TERMS 'O SERVICE:

BOSS MAKES A DOLLAR;
I MAKE A DIME.

THAT'S WHY I PRINT & READ
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Nº 7

THE VISE*

DESPATCHES FROM THE FIELD:
ANNVS NOVIS, CRAPVLA VETERIS

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As a reward: $ ETERNAL GRATITUDE!

"Man is a tool-using animal. Weak in himself and of small stature, he stands on a basis of some half square foot, has to straddleout his legs lest the very winds supplant him. Neverless, he can use tools, devise tools; with these the granite mountain melts into light dust before him; seas are his smooth highway, wind and fire his unwearying steeds. Nowhere do you find him without tools. Without tools he is nothing, with tools he is all."

Thomas Caryle (1795-1881)

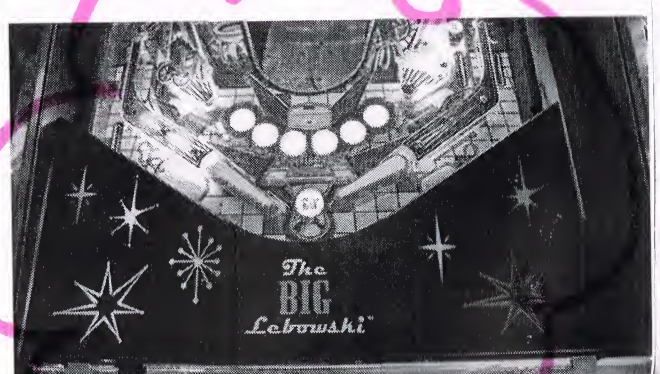
TOM LIPTON & DATE

PROM 1901

"HSS FOR PROGRESS!"

web server and a microcontroller, so it can send input from the targets to a local web page to display scores and graphics and play sounds.

I like to play with a ball bearing instead of the marbles that come with the kit. A bearing moves faster than a marble does, and its conductivity can be used to complete circuits. For instance, I made a target that is triggered when the ball touches a patch of aluminium foil on the surface of the playfield and a brass paper fastener that sits perpendicular to it.
Since ball bearings are quite a bit heavier than marbles, they can also be used to trip various kinds of switches. I made another type of target that mimics a pinball bash toy. When the ball hits it hard enough, the impact trips a shock sensor. This triggers a brief sound clip of an explosion and increments the score.
Playing around with cardboard pinball has taught me a lot about the physics of the game. I think it's a great first step toward building a cabinet-type machine, especially for someone who has spent far more time playing pinball than thinking about pinball design. Prototyping anything with cardboard is cheap, and it makes design iteration much faster. If something doesn't work out, I can just get some more cardboard and try again. Seeing the game so stripped down and simplified has given me the understanding I need to go forth and build the awesome machines of my dreams.

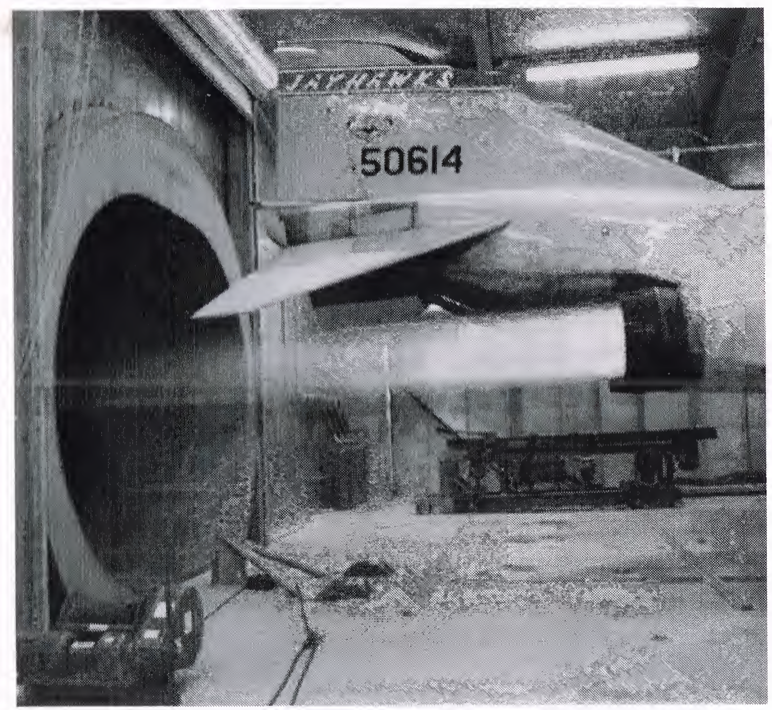


Afterburners and end users

By Tom Lipton http://www.oxtoolco.com/

I was recently reminded of one of those great stories that also has a useful lesson buried it. But first I just want to talk a little about the relationship between the user and the maker.

In many cases the user and the maker are one in the same person. It is not for a customer or client, and it is not intended to solve any specific problem other than the problem of my need to built things. Part of what I do in this line of work is listen to people tell me about their technical problems some they would like solved and have some fun in the process. This problem solving process between the user and the maker has some built in potential pitfalls.



Sometimes I find it very easy to get seduced by a nifty technical problem and expend more time and energy than the user had in mind. In fact if the users had some idea how much time you might spend on their problem they probably would never tell you about it in the first place. We might built a pilot plant when all they had in mind were a couple of buckets with a hose between them. It is certainly easier to avoid the business problems if your not on an owners clock with the solution. This is sometimes referred to overkill or over engineering and is deadly to the user, maker business relationship. If you are a one person operation and it matters little if you spent one hour or a hundred hours on the problem because its transparent to the user who uses the cost as a yardstick. The only real damage is you end up working pretty cheap sometimes.

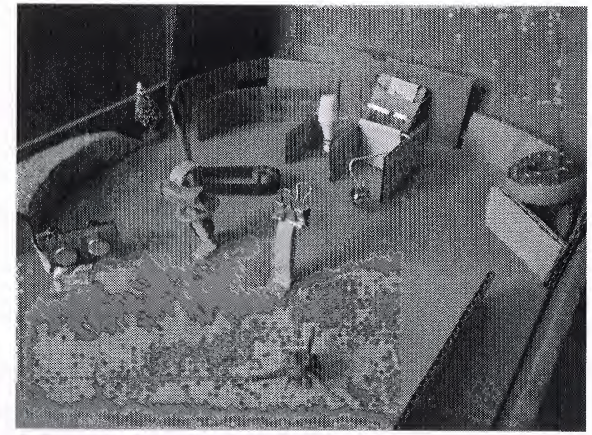
It can be especially difficult for people like me that really enjoy this work and do it for the fun of problem solving and working with my hands. A real interesting problem has the same effect on me as a time machine. I look up and hours have flown by that only seem like minutes. The reason for the time dilation effect is that I use my toolmaker friend Charlies rule, whatever I spend my personal shop time on has the requirement that it has to be stimulating. As designers and makers we can be easily lulled into thinking we fully understand the problems users bring to us. After all this is our job, to figure things out that other people are having trouble with. I am guilty of focusing my attention on what my experience tells me the problem is. After many years I have learned to trust these instincts and rely on my own judgement even though I'm many times wrong after a deeper look. The story I mentioned at the beginning is one that illustrates this well.

A workmate of mine told me this story about a situation that happened when he was in the air force. His job in the air force was aircraft maintenance and electronics. In fact he was a crew leader assigned to maintain a squadron of F4 Phantom fighter bombers. I never got where this all took place but I think it was an air base in Germany somewhere. The crews duties were to keep an airwing of these complicated machines repaired and maintained during the cold war. They had the training, tools and the resources to strip one of these aircraft down to the airframe if necessary. As part of their job they regularly changed engines and did full engine rebuilds. The flight mechanics out in the field like my friend Jim probably knew these machines better than McDonnell Douglas did. When you spend this much time with a particular machine you get to know it like a spouse or child, learning all its moods and behaviors. One of their duties was to respond to user (pilot) reports of maintenance issues or malfunctions.

One day a repair ticket comes in on one of the squadron F4's. The pilot complained that the throttle control was malfunctioning and he could not get his afterburners to engage. Part of the process was to talk to the pilot and get as much information as possible before doing the repair. As I understand how the throttle works on the F4 based on my

you have the absolute necessities for playing pinball: a plunger, a pair of flippers, and an angled playfield. But really, that's just the beginning. Now you get to design the obstacles, targets, and graphics that make it into a pinball machine.

There are so many possibilities that I still haven't decided on a theme or even attached anything to the playfield. But I couldn't let my indecision stop me from building things and testing them out. I decided to try prototyping targets and obstacles on a thin piece of poster board cut to fit the playfield dimensions. The right type of poster board is stiff enough that it won't buckle from rubber band tension and thin enough that it doesn't affect ball movement. I keep adding things to the same piece of poster board, so I have a proving ground that doubles as a playable game.

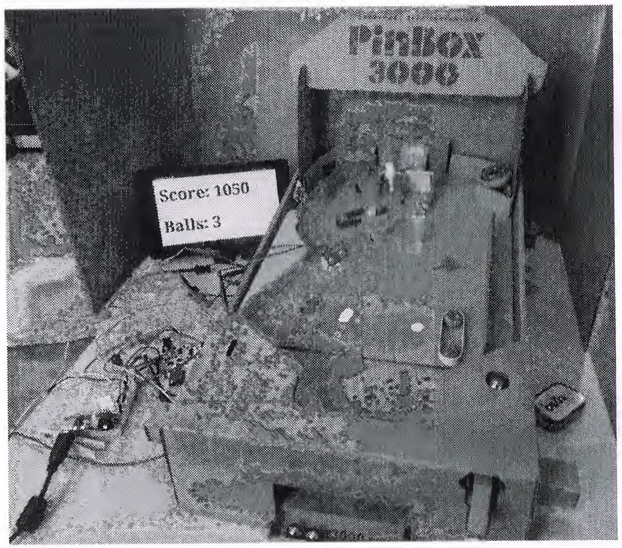


I've found that mimicking traditional pinball components is a good place to start. You could speed the ball up with ramps, slow it down with loops and obstacles, or bounce it around with rubber bands stretched around posts. You can salvage materials for obstacles from the stuff in your recycling bin, or fabricate them on a 3-D printer. Anything that you think might enhance the playing experience probably will. Just keep in mind that the ball must be able to roll freely from top to bottom without getting stuck.

It's easy to add lights and sounds and scorekeeping, especially if you know your way around microcontrollers. My friend and I used an Arduino-compatible Wi-Fi-enabled development board. It acts as both a

Cardboard pinball
by Kristina Panos

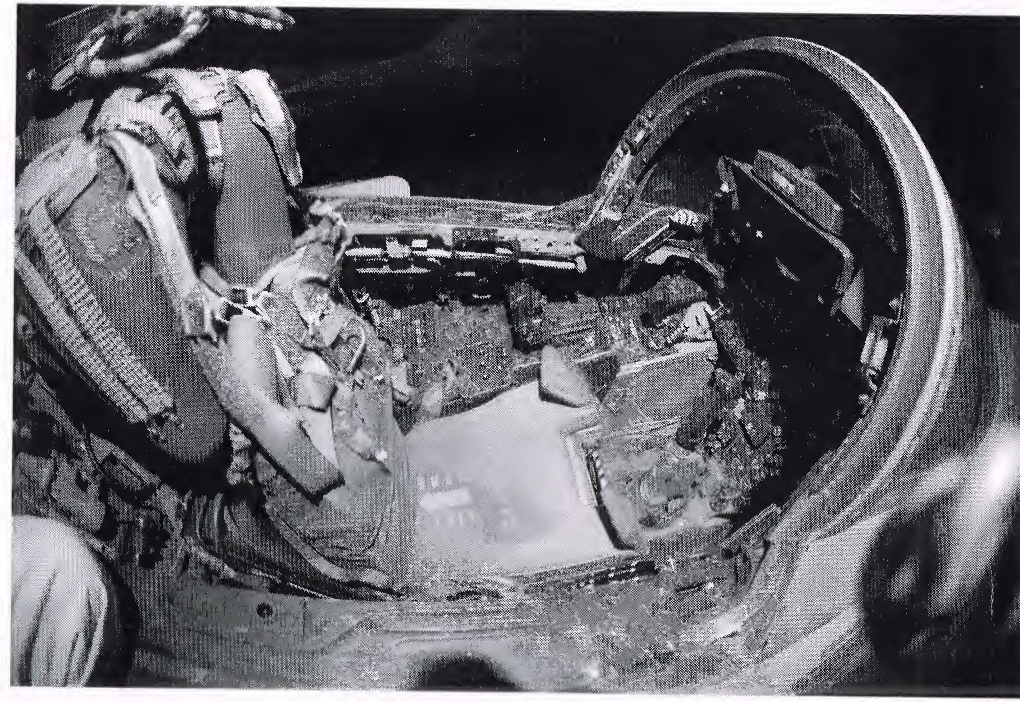
Ever since I was a little kid, I've been fascinated by pinball machines. It's because pinball is such a complex sensory experience. I love the immediacy of standing there, gripping the sides of the machine, completely focused on keeping the ball on play amid the flashing lights and snapping solenoids. It's just me versus gravity and distraction, and all I've got is a pair of flippers.



I would love to have my own pinball machine, but I tell myself I don't have enough space for one. I'm secretly afraid I'll get bored playing the same table over and over again, or that something will break and I won't be able to fix it. Curious tinkerer that I am, I like to dream about building my own machine. I figure I could start with something small and simple made out of plywood and work my way up as I learn. But I've never started on it because it's too daunting to take the first step. A commercial pinball machine is such a complex concert of components. How does one even begin to emulate one?

And then a few months ago, I found out about the PinBox 3000. It's a tabletop-sized DIY pinball machine made entirely of cardboard. The kit is really easy to build—you just punch out the pieces, fold them up, and insert tab A into slot B. You don't need any tools or bonding agents. I know it doesn't sound sturdy, but believe me, it is. Once it's put together,

friends description there are two independent slides that are advanced to increase thrust in both engines. Near the maximum throttle position there is a little micro switch that closes to send a signal to the engine control to ignite the afterburners. After discussing the problem with the pilot he was pretty sure this switch was the problem based on his experience.



They opened up the left console and performed the recommended check on the switch. Small surprise, the switch passed with flying colors. I guess there were several other things that got checked during the repair but all their checking didn't pinpoint any problems. Everything got put back together and the crew signed off on the repair as good. They returned the plane back to flight status and gave it back to the pilot.

The next day they got an irritated call from the pilot asking why they didn't fix the problem. He still could not engage the afterburners even after their "repair" job. My buddy Jim explained that they had thoroughly checked all the afterburner systems and found no problems. He described all the tests that had been performed and whatever minor adjustments had been made. They would have to take another look and see what was going on.

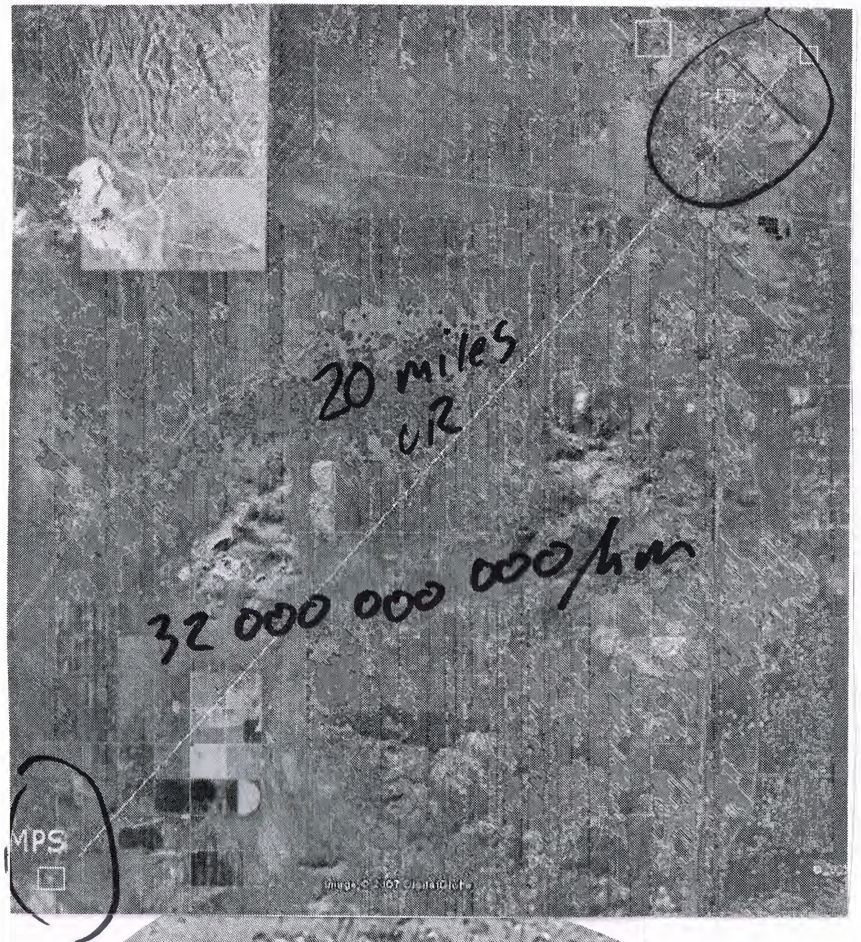
After they got their hands on the plane again the crew performed the same checks they did the first time. Just as before they found everything functioning to specifications. Reaching for ideas they decided that the problem might be related to vibration or heat when the engine was running during flight. It was decided that they would do a chain down test with the engines running. A full power engine test on the ground is a big deal. You don't just throw a rope around the trailer hitch and loop it around the oak tree next to the garage. The procedure is complicated and dangerous to the ground crew who have to get close to the machine when its running at full power.

Each one of the Phantoms General Electric engines produces 18,000 pounds of thrust in afterburner. The procedure is to chain it to the flight line in a special area using heavy duty chains arranged in a particular configuration. I'm taking a guess here that the chains didn't come from the McMaster Carr catalog. After getting the proper clearance the crew went through the lengthy procedure dragging the gear out to test the planes engines on the ground.

An F4 in full afterburner in a test stand somewhere gives you an idea of what these guys went through.

So they are set to go with the test. They run the engines up to full power slowly to make sure the rigging gear is good and there are no surprises. With a final click the throttles were pushed past the little micro switch and low and behold the afterburners kick in boosting the load on the chains to nearly 40,000 pounds. They try it several times since they spent all this time on the ground engine test without a hitch. After shutting it all down they pronounce the engines, plane and systems are all functioning as designed. As a precaution they even replaced the switch to put any doubt to bed. They returned the plane back to the flight line and tell the pilot everything is functioning properly and has been tested thoroughly. The pilot hearing this seems satisfied especially after hearing the test that his plane had been put through and the switch replacement. He told the my friend that he had a flight the later in the week and would let him know how it went.

Around this time my friend is pretty sure of himself that the switch is fine and functioning and his assessment and diagnosis were correct. What is bothering him slightly is that the problem might be an intermittent problem that they just couldn't



1 - Having an enormous aviation ~~boneyard.~~ BONER YARD.

2 - Being an Inland Spaceport and the alternate landing site for the (former) Space Shuttles, and,

3 - Being the home of Scaled Composites, the company that built SpaceShipOne and won the $10,000,000 Ansari X-Prize by being the first private, manned, reusable spacecraft to make it into Earth's orbit twice in two weeks.

A few years after winning the X-Prize and mid-aquisition by Northrop Grumman, a team was doing a cold flow test with propellant for SpaceShipTwo several miles east of town.

The July 26, 2007 test involved a 15-second burst of 10,000 lbs of Nitrous Oxide (laughing) gas from a pair of pressurized holding tanks. The test site was loaded up the night before and the tanks sat in the sun until the next day. With air temperatures in July well over 40'c in the shade and likely 55'c on the tanks, the internal pressure for the rocket fuel reached somewhere around 700 PSI.

While most of the test staff were protected behind a berm 430 feet away, those conducting the experiment were nearby when the tanks ruptured. The decompression left nothing more than matchsticks of the buildings, an overturned semi, a crater, and 3 dead with 3 more seriously injured.

20 miles away the building we were in shook when the shockwave ~~reached us.~~ (BUILDIN' A ROBOTIC WALKING TERROR)

~~This was~~ a cold-flow test of the propellant's oxidizer only, no fuel, no ignition, performed by prize-winning rocket scientists who, even combined, got something very wrong that day.

reproduce. Those thoughts went out of his head as soon as the next plane came in for work. He was satisfied that he had understood the problem and done everything technically correct to fix it.

I don't know if you have ever met a fighter pilot that's a high ranking officer to boot. Lets just say they didn't get where they are from being meek and conservative. I think they actually take training on how to ream somebody out until all that's left is a smokin pile that used to be the focus of their attention. I'm sure it wasn't a gentle summer breeze blowing in Jim's direction. The first clue they got that the problem wasn't resolved was a loud angry phone call from the pilot (major so and so) barking at them for not fixing a simple problem. After going up one side of my friend Jim and down the other the pilot told him to be front and center to go for a test drive with him the next day Now I would really like to go for a ride in one of these but even my enthusiasm is damped at the thought of an expert pilot that is pissed off at me giving me a ride in a high performance machine.

Jim shows up the next day all kitted out for his test drive in the jet with the mysterious problem. The pilot is in a hurry to get on with the demonstration so they load up and head out to the runway. They taxi out to the runway and get in line to take off. The pilot asks the tower for clearance to do a maximum rate climb out after takeoff which they granted. The little glurping sound is Jim's guts tightening up. During all this he is pretty sure the afterburner is going to kick in since he just tested it a few days before. The technician geek in him is watching the pilot from the backseat of the fighter for any clues to the problem. Finally its their turn to take off.

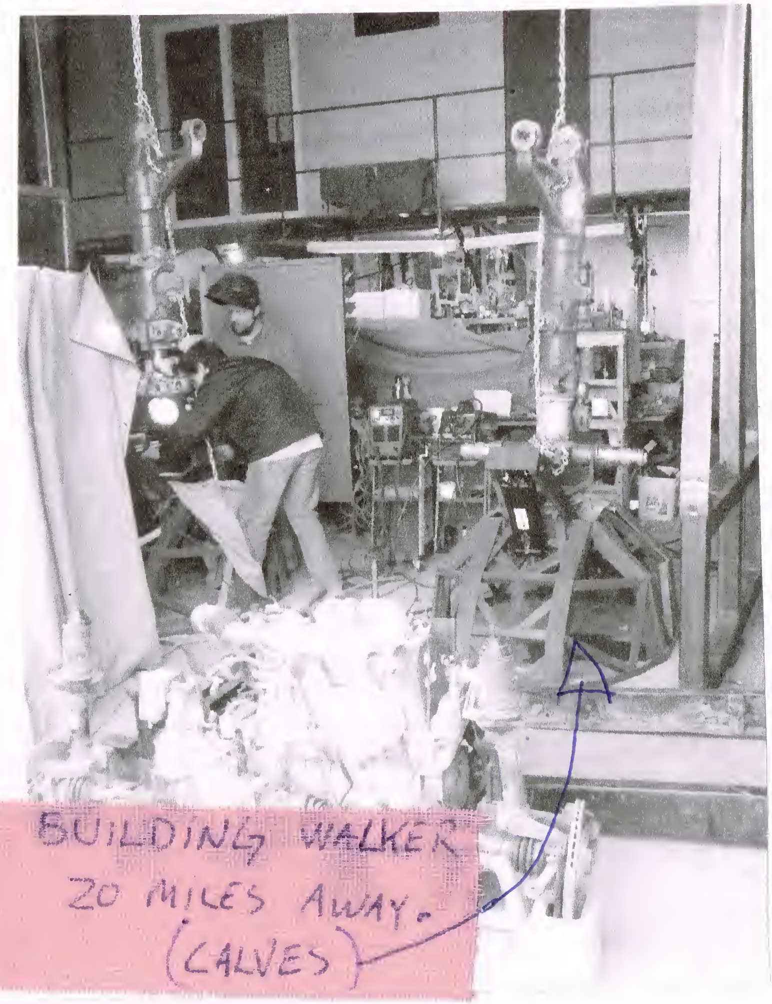
The pilot puts the brakes on and throttles up to take off power but not afterburner. Finally they are off accelerating down the runway. The plane gets its wheels off the ground and the wheels up safely when the pilot announces "You ready?" Jim has been ready from the night before so he braces himself for that additional 12,000 pounds of thrust from the afterburners he positive are about to be lit. He watches the pilot grab both throttles and slam them to the firewall in about a millisecond. Pffffffffff. No afterburner. In an instant Jim realizes what the problem is, but right now he has to listen to another reaming session this time over the headset from the pilot about wasting his time and not believing him that the problem even existed. I don't know how long the ride lasted but after that it couldn't be short enough for me.

Vhen they performed the tests on the ground they advanced the throttles like any good echnician would, slowly and smoothly. In his shoes I would have done the same thing. The pilot on the other hand who's job it is to make instantaneous life and death lecisions just wanted his power to happen NOW not thinking about treating the equipment with like a newborn baby.

'm not sure what the exact problem was with the switch but it was related to the length of time the signal from the switch could be read. The ground crew solved the problem by lengthening the tab that contacted the switch which increased the closed time of the switch. This added a few more milliseconds for the logic controller to read the signal. I nay not have all the details of the story perfectly correct but the moral is the same. Whats the moral of this story? Moral number one, the user and the maker have different needs.

Second, don't let yourself get seduced by a technical problem. Mother nature never cheats or lies to us, but she will let you make a fool of yourself because you are the easiest to fool.

DON'T FVCK W/ PRESSVRE VESELS!



The town of Mojave in California, located a dozen miles north of Edwards Airforce Base on the edge of the desert it's named after, is famous for three things:

capacitors burst while the mosfets charred, a sort of electronic ritualistic suicide. Those pixies dance in heaven now. I'll put the board in epoxy and use it as a paperweight, since the molten insulation looks pretty neat.

We had no idea what the hell we were doing. We weren't too bad.

We had time before the next race. Two hours. Another team had a spare 48V 1000W scooter motor controller that we bought for $40. When a motor draws 1000W at 36 volts, it draws 1333W at 48 volts, $V = IR$. Our new controller was rated at 1000W. We knew that the next time we'd see our motor controller, it'd have chooched its last. Racing was our objective, and magic smoke would be our end.

We only lasted 5 laps before that acrid smoke returned. We carried our kart to the pits for a second time. The motor controller had failed identically to the first.

We had raced, and had fun doing so. We weren't the fastest. We had no idea what the hell we were doing. We weren't too bad.

As it happened, this very day was the subject of my college essay. I'm currently a senior, and I'm looking forward to attending Columbia University next fall to study mechanical engineering. I suppose the real lesson here is that it's important to fail wholly and catastrophically, because it makes a good college essay.

For next year's race, we're updating our kart with an overrated, fan cooled motor controller, thicker wire all round, 48V motor system, a reverse relay, and a current/voltage monitor. I can't wait to return for another year, to race and talk with other teams, to break something. Next time, we're crossing that finish line.

FIG.1

BY: JONATHAN KATZ

What follows is a story about failure.

After finishing my B.Sc. at the tender young age of 31, I chose to go into the field of clinical research. That is, performing medical experiments on human beings to asses the safety and effectiveness of new treatments. Actual science experiments, carried out under incredibly tight control. One vial of blood going missing can and will invalidate a million dollar drug trial. I've seen the tears with my own eyes.

Real fucking science.

A large proportion of these trials are carried out by organizations that are hired by pharma companies to test their drugs for them. I landed in such a place. Our task was essentially to try drugs on healthy people, and see if anyone got sick.

The facility where I spent most of my time was about half way between a hospital and a prison - a single big room, lined by "cells" that each contained four bunks, with about 100 beds total. When a trial was in progress, the place was locked down. Only staff could come and go.

Sometimes even the bathrooms had to be locked down.

One of the more interesting aspects of this process is that most of the test subjects were regulars, ie. professional guinea pigs. It pays pretty well for the time put in, and you could support yourself doing it for a living.

I found dealing with these people to be disconcerting. The light in their eyes had long since gone out. The world had defeated them. Unlike most of my co-workers, I went out of my way to treat them like friends.

But there was one particular trial that I will always remember.
It was for a drug that was meant to treat a terminal respiratory illness. It was inhaled in powder form, through a disk shaped plastic inhaler that contained 30 doses, one per day for a month.

The 60 or so test subjects were checked in one evening, and my Soviet friend and I were assigned to hold down the fort overnight. I always got to sit in the nicer chair, because after I showed him what happens when the piston in an office chair fails, he refused to sit in them.

This from a 250lb. shaved gorilla that likes to go camping in Northern Ontario in the winter. He was a good friend.

The subjects were to be dosed early the next morning, so we were really just there to maintain order. But even that became a challenge, as the temperature outside had reached -24.5C. That number might sound pretty specific, but in such a place, we have gear on hand to measure temperature accurately. Many of the sleeping rooms were not able to maintain anything close to room temperature, and we had to fight back a possible mutiny.

But the morning came, and all was well, putting aside the fact that there was no hot water for the showers. Given that their investment in the trial was close to a million dollars, the company who's drug we were testing sent in some brass around 6 am, to see how things were going.

Of course, when dosing people with a new drug, there must be an M.D. present to ensure that the subjects are safe, and sign the relevant documents, which are beyond numerous. When the client asked our M.D. what kind of drug we were testing - he didn't know. Though he was ultimately responsible for the safety of these people, he had not even read the protocol.

So fine, whatever, he's got a license, and it's all good, as long as nobody dies.

Around 8am, they start dosing the subjects for the first time. It does not go well. Later that day, the trial is cancelled, and all the subjects are sent home.

What happened?

The company that made the new drug delivered it in a new, untested inhaler. 30 dose plastic disc inhalers are nothing new. In bulk, you can buy them for a few bucks each.

So these idiots spent high six figures to find out that their inhaler was shitty. And they learned zero about the drug. The trial had to be redone from scratch.

The lesson here is that you need to isolate your variables if you want meaningful data. But people still fuck that part up when they're spendng $800k.

: DATVMS (HE RVNS):
REDIT.COM/R/SKOOKVM

Racing was our objective, and magic smoke would be our end.

The Power Racing Series is a national event where adults rebuild and race kids ride-on toys. Multi-kart pileups are frequent, as are smokey breakdowns, trackside welding, fire, and flagrant rule violation. In fact, flagrant rule violation is encouraged. Sneaky rule violation is banned.

Last year, we built a car that raced in this crazy event, surrounded by teams full of adults and college students with knowledge, experience, and resources. With none of the above, we bought a razor dune buggy frame, a slightly sketchy 1000W 36V brushed DC scooter motor, and a motor controller with a wiring diagram that included helpful labels like "to put" (which turned out to be for the throttle). Most of the time we spent working on the car was focused around the chain, the sprockets, and wiring everything up. In order to mount the far larger motor, there were many hours of drilling, sawing, filing and bashing to fit an aluminum adaptor plate we made to bolt our new motor into the smaller mount. Everything was done mostly alone, mostly in the dark, and mostly by hand. A corded drill is my only power tool, and therefore, it was our team's only power tool. We changed our gear ratio by taking out a jackshaft and running the chain straight to the motor. We drilled a hole in our frame to remount our chain tensioner to work with the new chain path. We added some extra pairs of wires into the commutator housing to supplement the wires that came with the motor, because even on somewhat short rides, the original wires got hot. Some silicone carne held some pieces of aluminum shelving bracket to our motor. This worked surprisingly well as a heat sink. We even drilled additional speed holes in the back plate of the motor for better cooling.

Our singular brake was a small brake disc on the solid rear axle. Our rear tires were bald. Our front tires were also bald, though we did have replacements for those. We used lead acid batteries when half the competition had lithium ion. Despite this, our Red Abomination was fun and quick. We were ready to race.

We quickly duct taped on some pool noodle bumpers (one of the few enforced rules of the Power Racing Series) and drove to the Maker Faire.

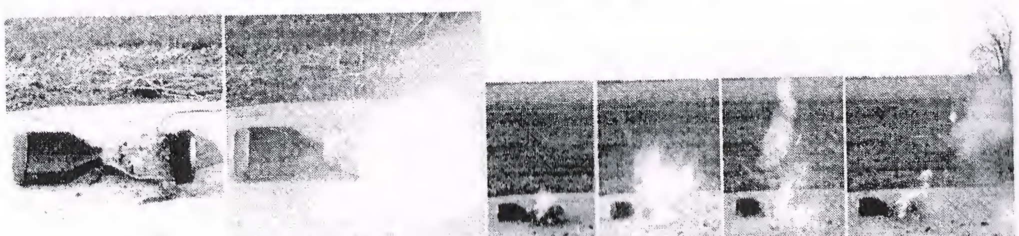
Our qualifying lap was trash. We were halfway through a tire change, so our front tires were almost entirely deflated. We also had some dead-ish batteries on the kart, because someone (me) had neglected to charge the batteries. Our qualifying driver made only one out of two laps before our crippled kart gave up. Because we weren't an overt safety hazard, we were allowed to race. The qualifying laps left us second to last, ahead of the only team to make their car slower than stock.

The race starts. We are doing better than I had expected. We were slower on the straightaways, but better in corners than many other teams, on account of our size and center of gravity. Our driver was doing a great job, getting the rear to rotate a bit in corners. We made it 16/25 laps before we lost our controller in a puff of smoke. An IR thermometer showed 140F on top of the motor controller. In that race we came 12/18. We weren't the only team to have technical difficulties. I have since taken apart the controller, it appears the

Making the electrical connection

There are two methods i know of for making the electrical connections to the cells. First is simply soldering the cells. Be careful not to let the cell get too hot when soldering. It is best to use a large soldering iron in order to have plenty of thermal capacity in the tip. I use a very large 300 watt soldering iron from the 1950s for my cells. The other option is to spot-weld the connections onto the cells. Spot-welding is the method that all manufacturers use, but it can be harder to do at home. If you try spot-welding, use a large capacitor for your power source not a battery. Using a battery as the source for spot welding is tedious and unreliable, with a tendancy to damage the cell.

One practice i have recently started doing is adding a 4 amp PICO fuse to each 18650 cell. When a cell fails, it is likely to short-out. I once had a cell short-out in my E-bike battery and could have caught my bike on fire. The cell started releasing its own stored energy as heat (about 5wh) but it was connected to 11 other cells in parallel causing those cells to feed more power into the shorted cell. The 11 good cells must have supplied something like 50 amps of current to the cell because the thick connecting wire i used had completely melted away. The shorted cell melted but did not catch fire due to that. if those connectors hadnt melted, my bike would have been burning on the side of the road. After this cell failure i realized i couldnt trust the connectors to melt whenever a cell failed, so i started putting a small fuse in series with each 18650. I feel this is far safer and more reliable than my previous battery packs. I strongly urge anybody making a battery pack to put a fuse on each cell.



Here are some pictures of when i blew up a Gyroboard (hoverboard) and the cells shot around like fireworks. When the cells deflagrate they shoot sparks and molten metal, and their contents escape at great speed.

The source for this guide's information is mostly based off my own experiments and experience over the past 5 years, almost all of it is documented on my main YouTube channel "Rinoa Super-Genius" if you want a closer look.

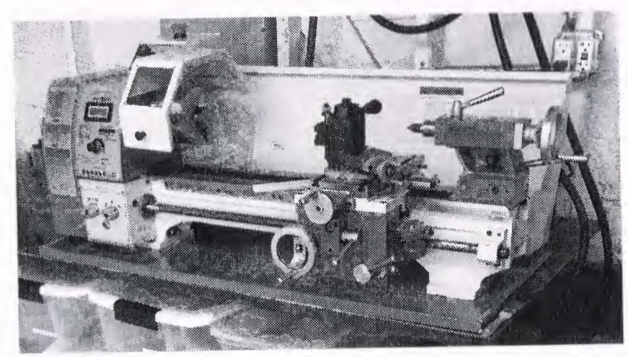
Rinoa

THE KING'O' MACHINE TOOLS:
OLD IRON VS. NEW OFFSHORE

Review: Precision Matthews PM1022V Lathe

Quinn Dunki
http://www.quinndunki.com/blondihacks

I recently picked up the PM1022V lathe from the fine folks at Precision Matthews in Pittsburgh. This is the sort of mid-to-high end hobbyist machine that you see everywhere now. You know the formula- Asian-made, imported, rebranded, possibly repainted, possibly tuned up a bit, and resold as an American product. No snark intended- the fact is these machines are rapidly improving in quality, and while they may not be your grandparent's 3000lb Southbend, they still represent a lot of value for your machine tool dollar. This particular machine appears to be based on the Weiss WBL250–F from Weiss Machine & Tools in China. The lathe appears to be unaltered from how Weiss offers it, although Precision Matthews does include an excellent accessory package, and excellent customer support. They also provide a well-written English manual (a fairly rare thing with these Asian-import tools). A comparable machine would be the 8.5 x 20 HiTorque from LittleMachineShop, itself based on the Chinese Sieg SC4. I nearly pulled the trigger on the LMS lathe, but in the end PM got me with a slightly more powerful motor that includes more accessories for about the same price (as of this writing). Both are great companies, however, and you can feel good about supporting either one. I have bought much of my tooling from LMS, as they put together nice packages, and have a great selection.



Here's the PM1022V installed on a steel bench, bolted through the holes provided in the feet (and through the included chip pan). You're on your own to level it, so either adjust the bench itself, or shim the lathe's feet.

This is a very substantial machine for model making or other hobbyist use, but it's probably too small for car parts or agricultural-scale jobs. At 360lbs and 44" long, it's hefty, but small enough to fit in the corner of a garage. It's 22" between centers, but has a surprisingly generous 10" swing. That's a lot for a machine of this size.

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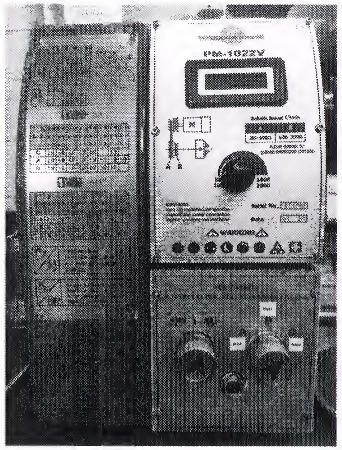
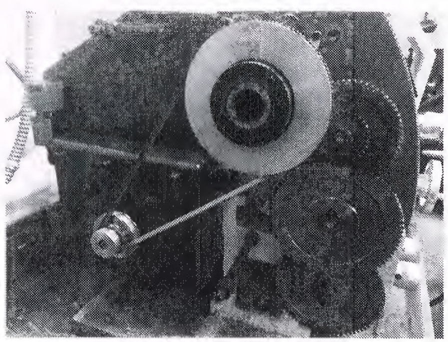


Here's a shot of the control panel. There's a handy threading and gearing chart on the left, and on the right is a digital tachometer. The tach is pretty and lights up blue, so you know it's high tech. Unfortunately, it also appears to be strictly decorative. I found it to be wildly inaccurate. So much so that I had to run the motor through its range with a hand-held tach attached to the spindle so I could mentally calibrate it myself. The digital tach on the unit I received is only about 80% accurate. Good odds for a stock broker. Not so nice for a speed controller.

The black knob in the middle controls the aforementioned speed. It's fun to adjust while the machine is running. There might even be a purpose to do so, such as when facing or parting off. I haven't tried that, but in theory you could adjust dynamically during an operation to keep surface speed at the tool consistent as diameter changes.

At the bottom, you can see the quick-change gear box. This is a nice feature in a machine of this modest size. It can power feed in both directions, and the feed transmission has three gears. Combined with the variable speed, this is all the control you need for your feed. Lathe rhymes are fun.

There's one little gotcha here. The machine claims a range of 50-2000 RPM. However, you actually only get half that range with the installed gear train. The dirty secret is that the machine includes a second set of change gears that must be swapped in to get the upper 1000-2000 RPM range. Furthermore, the manual very cryptically indicates that the high speed range is not suitable for cutting/turning, due to the loss of torque. That certainly begs the question of what the point is of the higher range, but for High Speed Steel tooling, the low RPM range is sufficient for anything you want to do. You won't achieve the surface speeds needed for carbide tooling, but this machine doesn't have the horsepower for carbide anyway. Stick to High Speed Steel and you'll be a happy camper.



Here's a look at the drivetrain, which hides under a cover behind the spindle. On the right are the change gears. On the left you can see the arbor on the big DC motor. The gear train is driven by a smooth V-belt which makes for quieter operation, and is a nice theoretical safety valve if you crash the chuck. I wouldn't want to test that, but in theory the belt will give before any more expensive part of the drivetrain does.

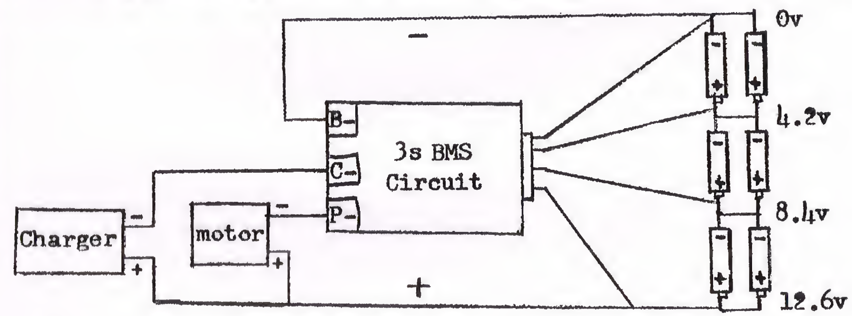
You can also see the 1" spindle bore here, which is frankly not as large as some machines in this class, but certainly workable. The drivetrain cover has a hatch in it to allow long stock to protrude out through there if needed. Also note the electrical interlock on the left edge

Balance charging and BMS circuits

If you have cells in series, you need to keep them ballanced. Lithium-ion cells have no inherent mechanism to inhibit overcharging so the cells can drift in voltage from each other over time. You can monitor each series pack manually or use a BMS (Battery Management System) to maintain the cells.

If cells become unbalanced, they run a risk of overcharging and undercharging, both lead to failure and possible fire. Cells mostly drift from each other over many charge/discharge cycles because every cell (especially used cells) have different self-discharge rates and some are less efficient when converting their chemical energy into electricity resulting in waste heat.

A BMS circuit can easilly be obtained from the internet for a reasonable price. Be sure to get a BMS with the correct series configuration for your battery pack. I originally built my E-bike battery to be 12 series configuration but had to retrofit it to 13 series when i had trouble finding a 12s BMS. Be sure the BMS you get is also for Lithium-ion or LiPo batteries, LiFePo4 BMS circuits wont be compatible with the higher voltage of an 18650.



Here is what a 3s BMS would look like when connected up. notice how the ballance leads have one more wire than the series configuration of the pack, this is to allow the BMS to "see" all the parallel packs. Cells in parallel will naturally ballance against each other, so you only need to ballance the series cells.

Structuring the Cells

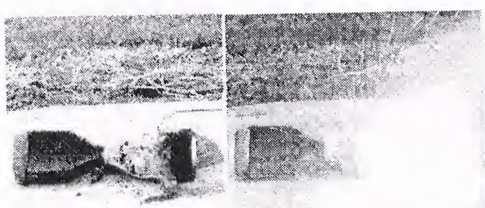
Along with electrically connecting the cells together, you must also physically connect them together. If the cells move in relation to each other, the connectors between them will become stressed and possibly fail.

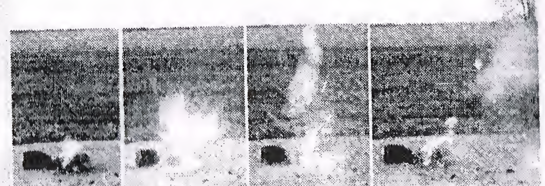
I built my first large battery packs by simply taping the cells together, This worked surprisingly well. the tape has lasted years and thousands of miles. On a newer battery i used a 3D printer to make a plastic frame to hold the cells, this has worked well also. I believe there are other mounting methods available on the internet, but my homemade solutions have lasted more than expected.

Making the electrical connection

There are two methods i know of for making the electrical connections to the cells. First is simply soldering the cells. Be careful not to let the cell get too hot when soldering. It is best to use a large soldering iron in order to have plenty of thermal capacity in the tip. I use a very large 300 watt soldering iron from the 1950s for my cells. The other option is to spot-weld the connections onto the cells. Spot-welding is the method that all manufacturers use, but it can be harder to do at home. If you try spot-welding, use a large capacitor for your power source not a battery. Using a battery as the source for spot welding is tedious and unreliable, with a tendancy to damage the cell.

One practice i have recently started doing is adding a 4 amp PICO fuse to each 18650 cell. When a cell fails, it is likely to short-out. I once had a cell short-out in my E-bike battery and could have caught my bike on fire. The cell started releasing its own stored energy as heat (about 5wh) but it was connected to 11 other cells in parallel causing those cells to feed more power into the shorted cell. The 11 good cells must have supplied something like 50 amps of current to the cell because the thick connecting wire i used had completely melted away. The shorted cell melted but did not catch fire due to that. if those connectors hadnt melted, my bike would have been burning on the side of the road. After this cell failure i realized i couldnt trust the connectors to melt whenever a cell failed, so i started putting a small fuse in series with each 18650. I feel this is far safer and more reliable than my previous battery packs. I strongly urge anybody making a battery pack to put a fuse on each cell.





Here are some pictures of when i blew up a Gyroboard (hoverboard) and the cells shot around like fireworks. When the cells deflagrate they shoot sparks and molten metal, and their contents escape at great speed.

The source for this guide's information is mostly based off my own experiments and experience over the past 5 years, almost all of it is documented on my main YouTube channel "Rinoa Super-Genius" if you want a closer look.

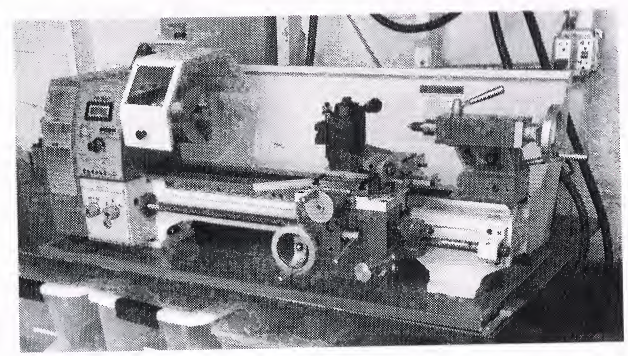
Rinoa

THE KING'O' MACHINE TOOLS:
OLD IRON VS. NEW OFFSHORE

Review: Precision Matthews PM1022V Lathe

Quinn Dunki
http://www.quinndunki.com/blondihacks

I recently picked up the PM1022V lathe from the fine folks at Precision Matthews in Pittsburgh. This is the sort of mid-to-high end hobbyist machine that you see everywhere now. You know the formula- Asian-made, imported, rebranded, possibly repainted, possibly tuned up a bit, and resold as an American product. No snark intended- the fact is these machines are rapidly improving in quality, and while they may not be your grandparent's 3000lb Southbend, they still represent a lot of value for your machine tool dollar. This particular machine appears to be based on the Weiss WBL250–F from Weiss Machine & Tools in China. The lathe appears to be unaltered from how Weiss offers it, although Precision Matthews does include an excellent accessory package, and excellent customer support. They also provide a well-written English manual (a fairly rare thing with these Asian-import tools). A comparable machine would be the 8.5 x 20 HiTorque from LittleMachineShop, itself based on the Chinese Sieg SC4. I nearly pulled the trigger on the LMS lathe, but in the end PM got me with a slightly more powerful motor that includes more accessories for about the same price (as of this writing). Both are great companies, however, and you can feel good about supporting either one. I have bought much of my tooling from LMS, as they put together nice packages, and have a great selection.



Here's the PM1022V installed on a steel bench, bolted through the holes provided in the feet (and through the included chip pan). You're on your own to level it, so either adjust the bench itself, or shim the lathe's feet.

This is a very substantial machine for model making or other hobbyist use, but it's probably too small for car parts or agricultural-scale jobs. At 360lbs and 44" long, it's hefty, but small enough to fit in the corner of a garage. It's 22" between centers, but has a surprisingly generous 10" swing. That's a lot for a machine of this size.

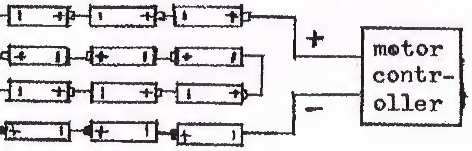
It's powered by a 1HP brushless DC motor with a digital speed control. In addition to giving you a lot of torque for low mass, the DC motor allows you to change your feeds and speeds with the twist of a knob, even while the machine is running. This is something AC machines simply can't do. On some DC lathes, you can even reverse direction under power, which is great for threading. I haven't tried that on the PM1022V, and can't say whether that is supported.

Cells found between 2v and 4.2v have the least amount of internal damage.

Building a Battery

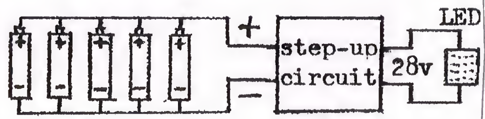
So now we want to run a device off 18650s. You need to know what voltage range it needs, and how many amps it will pull. I recommend having at least 1 Amp-Hour (1,000 mah) of capacity for every 1 Amp you plan to pull. This will ensure your cells are stressed less, will last longer, and won't heat up as much. You can make a battery pack to directly run the device, or use a step-up boost converter to reach the required voltage.

48v E-Bike Battery



12s1p 48v (50.4v)

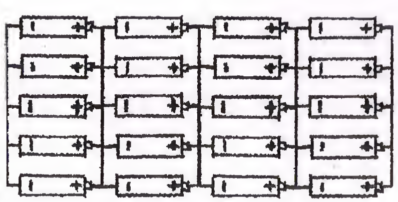
Lantern Battery



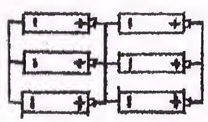
1s5p 4.2v

I built my E-bike battery to directly output the correct voltage my E-bike motor controller required. For my high-powered LED Lantern upgrade, i instead put all my cells in parallel to give 4.2v. I then used a step-up boost circuit from ebay to turn that 4.2v into 28v to run the LED. Using the boost converter to step-up the voltage helped make charging simpler and allowed for finer voltage control. Step-up circuits waste energy, are a possible failure point, and cant handle much power, so they arent useful when your project uses more than a few watts.

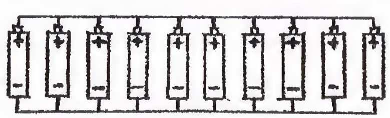
Once you know the voltage and capacity requirements, you can decide how many parallel and series cells you need in your pack. Remember that connecting cells in parallel adds the capacity, and series adds the voltage.



4s5p



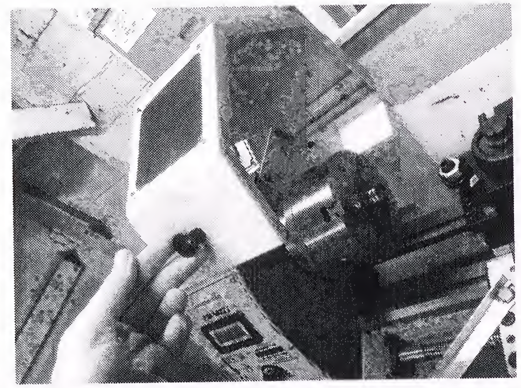
2s3p



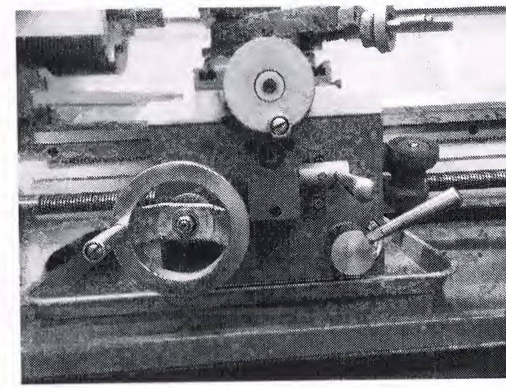
1s10p

Here are examples of how cells could be configured, be sure to make sure every parallel pack of cells has a similar capacity. It is common to describe the series and parallel configuration in a pack by the " _s_p ", for example the E-bike battery i use is 13s12p and my laptop has a 3s2p configuration.

of the cover. This actually works very well- it doesn't interfere with quick removal and reinstallation of the cover, but might save your fingers someday.



Speaking of safety, this electrically interlocked shield over the chuck is a nice touch. It helps keep your chicken tenders clear of the blender, and also physically prevents you from leaving the chuck key in place. The included chuck key is also spring loaded, making for two layers of safety in this important area. Caving in your face with a chuck key missile is no picnic. If safety devices like this raise your libertarian ire and you wish to fly free like a bird in a meat grinder, the shield is easily removed. This thing has already saved me from an exploding cut-off blade, and once prevented me from dropping my camera into the spinning chuck, so I'm happy to keep it. Maybe you're more infallible than me and won't need it.



Enough safety. Let's get to the good stuff. Shown here is the carriage. Bottom left is the main carriage hand wheel. It has a spinning crank and feels nice in your hands, like a cool margarita on a hot California day. This control has the most backlash in it, but not so much as to be alarming. Being in North America, the machine I received is calibrated in Imperial units, but it can cut both Imperial and Metric threads. The hand wheel scales are all in Imperial as well, and the main one measures in ten-thousandths. This a fairly coarse, but convenient unit.

Top center we have the cross-feed hand wheel, also with a spinner crank. This wheel measures in two-thousandths, which is a somewhat odd unit, possibly an artifact of its Chinese (and therefore metric) origins. Still, it's easy enough to measure between the ticks to get a single thousandth where needed. I have found myself tending to scale my projects to even-numbered dimensions, just to make it easier to do the math with these cross-feed units. The cross-feed scale is direct-read, meaning the numbers tell you the reduction in total diameter that your turning will net. If you are measuring distances (such as along an end face), you'll need to halve these numbers. Direct-read is very convenient for turning to a diameter, however.

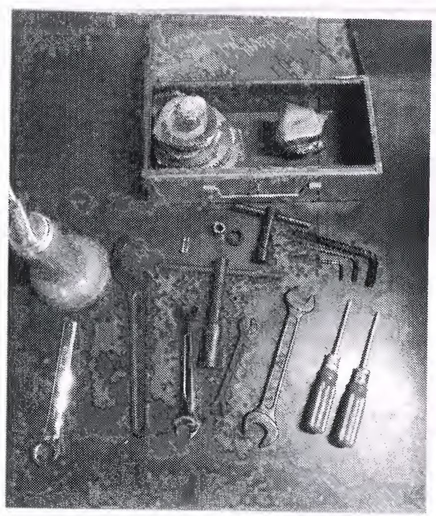
On the far right is the half-nut lever and threading dial. This machine can turn all manner of metric and Imperial threads, so you needn't worry about making anything that screws into anything else (aside from local laws, as applicable).

In the center of the carriage, I've saved the best for last. That's the power feed clutch, and it has three positions, instead of the expected two. That's because this machine has power feed on both the main axis and the cross-feed. Power cross-feed on a small bench machine like this is extremely unusual, and it's a terrific feature. If you have a lot of facing to do, or plan to do milling-like operations with big square pieces in the four-jaw chuck, power cross-feed is a real boon.

Speaking of accessories, Precision Matthews leaves nothing behind here. Included in the price, you get a 5" three-jaw chuck (with set of normal and reverse jaws), a 5" four-jaw chuck, an 8" faceplate, a follow-rest, a steady-rest, and best of all, an Aloris-style quick change tool post. Throwing in the quick change tool post is a real selling point for PM, and it's actually quite a nice unit. It comes with two regular tool holders, a cut-off blade holder, a knurling tool, and a boring-bar holder. This a real kick-start to your lathe tooling horde.

The quality suffers a bit in the accessory department. The chucks and faceplate seem well made, but the rests are hastily-cast hunks of cast iron painted blue. They don't fit the ways particularly well, and the adjustments are stiff and hard to set. These are certainly usable, but plan to spend some time tuning them up with a file (and oil, and possibly better hardware). The most maddening part of the steady rest is that you have to completely disassemble it to mount it on the lathe. The base clamp doesn't fit between the rails on the ways, so you have to thread it up from below. It can be modified to fit through from above, but this seems like an obvious oversight from the factory. No doubt these accessories are from the Weiss parts bin and no particular effort has been made to match them to this lathe.

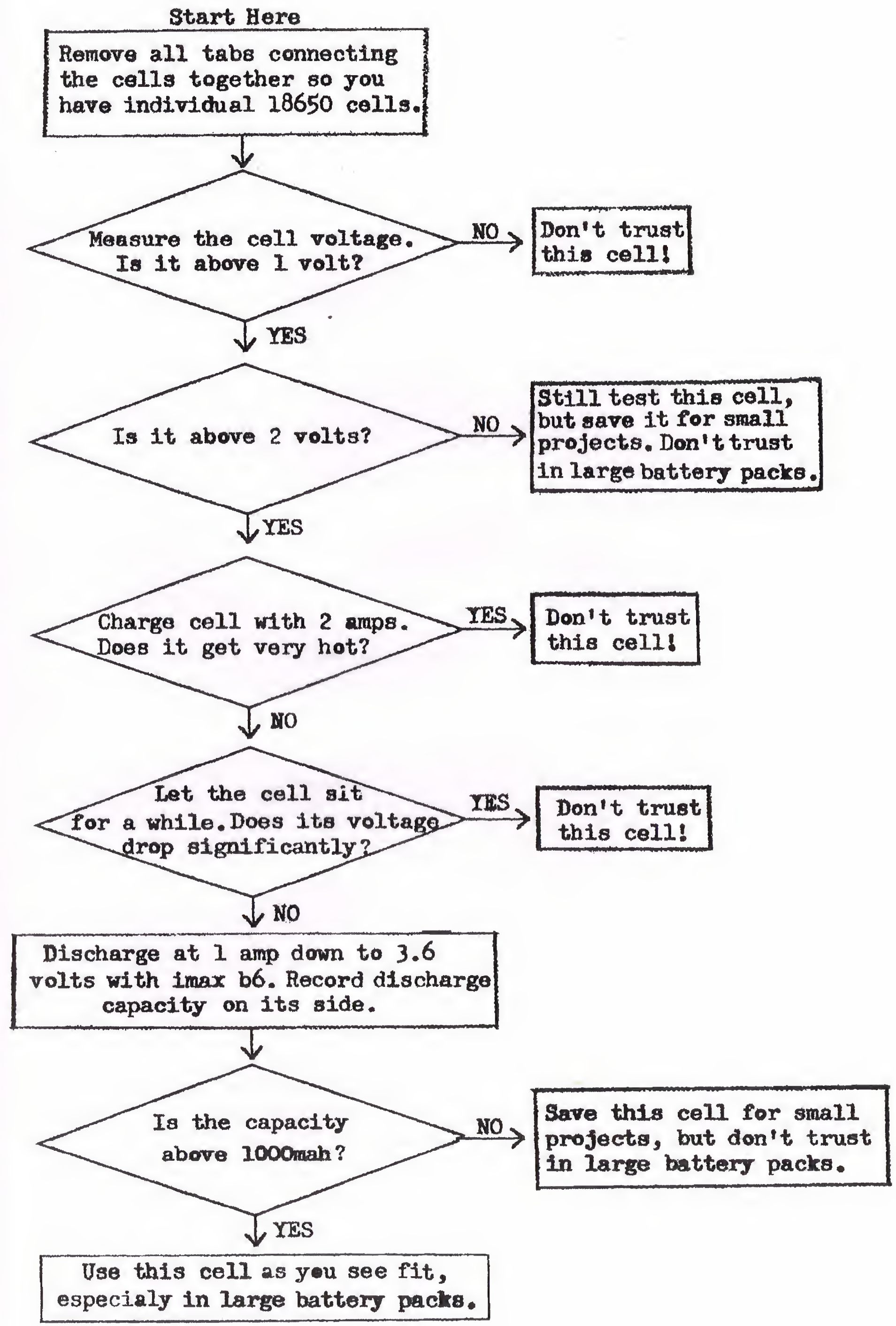
The lathe also comes with a little metal tool box (nice touch) with all the tools you need to work with the machine (and some who's purpose I still have not deduced).



Here we have various wrenches, spanners, allen keys, etc. In the toolbox, you can see the change gears, and the reverse jaws for the three-jaw chuck. The chuck key is spring-loaded, which is a very nice feature. Of the wrenches, you'll mainly use the large one for the tool post, and the middle-size one for setting the cross-slide angle.

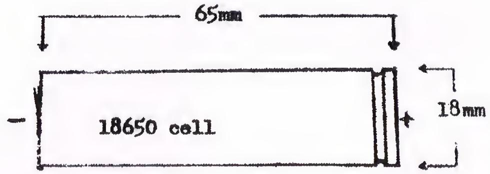
The chrome wrench on the left is not included. That's a cheap 17mm wrench I bought at the hardware store and cut the end off of, to make a permanent tool-post wrench. The included open-end wrench gets tedious pretty quickly when making tool-post adjustments.

Included but not shown is the world's worst oil can. That thing leaked more oil all over my bench than it ever applied to a machine. I replaced it with the quality Goldenrod can you see in the photo, and I wish I had done so sooner. Note that some models of Goldenrod can have a flared tip that doesn't fit the GITS oilers on this machine. Luckily, the tip unscrews, and it was a simple matter to mount it in the lathe and turn down the flare on the end. I recommend doing the same, and throw that factory oil can as far as you can manage. Perhaps bury it in the yard and grind salt into the earth so nothing ever grows there again. Bury a stone tablet above it, warning future generations of the evils of this vile oil spewing contraption.



THE TINKERER'S GUIDE TO THE 18650

By Rinoa   version 1.4



Since 1998, the Lithium-ion battery has dominated the world of energy storage. It replaced the weaker technologies such as Nickel-Cadmium and Nickel-metal hydride due to its reliability and higher operating voltage. This higher voltage allows the Lithium-ion cell to hold more Watt-Hours in the same space. The 18650 (eighteen-six-fifty) is the most prevalent Lithium-ion cell, so it is a good start for many DIY projects.

18650 cells can have a capacity ranging from 4 Watt-Hours to 12 Watt-Hours. They are fully charged at 4.2 volts, and fully discharged at 3.6 volts. Their chemistry has diversified and evolved over the decades leading to cells that specialize in capacity, power, and longevity. There has also been a steady increase in the capacity of 18650s over time. Most of these operate at the same voltage and wont be catastrophic if mixed, however LiFePo4 cells operate at a lower voltage and can not be mixed with other types. There are some specialized cells that can operate at 4.35 volts.

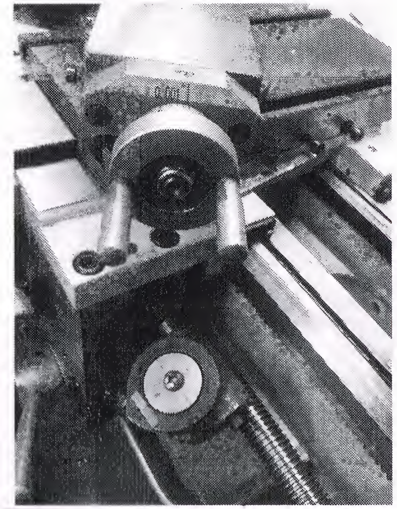
Inside an 18650 is a tightly wound coil of plates, this configuration is called a "swiss roll". The roll is housed within a durable metal cylinder that greatly increases durability. At the end is a cap that allows the cell's electrolyte to vent. Some well-designed 18650 caps can act as a fuse in case of failure.

19670 or "protected 18650" cells have a small monitoring circuit at one end that make the cells more fool-proof, however these cells aren't common.

How to test 18650 cells

You must test the 18650 before you use it due to the risk of failure and even deflegration. Here is a method i have developed over several years of experimentation.

I find the "Imax B6" does a good job with charging and discharging. Some knock-off Imax units can have programming issues that make the lithium discharge setting not work propperly. Try the NiCad discharge setting if you experience this. I set the NiCad cutoff voltage to 3.0v to take into account the voltage drop, this almost always results in the cell settling at 3.6v.

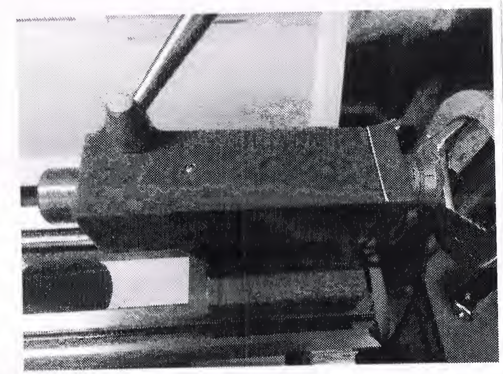


Lastly, we have the compound. It's about what you'd expect from a compound- plenty of angle adjustment, and graduated in thousandths. The two-handle style crank is nice for turning tapers with both hands. The action on mine is not as smooth as I would like. It has a couple of stiff spots in the travel. Perhaps I'll try taking it apart and tuning things up a bit.

Here's another view of the threading dial as well. It's technically an option on the Weiss machine, but Precision Matthews wisely includes it.

Down beside the cross-slide, you can see a rough-cut piece of aluminum sticking out. That's my homemade carriage locking wrench. They include an allen key for this purpose, since the lock is a simple cap screw. However, the allen key interferes with the gib screws on the cross-slide, making facing and parting operations a real pain in the ass. You have to keep removing and reinserting the allen key to lock the carriage for each pass. Instead, I cut the end off their key and pressed it into a hexagonal hole in a piece of aluminum scrap. This makes a low-profile wrench that slides neatly under the gib screws no matter what position the lock is in. The PM1022V has its share of little annoyances like this.

Down on the tailstock end, all is as you would expect. The crank is very free spinning, and has a good mass to it. This is nice because it means you can spin the ram in and out very quickly. The ram is marked in both metric and Imperial (no doubt to save on parts costs), but the crank scale is Imperial only.



The tailstock is adjustable laterally, for turning long tapers with the offset-tailstock method. I'm not a fan of messing with the precision alignment of the tailstock and spindle, so I haven't personally tried this.

Okay, you have all gory the details that the internet won't tell you. Now let's talk about the upsides and downsides of this lathe. I will say that it's surprisingly well made for a machine of this price point. All the controls are smooth and precise, and I find cuts to be accurate and repeatable. In the 10-12" range that I've been working, I have not detected any taper. Alignment from the factory seems very good. It's possible that Precision Matthews does some tuning on these machines before shipping them out. They did, for example, install the quick-change tool post for me and included the Weiss four-way post in a box.

The ways are a double-prismatic design and induction-hardened, which is certainly nice at this price point. The finish on them is flawless, as far as my primitive brain can tell.

THIS SPACE LEFT INTENTIONALY BLANK.

The working area is where we start to see the cost-cutting. 22" between centers is not going to win any awards, especially for a machine that is more than twice that in overall length. You also start to see the limits of travel on things pretty quickly. For example, the cross-slide travel of 5" is adequate, but you will hit that limit when facing if you don't set your tool post angle to maximize reach on the face of the part. The meager 3" travel on the compound will also limit the tapers you can cut using the convenient compound-feed method. You won't be turning new morse tapers for your tailstock with this compound. There are other methods, of course, such as the aforementioned offsettable tailstock. Still, a little more compound and cross-feed travel would go a long way here.

The controls are mostly smooth, but as I mentioned, the compound has sticky spots in the travel on my machine, and the backlash on the carriage feels higher than necessary. At some point I may disassemble all this to see what can be improved.

The included quick-change tool post is nice, but the locking handle interferes with the longitudinal mounting position. Mounting a boring bar or similar tool in that position requires a bit of a dance of jockeying the lever to get the tool holder past it. I've also found the rotation of the tool post on the top surface of the compound to be a bit sticky. There's one spot in particular where the spring-loaded detent tends to snag. You notice it only when spinning the tool around 180° to check tool bit height against the tailstock. Some radiusing with a file on that detent would likely resolve this.

Horsepower-wise, I would describe this machine as "pretty good". It handles 80 thou depths of cut in 1018 steel without complaining too much, but you are effectively limited to High Speed Steel tooling. I spent some time experimenting with carbide insert tooling, and I couldn't get good finishes. Carbide demands minimum speeds and depths of cut that this machine doesn't have the horsepower to achieve. The tradeoff is that electronically-controlled variable speed, however, which is a dream. I have built projects large and small on this machine, and have yet to touch the change gears. Short of very specific thread-cutting jobs, I can't see ever needing them.

The power cross-feed is an amazing feature, of course, but I will say that the clutch has a bit of room for improvement. It's not clear what the clutching mechanism is, but it feels more like a half-nut than a friction clutch. The engagement is a bit rough, and I worry it may stress the leadscrew. Time will tell. The disengagement is nice, however. Very positive-feeling and confidence inspiring when power-feeding towards the chuck and trying to disengage as late as possible.

My single biggest complaint is the terrible digital tachometer. I don't know if they are all this poor, or if there's something wrong with my unit. I've learned to adapt to it mentally, but it's disappointing to say the least. At some point I may disassemble the head and try to figure out where the failure is. A digital tach is not a difficult thing to build, so it's mystifying why this one is so bad.

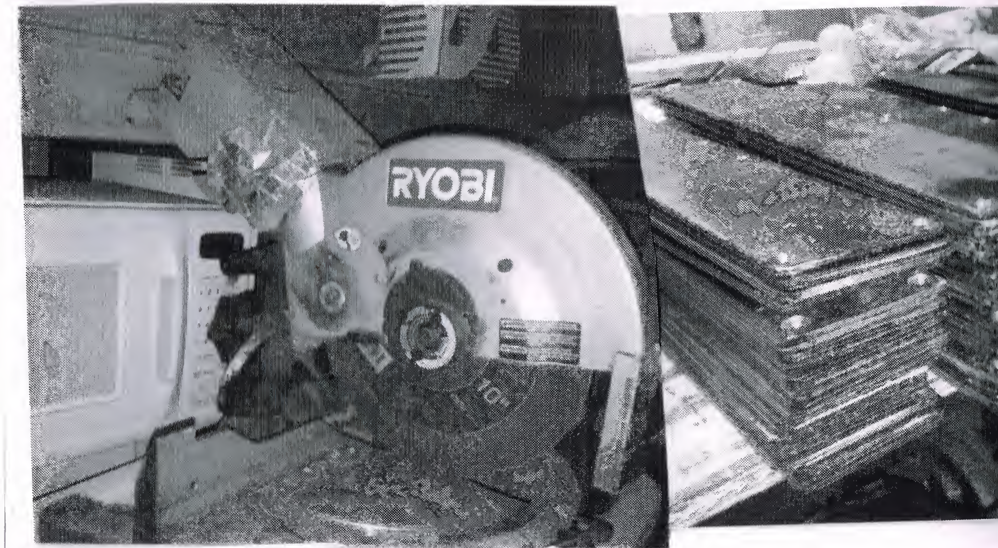
Overall, I think this machine is a terrific value for the money, and a lot of lathe for the hobbyist. While it may not have the power and cachet of restoring an old floor-standing Hendey you found on craigslist, the fact is this machine is very capable, arrives ready to make chips, and is a great introduction to the mad science of machining.

For more information on this lathe, check out my blog at http://www.quinndunki.com/blondihacks. You can see some of the projects I've been making, and see what it was like to receive and set up this machine.

WWW.QUINNDUNKI.COM/BLONDIEHACKS

"Abrasive Saw Converted to Dry Cut"?

No no no. You're going at it all backwards. Starting with the wrong foundation and headed in the opposite direction ya see. Lemme show you..

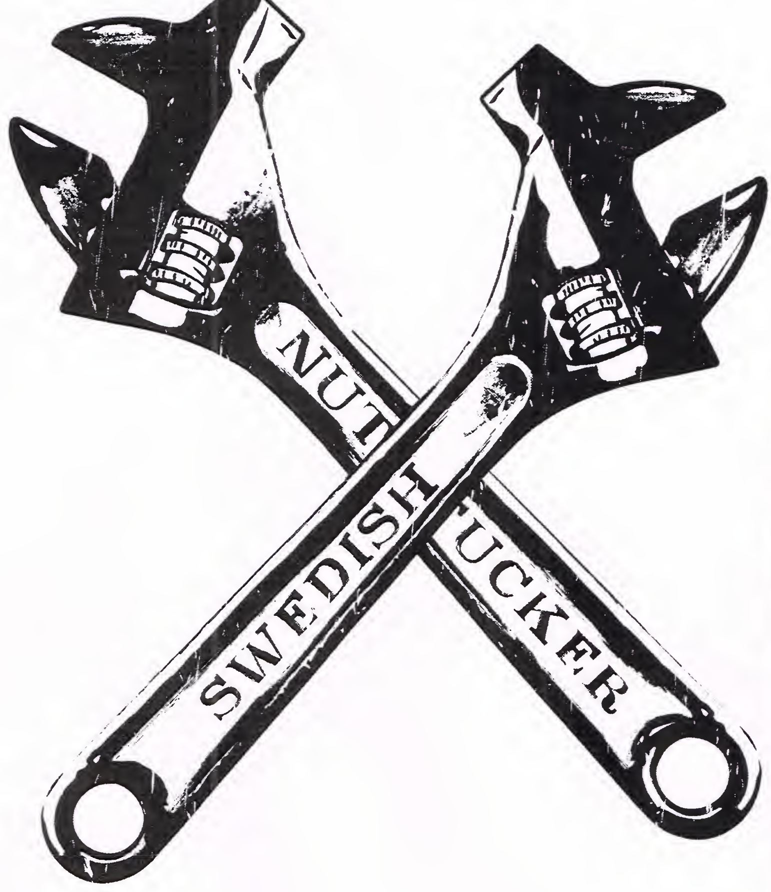


Take the cheapest, most disposable chop saw you can find, throw in an abrasive wheel, start yer job. Don't worry about the plastic, it's a self-clearancing device at this point, you just replace any plastic that melted or disappeared with some computer PSU cases, alum tape, and rebar tie wire. No problem. You gotta shim the back of the fence after a few cuts 'cause wood blades don't shrink as they're used. And, gloves help with the red hot metal that is clampless.

Why would you go back to a saw with teeth like a damned lumberjack when you could have this magnificent fire hazard?

This was my actual abrasive saw for 3 years until I picked up a Milwaukee abrasive saw at a dead grandpa "kids just want it gone so they can park their SUVs" sale. Loaned it to some highschoolers building robots and the fools burnt the trigger out on me by feathering it, so in a pinch I "converted" a $5 DeWalt dump special the same way for 8 hours of chopping I needed to do a few weeks ago. No ~~regrets~~ NO RAGRETS

TAP CHART



TAP DRILL SIZES

TAP SIZE	DRILL SIZE	DECIMAL
4-40	43	0.0890
6-32	36	0.1065
8-32	29	0.1360
10-24	25	0.1495
10-32	21	0.1590
12-24	16	0.1770
1/4-20	7	0.2010
1/4-28	3	0.2130
5/16-18	F	0.2570
5/16-24	I	0.2720
3/8-16	5/16	0.3125
3/8-24	Q	0.3320
7/16-14	U	0.3680
7/16-20	25/64	0.3906
1/2-13	27/64	0.4219
1/2-20	29/64	0.4531
9/16-12	31/64	0.4844
9/16-18	33/64	0.5156
5/8-11	17/32	0.5312
5/8-18	37/64	0.5781
3/4-10	21/32	0.6562
3/4-16	11/16	0.6875
7/8-9	49/64	0.7656
7/8-14	13/16	0.8125
1-8	7/8	0.8750
1-12	59/64	0.9219
1-14	15/16	0.9375

PIPE TAP DRILL SIZES (NPSC)

TAP SIZE	DRILL SIZE	DECIMAL
1/8-27	11/32	0.3438
1/4-18	7/16	0.4375
3/8-18	37/64	0.5781
1/2-14	23/32	0.7188
3/4-14	59/64	0.9218
1-11-1/2	1-5/32	1.1562
1-1/4-11-1/2	1-1/2	1.5000
1-1/2-11-1/2	1-3/4	1.7500
2-11-1/2	2-7/32	2.2187
2-1/2-8	2-21/32	2.6562

IF IT AIN'T BROKE, TRY HARDER

Diode Press