking you already know it all, then your abilities and skills stop at the same time. Book Feedback I talk about education in my book but in a much broader spectrum.

This was due to the book being written for the 14 year old and up age groups that are considering a career and thinking of being a gunsmith. I have since received feedback from fellow gunsmiths that have been both positive and negative on my take of getting a quality education. All are correct in their feelings but consider that individual circumstances ultimately drives the need for and type of education to move forward with your goals. Attending Gunsmith School is not for everyone.

Some people have a gift of self-learning; so much so they might not need to attend a school for their education. Others are in a position in their lives that attending an accredited gunsmith school just isn't practical but are capable and willing to learn well on their own. I had a number of goals in mind while writing this article.

One was to shed some light on what an accredited Gunsmith School can offer, what it may not offer, and more importantly, to educate the aspiring gunsmith by providing some insight into attending a Gunsmithing School since that was my choice. I was in a position of being able to attend school for two years and earn an

Associate's Degree. If I had found I didn't like the work or my commitment waned then at least I would have earned an A. A. S. Degree.

However, the school that I chose to attend also offered students the ability to simply take individual non-degree gunsmithing courses and some of the students did just that. It could have been that they already had a degree or didn't want or need one. When considering a higher education path, look at all of the angles, the benefits, the types of courses offered by a particular school, and make a sound decision.

Look at what each school has to offer (quality rather than just cost) as far as the courses that you will take, whether what they offer is truly needed based on your current level of experience, whether or not they offer a degree, and whether or not they have other courses available to you at their school that can enhance your career learning goals. For example, you might benefit from business classes that are not part of the gunsmith curriculum. All of these things should be considered before making your decision.

There are many more avenues of research available now. I won't endorse any particular school as I don't know what each has to offer. Whether you decide to attend a formal school or not, you should always maximize the return on your efforts and money spent. This is true of any career or higher education choice that you make. Don't wander aimlessly trying to satisfy your intended career goals. Cut to the chase and get going on your chosen career path.

If you jump in with both feet, you might quickly learn or decide this career is not for you. But then again, you may find this was exactly what you wanted all along. Just know that if you do go to school, you will carry with you those experiences, relationships, and that fundamental core knowledge in all that you do for the rest of your life. The choice is yours to make. AG

MAINTENANCE & REPAIR

Phoenix Arms HP22

Sometimes a repair can be as simple as replacing a part. Here's how I handled repairing a Phoenix Arms HP22.

BY ROY SEIFERT JULY 2021

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I had been searching for a small 22 Long Rifle pistol to carry as a backup to my primary everyday carry when I came across a broken Phoenix Arms HP22. The seller disclosed that the hammer would not stay back. Looking at the schematic on the Phoenix Arms web site (Phoenix-Arms.com) I guessed the problem was either the hammer, sear, or sear spring, all of which I could purchase directly from Phoenix Arms. Because I was not the original owner with a warranty card on file, their lifetime warranty would not apply.

I could send it back to the factory and have them fix it for a \$50 service fee, but what's the fun of that? I decided to tackle the repair on my own. First, some background info. Phoenix Arms is located in Ontario, California. They make two very affordable semi-auto pocket pistols, the HP22A in 22 LR, and the HP25A in 25 Automatic Colt Pistol. My gun was the earlier HP22 model that came with a three-inch barrel, but Phoenix Arms also has a five-inch extended barrel available.

The grip is small; my little When purchased the hammer would not stay back. finger hangs off the bottom, but the company offers an extended magazine available with a finger rest. This gun has a varied reputation; some people hate it, but others say it's one of their favorites. This little gun is quickly becoming one of my favorites. Disassembly When I purchase a used gun I always disassemble and clean it. As usual, this gun was dirty Notice nothing is touching the top of the sear spring.

That leg of the sear was missing. and dry like most used guns I acquire. First, I made sure the gun was unloaded. To disassemble the gun, I opened the slide about 1/4 inch, pulled the takedown lever towards the muzzle, and lifted up on the front of the barrel to remove it. That allowed me to remove the slide from the frame. Removing the slide allowed me to remove the recoil spring, recoil spring guide, and takedown lever by lifting the assembly up and out of the frame. This is all that is required for cleaning.

I REMOVED THE LEFT GRIP PANEL WHICH EXPOSED THE THUMB SAFETY,

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The two legs contact the sear spring and the trigger bar. Both legs were broken off when I received this pistol. Clockwise from the top, slide lock, sear block, spring detents, and magazine release block. magazine block, and sear spring. Then I removed the right grip panel to gain access to the trigger bar and disconnect. I removed the thumb safety, magazine block, and disconnect to give the gun a thorough cleaning. After cleaning I lubricated all the pivot and friction points.

The grip screws were damaged, so I ordered new ones direct from Phoenix Arms. I also noticed that the recoil spring was bent and kinked, so I ordered an extra power recoil spring from M*Carbo (MCarbo.com, Reviewers on the Internet indicate that the recoil spring is weak, which I'm sure is why this gun is designed to shoot standard velocity ammunition only. Extra-Safe Safeties This gun has two external safeties. On the slide is a firing pin block safety. In the down position the firing pin is blocked.

There is also a thumb safety on the frame. With the thumb safety up in the safe position, the sear is blocked, preventing the hammer and trigger from moving, and the magazine can be removed. When the maga-

zine is removed the thumb safety cannot be disengaged. With the magazine inserted and the thumb safety down in the fire position, the magazine cannot be removed. With the safety up and blocking the sear the slide can be retracted only about 1/4" to check if there is around in the chamber.

With the slide retracted, moving the safety in the up position locks the slide open. Firing Pin Block Safety On to improving the firing pin block safety. The firing pin block safety on the slide was very loose and sloppy, and I was afraid it would engage under fire. This safety is held in place with a small, straight spring inside the slide. Set into the rear of the slide is a rear plate like the firing pin stop on a 1911. This plate is held in place with a set screw.

I loosened the set screw and moved the rear plate down to expose the end of the spring. I used the smallest jeweler's flat-blade screwdriver to lift the spring out of the recess, then removed it with a pair of needle-nose pliers. I put a slight curve in the spring so it would apply more pressure against the safety. I removed the safety, cleaned and oiled the recess in the slide, then reinstalled all the parts. Now the safety positively clicks in place and does not move around.

Hammer Repair Moving on to repairing the hammer not cocking. To my surprise, when I removed the grip panels, I discovered the side legs were broken off the sear. No wonder the hammer would not stay cocked; there was nothing for the sear spring to engage! When I examined the sear, the metal was ragged where the legs would have been indicating they were broken, not cut. Did someone break these off on purpose to disable the gun, or was this just a malfunction of the part? I ordered anew sear direct from Phoenix Arms.

I removed the sear spring, drove out the sear pin from left to right and removed the old sear. I installed the new sear and fixed it in place with the sear pin. I added a drop of oil to lubricate the pivot point and put some Brownells Action Lube Plus (Brownells.com) on the sear edge. Sear Not Resetting With the new sear and sear spring installed I could manually cock the hammer and it would stay cocked. However, if I tried to cock the hammer by cycling the slide, the sear would not catch on the hammer.

BECAUSE MY GUN WAS THE HP22

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This will enhance cartridge feed reliability and prevent damaging roundnose soft lead bullets. The disconnecter has been removed. The L-shaped recessed area holds the disconnecter and disconnecter pivot pin. Notice the horseshoe-shaped divot in the rear of the channel. It looks like someone got heavy-handed with a punch. model, but I was installing HP22A parts, I purchased anew hammer from Phoenix Arms. When I installed the new hammer, the hammer engaged the sear when I cycled the slide.

New Trigger M*Carbo sells a spring kit for the HP22A, but the springs will not fit on the HP22. The HP22 did not have a trigger return spring. The metal around the pivot pin hole in the HP22 trigger is solid. The metal around the HP22A trigger pivot hole has been milled to accept the trigger return spring. To use the M*Carbo trigger return spring I ordered anew trigger from the factory. The new trigger came with the trigger bar and trigger spring already installed.

I removed the HP22 trigger by driving out the trigger pivot pin, then installed the HP22A trigger and M*Carbo trigger return spring. This increased the trigger pull by a few ounces, but now the trigger returns positively. Disconnecter Channel The next problem I found was that the disconnecter would not always reset. It looked like it was

binding between the frame and the grip. I removed the right grip panel and disconnecter and used a narrow 320-grit polishing stick to polish the channel in the frame.

It looked like someone missed a pin and punched a divot in the frame. This created a burr in the magazine well that caused the magazine to bind. I used a flat jeweler's file to remove the burr on the inside of the frame, then polished with a 320-grit polishing stick. I also polished the inside of the plastic grip panel with 400-grit wet/dry sandpaper to ensure it was smooth and flat.

I added a drop of oil to the disconnecter channel and disconnecter pivot pin, reinstalled the grip panel, and everything worked as it should. Polishing the Feed Ramp I used a 1/4-inch Cratex bit and my Dremel tool to polish the feed ramp. I ran the Dremel at a slow speed and moved the bit up and down the ramp. It didn't take long for the ramp to become polished. Modifying the Magazine This pistol came with an all-metal magazine. The top front of the magazine would bind when I inserted it into the grip.

The magazine body had a small blob of weld at the seam causing the magazine to bind. I took a fine file and filed the weld seam smooth so it would easily slide into and out of the grip. I touched up the ex-

posed metal with Brownells Oxpho-Blue liquid. I purchased anew magazine from Phoenix Arms, but the follower and base pad were made of plastic. This magazine was too light to fall out of the pistol. I purchased another allmetal magazine off e Bay. The plastic one is my backup/spare.

Dry Firing I downloaded the manual from the Phoenix Arms web site and it clearly states do not dry fire this pistol. If the firing pin block safety is off, I can understand why because the firing pin will dimple the top of the chamber and if the firing pin block safety is on dry firing may damage the hammer. I folded a narrow piece of leather back on itself and placed it in front of the firing pin. This acts as a buffer so I can safely dry fire the pistol.

Summary I'm sure whoever owned this pistol before me got very frustrated with all the problems. Maybe that's why the sear legs were broken off to prevent someone else from using this faulty pistol. However, with some new parts and polishing I was able to return it to usable condition. For the money that I spent for parts I probably could have purchased anew HP22A.

But for me, part of the satisfaction of gunsmithing is diagnosing and repairing problems, and I now have a fully functioning, reliable, 22 LR carry pistol. AG

MACHINING

Open Source CNC

The open—and sometimes free—world of Computer Aided Design and Manufacture and Computer Numerical Controlled machines.

BY DEAN MEIER JULY 2021

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Computer Aided Design, the use of software to build prototypes and the specifications of parts virtually, and Computer Aided Manufacturing, the use of software and computercontrolled machinery to automate a manufacturing process, has become increasingly important in all industries. Fortunately for gunsmiths in even the smallest shops, the cost of entry has gotten more affordable.

Any manufacturing process needs three components for a CAM system to function: Software that tells a machine how to make an item by generating toolpaths, machinery that can turn convert software instructions in machine steps to transform raw material into a finished product, and post processing converts toolpaths into a language machines can understand. CAD focuses on the design of parts and products while CAM converts the design into steps toward construction.

History Machine-controlled manufacture is older than many realize. In 1839 French weaver Michel-Marie Carquillat wove a 2x3' silk portrait of Joseph-Marie Jacquard. Done by hand, this large and detailed image would have taken several workers many months to complete. Instead, the image with caption and Carquillat's name was woven on a Jacquard machine, an automated loom using 24,000 Jacquard cards, each of which had over 1,000 hole positions.

Once all the programming was completed, the process of weaving the image with the punched cards could be done in about eight hours with a single weaver operating the Jacquard loom. The Jacquard loom did

no computation, unlike digital machines that would be created over a century later, however, storing and using information via punched holes in a card was an important conceptual step in the history of computing.

Charles Babbage used the same idea for data and program input and output and storage in his general purpose programmable computer, the Analytical Engine described in 1837 and programmed by Countess Ada Lovelace, widely considered the world's first programmer in the modern sense. In the late 1800s, German inventor Herman Hollerith made use of punch cards in his Hollerith Electric Tabulating System, marketed by the Tabulating Machine Company.

Hollerith would reorganize under a holding company called the Computing-Tabulating-Recording Company. In 1924, the Computing-Tabulating-Recording Company was renamed International Business Machines. Stacks of punch cards were programs in the modern sense of the word, though the word "program" did not have that meaning until after the development of electronic computers after World War II.

John Parsons first introduced Computer Numeric Controlled machining in the 1950s using punch cards to program and automate machinery. In 1949 the United States Air Force funded Parsons to build an automated machine that could outperform manual machines. With some help from Massachusetts Institute of Technology, Parsons developed the first

prototype. Between the mid-1940s and 1950s, various developments were made in computer software.

Some of these developments include servo-motors controlled by generated pulse, a digital computer with built-in operations to compute and coordinate radar-related vectors, and the graphic mathematical process of forming a shape with a digital machine. In 1953, MIT researcher Douglas Ross saw the interactive display equipment being used at SAGE (Semi-Automatic Ground Environment) radar stations. Ross and his MIT Lincoln Laboratory colleagues started using it on workstations to provide instant display of data.

This helped programmers to use and debug software in real time rather than via a batch-processed stack of cards or print out. Ross coined the term "Computer Aided Design" in 1959. The invention of the 3D CAD/CAM is attributed to French engineer Pierre Bézier at Renault. Between 1966 and 1968, based on his mathematical work with computing surfaces, Bézier developed UNISURF, a pioneering surface CAD/CAM system to assist with car body design and tooling.

UNI-SURF became the working base for the following generations of CAD software. Those of you familiar with computer graphics recognize his namesake Bézier curve, the use of Bernstein polynomials in vector graphics. CAD implementations have evolved dramatically since this early development. In the 1970s, CAD with three dimensions was

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S. Air Force and programmed with punch cards. CNC has gotten much smaller, cheaper, and easier since then. typically limited to producing drawings similar to hand-drafted drawings. Advances in programming and computer hardware in the 1980s saw solid modeling, allowing more versatile applications of computers in design activities. In 1981, solid modeling packages such as Romulus (Shape Data) and Uni-Solid (Unigraphics) were offered.

Autodesk, Inc. was founded in 1982 by John Walker who coauthored the two-dimensional design system Auto CAD which is widely used by architects, engineers, and structural designers to design, draft, and model buildings and other structures. Auto CAD as a commercial software product is also noteworthy for being a desktop app running on microcomputers with internal graphics controllers.

Prior to Autodesk, most commercial CAD programs ran on expensive mainframe computers or minicomputers with each CAD user working at a separate graphics terminal. Through the 1980s and 1990s CAD/CAM was increasingly available on personal computers as PCs using inexpensive commodity hardware affordable for individuals became powerful enough to run design software and control machines, completely revolutionizing how manufacturing is approached.

The earliest CAD and CAM jobs were reserved for expensive automotive and aerospace applications, often with government funding, but the cost of the software and hardware to run it has gotten much cheaper. CAD/CAM Process Since its inception, CAM has delivered many improvements to manufacturing. This include improved machine capabilities with CAM systems taking advantage of 5-axis machinery to make more sophisticated parts. This improves machine efficiency and improved material usage.

Additive manufacturing (“printing” additive layers rather than cutting away) can produce more complex geometries with minimal waste and lower costs. Using CAD, a designer makes a 2D or 3D drawing, which could be a gun part or receiver, engine crankshaft, kitchen faucet, or anything else. Any CAD design is a model containing a set of physical properties that will be used by a CAM system.

With a model design completed in CAD, it is then be loaded into a compatible CAM machine, directing it to prepare for machining, which is the controlled process of transforming raw material into a defined shape through actions like cutting, drilling, or boring. CAM software does this with several actions. First, the model is checked for geometry errors that will impact the manufacturing process.

Toolpaths (sets of coordinates the machine follows during machining) are computed, setting required machine parameters, such as cutting speed, voltage, cut/pierce height, etc. The CAM system can also determine the best orientation for apart to maximize machining efficiency. CNC Machines Modern manufacturing machines run various Computer Numerical Control machines to produce parts. Prior to CNC, machining manufacturing centers were all operated manually by machinists.

We’ll start with CNC routers, machines that cut parts and carve shapes with high-speed spinning tools. CNC routers for woodworking can route out a stock blank and create decorative engraving with appropriate tooling, CNC routers have 3-axis cutting capabilities, which allows them to move along the X, Y, and Z axes. Milling machines automate milling metal, wood, composites, and the like, removing material from a raw block. They are extremely versatile with a large variety of tools.

Likewise, lathes spin the work piece to be cut with a stationary tool. The primary difference from their manual counterparts is the ability for the machine-controlled tools and vice to programmatically make changes on its own. With the workpiece set, the CNC machine takes over, essentially working as a journeyman/apprentice for you based on your design. G-Code G-code is the generic name for the most widely used CNC program-

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ming language. Developed by the Electronic Industries Alliance in the early 1960s, a final revision was approved in February 1980 as Recommended Standard #274 (RS-274). G-code is a plain-text language, meaning that it can be read in a standard text editor and be interpreted by CNC machines. Gcodes control the movements of a machine, dictating how and where a machine should move to fabricate apart. M-code controls miscellaneous machine functions, including starting and stopping specific actions or programs.

G-code's programming environments have evolved in parallel with those of general programming. Raw G-code is similar to programming in Assembly, where each instruction explicitly directs a single, specific operation. The first CNC programs required writing a program with a pencil and then typing it into a tape puncher. As CAD improved, G-code editors became increasingly automated where specific steps are abstracted from visual designs. Modern desktop CAD software now generates G-code based on your design.

While a G-code file is plain text, it's not designed to be human readable, although it's easy to look through the file to see what it is doing. G-codes tell the controller what sort of motion is desired. An example: G01 X1 Y1 F20 T01 S500. G01 indicates a linear move, based on coordinates X1 and Y1. F20 sets a feed rate, which is the distance the machine travels in one spindle revolution. T01 tells the machine to use Tool 1, and S500 sets the spindle speed.

Open Source Open source software is software with source code that anyone can inspect, modify, and enhance. Source code is the part of software that most computer users don't ever see; it's the code computer programmers can manipulate to change how a piece of software—a program or application—works.

Open source is derived from the free software movement where programmers share the goal of obtaining and guaranteeing certain freedoms for software users, such as the ability to run, read, modify, and share software freely, without restrictions. "Free" here primary refers to freedom, not necessarily price, although most open source and free software can be had at no cost. The common example is free speech, not free beer.

A large successful example of this is the GNU Project ("GNU's Not Unix!") which developed a complete Unixlike operating system commonly paired with the Linux kernel for the operating system core. GNU/Linux systems power most of the Internet, the majority of current supercomputers, as well as Android mobile devices (smart phones and tablets) and many small, embedded devices. Commercial, closed-source, non-free software sells with an initial base price of several hundred to several thousand dollars.

Often, this price is a license that has to be repurchased every 1-3 years. For example, the base Auto-CAD software costs \$1,690 per year for single license. The availability

of free and open-source CAD software provides options for small shops and hobbyists. BRL-CAD (BRLCAD.org) is a constructive solid geometry (CSG) solid modeling CAD system that features an interactive geometry editor, ray tracing for graphics rendering and geometric analysis, scripting, image-processing and signal-processing tools.

The entire package is distributed as a ready-to-run program or as source code to compile on your local machine. In 1979, the U. S. Army Ballistic Research Laboratory (BRL, now the United States Army Research Laboratory) needed tools to assist with computer simulation and engineering analysis. With no adequate CAD program available at the time, BRL software developers created their own. The software utilities could interactively display and edit geometric models.

This suite of utilities was packaged as BRL-CAD and publicly released in 1984. The BRL-CAD programmers were allowed to release it as an opensource project in 2004. The BRL-CAD source code repository is the oldest known public version-controlled codebase in the world that's still under active development, dating back to 1983. It runs on all POSIX and Unix-like operating systems, including mac OS (previously Max OS X) and GNU/Linux. Libre CAD (LibreCAD.org) is Far

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an open source 2D-CAD program started as a project to build CAM capabilities into the community version of QCad for use with a Mechmate CNC router. Libre CAD is a free, open source CAD application for Windows, Apple, and GNU/ Linux with support and documentation free from a large community of users and developers. Most of the interface and handle concepts are analogous to Autodesk's Auto CAD.

Libre CAD uses the Auto CAD DXF file format internally for import and save files, as well as allowing export to other file formats. Free CAD (FreeCADweb.org) a free, open source, general-purpose parametric 3D CAD modeler and a building information modeling (BIM) software with finite element method (FEM) support. Free CAD is intended for mechanical engineering product design but also expands to a wider range of uses around engineering, such as architecture or electrical engineering.

Functionality can be extended using the Python programming language. It is intended to be a feature-based parametric modeler with a modu- As with many modern 3D CAD modelers, Free CAD has a 2D component to facilitate 3D-to-2D drawing conversion. Under its current state, direct 2D drawing (like Auto CAD) is not the focus for this soft-

ware, nor is animation or 3D model manipulation. However, the modular nature of Free CAD allows it to be adapted for such environments.

In addition to its own main file format (FC-Std), Free CAD also works with DXF, SVG, and a host of other common CAD file formats. JScut (JScut.org) is unique as it is Web-based CAM software written in Java Script that runs in a web browser. No need to install anything; just visit the website and your browser is automatically running CAD software. JScut converts SVG image files to CNC cutting paths. Written by Todd Fleming, the user interface uses Bootstrap, a popular front-end framework library for web development.

It provides a 3D G-code simulation view, Vcutter support, and G-code output in inches or millimeters. Firefox, Chrome, and Safari browsers are supported and files can be saved in Google Drive. Far Py - (Py CAM. SourceForge.net) is a toolpath generator for 3-axis CNC machining. Available for Mac, Windows, and Linux, Py CAM is a Python-based CAM loading 3D models in STL files or 2D contour models from DXF or SVG files.

The resulting G-Code can be used with Linux CNC or any other machine controller. lar software architecture, which makes it easy to provide additional functionality without modifying the core system. The basic workflow is preparing the model/design, defining operations (specify tool, define milling process, specify the bounding box), then generate and examine the toolpaths for the job. When satisfied, the results are exported as G-code. Design software has open source options and so do CNC machine controllers.

Linux CNC controls CNC machines and can drive milling machines, lathes, 3D printers, laser cutters, plasma cutters, robot arms, hexapods, and more. This controller supports machines with up to 9 axes. As the name implies, it runs a computer using some version of Linux, with Debian or Ubuntu preferred. Linux CNC accepts G-code input, using it to control a CNC machine's response.

Linux CNC provides several graphical user interfaces, G-code (RS-274) interpreter, real-time motion planning system with lookahead, operation of low-level machine electronics such as sensors and motor drives, and a breadboard layer for quickly creating machine configuration for your machine. Linux CNC is not CAD, so you'll have to use a different program to create the initial design.

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DIY CNC Given the no-cost options for CAD/ CAM and CNC software, what about Do It Yourself hardware? Is it possible to obtain low-cost CNC machines? How about building your own? American Gunsmith has reviewed Tormach CNC machines, which is one company offering low cost commercial CNC machines using their proprietary Path Pilot software.

CNC has gone from complicated multi-million dollar installations to commercial grade Hass machines in the tens of thousands range to Tormach and other CNC machines at the \$1,000-\$10,000 price point. CNC programming has gone from punch cards to Assembly to desktop visual tools to web-based options, such as PathPilot and JScut. Grbl (github.com/gnea/grbl) is a high performance, low cost alternative to parallel-port-based motion control for CNC milling.

This version of Grbl runs on an Arduino with a ATmega328P microcontroller, such as the Uno, Duemilanove, Nano, or Micro. These units can be had in the \$20-\$30 range. Written by Simen Svale Skogsrud (Norway) and Dr. Sungeun Jeon, Grbl uses cheap AVR-chips to achieve precise timing and asynchronous operation. It is able to maintain up to 30k Hz of stable, jitter free control pulses. It accepts standards-compliant G-code and has been tested with the output of several CAM tools with no problems.

Arcs, circles and helical motion are fully supported, as well as, all other primary G-code commands. Macro functions, vari-

ables, and most canned cycles are not supported, but the authors feel a Graphical User Interface can do a much better job at translating them into straight G-code. Grbl includes full acceleration management with look ahead. That means the controller will look up to 16 motions into the future and plan its velocities ahead to deliver smooth acceleration and jerk-free cornering.

To be clear, the free and open source Grbl software combined with a \$30 Arduino can form the basis of an entry-level CNC machine you can build yourself. Nikodem Bartnik designed and built a CNC machine using a Dremel tool, LMU12 bearings, Nema17 motors, Arduino microcontroller, aluminum profiles, and free software. The purchase price of the all the needed components is around \$300. The entire project instructions and parts list is on the Instructables.com website under "DIY 3D Printed Dremel CNC". Gunsmith CAD/CAM?

Manual machine tools as well as hand tools remain vitally important for many tasks, especially in gunsmithing. For custom, one-off jobs, manual machining and hand tool work is often still best. Consider Carquillat and the Jacquard loom. A silk tapestry that would have taken several weavers months to complete was completed in one day by Carquillat but this was after programming the 24,000 cards of information in set up.

This makes sense given Jacquard wanted multiple silk tapestries made as well as a means to show off his automated loom. Thankfully, CAD software is much easier to

design with. With modern CAM machines using a well-designed model, the only human intervention required for running a CNC machine is loading a program, inserting raw material, and then unloading a finished product. But this only works after creating a successful model. Is CAD/CAM a good idea for you? As with almost everything, it depends.

Even for a small shop, consider the types of jobs and guns worked on most often, especially if it involves difficult-to-find parts. CAD software can help model apart even if it's a one-off job to be finished manually. However, with a design already made, it could just as easily be handled with a CAM CNC machine. Given that the cost of affordable CNC machines are now within the range of hobby gunsmiths and that open-source designs allow building your own, this is realistic.

Regardless, the design can be saved indefinitely and cheaply as a computer file. The time and cost savings if that job ever crops up in the future is big. The real win is that this is now a realistic option for individual gunsmiths and hobbyists. In the 1950s, using a CNC machine required a Ph D in Engineering and millions of dollars from a huge corporation or government entity. Today, kids are downloading instructions and software for free and building basic CNC machines for around \$300 in parts and supplies. AG

MAINTENANCE & REPAIR

Reader Forum

BY AMERICAN GUNSMITH EDITORS JULY 2021

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Browning B-78 Repair I have a Browning B-78 in 30-06 Springfield with beautiful wood. Unfortunately, it will not eject nor lift the fired case. I suspect an ejector problem. I took it to an authorized Browning repair shop where they had it for a year and did nothing. Seeking help from two other gunsmiths also didn't help. This is a beautiful rifle and I am a single shot fan. I hate to give up on it. You are my last hope. From Mark Hollensen.

The Browning B-78 was a competitor to Ruger's No. 1 single-shot rifle with a design similar to the old Winchester High Wall. Production of the B-78 High Power rifle began in 1973. A "Bicentennial Model" was produced in 1976 and the B-78 was discontinued in 1982. Browning has a history of this rifle under "B-78 High Power Rifle". Parts for the B-78 have dried up but many are scattered in local shops.

Ahlman's Custom Gun Shop (Ahlmans.com), and Lee's Gun Parts (LeesGunParts.com), are two places to begin your search

for parts. I am guessing that apart or two are missing completely from the rifle, but it could be the extractor or ejector firing assembly is damaged. I am not certain which Browning Authorized Repair shop took the rifle in for a year, but I see that Alhman's is one for this particular rifle. Lee's should have parts if Alhman's does not.

To start working on a B-78, install some old scope rings and remove the top half of the rings. Turn the 78 upside down and you have a stabilized rifle to work on, better than putting the receiver in a vise. Install the spring and the plunger that you ordered into the extractor. To install the breech block assembly, move the extractor rod a bit to get it to slide down all the way (easy to do). Insert the lever pin. Slide the pin in enough to catch the lever ring, hitting the plunger pin.

With a small Philips screw driver, insert on the opposite side and compress the plunger and spring to finish inserting the lever pin (also easy to do). Now ready for the hard

parts. On the bench, assemble the trigger housing assembly, the mainspring guides, and the springs and hammer along with the pin flats. With one hand on each side, pick this assembly up without it falling apart. Carefully start the trigger assembly down the slots on the inside of the receiver.

Manipulate the hammer around so the spur of the hammer is sticking out the top slot of the receiver. You might have F. M. "Doc" to compress the two springs just a bit by pushing on the hammer. Push the trigger assembly all the way down till it bottoms out. This is the magic tip: Start to close the lever just as you would when you are loading it. You might have to wiggle things a bit but when everything is lined up the lever will compress the mainsprings and the whole action will close.

When this happens, slowly lift the lever until you can see the holes to insert the breech block pin and the trigger housing pin. Be sure to insert the right end of the pin in the right side as there is a difference.

Stuck Case Removal Here's an alternative way to remove a case stuck in a reloading die when traditional ways will not work. One job I regularly do as a gunsmith is to remove stuck cases from reloading dies. Normally this is achieved by drilling and tapping the primer pocket and using a bolt and socket to remove the case. Occasionally I will have a job come in that is not as simple.

In this particular case the owner of the die had already tried to fix it himself, and in doing so had separated the case head from the rest of the case. To remove this particular case I used an epoxy to fill inside the case and then beat against it with a hammer and punch. I started by removing the stem and bushings that might be in the die. Then I use acetone to remove any oils that may have been inside of the case. I used modeling clay to plug the case neck.

With the reloading die upside down I then filled the case with an epoxy made for adhering to metal. After the epoxy cured for 24 hours, I removed the clay and screw and put the die into a press. Using a punch, I drove the case out. or post a letter to Falls Church, VA 22041. For subscription questions or mailing problems contact American Gunsmith

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