Dust Sniper (quiet extractor system)

by **bongodrummer** on March 22, 2010

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BongoDrummer is founder and member of Flowering Elbow. He loves to learn about, invent, and make things, particularly from waste materials.

Intro: Dust Sniper (quiet extractor system)

In this project we turn a bunch of old free stuff, including two old household vacuums into what is arguably the most useful and necessary of workshop tools: *the dust extractor*. But why stop there? Lets make a really fantastically effective dust extractor, one that is whisper quiet, never stops sucking or plagues you with blocked filters, one that is versatile enough to take dust from a variety of power tools, one that turns on and off on its own so you never forget, and most important of all, one that does a good job of extracting the small - most deadly - particulates from the air you breath... Step forth, 'The Dust Sniper'.

This project was borne out of my dissatisfaction with commercially available dust extractors. After a fair bit of research I purchased one of the more expensive 'quiet' workshop vacuums, and was not happy with its performance (I sent it back unused after taking a dB reading of it). In exasperation at the dusty noisiness of it all, and wanting to re-use materials and spend as little as possible, I began the Dust Sniper (DS) project.

This DS ended up costing about £20 total. So it is possible to reused a bunch of stuff destined for landfill and end up with an aesthetically pleasing and useful tool-workbench. And of course we can learn loads about sound, cyclones and dust related jazz along the way. Because the DS's parts are mostly recycled, there is no comprehensive list of materials up front, instead I will give tips as we go along suggesting possible reclaimed bits that will do the job and where you might find them (if you don't care *why* we chose certain materials and just want a 'scavenging list', check out the last step).

My kingdom for some silent clean air

I'll throw it out there to begin with, most dust extractors are bad. Even the expensive ones, like the Festool, extract a continuing fee, needing regular bag and filter changes to keep working properly. The less expensive, well... lets just say they can be seriously bad for your mental and physical health, as you will find out if you follow along with this Instructable.

The Dust Sniper (DS) is effective and very quiet - the two main goals I had when starting this project. It does, however, fulfil these requirements at a cost. Namely, it is very heavy and big (compared to your average canister style vac), so it won't be perfect for everyone. This isn't necessarily the disaster you might think though. In fact it can be darn right useful if we use the DS as a mobile work surface. That way we will end up with nice clean air, a quiet place to create our mad jazz, and a super sturdy, rollable worktop thrown in! Ideal if you are still setting up a workshop, as I am.

Image Notes
1. The Dust Sniper (DS) - noiseless extractor and work surface. It has two hose outlets and an automatic switch/power feed for power tools.

Image Notes
1. The old drop box setup, accompanied by the famous sidekick, Mess.
2. This connected up to a (noisy) vacuum, which needed constant bag changers, grrrr. Its filtration was also unhealthily inadequate.

Image Notes
1. Control panel, power tool socket, and vacuum hose ports.
2. Double cyclone separation area.
3. Solid work surface.
4. Vacuum housing: contains noise reduction treatment for incoming and exiting air, and double box isolation.

Step 1: Noise Loves Dust

We might not often think of noise and dust being co-conspirators, but they do help each other to cause workshop misery. Dust, particularly for those that do much woodwork with power tools, gets everywhere: in the air, in your lungs, and in the belts and bearings of our tools. Power tools, like an orbital sander, a jigsaw, a planer, or a router create a lot of dust and without good extraction, and sometimes even with it, the quantity of dust that gets into our tool's workings is enough to cause big increases in noise levels.

Lots of noise is bad. As anyone who reads the FE blog will know, I am particularly fastidious about cutting down on noise (see for example, my quest for the quietest bandsaw). I can think of a load of good reasons for my desire for quiet tools, but probably the most important, and one that anyone using power tools should take seriously, may be gleaned from the following:

> "*The first handicap due to noise-induced hearing loss to be noticed by the subject is usually some loss of hearing for high-pitched sounds such as squeaks in machinery, bells, musical notes, etc. This is followed by a diminution in the ability to understand speech; voices sound muffled, and this is worse in difficult listening conditions. The person with noise-induced hearing loss complains that everyone mumbles. High frequency consonant sounds of low intensity are missed, whereas vowels of low frequency and higher intensity are still heard. As consonants carry much of the information in speech, there is little reduction in volume but the context is lost. However, by the time the loss is noticed subjectively as a difficulty in understanding speech, the condition is far advanced.*" (p146 Engineering Noise Control)

Ok, so dust often equals more noise. How ironic that adding a dust extractor can be so noisy then. Lets leave 'noise' at that for now - for more noise related background and nerdy theory, checkout step 8.

Dust is a serious problem.

Actually aside from helping along hearing loss, dust can cause bigger problems. At this point I am going to go ahead and assume that everyone is comfortable with the idea that dusty lungs are bad and to be avoided. The problem is *most people don't realise just how dangerous dust is,* especially to us lone inventors, DIYers, and makers, who do not have the protection of government legislation, which enforces air quality standards* in factory and workplace environments.

At home, people tend to use cheap and ineffective extraction systems and/or pathetically inadequate masks (or no protection at all). I must admit from time to time I have been guilty of this, not wanting the noise of the vac or being in a rush - very bad! The precautionary principal should definately apply here. Particularly until you have finished your DS, *a good dust mask, goggles and ear defenders are your friends!* For more info on dust and health check out this post on The Dangers of Wood Dust and this table of wood dust toxicity levels.

> **It is interesting to note how these standards are constantly being raised, as more research is done on the effects of wood dust. See, for example, Jette B. Lange, 2008 "Effects of wood dust: Inflammation, genotoxicity and cancer"*

Image Notes
1. Dust must be eradicated because it is in cahoots with noise. Both are EVIL!
2. The Dust Sniper (DS) doing its thing.

Step 2: Cyclonic filtration - Overview

The details, instructions, and measurements of the actual cyclones have been up on the Flowering Elbow website for some time. Rather than have them repeated here, check the cyclone build guide steps on flowering elbow.

Image Notes
1. First draft of one of the cyclones.
2. These will secure the cyclone by attaching to the dust sniper's outer box
3. This connects up to the vacuum - is is the 'air outlet'.
4. The dusty air goes in this chute.
5. I have called this part the 'cyclone upper body'.
6. This is the cone.

Image Notes
1. First test of the cyclone mk1. Inlet hose with its crude 'washing up liquid and duct-tape' attachment.
2. Goes off to the vac.
3. Look inside - here we see some good old fashioned helter skelter dust, flying to its true home - the waste container.
4. Collect my pretty, collect!

Step 3: Noise reduction - background information (and some theory you can skip)

So when I was building this, I spent a while researching about noise, sound and jazz, if you're into that kind of thing too read on... If you are a sound wizz already, look away. If you are bored easily and/or just want to hammer things together you can skip it too.

So what Is sound anyway?

Every school kid will tell you sound is basically the result of things getting excited and vibrating. Everything vibrates anyway, but if you do something like hit the table in front of you (assuming there is one), you change the way it vibrates and it passes on that vibration to the air. In the air we can imagine a series of high and low pressures, which in turn vibrate the internal gubbins of our ear - causing us to register what we call sound.

As with most subjective things in life we humans like to try and measure and quantify these vibrations. The quantity most often used to measure the "strength" of a sound wave is the 'sound *pressure* level' (SPL or sometimes Lp, not to be confused with 'sound *power* level') measured with respect to a standard reference pressure of 2 ×10?5Pa.

SPL is expressed in dB (or Decibels) which are a logarithmic unit, so that for every 6 dB decrease in volume, the sound is perceived as being half as loud.

Blocking out Nasty Sound (noise)

When an airborne sound wave encounters a solid blocking its path, it effectively bashes into it, the disturbance causes the solid to vibrate. This vibration is transmitted through the solid. Now on the other side, the surface acts as a new emitter by disturbing the air and producing a new sound wave. By this process the sound effectively passes through the barrier. The efficiency of the transmission depends on the physical properties of the solid in particular, its mass.

How much of the sound is blocked out? Well, if L1 dB is the sound pressure level on the noise source side of the partition and L2 dB that on the other side, then the Sound Reduction Index (SRI) or Transmission Loss (TL) is defined as:

TL = SRI = L1 - L2 dB

The transmission loss, or SRI, varies with mass and frequency. In general the higher the frequency the better the sound is blocked, hence the higher the SRI will be. There are exceptions to this when partitions start vibrating at their resonance frequencies. More on that later, for now all we need to know is that:

1. For precision work (or for special noises with a particular frequency content), the SRI index is quoted for particular frequencies, normally in octave bands.

2. For many purposes and for convenience, the SRI is quoted as a single number, which is the average SRI between the frequencies 100 – 3,150 Hz. The resultant sound level is then quoted in *dB(A)*. (A) presumably standing for average.

The Mass Law

The so called 'mass law' simply states that by increasing the mass of a partition, we increase the transmission losses or SRI of the partition proportionally. So mass is generally a good thing when we are trying to reduce sound (think about the useful properties of lead). The mass law however only applies to a given material, over a specific range of frequencies. It could be, for example, that a deep bassy noise (low frequency) travels through a panel with very little reduction in volume even when you increase the mass of a panel. Indeed it is often the case that low frequency noise transmission is more effected by the *stiffness* of a material.

Again, this all depends upon the material in question. A lead curtain's behaviour, for example, is essentially mass-law controlled over the entire audible frequency range. For a more geeky explanation along these lines, check out "Engineering Noise Control: Theory and practice, Fourth edition, David A. Bies and Colin H. Hansen (2009)"

For us, the mass law is a good demonstration of the compromise we are going to make between light weight and sound reduction. "[*We] should rule out the use of low density fibreglass (such as insulation batts used in house ceilings), as well as typical polyester blankets. In fact polyester blankets are likely to be completely ineffective.*" (Bies & Hansen, 2009 p 386). Although if we can compress them a lot and have them to hand anyway, it is a different story...

Building less symmetrical and more random please

As with double or triple glazing, it is important not to have all the panes the same thickness, as this accentuates the dip in the TL (transmission loss) curve at critical frequencies. The same goes for our purposes when we construct a double wall box. It is better to use different materials as well as thicknesses for the different layers. That way we will block out a broader range of frequencies.

While preventing resonance by mixing materials and shapes is good, it is also well worth incorporating an air (or foam) gap, which prevents the direct transmission of vibration. Vibration is easily transmitted to other materials by mechanical coupling - avoid if possible.

> "*Acoustic isolation is generally accomplished by providing as wide a gap between the panels as possible and by filling the gap with a sound-absorbing material, while ensuring that the material does not form a mechanical bridge between the panels.*" (Bies & Hansen, 2009, page376)

Absorbing Sound

The nature of the surfaces on which the sound wave falls determines how much will be absorbed. Hard rigid non-porous surfaces like glass, marble or concrete, provide the least absorption and are thus the best reflectors. Soft porous surfaces and those which can vibrate absorb more of the sound. When sound energy is absorbed it is converted into heat energy, but this energy is very small so no need to worry about overheating caused by sound.

The amount of sound absorbed is proportional to the area of the material concerned. So if S is the sound absorbed and A is the area of the exposed material, we can say that S is proportional to A. In general this means that rough surfaces are better at absorbing than finely finished ones. Further,

S = aA

where: a is the *Absorption Coefficient.*

The Absorption Coefficient is a number always less than 1 (because it has no units, it is a ratio) and is small for a material that reflects most sound and large for a material that absorbs most of the sound incident upon it. It is determined by the amount of sound absorbed by a material divided by the sound energy arriving at the surface (so a = absorbed sound energy / incident sound energy). Just for interest the table below (from the Sengpielaudio website) shows a bunch of absorption coefficient values for various materials. As you can see, different materials are better or worse at absorbing different frequencies.

Floor Materials	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
concrete or tile	0.01	0.01	0.15	0.02	0.02	0.02

linoleum/vinyl tile on concrete	0.02	0.03	0.03	0.03	0.03	0.02
wood on joists	0.15	0.11	0.10	0.07	0.06	0.07
parquet on concrete	0.04	0.04	0.07	0.06	0.06	0.07
carpet on concrete	0.02	0.06	0.14	0.37	0.60	0.65
carpet on foam	0.08	0.24	0.57	0.69	0.71	0.73

Seating Materials	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
fully occupied - fabric upholstered	0.60	0.74	0.88	0.96	0.93	0.85
occupied wooden pews	0.57	0.61	0.75	0.86	0.91	0.86
empty - fabric upholstered	0.49	0.66	0.80	0.88	0.82	0.70
empty metal/wood seats	0.15	0.19	0.22	0.39	0.38	0.30

Wall Materials	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Brick: unglazed	0.03	0.03	0.03	0.04	0.05	0.07
Brick: unglazed & painted	0.01	0.01	0.02	0.02	0.02	0.03
Concrete block - coarse	0.36	0.44	0.31	0.29	0.39	0.25
Concrete block - painted	0.10	0.05	0.06	0.07	0.09	0.08
Curtain: 10 oz/sq yd fabric molleton	0.03	0.04	0.11	0.17	0.24	0.35
Curtain: 14 oz/sq yd fabric molleton	0.07	0.31	0.49	0.75	0.70	0.60
Curtain: 18 oz/sq yd fabric molleton	0.14	0.35	0.55	0.72	0.70	0.65
Fiberglass: 2" 703 no airspace	0.22	0.82	0.99	0.99	0.99	0.99
Fiberglass: spray 5"	0.05	0.15	0.45	0.70	0.80	0.80
Fiberglass: spray 1"	0.16	0.45	0.70	0.90	0.90	0.85
Fiberglass: 2" rolls	0.17	0.55	0.80	0.90	0.85	0.80
Foam: Sonex 2"	0.06	0.25	0.56	0.81	0.90	0.91
Foam: SDG 3"	0.24	0.58	0.67	0.91	0.96	0.99
Foam: SDG 4"	0.33	0.90	0.84	0.99	0.98	0.99
Foam: polyur. 1"	0.13	0.22	0.68	1.00	0.92	0.97
Foam: polyur. 1/2"	0.09	0.11	0.22	0.60	0.88	0.94
Glass: 1/4" plate large	0.18	0.06	0.04	0.03	0.02	0.02
Glass: window	0.35	0.25	0.18	0.12	0.07	0.04
Plaster: smooth on tile/brick	0.013	0.015	0.02	0.03	0.04	0.05
Plaster: rough on lath	0.02	0.03	0.04	0.05	0.04	0.03
Marble/Tile	0.01	0.01	0.01	0.01	0.02	0.02
Sheetrock 1/2" 16" on center	0.29	0.10	0.05	0.04	0.07	0.09
Wood: 3/8" plywood panel	0.28	0.22	0.17	0.09	0.10	0.11

Ceiling Materials	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz

Acoustic Tiles	0.05	0.22	0.52	0.56	0.45	0.32
Acoustic Ceiling Tiles	0.70	0.66	0.72	0.92	0.88	0.75
Fiberglass: 2" 703 no airspace	0.22	0.82	0.99	0.99	0.99	0.99
Fiberglass: spray 5"	0.05	0.15	0.45	0.70	0.80	0.80
Fiberglass: spray 1"	0.16	0.45	0.70	0.90	0.90	0.85
Fiberglass: 2" rolls	0.17	0.55	0.80	0.90	0.85	0.80
wood	0.15	0.11	0.10	0.07	0.06	0.07
Foam: Sonex 2"	0.06	0.25	0.56	0.81	0.90	0.91
Foam: SDG 3"	0.24	0.58	0.67	0.91	0.96	0.99
Foam: SDG 4"	0.33	0.90	0.84	0.99	0.98	0.99
Foam: polyur. 1"	0.13	0.22	0.68	1.00	0.92	0.97
Foam: polyur. 1/2"	0.09	0.11	0.22	0.60	0.88	0.94
Plaster: smooth on tile/brick	0.013	0.015	0.02	0.03	0.04	0.05
Plaster: rough on lath	0.02	0.03	0.04	0.05	0.04	0.03
Sheetrock 1/2" 16" on center	0.29	0.10	0.05	0.04	0.07	0.09
Wood: 3/8" plywood panel	0.28	0.22	0.17	0.09	0.10	0.11

Miscellaneous Material	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Water	0.008	0.008	0.013	0.015	0.020	0.025
People (adults)	0.25	0.35	0.42	0.46	0.5	0.5

So you get the idea. Armed with all that knowledge you are ready to scrounge up some free materials and get building, right?

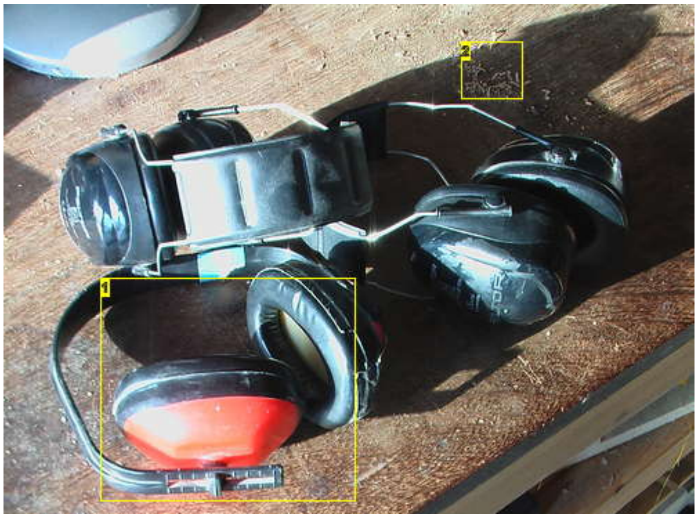


Image Notes
1. They may look ridiculous, be uncomfortable and annoying, but when using noisy tools these are your friends, and your friend's friends when they come to help.
2. Dust will soon be no more, Bwahahahahaaaa!

Step 4: Enclosure construction - material choice & general notes

On average, people in the UK trade their kitchen in for a new model every four to five seconds (I may have made that up) - that is a whole lot of kitchen worktops being thrown out and replaced. Indeed, composite wood counter worktop seems to be one of the most commonest things to pop up in skips here there and everywhere. That was of course, until I thought of using it to make part of the enclosure - being MDF'esque, dense, stiff and heavy, it should be a useful material for sound proofing. After looking and incredulously not finding any kitchen worktop for some time ("Credit crunch curtailed peoples propensity towards kitchenocide, discuss."), freecycle came up trumps and delivered an ample bounty of fire door material.

When I went to collect the two freecycle fire doors, they were actually getting rid of four of them (nice big heavy strong composite things), some kitchen worktop, and some useful bits of hardboard too - score! I ended up using some of these bits to make the DS and having plenty to spare besides.

When it comes to making sound enclosures, those 'audiophiles' and DIY speaker builders are somewhat ahead of the game - by that I mean they are quite happy to try experimenting with unusual materials and techniques and also perfectly willing to share their experience and knowledge. We can learn a fair bit from their build techniques and material preferences.

Here are some things that speaker enclosure makers experiment with that you might be able to scavenge or otherwise get your hands on:

- Plywood (without voids is best), mdf, hardboard, etc. All these laminated sheet materials are rigid and easy to construct into airtight enclosures - look out for them turning up in skips.
- Plasterboard - Used extensively in construction, can be laminated with acrylic latex-silicone caulk to provide very effective damping.
- Sand. This is well known as a good dampener of sound, I used some of this in the DS and also to damp my bandsaw. Best of all it is free if you know where to look (a beach might be a start, though in the UK it is technically not legal to just take stuff off beaches).
- Oil based plasticine. This is the stuff that never really dries. I have no personal experience with this, but apparently it can be rolled into flat sheets and adhered to panels to damp sound.
- Scrap steel, can be used to stiffen up panels, and to change their resonant frequency. angle iron makes excellent bracing because it can easily be screwed (and glued with damping glue).

General construction points:

1. Use lots of glue to make joints air tight. The reason for this is twofold: one, so that we can control the flow of air leaving the vacuums and make sure it is filtered and clean, and two, so that no sound escapes. Even little cracks can make a big difference to the sound reduction index on an enclosure - think about a car window - opening it just a little makes a big difference to the noise you can hear outside.
2. Ensure straight well fitting edges - all gaps must be filled.
3. MDF and chipboard resonate at averagely 150-400 Hz, with the strongest resonances usually at 250-300 Hz. All materials when they vibrate produce sound waves, so If we don't brace it properly we may have small movements in sides of the DS, but because of the area involved even this could be quite loud.
4. We need to treat both structural borne sound (so called 'impact sound') and airborne sound. The first involves mechanically isolating any sources of vibration with the main structure of the enclosure. The second, ensuring that we have good rigidity and mass.
5. As I already mentioned, when we add bracing to panels, we want to divide up the various panels into sections of unequal area. If not there is a chance that you will have several panels with a common resonance frequency that will combine (and sound loud).

Image Notes
1. Jackpot! Went to collect two unwanted fire doors from freecycle - they actually had 4, and a few other useful bits of mdf and kitchen worktop they wanted rid of.
2. Called in at my parents on the way to pick up an old judo/aikido mat I had stashed away when our club threw it out.
3. Extra bonus - find some random old lead sheet (!) lying about in parents shed.

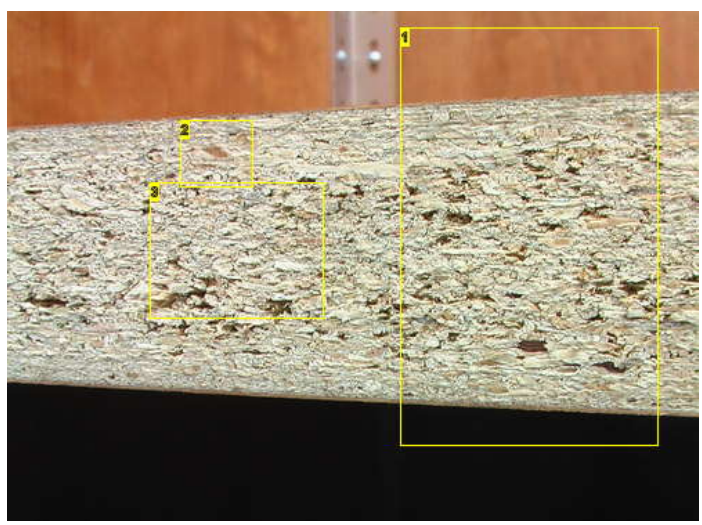


Image Notes
1. This is a cross sectional shot of the Fire door material. Notice the duel density.
2. High density outer layers
3. Less dense inners.

Step 5: The Inner Enclosure

The inner box will not be bearing much weight, and to make the space usage sensible, it is not a massive construction of fire door or kitchen worktop material. Check out the photos for build ideas.

A Note on the Enclosure and Heat

"But won't the motors overheat if they are in an enclosure," I hear you cry. Hold on there, vacuum motors are something of a special case when it comes to cooling. They blast all the air that they suck in through the motor windings (after passing it through a filter to remove the dirt). So long as any subsequent filters (post-motor filters) remain unblocked, this system works perfectly, and means that vacuum motors can be much smaller than they would otherwise be, and wrapped in a convenient insulative plastic case. Incidentally, this is why vacuum motors make very poor motors if we try and re-purpose them for anything other than air moving applications.

For the DS this means that we need to keep a reasonable exit path open for the air being pumped out of the motor, and that we can expect warm to hot air to be travelling this path (step 11 & 14 deals with this). But it also means that we don't have to worry about trying to blow in cool air to pass over the motor, the vacuums themselves do a very good job of that already. Almost all vacuums are fitted with a heat sensitive safety switch, that will cut power if the motor is overheating. If yours has not, it is probably worth adding one, or finding a different vacuum to use.

***MDF warning*:**

MDF is typically about 9% urea-formaldehyde resin, it is the stuff that bonds it all together. When we cut it to size we effectively pump out a load of particles of this stuff. Dust is a big MDF hazard (read the first few steps for the lowdown on dust badness). But there is another consideration, particularly if you are sensitive to formaldehyde, and that is the long term 'off gassing' MDF does. Formaldehyde-free MDF does exist, but if we are scavenging our materials one must assume the worst. In this design the 'off gassing' will hopefully be less of a problem as the inner box will be sealed in. In general though, you can control these emissions by finishing the surface with a veneer or a sealing paint, and this is a good practice whenever you make MDF things that will be in living areas.

***Lead warning*:**

Lead is great! It can practically be 100% recycled, has fantastical blocking properties, and is comic book style heavy. Lead is not good however, inside the human body! A tiny bit inside, is way more than we want. Luckily it only really gets in there if we are careless. It is best to handle the stuff with thick gloves - you don't want to cut yourself with lead! Wash hands before you eat after handling the stuff. Do not do anything that creates lead dust, unless you have the ultimate dust extractor (presumably you wouldn't be making this in that case!), are wearing a quality ventilator and goggles, and have a way of properly disposing of the dust. I would advise against doing anything that might make lead dust, and really you don't have to because it is so soft - it cuts with tin snips. Don't be tempted to melt it, unless you have the correct safety equipment - the vapour is another way it can get inside you.

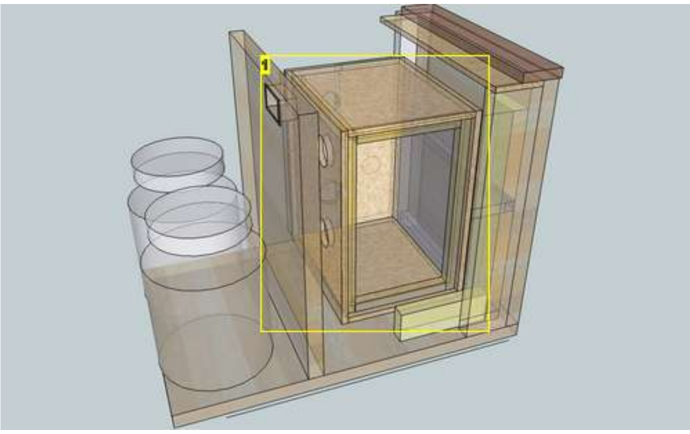


Image Notes
1. This inner enclosure is the bit we are working on now

Image Notes
1. This part of the board is going, as it seems to have had moisture damage.
2. These bits of mdf will make the two vertical sides of the inner box.

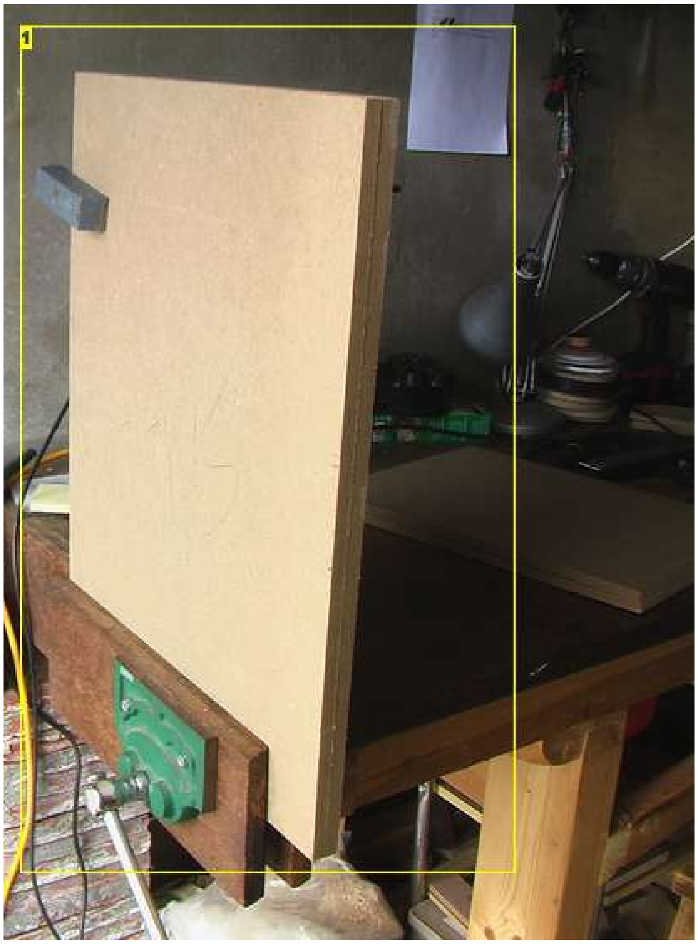


Image Notes
1. After cutting to size with the jigsaw, I clamp them together and plane the four edges, so they are flat and smooth, and exactly the same dimensions.

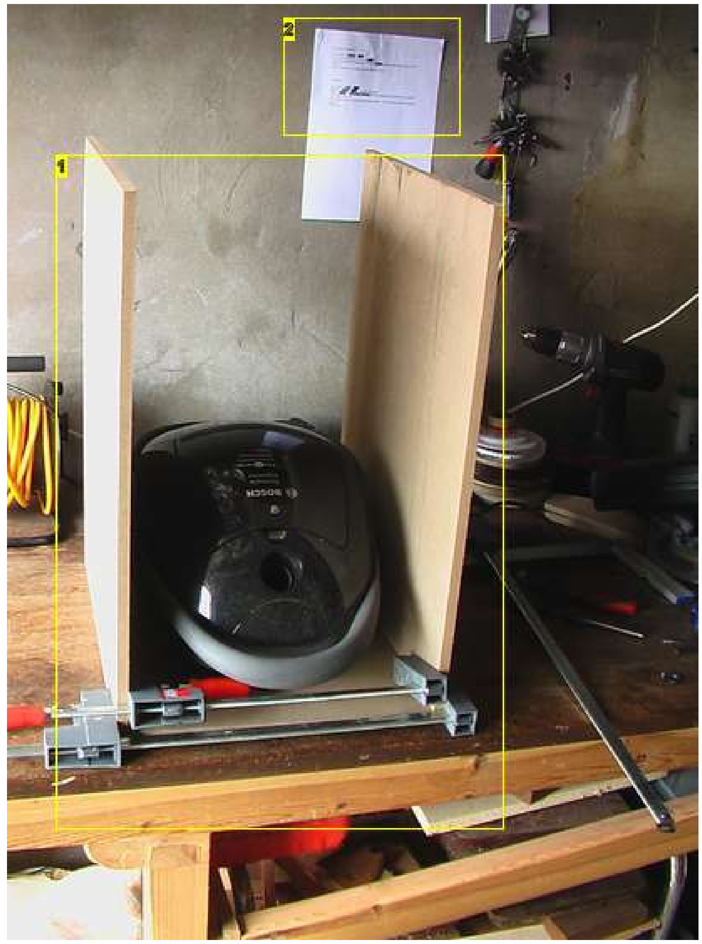


Image Notes
1. Two more bits are cut and planed to make a top and bottom. Here is one (the bottom) rigged up temporarily to check the sizing... It is about right, just enough room around the edges for some spiky foam (and possibly a thin layer of lead!).
2. After doing the SketchUp design it is nice to make a 'cutting wish list' and stick it up for reference.

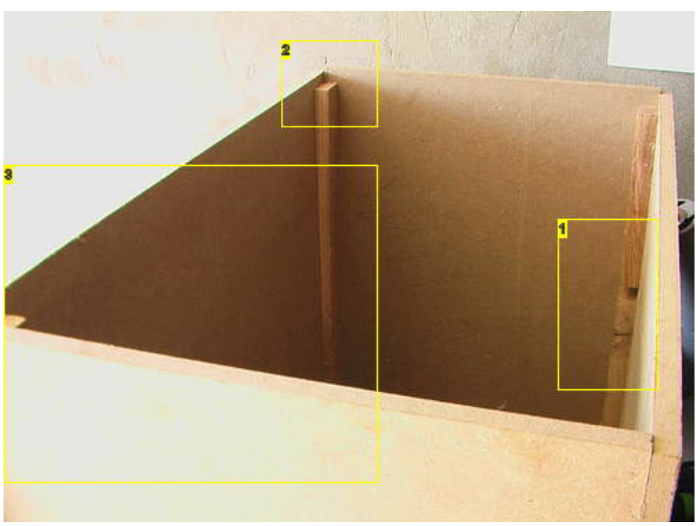


Image Notes
1. One of the interesting things about sound attenuation, is that it doesn't necessary help to make bracing symmetrical - quite the opposite in fact. So it is a great chance to use up odds and ends.
2. The front cover is going to fit on here.
3. I clamp, pre-drill and then screw together the box, before disassembling it again, and adding glue.

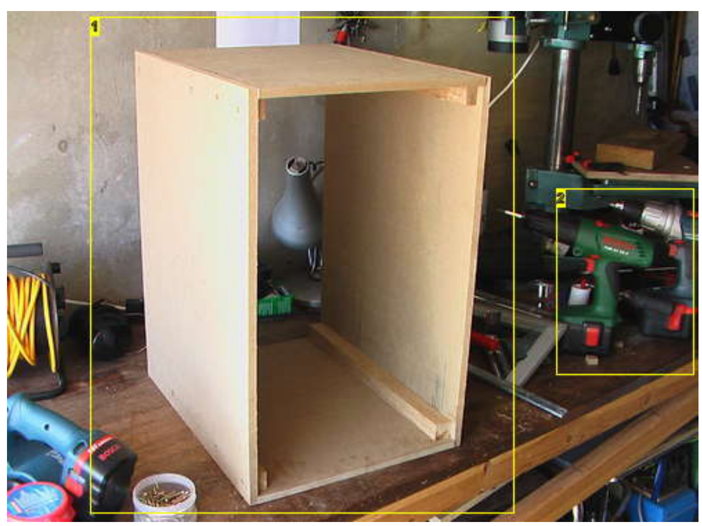


Image Notes
1. Size is about right for the two vacuum cleaners.
2. Super drills at the ready.

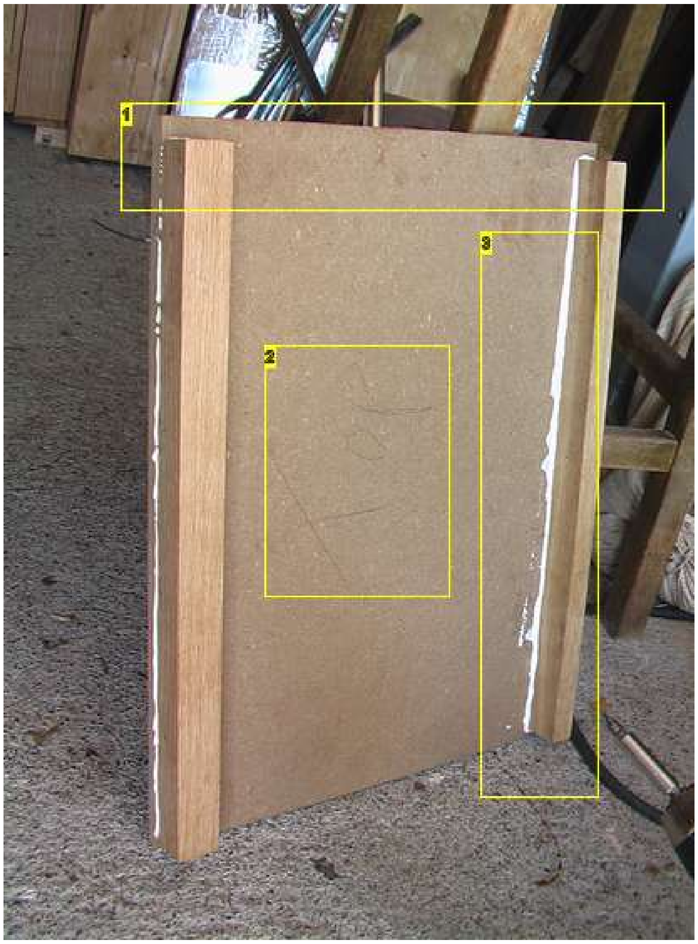


Image Notes
1. The gap at this side needs to be the same so the front can fit on and seal up nice.
2. Labelling helps!
3. Glued and screwed.

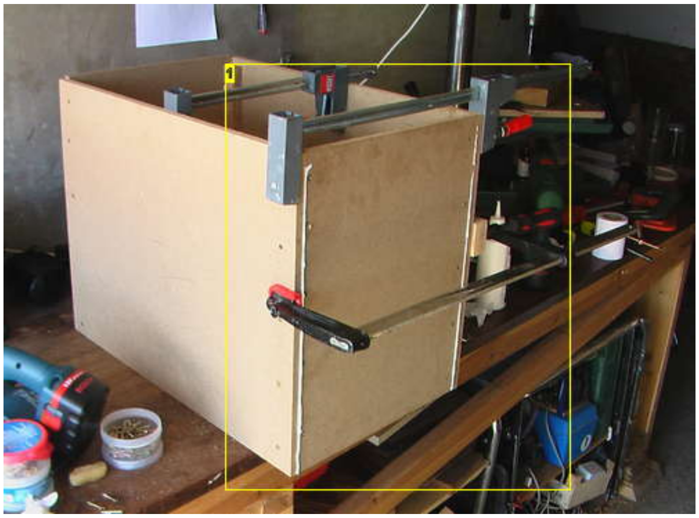


Image Notes
1. Screwed and glued back together. Clamps help too.

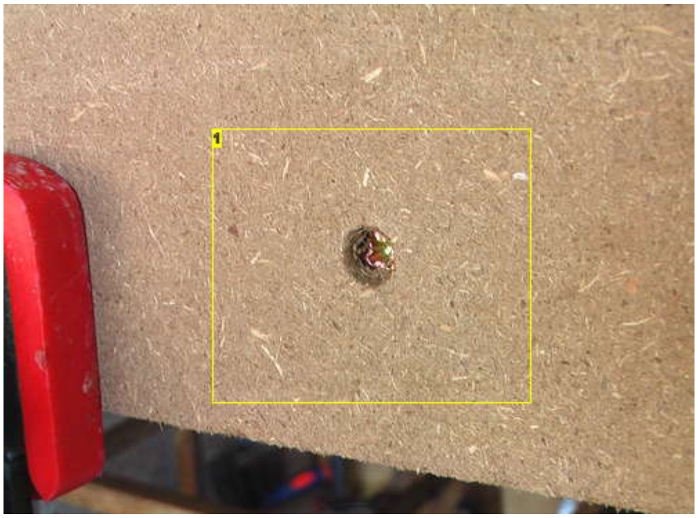


Image Notes
1. This stuff doesn't respond well to over torqued screws. This was a careless mistake, but not disastrous. If the screw was nearer the edge however...

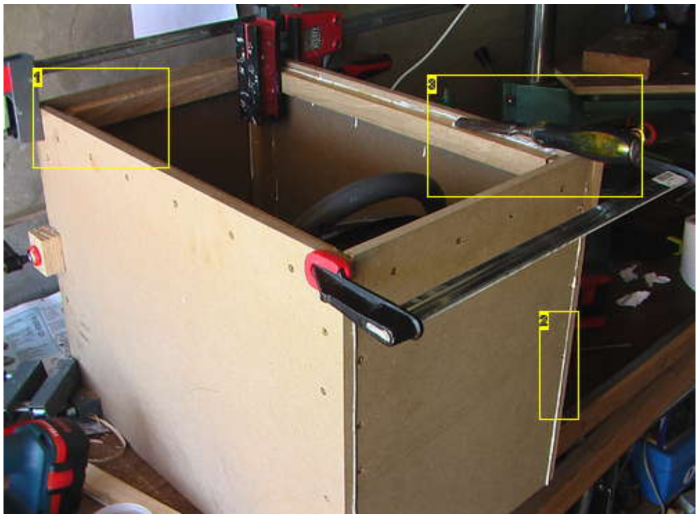


Image Notes
1. These braces run along the front edge. The front panel will squeeze against them, with some form of rubber seal.
2. As this is the inner, looks are not too important. You can leave a bead of glue here.
3. As the front will fit here we need to remove the glue. A light touch with an old chisel does a good job, once the glue had had 10-20 minutes to go 'rubbery'.

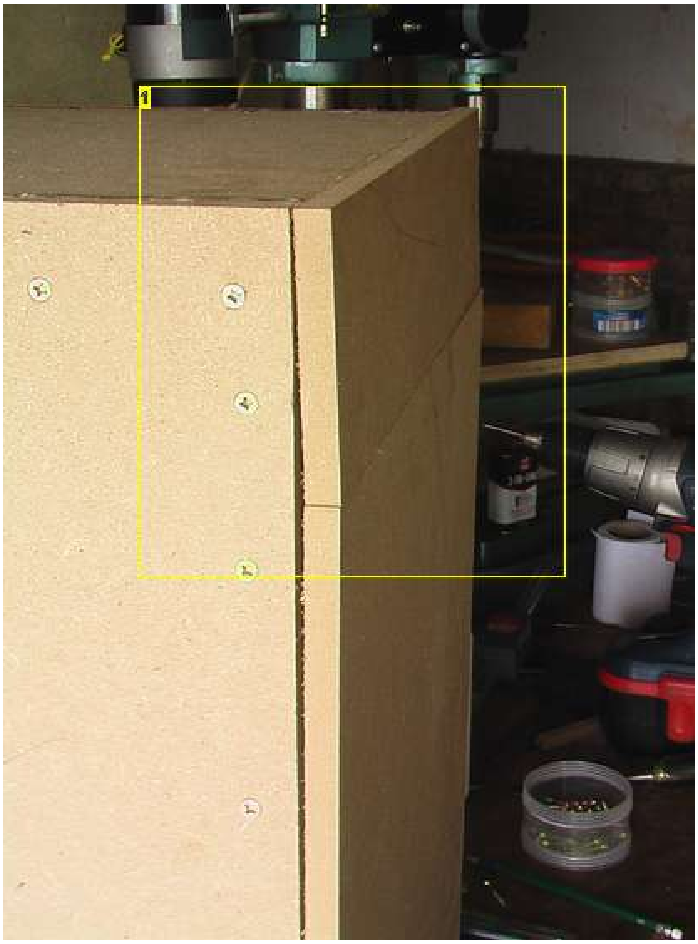


Image Notes
1. Running out of freecycle MDF meant joining these bits to make the part of the back - no probs as long as we get a good joint and a complete seal.

Image Notes
1. Checking out the sizing - just enough room for the spiky foam I have in mind, and the two vacuums.

Step 6: The Inner Enclosure's Tortuous Path

After making a nice sealed box the problem is that we need to allow air to flow in and out (so that the vacuum can suck stuff up and vent its exhaust air!). If we have holes for the air to go in and out, it is a safe bet that noise from the vacuum's air chopping impeller is going to maliciously exploit them and fire sound out at you. That is, unless we create an elaborate maze in which the noise will get lost (bwahahaha), but which our friendly air will have no problem traversing. People (that is, an author of one of the more obscure books I read) sometimes refer to such a system as a 'tortuous path'.

When we incorporate obstacles into the air stream, we add resistance to its flow. To maintain necessary airflow, most silencers have to increase the cross sectional area, so enough air can run through - making them quite bulky. This tortuous path or baffle system has the same problem.

There are many different designs to reduce sound that is transmitted through airflow passages: reflective, reactive, diffusive, depressive and active. Quick and concise description of different types of silencers can be found here.

For the dust sniper, the back of the inner box is where I made the baffle arrangement. I wanted to keep the two exhaust streams separate so it consisted of two paths, created by fire door off-cuts (produced while making the outer box). It ended up being damped by a sealed off panel of sand (see the pics and descriptions for build info).

Another consideration is that sudden changes in air pressure can be noisy - the sound of a vacuum usually increases when we put a crevice nozzle on the end for example. We can extend the changing pressure gradient though, by breaking the exhaust stream into a series of outlets - the same style of thing that you see on a big motorbike exhaust with lots of holes in.

> "Such a device has been shown to accomplish by itself, without any additional muffling, a 10 dB insertion loss in broadband noise in a steam-generating plant blow-out operation." (p434).

So that seems like a good idea, assuming the air coming out is making much noise...

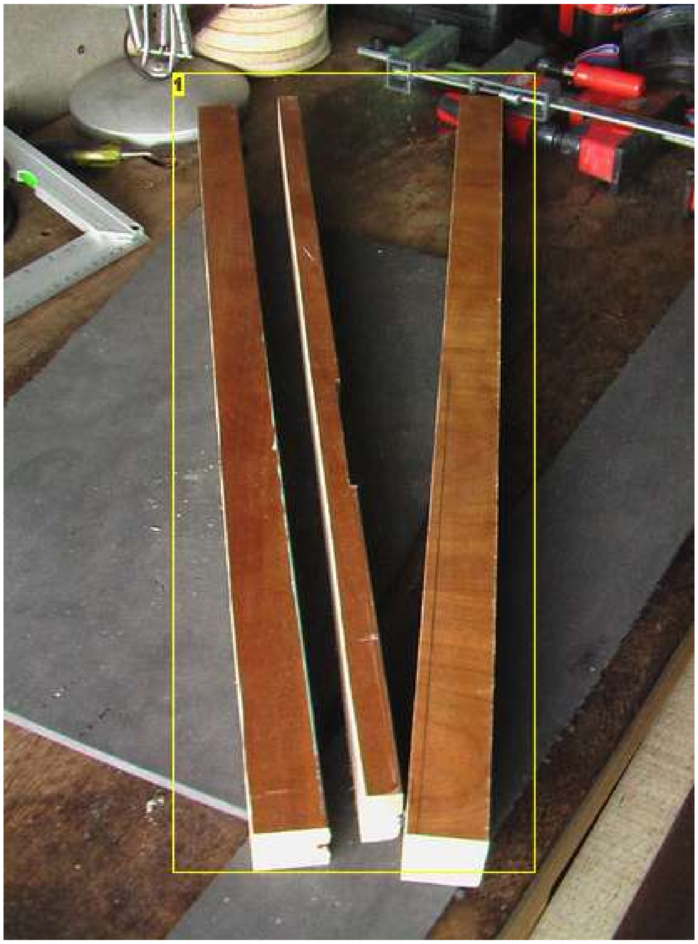


Image Notes
1. These are fire door offcuts from the outer box. They will be useful as they provide an even thickness.

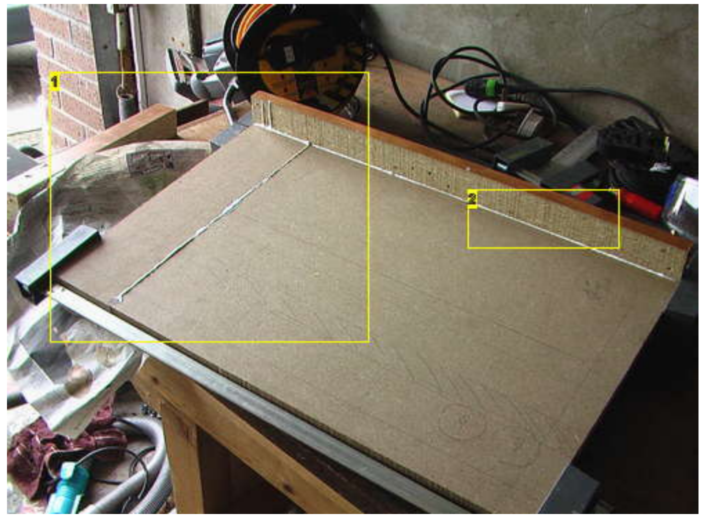


Image Notes
1. I had to join two pieces of the mdf to make a bit big enough to cover the back of the inner box.
2. One side piece

Image Notes
1. Side pieces on and a central divide, to keep the air streams separate.

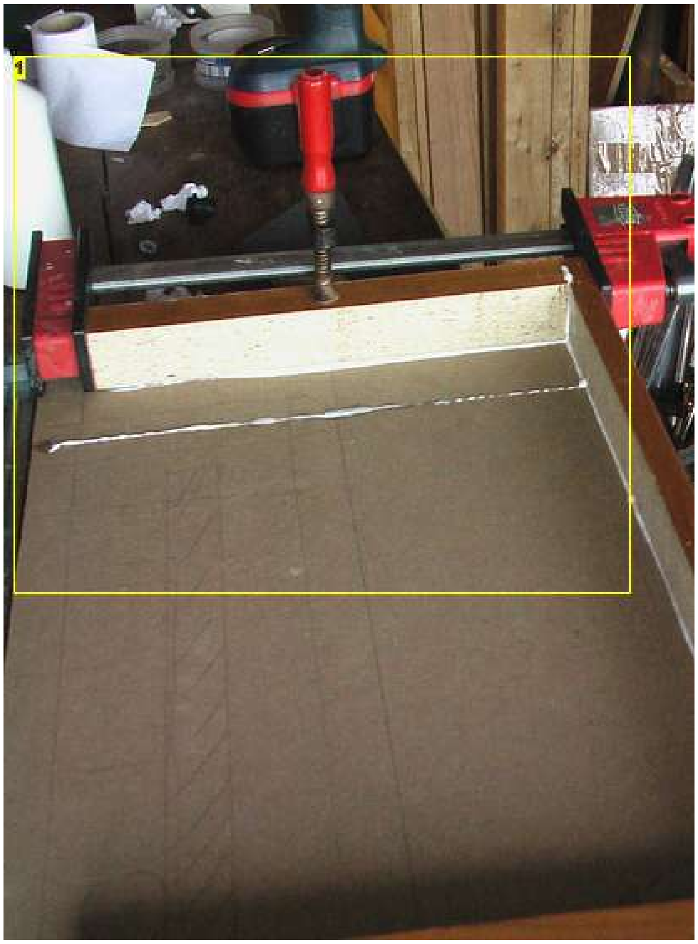


Image Notes
1. Glue clamping and screwing on the side pieces.

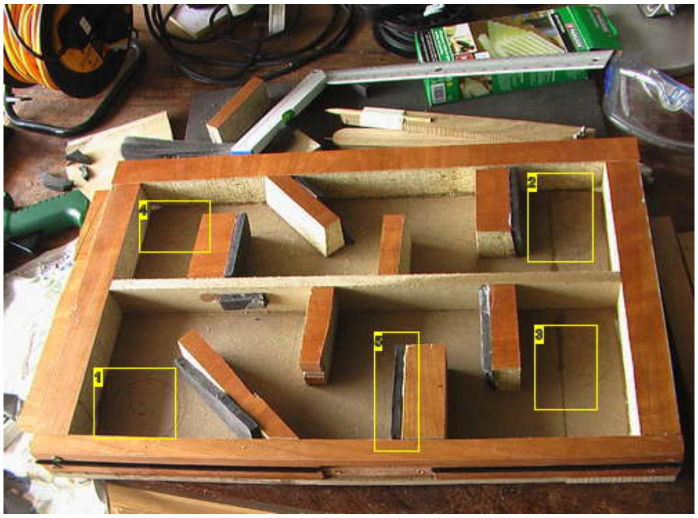


Image Notes
1. air stream 2 will enter here and travel right.
2. air stream 1 will enter here and go left.
3. air stream 2 will exit here.
4. air stream 1 will exit here.
5. foam and the rough edges will absorb some sound.

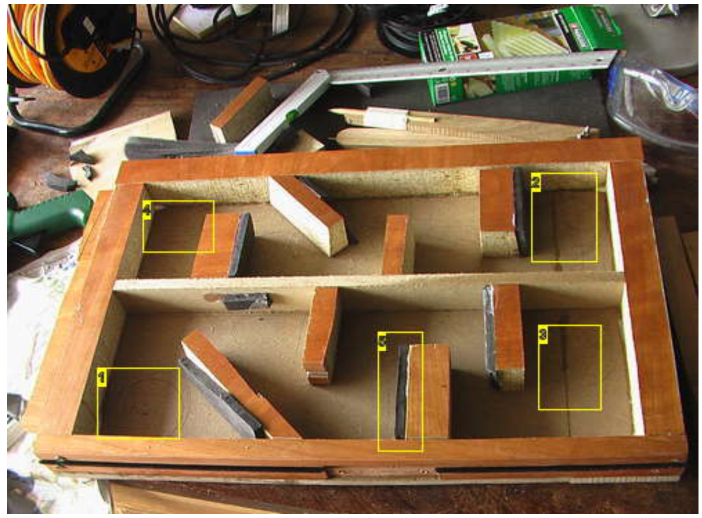


Image Notes
1. scramble about a bunch of off-cuts to see what looks good in a maze stylee.

Image Notes
1. All glued in place with some extra little bits of foam.

Image Notes
1. Now we need another side panel and I have run out of mdf. Not to worry though, in my freecycle haul, I was given a bunch of thin ply type panels. I have cut one to size.

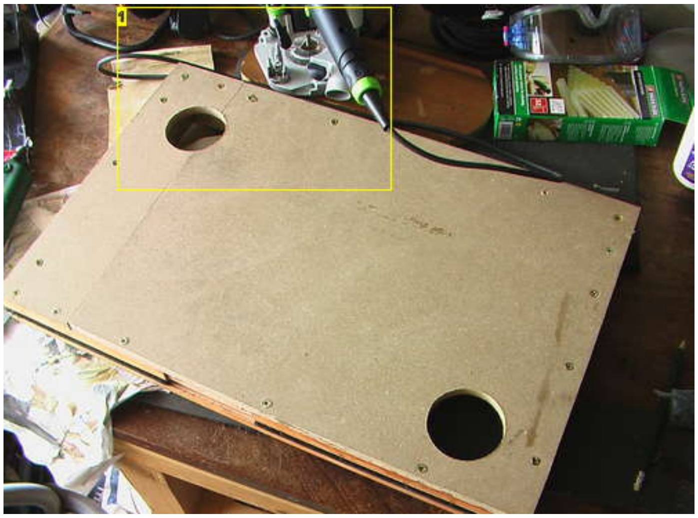


Image Notes
1. The air entry holes are routed out about 75mm diameter should do fine.

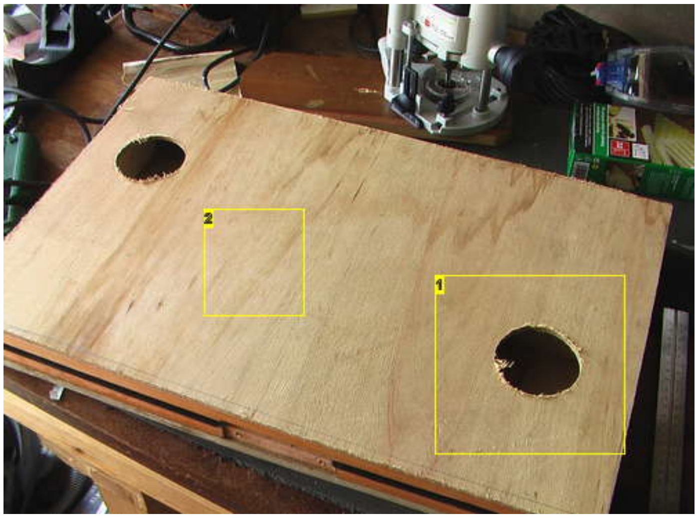


Image Notes
1. Exit holes routed in the thin panel.
2. This may be thin but will be a composite sand panel when we are done - a nice sound deadener.

Image Notes
1. I am going to use this steel sheet, saved from next door's broken dishwasher, which I took apart. First I mark with an old knife around my existing panel.

Image Notes
1. It is marked up ready. It is only thin, but its main function will be to hold in the sand.

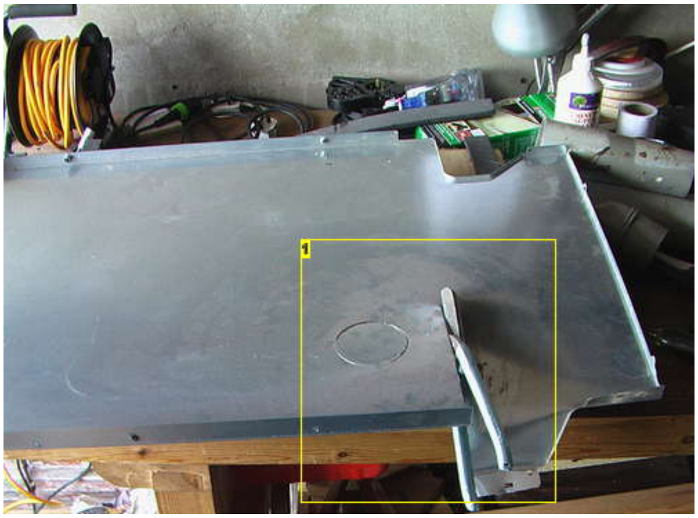


Image Notes
1. Magic tin snips are back!

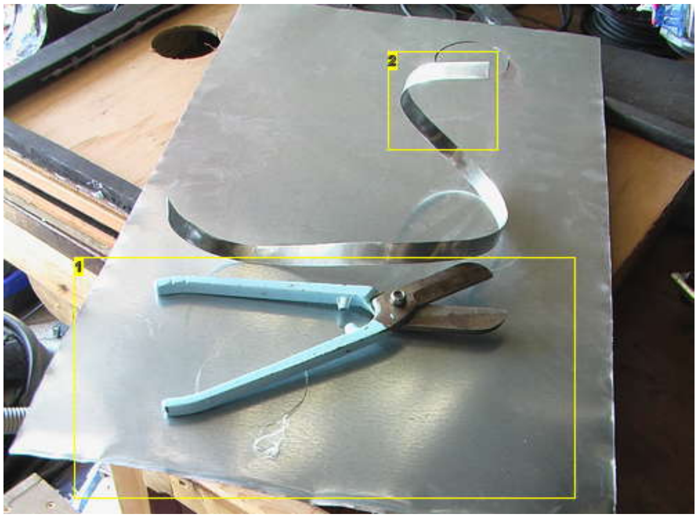


Image Notes
1. Panel cut to size.
2. A nice ribbon of steel.

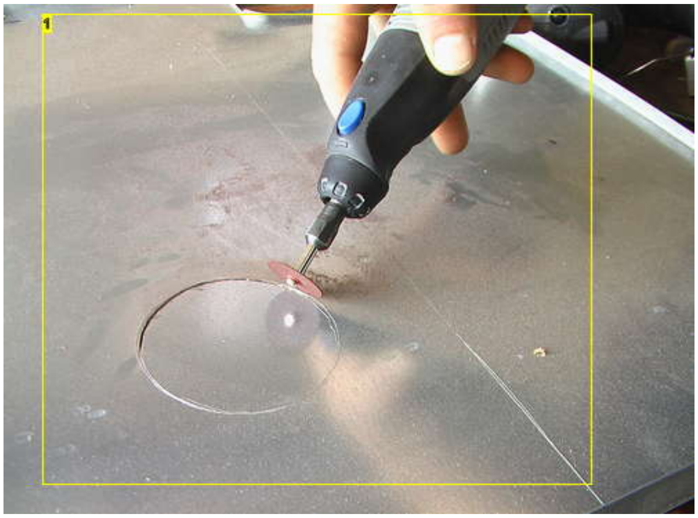


Image Notes
1. Using a dremel or similar it is possible to cut out quite nice circles. Point the tool towards the centre of the circle and hold it at an angle, and it should work well.

Image Notes
1. Hello is anyone in there?

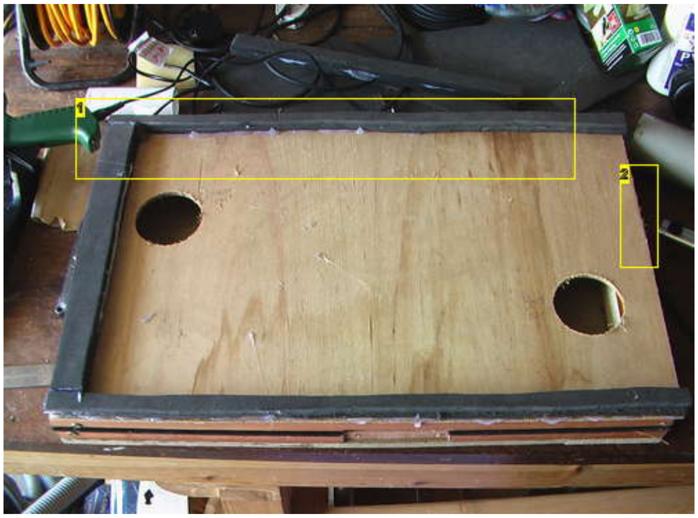


Image Notes
1. I stick a double layer of closed cell foam with a hot melt glue gun. This forms the sides of the sand panel.
2. If we leave the top off, we can pour the sand in here.

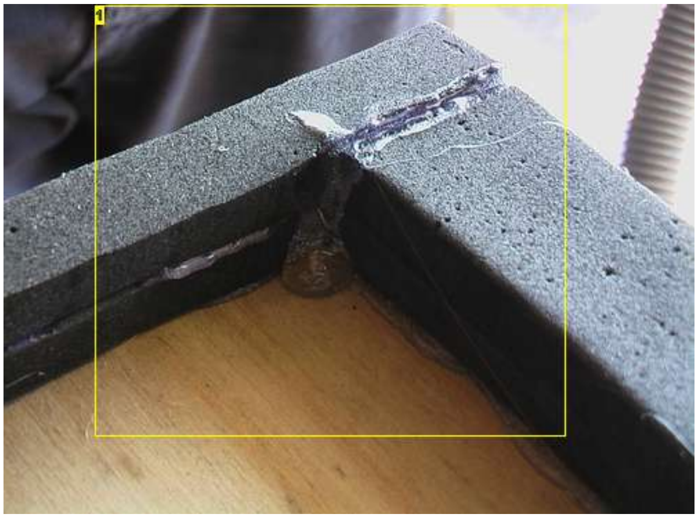


Image Notes
1. There can be no gaps, so plenty of glue is used. I did a few test pieces and the hot melt glue sticks very well to both surfaces.

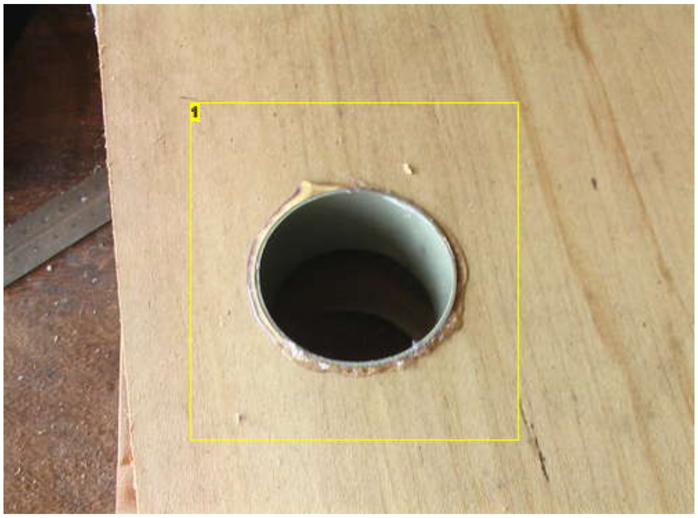


Image Notes
1. Glued in some bits of old drainpipe I salvaged to prevent air from blowing the sand about.

Image Notes
1. The pipes are cut so they stick above the steel panel. This will give us a lip to attach tubing to.
2. Some bits of foam in the middle should help to maintain the shape of the steel panel.

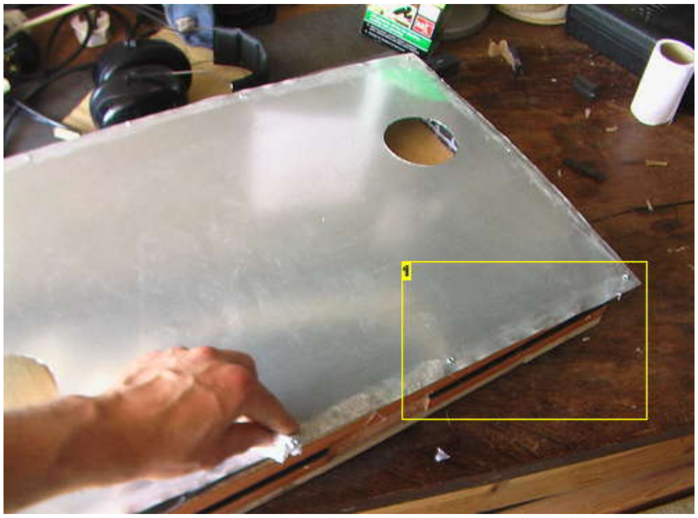


Image Notes
1. Prep the edges of the steel by sanding them so that they will glue better. It is also a good idea to rub them down with alcohol or similar to remove any oily residue.

Image Notes
1. Hot melt gluing the steel panel down. You have to be quite quick about it. Use a scrap of wood to push it - it gets too hot for the hands!

Image Notes
1. A view down the inside of the panel.

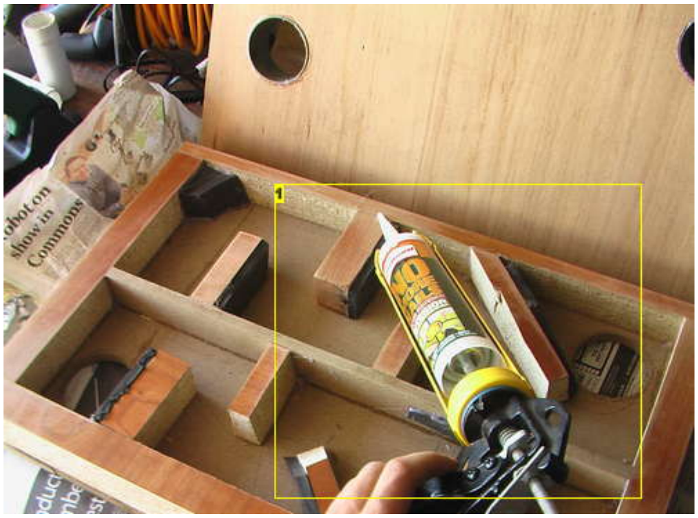


Image Notes
1. Am using 'no more nails' type stuff to glue on the back panel. This gives a flexible bond which helps deaden sound.

Image Notes
1. Ready to go. Again it is important to have continuous bead seal.

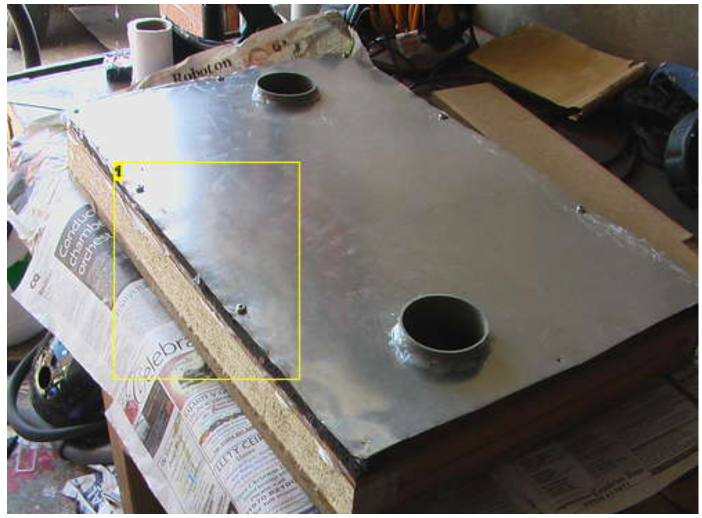


Image Notes
1. Screws go through the steel, foam, thin wood, and secure the lot together onto the tortuous path's outer.

Image Notes
1. With an assistant to hold the funnel (or take photos), It is pouring the sand in the top time. Weeee.

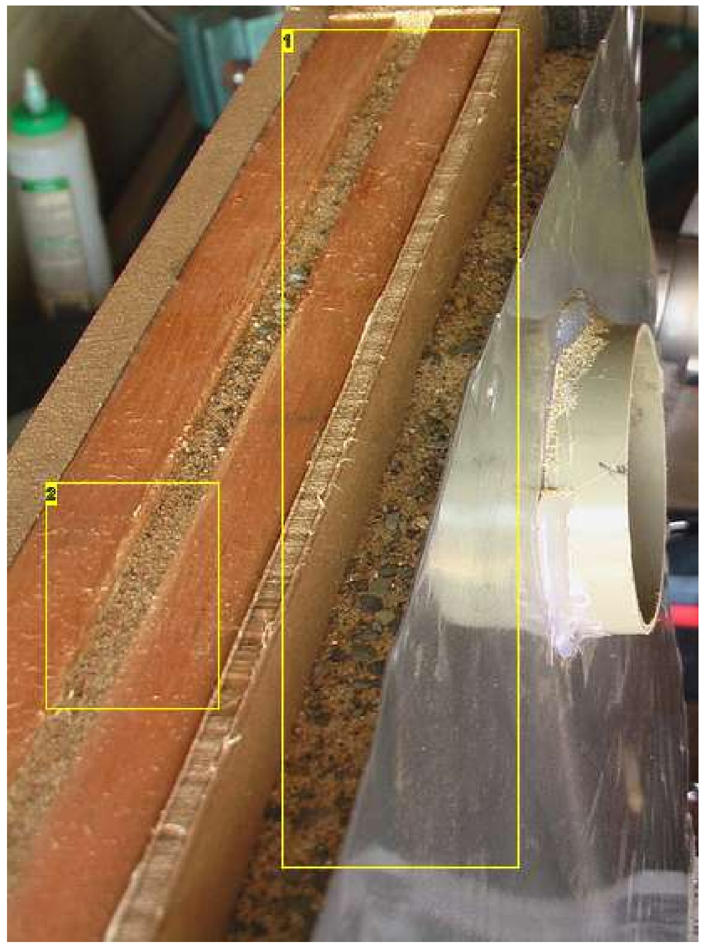


Image Notes
1. Give it a good jiggle about till the sand fills all the gaps and leave just enough room to put in your top bit of foam.
2. There is a secret maze in here, just waiting to waylay any stray sound!

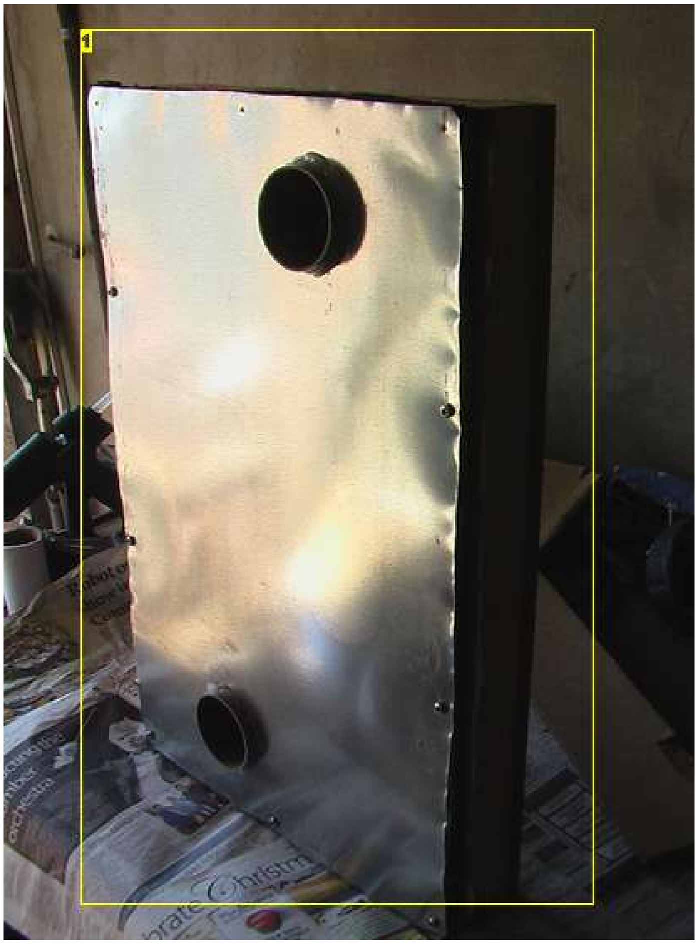


Image Notes
1. Top foam in, screwed and glued. A few knocks confirms it sounds completely 'dead' - excellent. Here is our back panel with its mighty Tortuous Path!

Step 7: Assembling the Inner Enclosure

Lets put this inner box together (see photos). The main challenge here is to make a very snug fitting front panel, which will have a tight seal, preventing sound from escaping.

Image Notes
1. First we put on the back panel/tortuous path, using screws from the inside and plenty of glue.

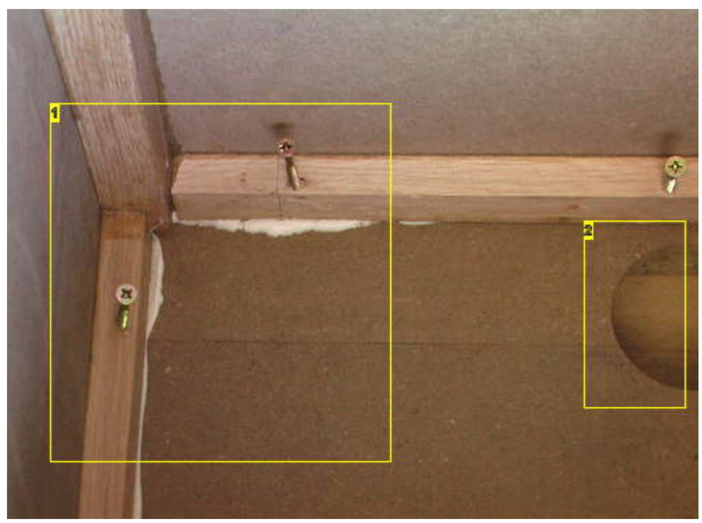


Image Notes
1. Before glue up, pre-drill the holes and do it at an angle to make driving them home easier.
2. The beginning of the sound maze.

Image Notes
1. The back panel squeezed on with the screws.

Image Notes
1. The bracing round the front is made to be continuous, so that the front panel can rest on it without gaps.

Image Notes
1. Cut a piece of ply slightly oversized for the opening. Then spend a while (ok ages) planing the edges down a fraction of a millimetre at a time for a perfect fit.

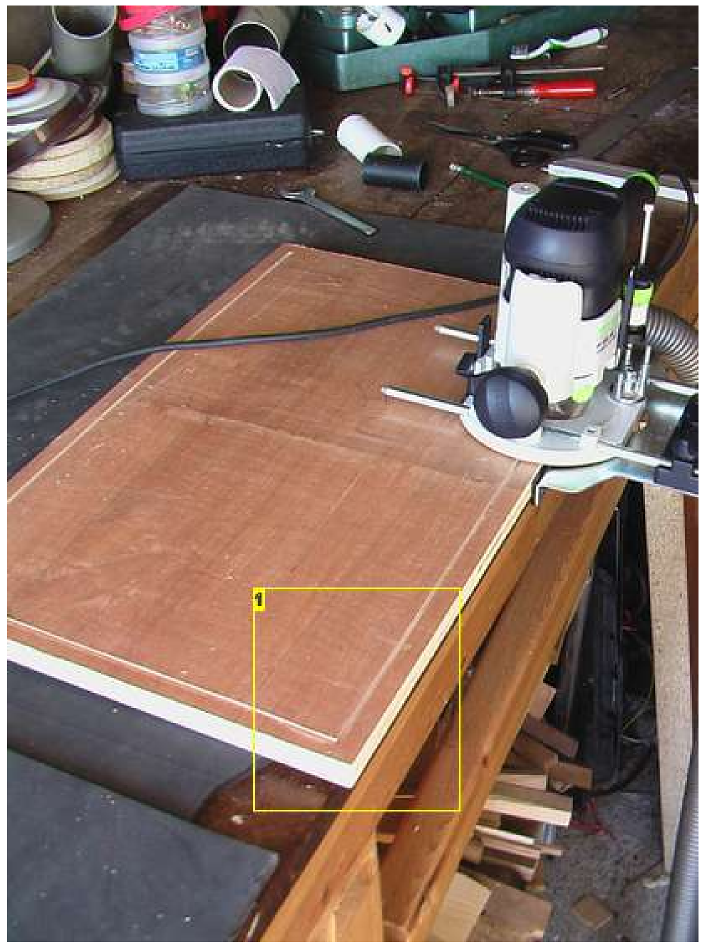


Image Notes
1. Once it fits, we can rout a 3mm channel round the edge. This will hold a rubber seal (which I happen to have for my composite oak doors project).

Image Notes
1. Ahh, satisfying picture-frame like front panel. I scrounged up some ply for this, having run out of mdf.

Image Notes
1. In you go seal...

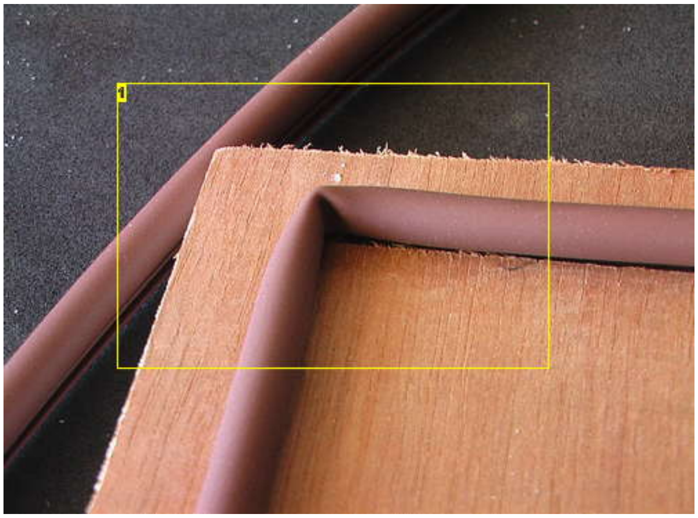


Image Notes
1. It can turn corners and everything, so we only get one point of joining weakness.

Image Notes
1. Testing the seal - looking into the light. All seems as it should be.

Image Notes
1. Another panel behind this one is sized up to overlap the front of the box.

Image Notes
1. Ready to glue the two sections of ply together, to form the front panel.

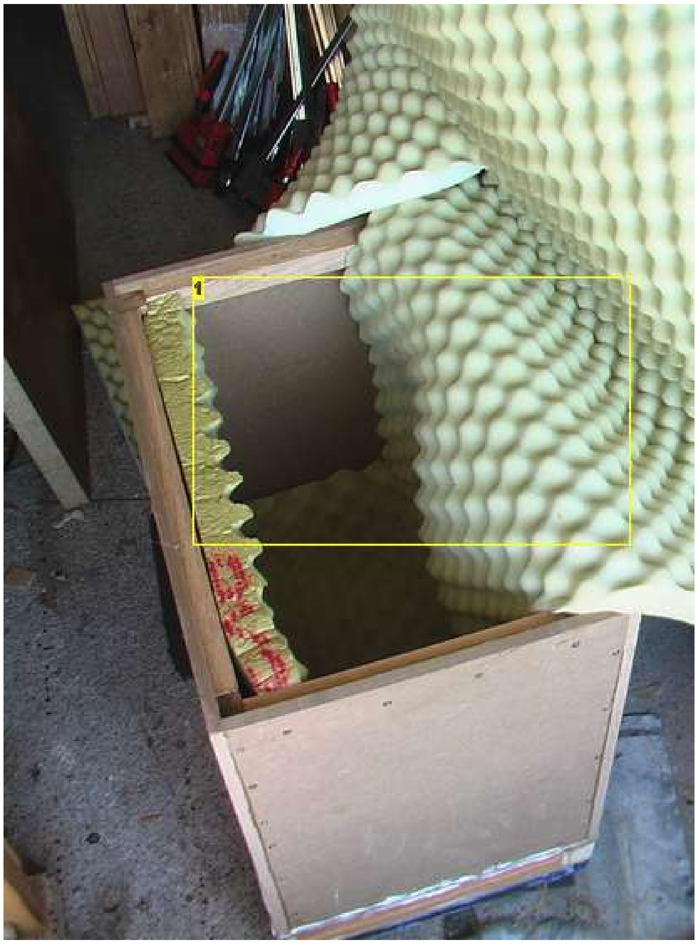


Image Notes
1. Here I'm sizing up some egg-crate foam to line the box for exrta sound-dampening

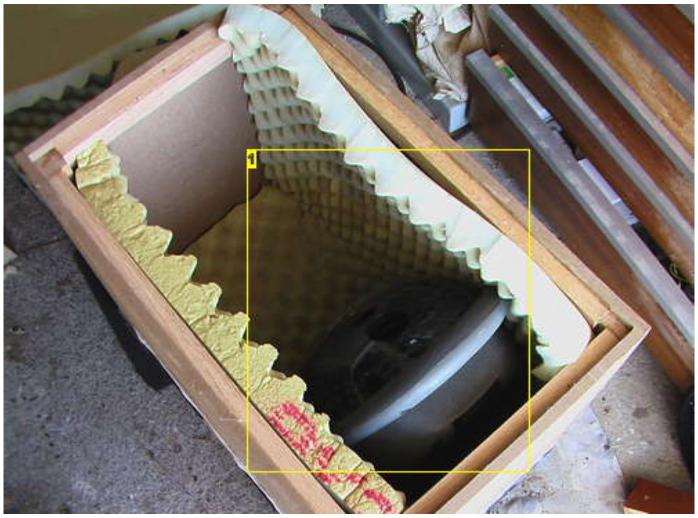


Image Notes
1. Foam fitted and testing out the fit of vacuum number 1

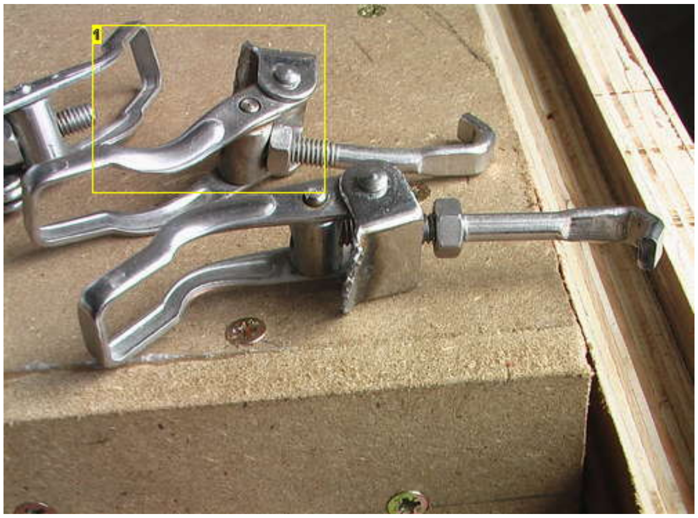


Image Notes
1. A friend salvaged these latches for me, from an old redundant tank he had laying about. There was three of them, and they look like they will be ideal to seal on the front panel.

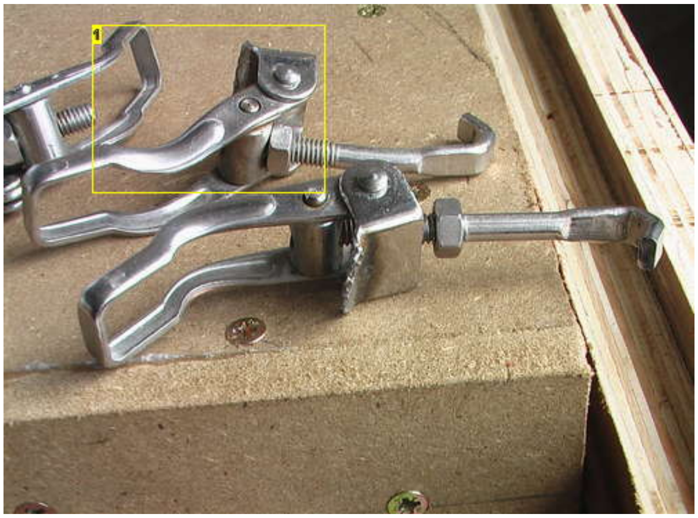


Image Notes
1. This seems to work very well. I screw one to the top of the box and the two others go lower down on the sides.

Image Notes
1. We have front panel sealability (and open-ability of course).

Step 8: The Outer part 1 - Housing

The outer housing wants to be quite robust, as it will be functioning as a worktop/ multi-use-surface. This is all good as I have a few thick, heavy fire doors to make it from. As a bonus when we make it massive, we are also helping to cut down the noise. I also have a quite delightful bit of scavenged teak to go on top (It was thrown out by my university's science department and matches my current workbench, which has a similar ancestry).

As it is going to end up on the heavy side of hefty when it is all together, we are going to want some casters to get it mobile (ish - well like a gigantic lumbering titan of a thing at least). As with the inner box, it also needs to be as sealed up and tight as possible, with no weak points for sound to leak out from.

To begin with I sized it up, based on the Sketchup 'plan' and got cutting. Being way too big to manoeuvre the doors through the bandsaw, and after some 'interesting' jigsaw antics, I borrowed my friend's mighty fine circular saw for the job. This worked very well in combination with a clamped on bit of wood, that I knew was straight, as a guide.

Similar to the inner box. We can prepare the individual pieces as best we can before sticking them together. It is a good idea to leave the lid off for easy access until after we have finished all the insides.

Image Notes
1. Using an awesome borrowed circular saw (thanks Dave!), I was able to cut nice straight lines in the fire doors to form the side pieces, base and back of the dust sniper.
2. Clamping a straight piece of wood on allows us to do nice lines.

Image Notes
1. These may come in handy later for air exhausts. But for now, I need to cut close to them, so need a level surface for the circular saw.

Image Notes
1. A good start seems to be to make two side panels. By putting them together side by side (closer than this) we can check them for accuracy.

Image Notes
1. Using the circular saw and a guide to cut the long base.
2. It is so cool to be able to use this cyclone now, to help build the rest of the dust extraction system. It looks so great that I have a hard job not staring at it while I am sawing - which leads to a few skewed saw lines, doh...

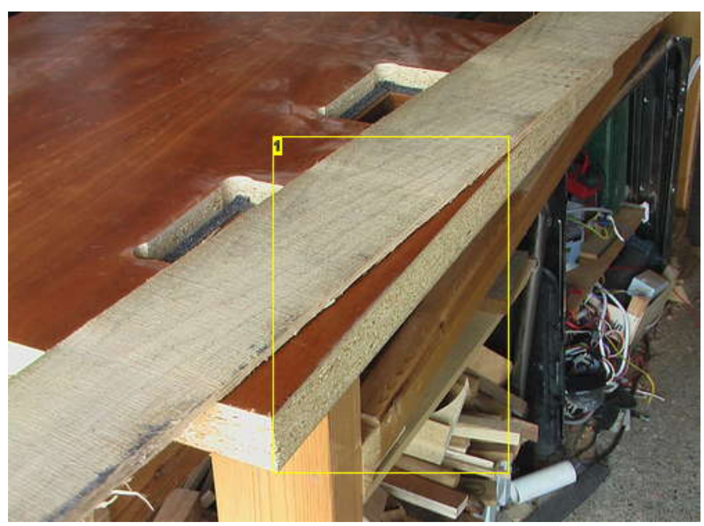
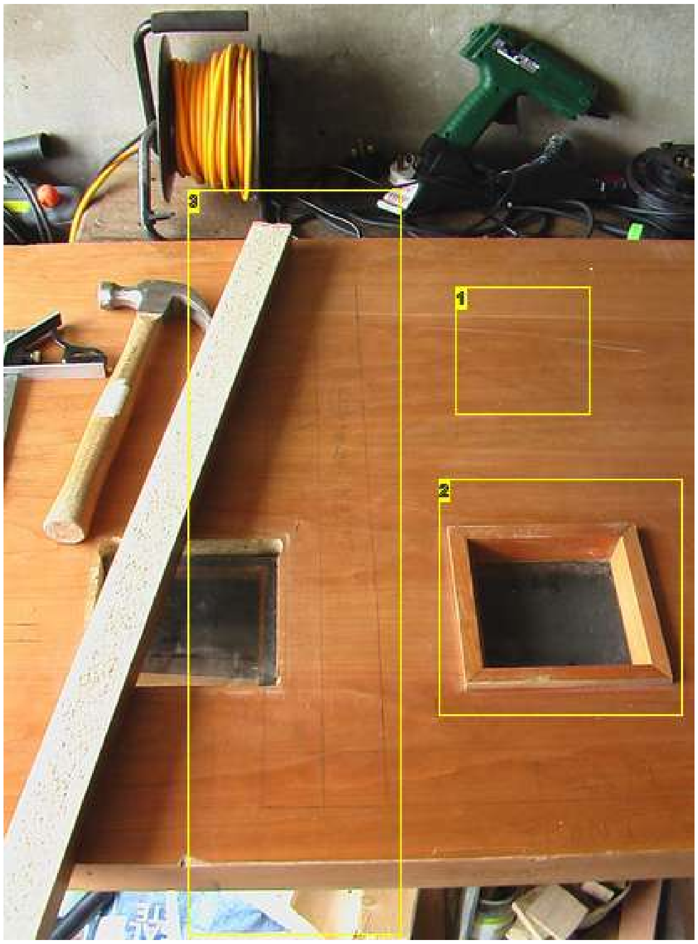


Image Notes
1. Lets face it, technical performance aside, particle board looks horrible and is generally not human friendly (at least not for a romantic like myself). So lets cover it up with some old scraps of oak. This one was an offcut from the great double door project. It needs cutting to size and a quick plane but should do the job.



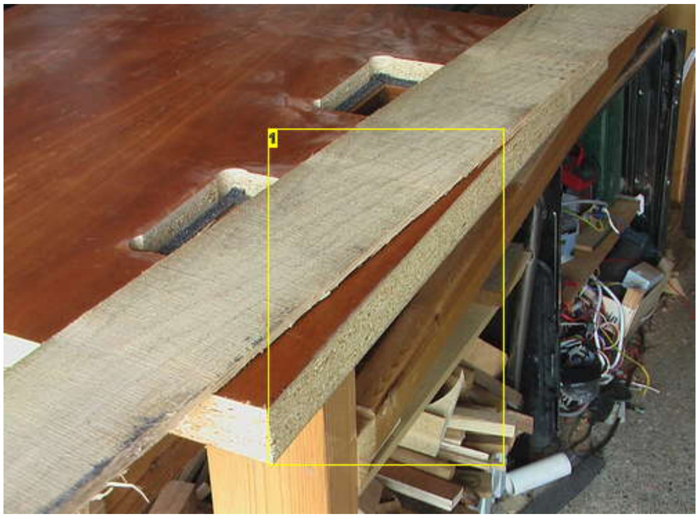


Image Notes
1. This piece is going to be the base, or bottom of the DS.
2. This one will need filling in later.
3. I am laying out in pencil where the side pieces will go.

Image Notes
1. The oak is being stuck on. I only have three long clamps (there are never enough!) so have to get a bit creative and indulge in some window clamp action.

Image Notes
1. Doh, the next side piece has no windows, so having to make do. Using a thick off-cut and some foam to equalise the pressure, it turns out nice enough.

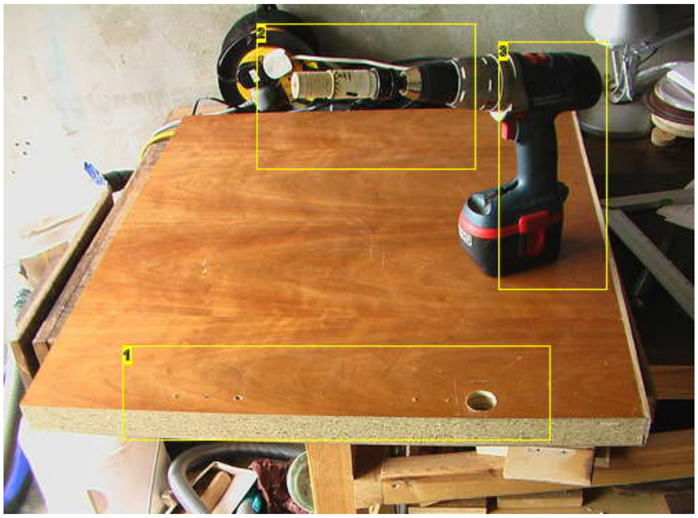


Image Notes
1. This is the side piece that separates the vacuum chamber from the cyclone cabinet. Here we need two passages to take the air from the cyclone to the forbidden cork forests (see step 16)
2. first drilled pilot holes with the drill press to ensure they were straight, before using the holesaw on em.
3. Glorious modded super drill.

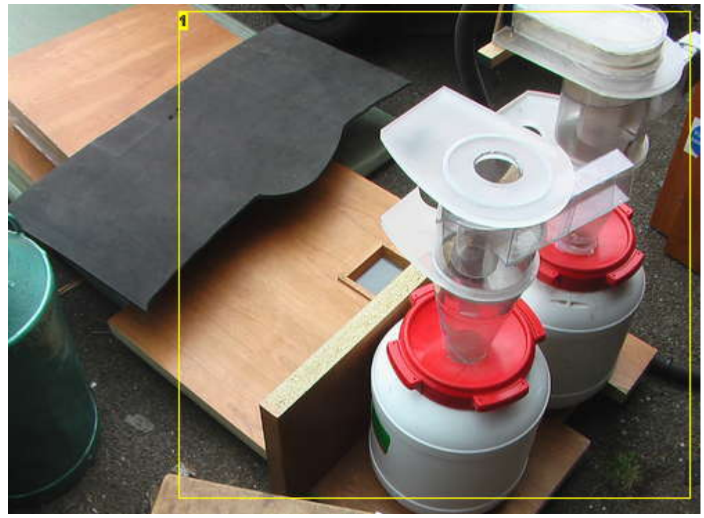


Image Notes
1. Mk1 and Mk2 cyclones are being measured and sized up for their new suit...

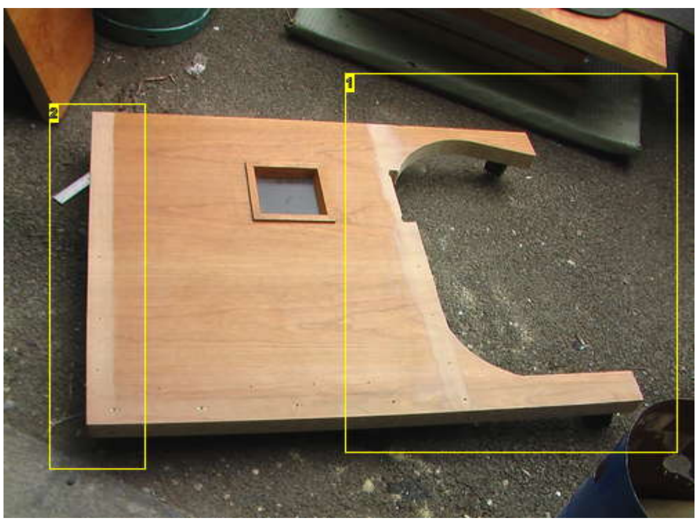


Image Notes
1. The legs need taking out a bit, so we get to it with the jigsaw,
2. The place that we are going to have sides and a back is sanded down so that we can make a good glue join.

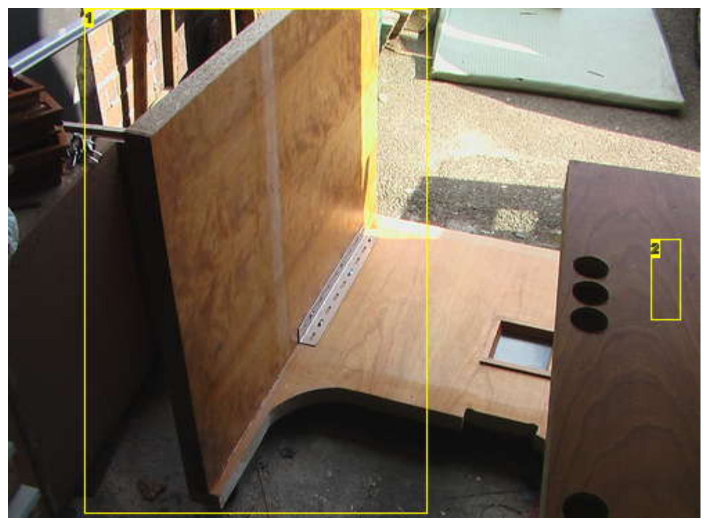


Image Notes
1. The back is on! Glued and screwed from the underside. I had a steel scrap taking up space to get rid of as well ;)
2. one side piece waiting patiently for its turn.

Image Notes
1. Wherever the screw heads will not show, like here on the underside, I use glue and screws.
2. These chair castors were way too small and insufficient. I ended up changing them for some much beefier ones I found.

Image Notes
1. The sides are on and it is taking shape. The inner box is approvingly trying it out for size. Now for a lid and a removable front.

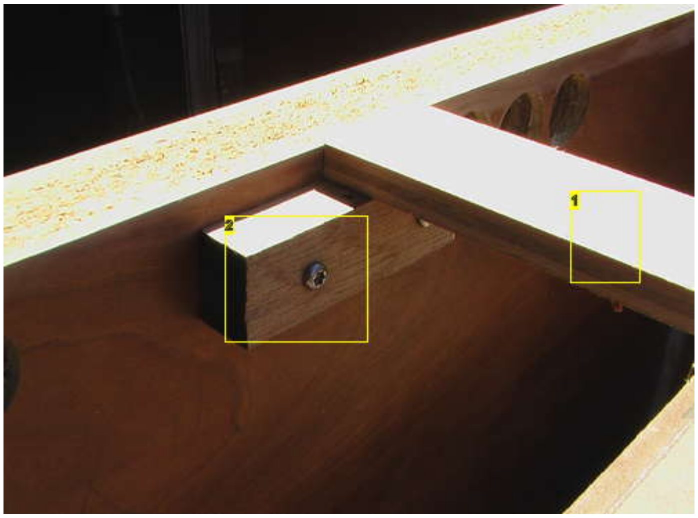


Image Notes
1. This is an off cut from the lid. We can use it to position some lid supports on the insides of the back and side panels.
2. Supports for the lid.

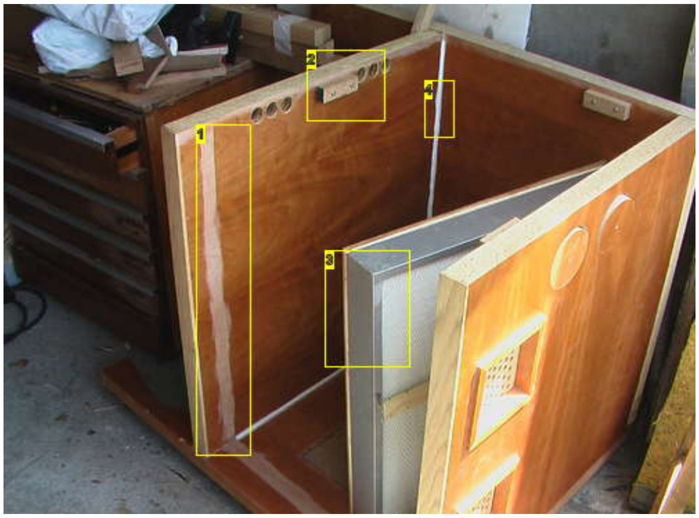


Image Notes
1. Sanded ready to accept the wooden bits that the front panel will seal onto.
2. Ply lid supports in position.
3. Outlet filter - wait for the next step for info on this..
4. As this may be a low pressure area, I am taking no chances here, the edges are doubly sealed with a bead of flexible frame sealant.

Image Notes
1. I cut some 5mm deep groves in the lid, to accept the same rubber seal used on the inner box.

Image Notes
1. Hello well fitting front panel!

Image Notes
1. Finally getting round to sealing up that window in the bottom, we don't want it leaking sound. It is filled with sand and a well fitting square of the last remaining mdf is sealed on with hot melt glue.

Image Notes
1. Glued, clamped, and screwed - Overkill stylee: that's the life of a 'front panel, seal fitting onto, mabob'.
2. Lid Ho.

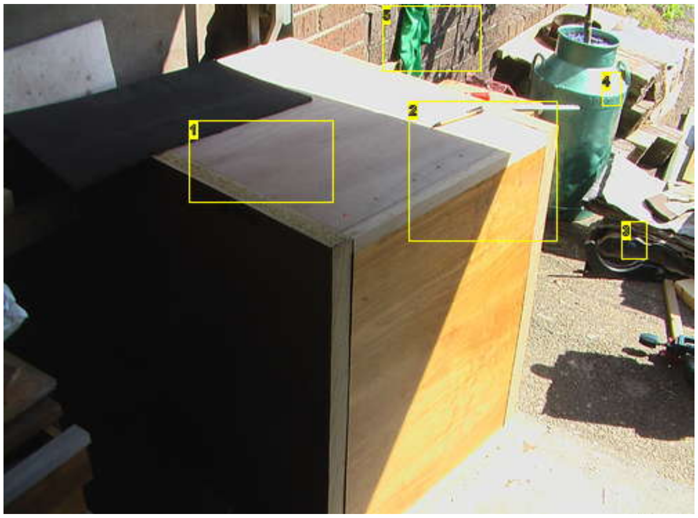


Image Notes
1. To top it all off, later we will put a delightful teak work surface on here.
2. And after all that we are paid off with ply lid and front fitting well together. This is a 'dry assembly', we will glue the lid later.
3. Lead, waiting to be used.
4. Milk churn
5. T-shirt - it is hot..

Image Notes
1. Old Aikido mat = good dense open cell foam = sound insulation.

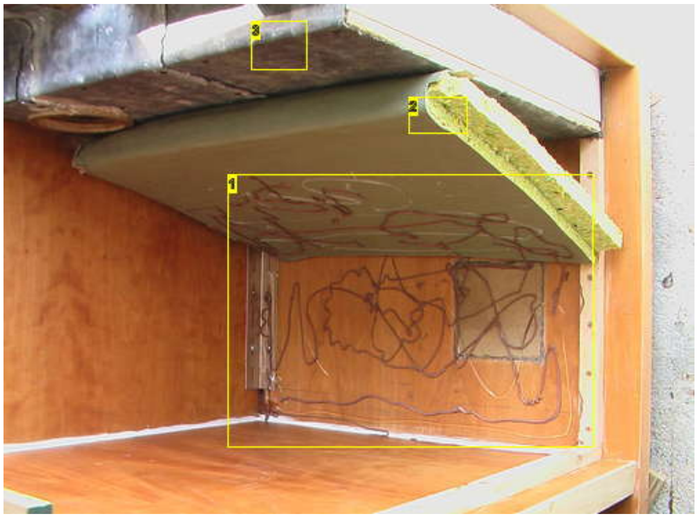


Image Notes
1. Some squiggly sealant to hold down your high density foam sir? Yes please.
2. This makes a good mechanical isolator, for the inner box to rest on.
3. This is the filter - we will come to that shortly.

Step 9: The Outer part 2 - Air Exit and filtration

After all that effort, we don't want to just blast out the air into the atmosphere. It is a happy coincidence that a filter, as well as removing very small particles that can kill us, is also a useful sound deadening material for the exhaust passage. This time fortune really did smile upon us, and a perfectly sized, HEPA filter fell from the gods (well, from our friend who works for a big pharmaceutical multinational who thinks nothing of skipping anything that is not made of purest, unmarred angel essence) into our gratefully receiving lap. This is not strictly necessary, as the vacuums have filters (though they are fairly pathetic in comparison) but certainly a welcome boon.

HEPA stands for 'High Efficiency Particulate Absorbing (or Arrestance, or even Air filter, depending on who your talking to)'. Basically is is pretty much the best commercially available air filtration of the sort that relies on the air passing through a fine mesh which catches the dust particles.

> "The HEPA standard exceeds the MERV specifications because they are the only mechanical air filter with an efficiency of 99.97% at 0.3 microns. This makes them at least 50% more effective than other types of mechanical air filters." http://www.hepafilter-pro.com/Filter_Ratings.php (For the grades of filter : http://www.filtration-engineering.co.uk/air_filter_testing.htm).

So we have one of these babies to integrate into the DS. As this will be right by the air outlet, it needs to be heavily soundproofed to make our other efforts worthwhile. Now is the time to deploy the lead!

Image Notes
1. Absolute jackpot! Scored this large 30cm x 30cm x 8cm pleated HEPA filter from a big industrial company who considered it unfit for use because it was stored inappropriately for 6 months.

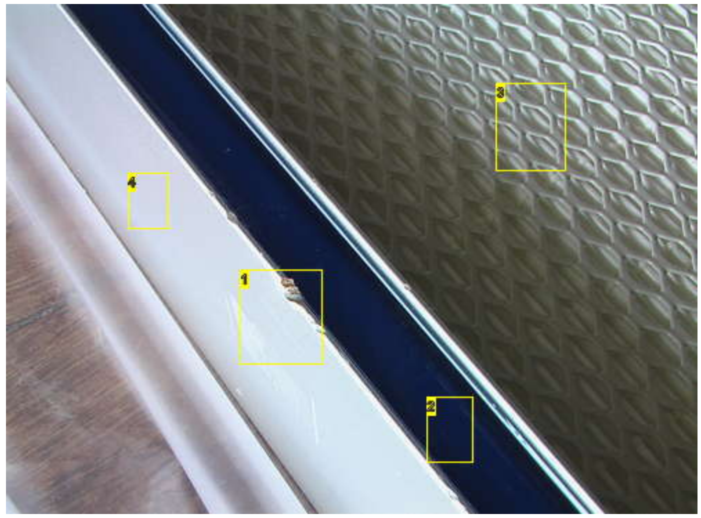


Image Notes
1. These kinds of scuffs may be a throw away signal for a big drugs company selling life or death concoctions in sterile clean rooms, but not really a problem for us.
2. It has exciting goo gel stuff round the rim too for a seal. Now we just need to make an inlet that seals against this.
3. It has a steel wire mesh protecting the rather more delicate pleated filter.
4. It has a nice aluminium over mdf (that's a guess) frame. I sound quite dead when tapped.

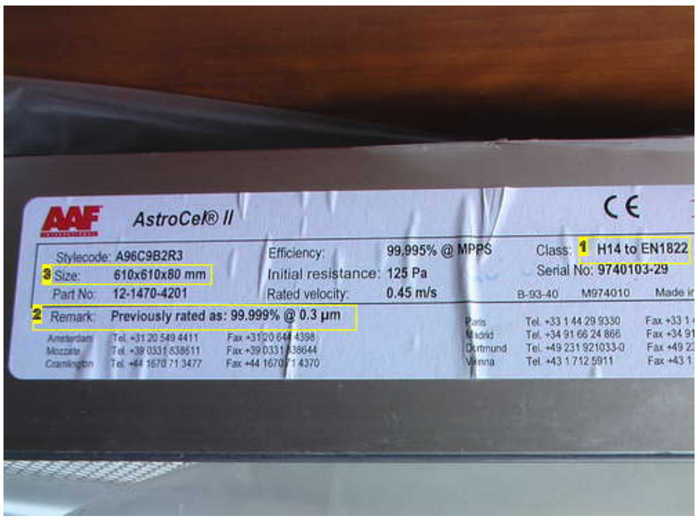


Image Notes
1. That is good!
2. Impressive, but slightly confusingly worded remark.
3. Big!

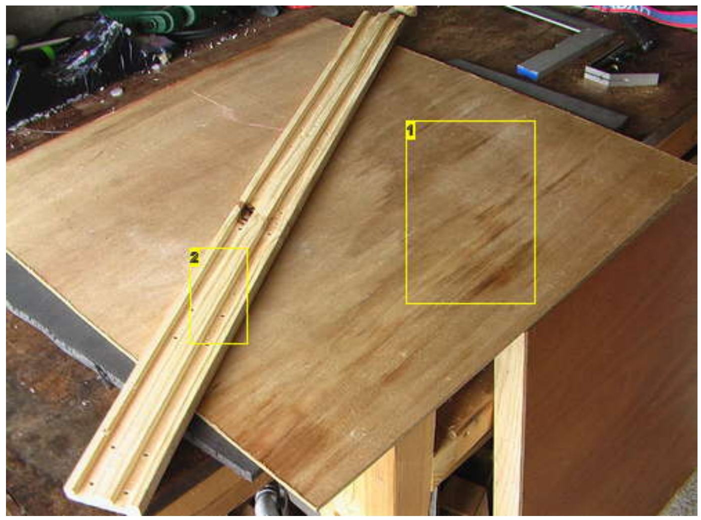


Image Notes
1. This scrap - obtained in the great freecycle haul - will form the air inlet.
2. I will split this scrap pine to form a border that will sit on the sealing gel.

Image Notes
1. Border is screwed and glued on.

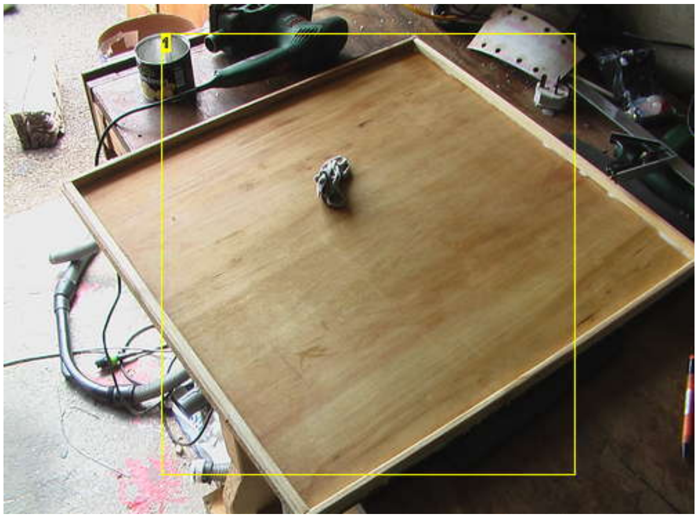


Image Notes
1. This is finely sanded and sealed with a load of coats of PVA-water solution.

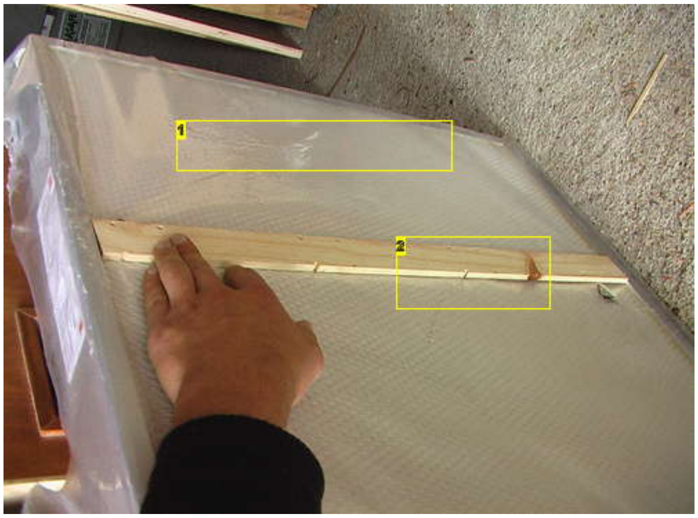


Image Notes
1. As you can see, I am keeping the filter in its bag till the last possible moment.
2. I want to keep the air streams a separate as possible - this bar will help.

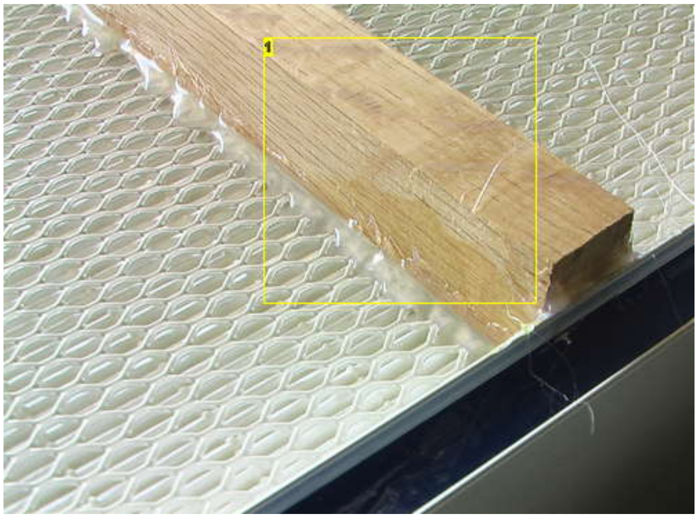


Image Notes
1. This will keep the steams as separate as possible on the other side. It will also help brace the steel grill and the inlet backing.

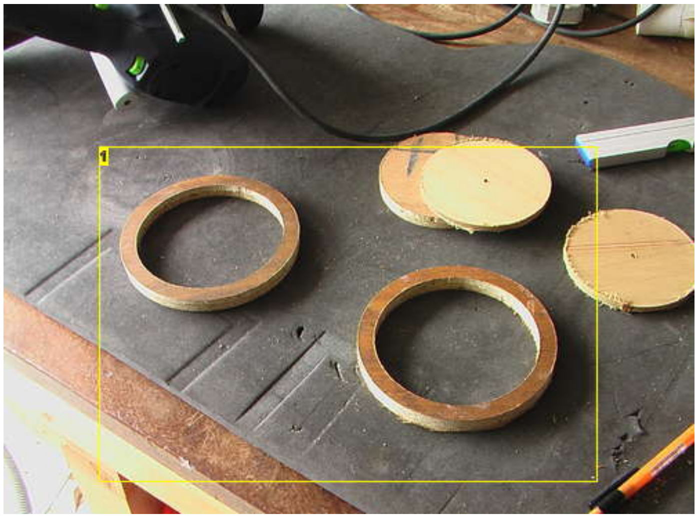


Image Notes
1. These nice little portholes (scraps from the cyclone making process) will make good duct joining points for our filter housing.

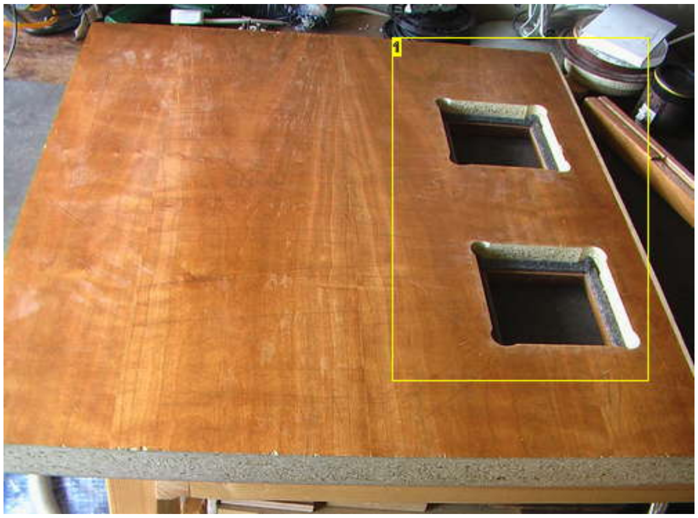


Image Notes
1. This part of the fire door is destined for the side of the outer box which will have air outlets. I am going to make use of the windows that are already there.

Image Notes
1. The large filter will fit over this area and seal against the side. After prising the window frames out on the inside, the glass is removed. Although probably not necessary (as there is about a 1cm gap) I rout some channels to help with the airflow. Bit of a mistake really: by the end, it had done a good job of blunting a nice router bit :(

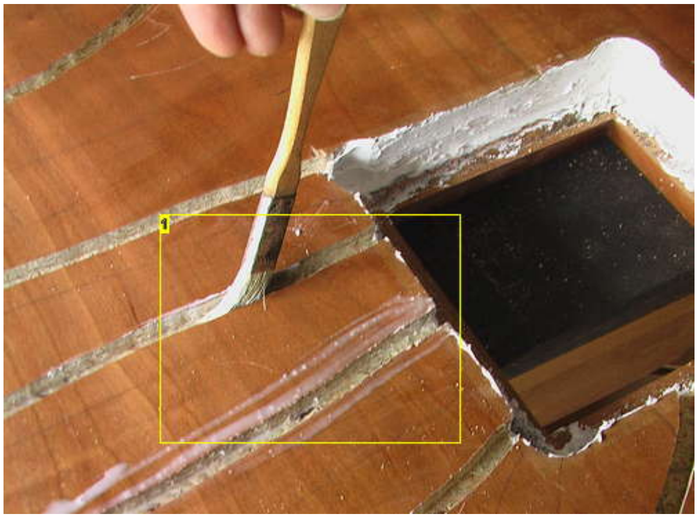


Image Notes
1. Because I don't want hot formaldehyde laden air being pumped out, I seal up the exposed particle board with a strong PVA-water mix.

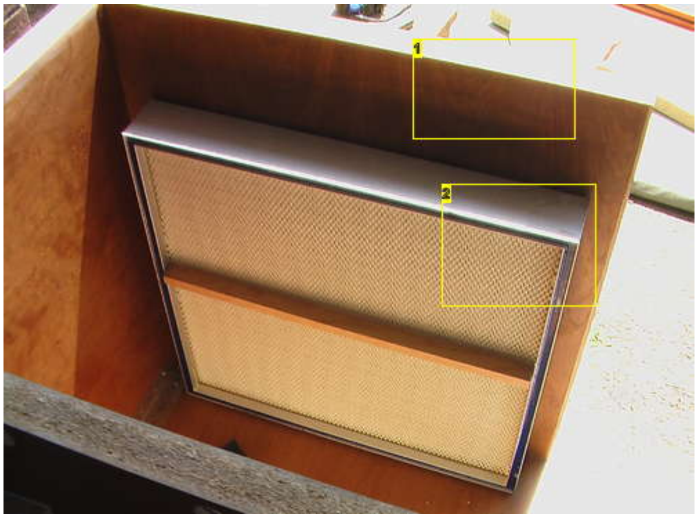


Image Notes
1. So this is the outer box side that has the window outlets (behind the filter).
2. When we are ready the filter can be sealed with silicone against this side.

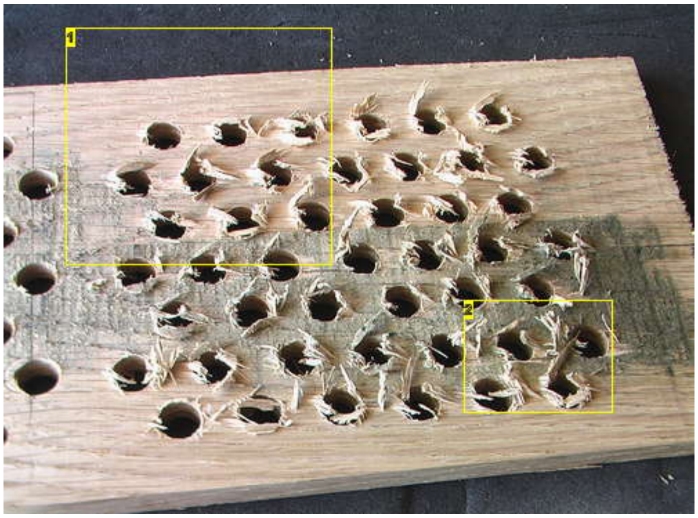


Image Notes

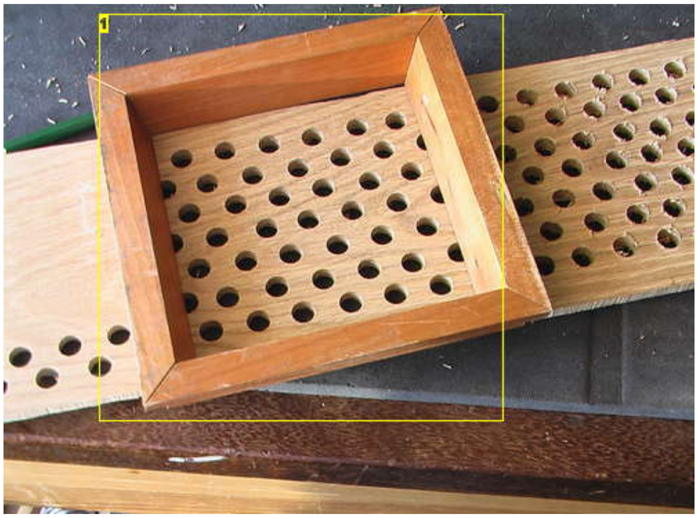


Image Notes

1. An off-cut of oak from the composite oak window/door project is becoming a cover for the outlets. It will offer a final stand against any escaping noise. Much of which will hopefully be reflected back to be absorbed by the filter.
2. The modded pillar drill made short work of this - how pleasing.

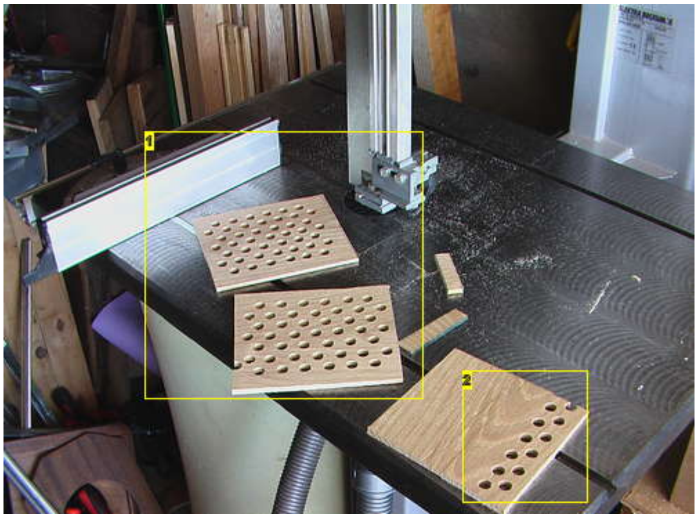


Image Notes
1. Cutting to size.
2. Oops

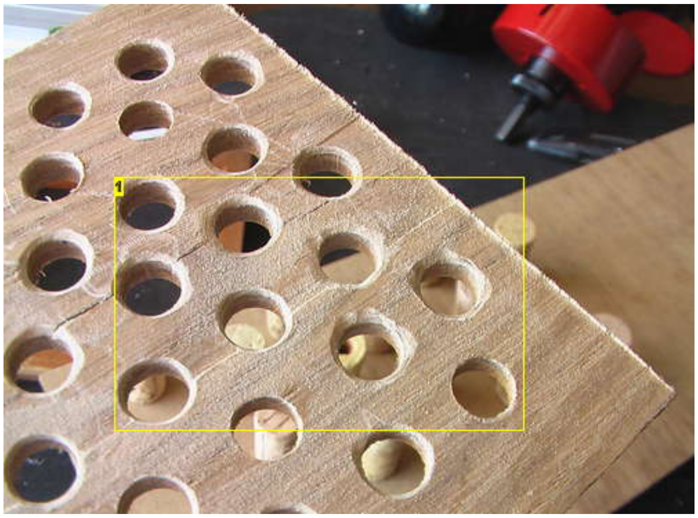


Image Notes
1. We don't want any sharp edges for the blowing air to whistle on, so they are quickly smoothed down with a little sanding drum and rotary tool.

1. Using one of the frames I took off to size it up. After a little cleaning up it should look quite nice from the outside...

Image Notes
1. Bathed in PVA-water mix I had left over... Note the 'professional frisbee' coating dish ;)

Image Notes
1. Oak sound guards installed and ready for action.

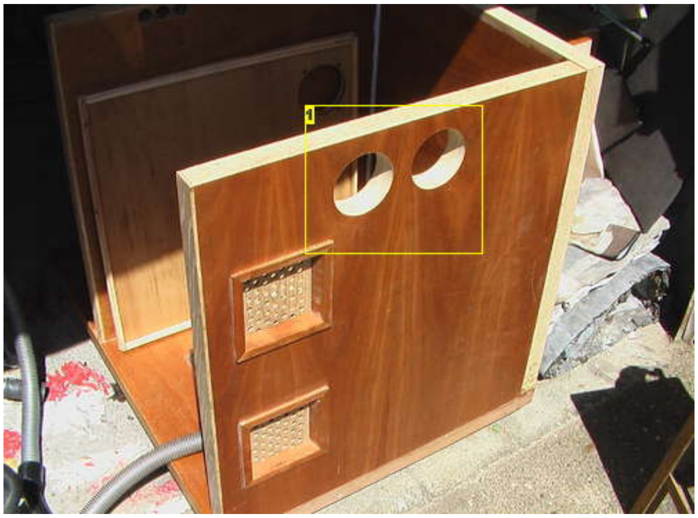


Image Notes
1. I want the option to bypass the filter on hot days when I can pump the exhaust air outside. This should increase filter life and help prevent the workshop overheating. These outlets were made with a standard holesaw.

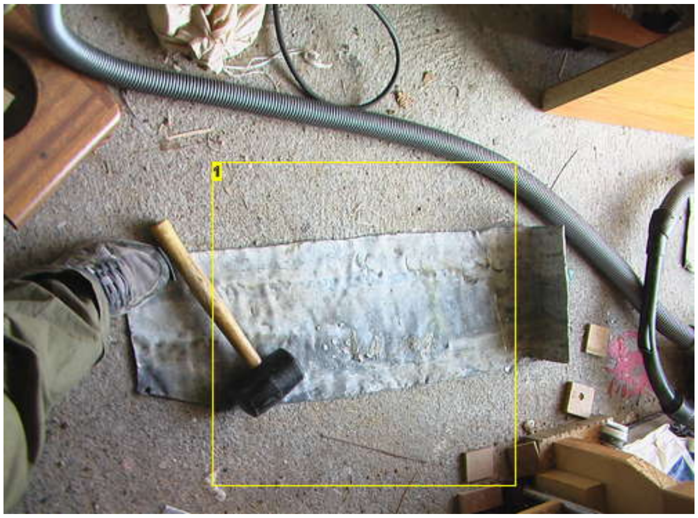


Image Notes
1. Ok, time to put that lead to use in soundproofing the filter housing. The housing is only thin wood and we don't want sound to have an easy straight path through the filter and out the exhaust holes of the outer box.

Image Notes
1. After some tin snip action, folding, and jiggling, the lead is making the right sort of shapes.

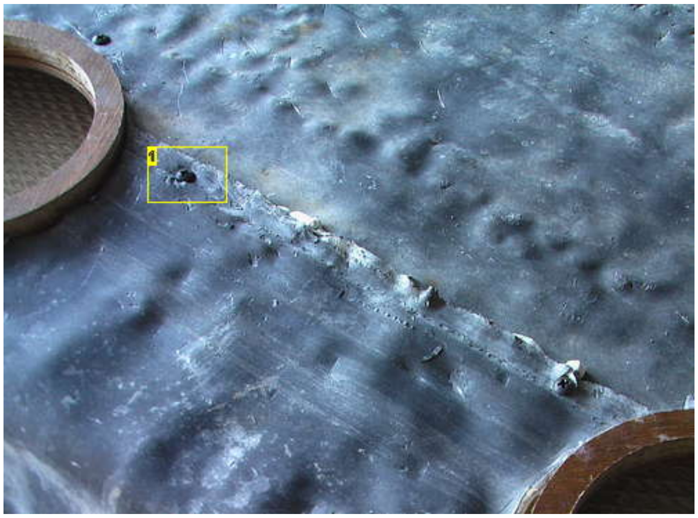


Image Notes
1. The joints are overlapped by about 2cm, and sealed with a bead of silicone.

Image Notes
1. The lead is bonded using a sound deadening concoction of silicone and acrylic based sealant. The silicone (clear) is particularly flexible and good at

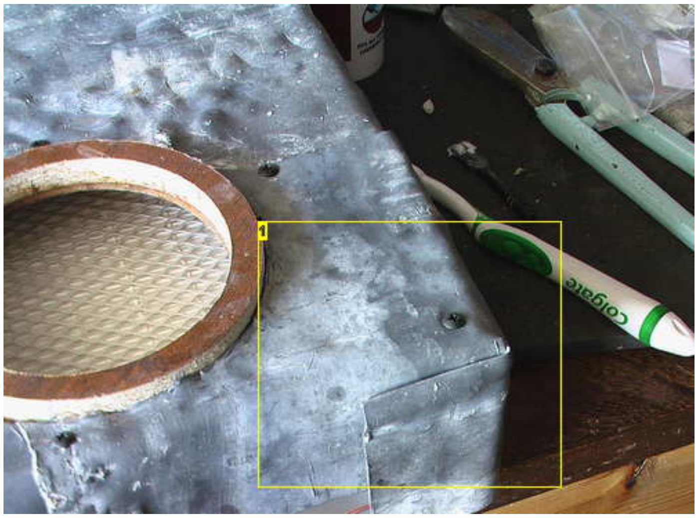


Image Notes
1. corners folded up sealed and screwed. Incidentally, there is no need to drill lead, a screw with half a point will just cut through.

absorbing, the acrylic (brown) makes a firmer glue bond...

Image Notes
1. This is the filter in position. The removable front panel will seal up to the filter, so we don't want/need the uneven bumpy surface of the lead here. Any overshooting bits can be trimmed flush with a sharp knife.

Image Notes
1. The lead 'wings' are sealed and screwed to the side panel.
2. Two continuous beads of silicone seal the edge of the filter to the side.
3. This brace is here to seal against the removable front panel.

Step 10: The Outer part 3 - The Forbidden Cork Forest (or Air Intake Sound Proofing)

Unfortunately, despite the sound having to travel against the airflow created by the vacuums, the gaps needed for the air to come in will still leak a lot of sound. As MahavishnuMan told me when I foolishly suggested the sound might be reduced by the inrushing air:

> "...in order to "suck up the sound", your vacuum would have to breathe in air at a higher velocity than what sound travels, which is 1,127 ft/sec at sea level and standard temperature and air pressure. Not only am I positive your vacuum doesn't suck at Mach 1, but if it did you would have a sonic boom loud enough to crack the box."

So yeah, we need to 'treat' the air inlets so that we defeat the escaping sound. For this purpose I am experimenting with what I fondly dub the 'Forbidden Cork Forest'. It is crucial that we don't add much to the air resistance, which is tricky when you are introducing obstacles to block sound.

The idea with the cork forest is that it will block sound with the sound absorbing 'trees' (the corks), while still presenting a smooth round aerodynamic surface for the air to pass through with minimal turbulence.

Image Notes
1. Initial idea brainstorming - layout round beams so that they easily pass air, but overlap to absorb and block sound.

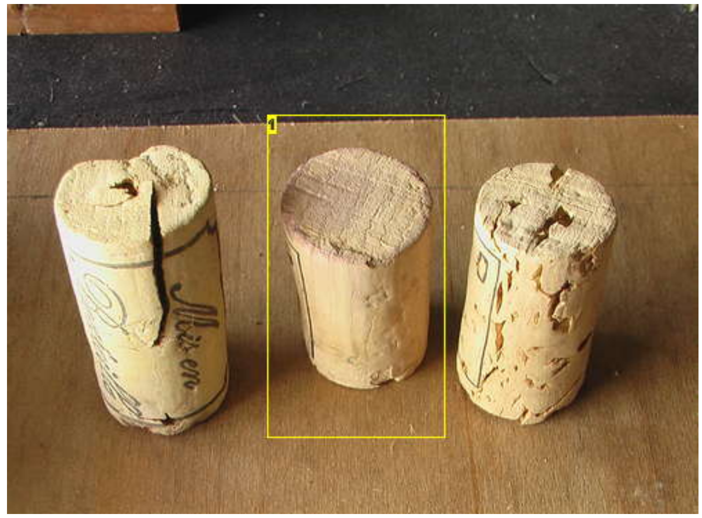


Image Notes
1. We have saved a lot of corks - they are of very variable quality. Some like the one on the left have damage from the cork screw. Others, like the right one, are just plane rough and would add too much air resistance. We select only the finest corks from virgin harvests, with skin as smooth as freshly picked rose petals...

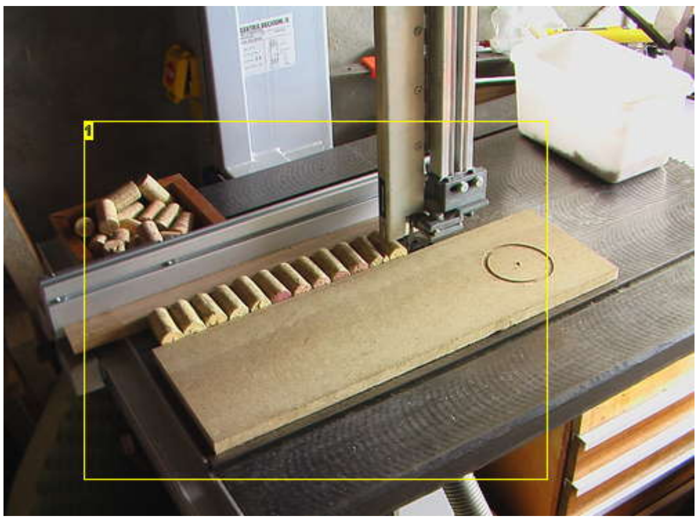


Image Notes
1. Using the new(ish) bandsaw with a fine blade is intensely satisfying - and makes them all the same height.

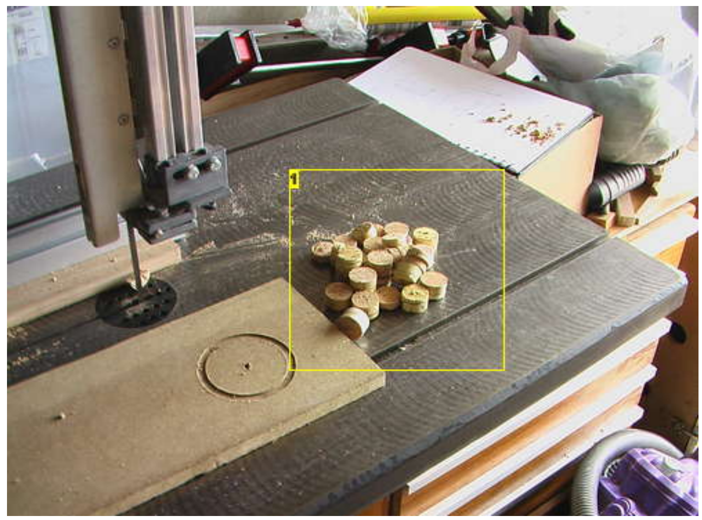


Image Notes
1. 'waste' noggins - stashed away for some future project.

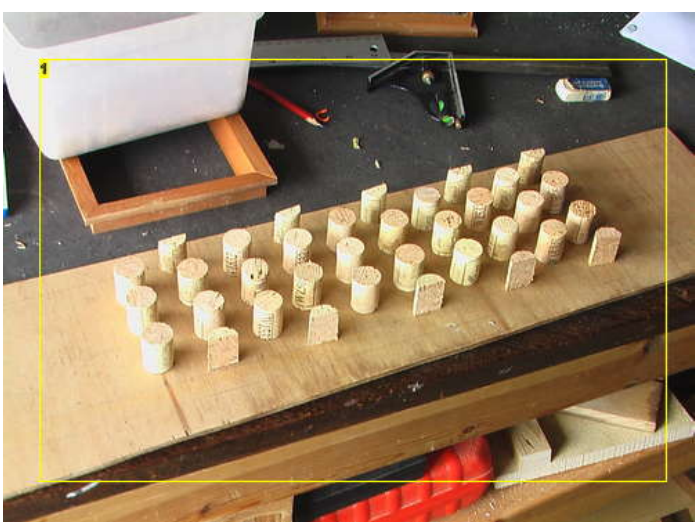


Image Notes
1. The army is assembled.

Image Notes
1. The air will be clever and weave its way through these corkish sentinels, will the

noise be as apt?

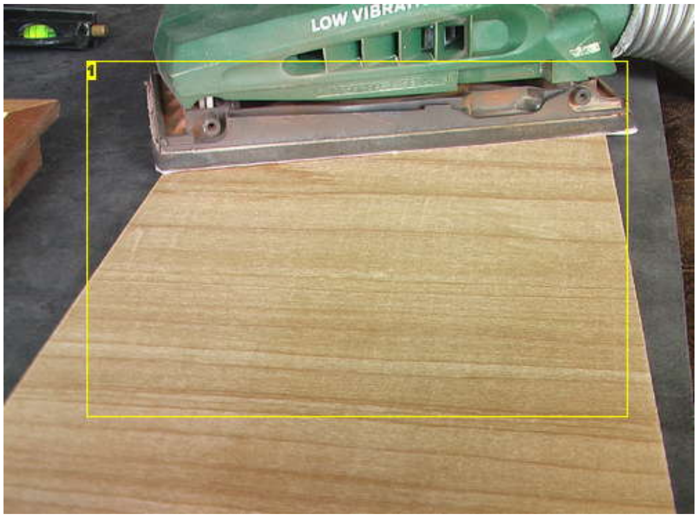


Image Notes
1. Prepping a bit of 'skip' board for the base. It wants to be nice and smooth.

Image Notes
1. Clamping on the two edges

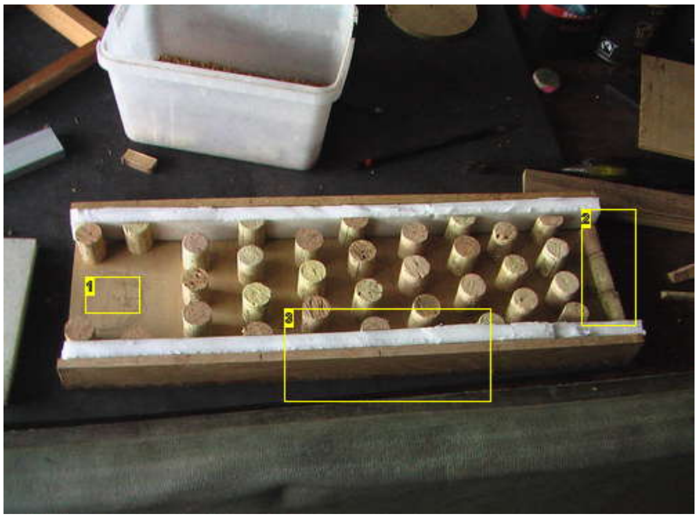


Image Notes
1. Sound from the vacuum enters the forbidden forest from this side, and is met by the imposing corks.
2. Air is sucked in here from the cyclone assembly and passes effortlessly (well maybe) through the friendly forest.
3. The sides are formed from scrap hardwood and an inner lining of foam.

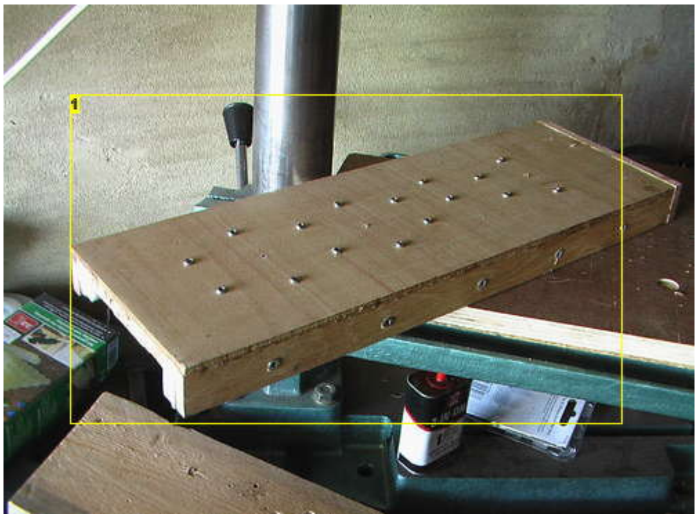


Image Notes
1. The corks are both glued and screwed in. Once this is sealed up a single one coming loose would be a major problem in terms of airflow.

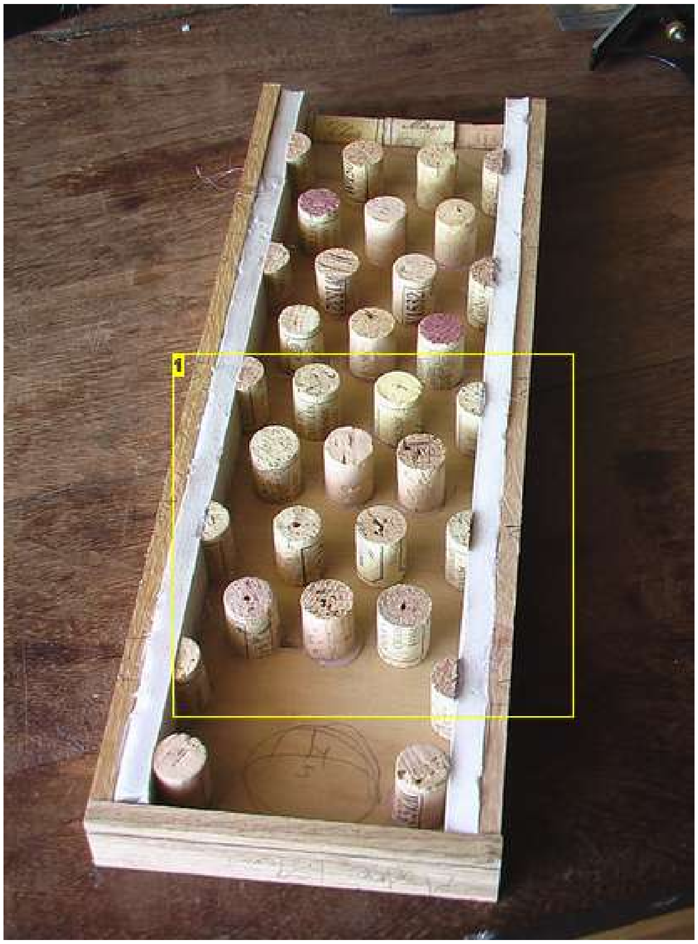


Image Notes
1. The cork forest ready and awaiting trial

Step 11: The Cyclone & Dust Cabinet

As the cyclones are transparent, we want to allow light into their area so we can see what is going on. I used some more of the nice 15mm thick acrylic for the side panels (see photos).

We can continue the theme of oak wood facing and make the control board and corner strut from some lovely scrap oak.

The cyclones themselves are the tallest part of this construction, and because we want the finished work surface to be no higher than our workbench, they need to sit below the level of the DS's floor. This is not a problem because the castors raise it high enough that I can still unscrew and empty the dust containers.

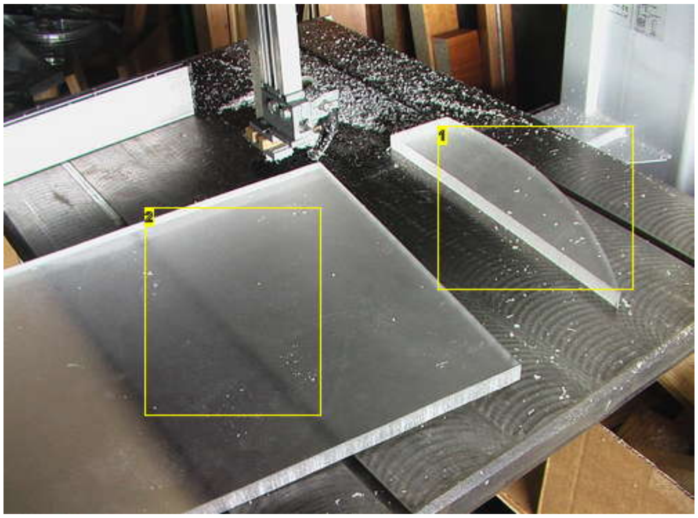


Image Notes
1. This is a fine material (considering it came from the skip), and would probably cost a bomb if you wanted to buy it new.
2. Cutting it to correct panel size.

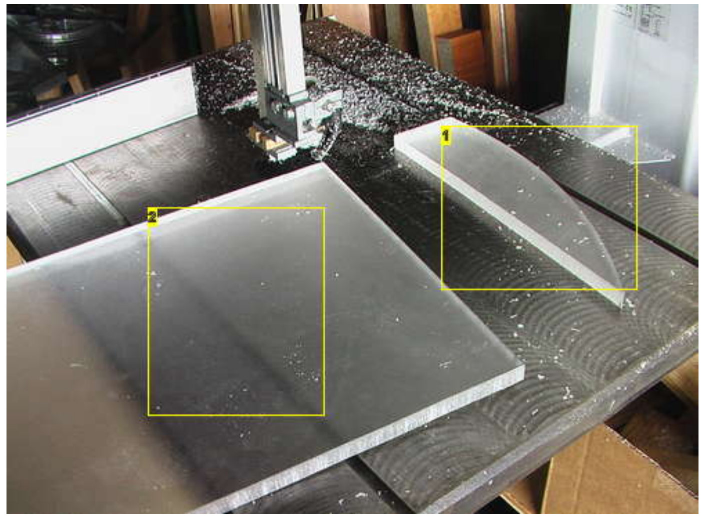


Image Notes
1. Here you can see the cork forest joining to the outlet of the cyclone.
2. This bodged on washing up liquid bottle will be changed.
3. This section is going to be cabineted off.
4. The inner box is out at the moment.

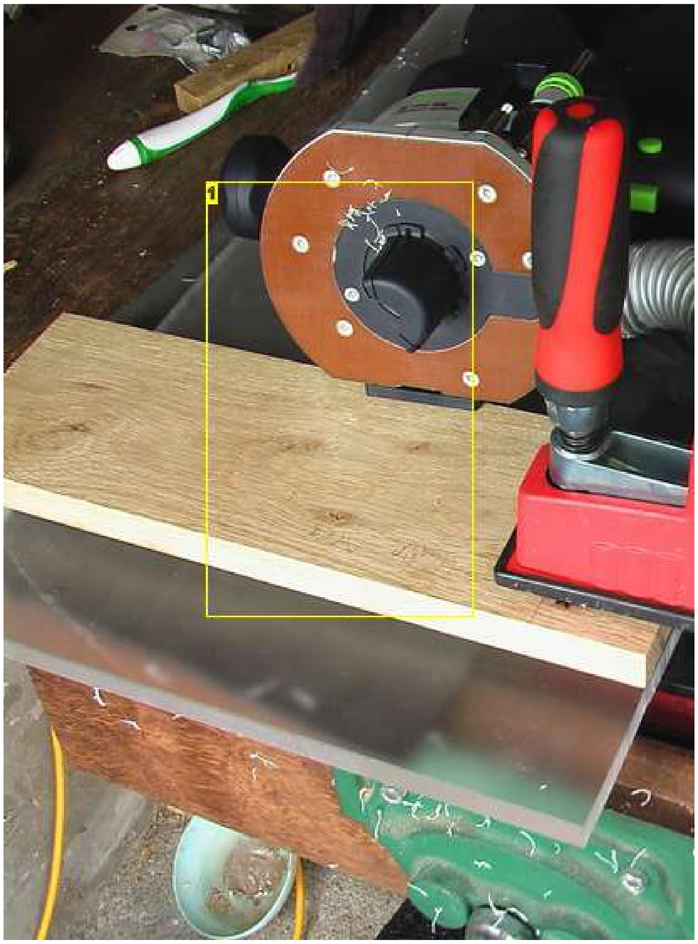


Image Notes
1. Using this wood clamped on as a guide I tidy up the bandsaw cut with a router. Not strictly necessary, but nice.

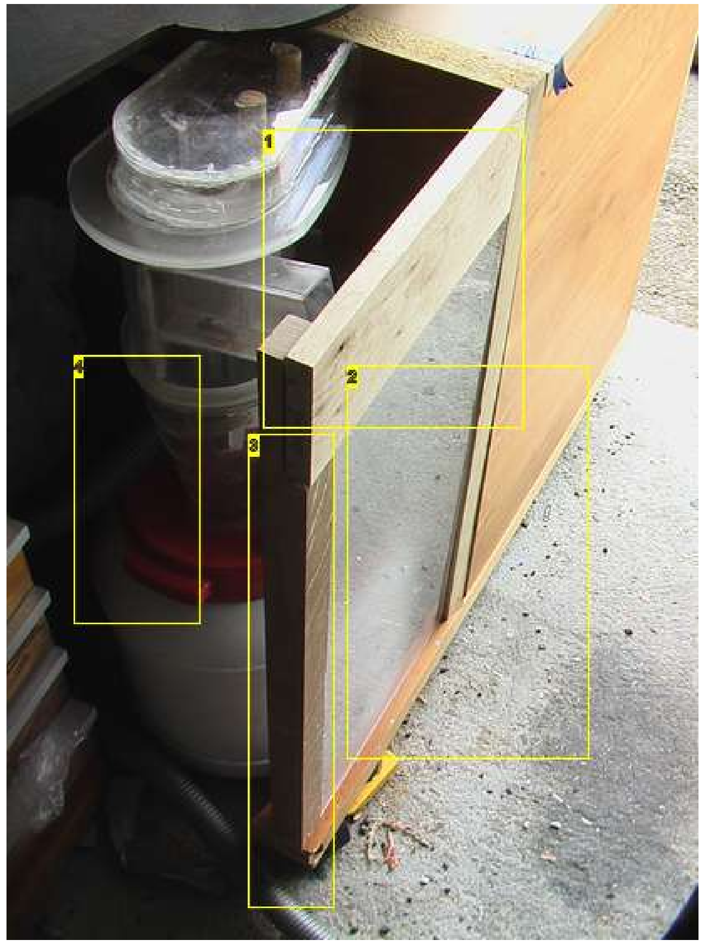


Image Notes
1. This will be the oak control board. It fits up to the corner strut with a simple lap joint.
2. Testing for fit before joining - looks good. Just need to design and cut the holes in the control board, and away we go.
3. The oak has some delightful figuring and rays to it... Pleasing.
4. Some panel doors will go here (eventually), to close off the cyclone area, and keep in that little bit of 'air rushing about noise'.

Step 12: The Top and Front

Because we are using the top of this DS to make our cool stuff, it needs to be nice. Some solid reclaimed teak will do nicely. I blogged about the origins of the teak worktop as I was doing it so I don't want to repeat it now. Enough to say it will be sturdy, help damp the sound, and provide years of service. To attach it, we don't really want to have a solid mechanical link, but instead use silicone-acrylic-latex caulk to bond it. This provides much better damping than screwing it.

The front of the DS gets some handmade catches - which are actually really simple - to hold it in place and compressed against its bubble seal.

Image Notes
1. This butchered old tap took some getting off.

Image Notes
1. Some general school science related scruffyness, but this should come out nice.

Image Notes
1. This hole is a bit inconvenient. But wait, if we flip it round and use it as a viewing window...

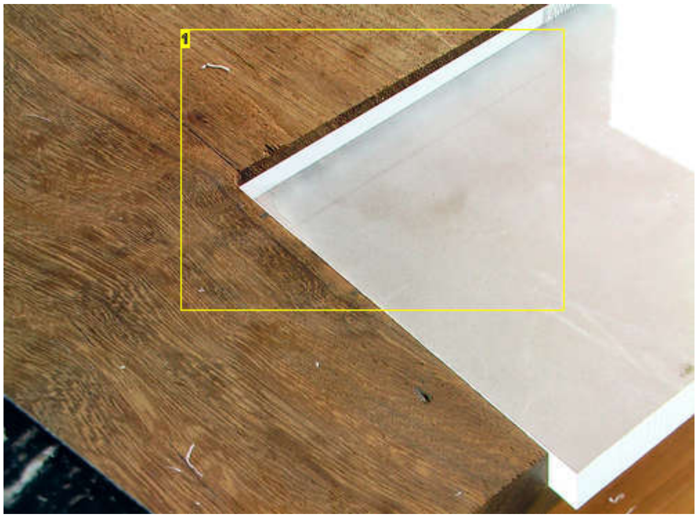


Image Notes
1. Some routing later...

Image Notes
1. Most mesmerizingly beautiful.

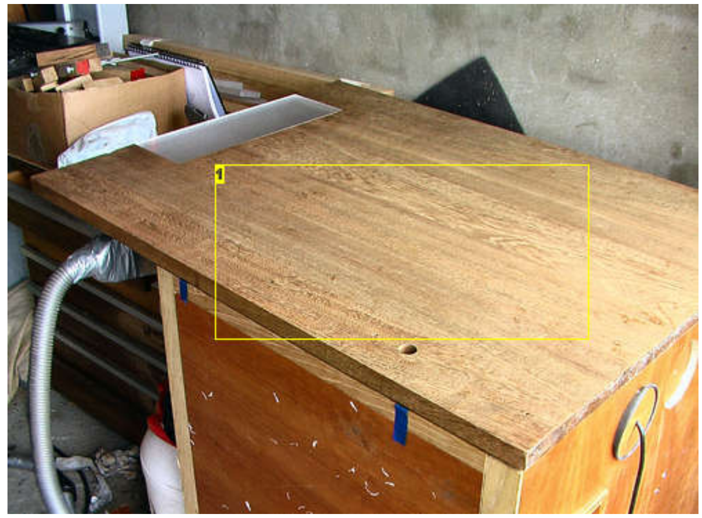


Image Notes
1. One new teak top.

Image Notes
1. Very simple catches.
2. Pre-completion use. very naughty.

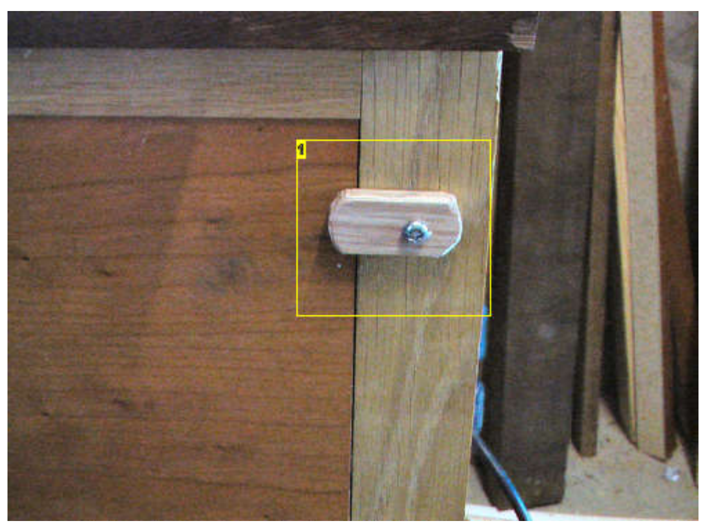


Image Notes
1. Yep, the catches are simple but effective. A single long screw holds them in just tight enough that they will rotate stiffly and hold the door compressed shut against the bubble seal.

Step 13: The DS Auto Switch

So we want a switch that turns the DS on automatically when we start up our power tool, and then turns it off again when we are done making dust. Ideally it will switch on just *after* the tool, so that the starting current of the power tool is not exacerbated by the simultaneous starting of the dust extractor. And when the power tool turns of, we want the DS to stay on for a few seconds so that the hoses are cleared of any remaining dust.

There are a load of different ways to approach the auto switch circuitry. Here, for example, is an auto switch that uses commercial current detector. The cheapest I could find the toroidal sensor component for this was for $50 so this was out as far as I was concerned. I wanted to make it without buying anything, using the odd bits and bobs I had knocking about, so my design was a bit, hum, unusual. There are a load of alternative ideas for this in the resources section at the end.

If you want to try out my design, instead of using a current transformer, which seems the standard approach, we use a reed switch, activated by a very small coil in the live power cable that supplies the power tool. The reed switch activates a relay, which in turn energises the heavy duty contactor, which is hefty enough to cope with switching both vacuums on or off at once. If you want to do it this way follow the circuit diagram below, nothing is too complicated, expensive or difficult.

To make the coil, just wrap some 16 AWG (or fatter) magnet wire round something thin that is a similar size as the reed switch. I used the blank end of a drill bit, but be careful not to scratch the enamel insulation (something plastic or wooden is better). To begin with I didn't even use magnet wire, just standard insulated wire, as you can see in the pics, and it still worked OK. This way is not as sensitive though, because of the insulation gap. So if you want to use it with lower current draw tools as well, magnet wire is better. About 13 turns is all you are likely to fit on the reed switch - that's fine.

The capacitor bank in the 6V relay circuit adds a delay to the switch, so that the DS stays on for a few seconds after the power tool is turned off. Having a capacitor bank like this though, means that we need to add a resistor (or around 8KOhm) in series with the reed switch, to protect it from the inrush current when it is switched on (without it the reed switch will weld shut). If you wanted to be a bit more elegant you could put together some kind of 555 time latch circuit, but I didn't have any 555s to hand.

If you just want a very quick and dirty solution, just having the reed switch activate the AC contactor worked OK when I tested it. You will not get any delay, and the motors will start together with this one, but it is very simple and it works (though how long the reed switch would last I can't say).

Components (circuit diagram below click the 'i' in top left to get full size):

Reed Switch - just one of a bunch I had laying round. It is about 1" in length, glass body, the coil goes tightly round this.
D1 - rectifying diode
D2 - rectifying diode
TR1 - a small step down transformer (to 6V) - time to use one of those 'wall warts' you have been saving.
C2 - 6.3V 4700uF (but just use what you have in your scraps box)
C4 - 6.3V 4700uF
C5 - 6.3V 4700uF
DC Relay - 6V DC relay, a smallish low current thing is what you want.
Contactor - Heavy duty contactor, I found this on a thrown out saw - these are useful for NVR applications.
R2 - 8.2KOhm resistor, important for protecting the reed switch.
C3 - a 0.22uF 275V AC capacitor
R1 - 330 Ohm resistor
B2 - a suitably beefy bridge rectifier

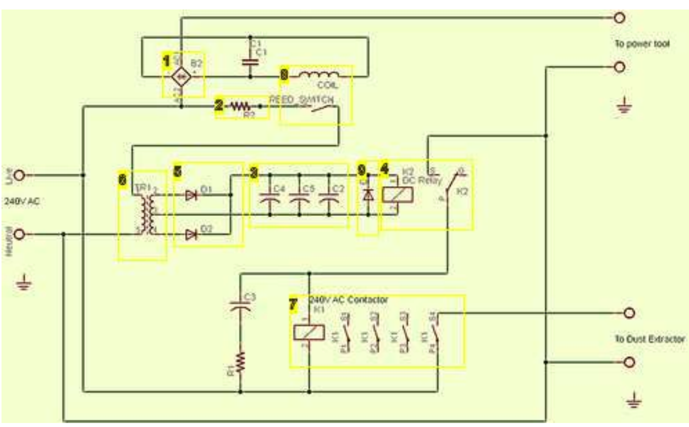


Image Notes
1. This just rectifies the current going through the coil, to help prolong the life of the reed switch.
2. about 8KOhms protects the reed switch from inrush current.
3. Capacitor bank, keeps relay energised for a few seconds after the tool is turned off.
4. 6V DC relay
5. You could rectify like this or you could use a bridge, either way... Or you could just use an all in one wall wart and let it use whatever rectification it likes...
6. 240V to 6V step down transformer
7. Main heavy duty contactor
8. Coil wrapped around a reed switch.
9. Diode helps protect against transients from the relay coil.

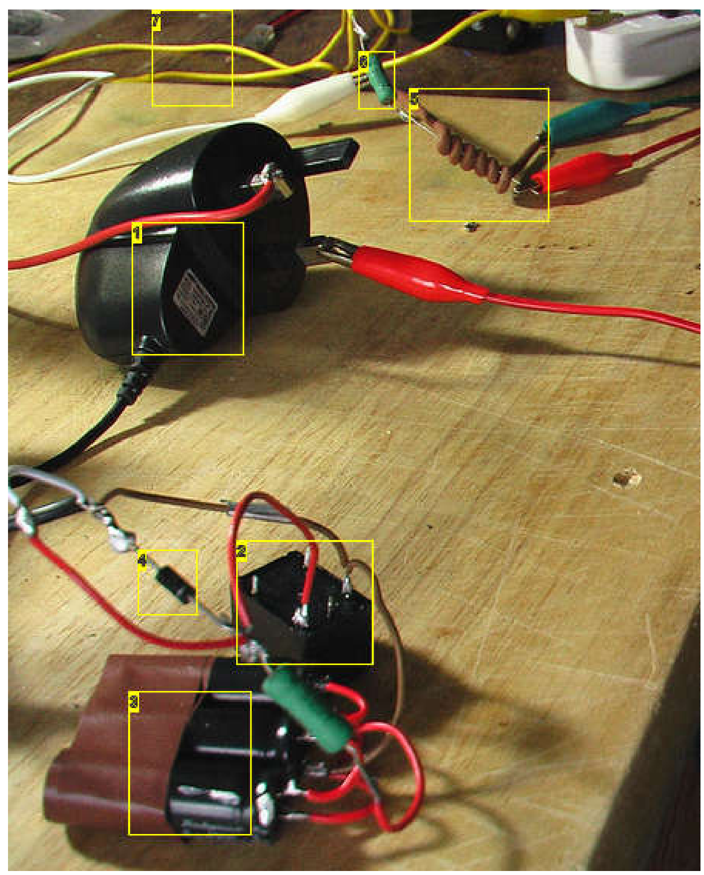


Image Notes
1. This little 'wall wart' give out plenty enough current at 6V DC, which is just

what we want for this little relay I salvaged from an old circuit board.
2. This relay is activated by 6V DC. When turned on it will pass the 240V AC used to energise the contactor coil.
3. Each of these capacitors are 4700uF. The three of them together make for a delay of about 3 seconds before turn-off (in other words they can supply the relay coil with power for 3 seconds).
4. This diode is used to help prevent transients.
5. This is the reed switch and coil. In the end, when I got some, I made the coil from proper magnet wire.
6. 8.2KOhm resistor in line with the reed switch helps protect its contacts.
7. General testing mess!

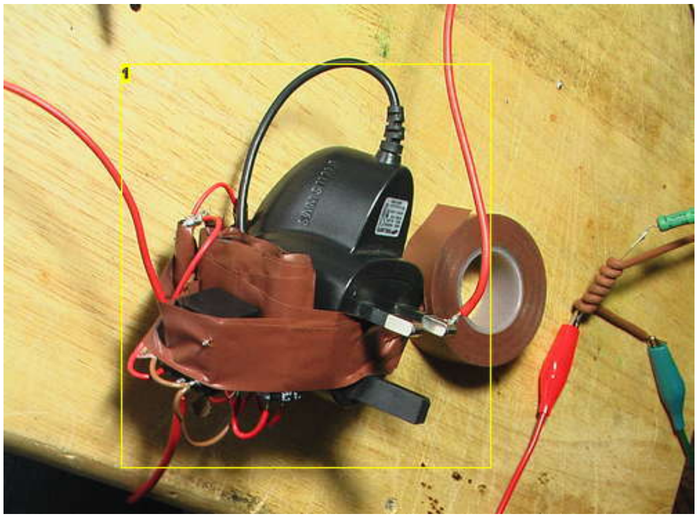


Image Notes
1. A condensed and taped up version of the previous photo. Relay, capacitor bank, transformer and the other little components are parcelled up (not the reed switch and coil though - that is mounted separately).

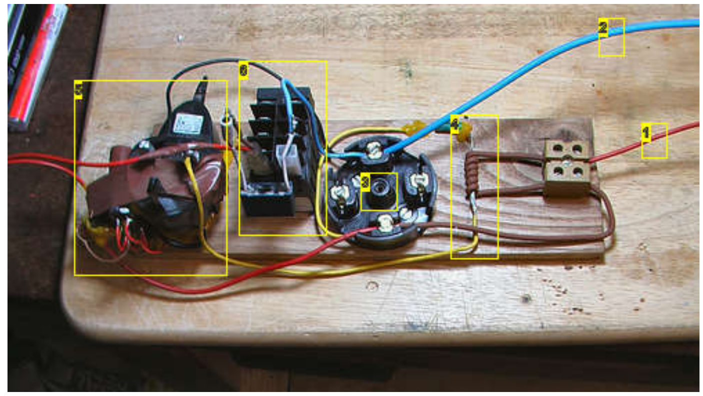


Image Notes
1. Live wire, off to supply the power tool outlet.
2. Neutral, to supply the power tool outlet.
3. This screw down junction box, is useful for organising connections.
4. The reed switch and coil.
5. The 6V DC relay circuit.
6. The contactor. A Capacitor and resistor across the coil help to suppress transient spikes.

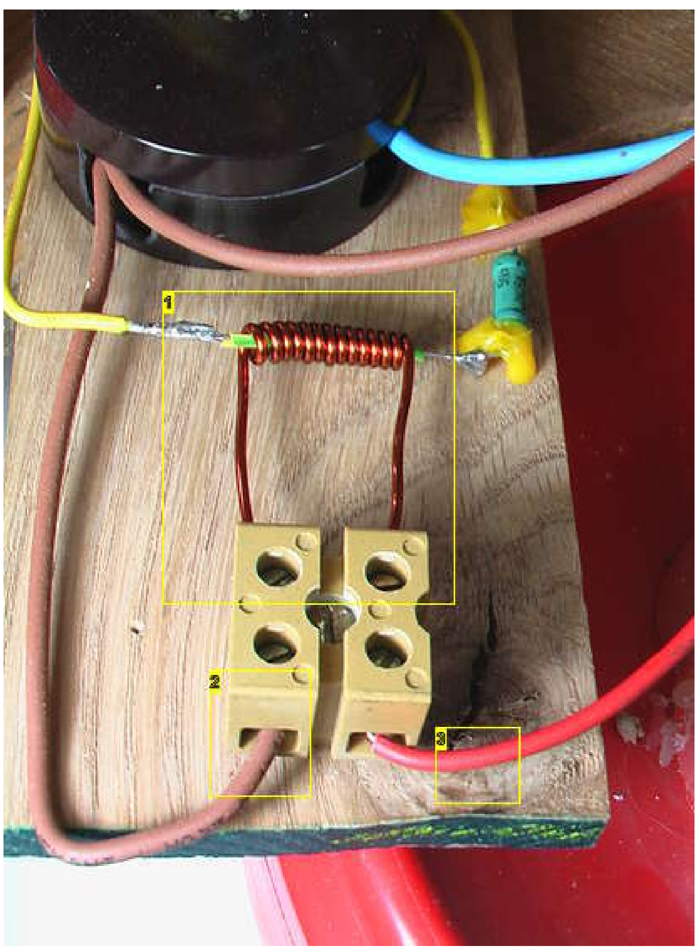


Image Notes
1. The reed switch in the coil of 15 AWG magnet wire. Or as I like to think of it, 'the flux capacitor'.
2. AC Live supply
3. Live that supplies the power tool socket.

Step 14: Controls and wiring

Ok so here is where we end up with plenty of head scratching, checking, double checking, and re-checking again. Remember that this is mains voltage we are tinkering with so get some qualified help if you need it.

The control board is basically going to consist of:
a dumb plug socket (just a plain socket),
a control socket (what we plug the power tools into, if we want auto dust extraction)
A master on/off switch (this turns everything on or off)
A switch that toggles between on/off/auto one of the vacuums
A switch that toggles between on/off/auto the other of the vacuums

Begin by making some real size sketches of how it might be on card and work from there. Of course, this control board would be a prime candidate for some laser etching. Anyway, preparing the board can be a classic woodworking task: we need to drill and chisel some holes that will fit our sockets, switches, and air inlets. Make sure to plan it all out carefully based on the switches you have acquired before setting mallet to chisel.

At this stage I also added in a 16A trip switch (that I was given when a neighbour was replacing their consumer unit). The fuse in the plug should give protection anyway, but a little extra is nice. Once you have everything sorted, and tested carefully rout the cables and secure them so they are all neat and tidy.

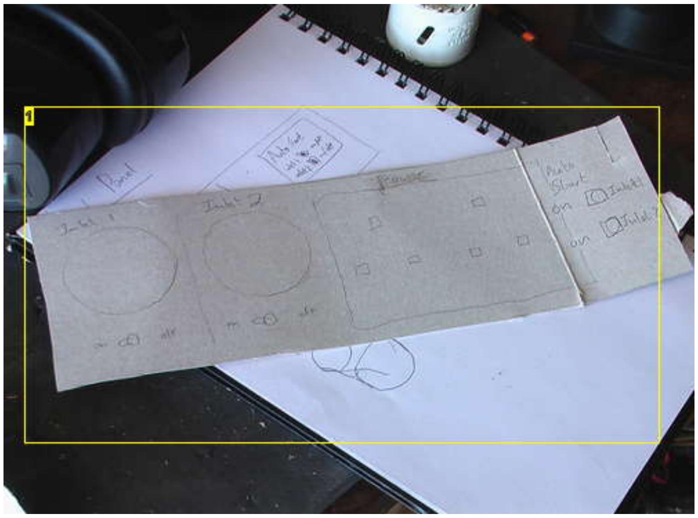


Image Notes
1. Brainstorming the control and outlet panel.

Image Notes
1. Drill some holes through the inner and outer box. Cut off the plugs leaving enough length of cable to wire it up. Feed the vacuums cables through to the cyclone cabinet - which is where we can house the electrics.
2. It is useful to label, so we know which cable is which. Also remember to inject some sealant round the entry points - we don't want to introduce holes in our sound proofing at this stage.

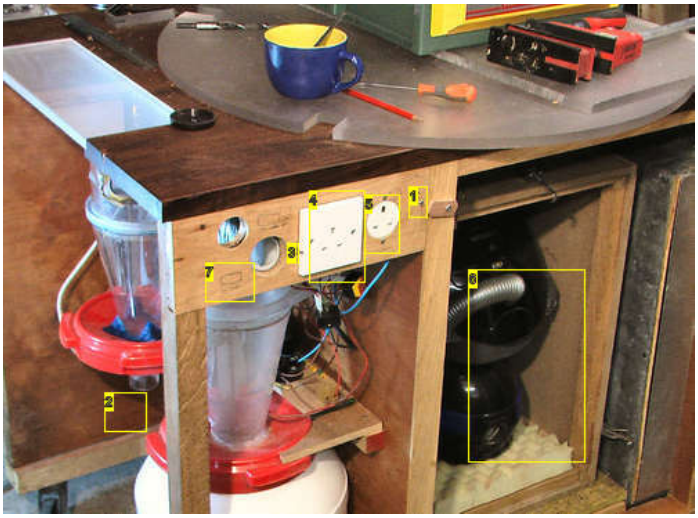


Image Notes
1. Main power isolator switch.
2. Power comes in at the back, just out of sight, in a nice industrial armoured

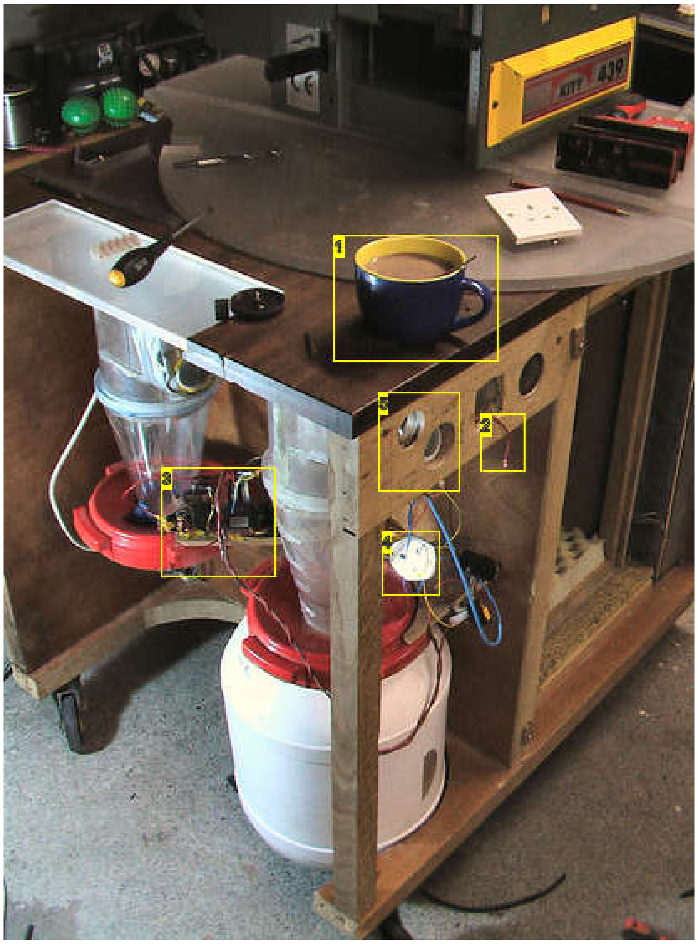
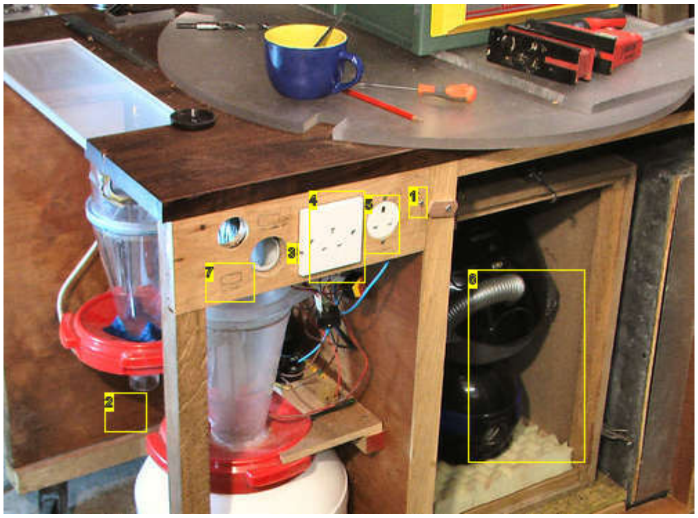


Image Notes
1. mmmm, hot choco!
2. Thread appropriate wires through ready for the socket.
3. The auto switch circuitry will get tucked away tidily before the DS comes on-line for regular use.
4. A little round plug socket I salvaged. That means we will have one round and one square, how perfect ;)
5. Holes and orifices are prepared and ready.



cable I have been saving. Useful because the wheels have a tendancy to roll over everything in their path.
3. Switches from 'on' to 'auto' (power out-take sensing).
4. This socket is the one that will trigger the DS if a power tool is used with it.
5. This socket just provides another convenient power outlet - it is not a DS triggering one.
6. Both vacuums in their snug inner box
7. These are switches-to-be. The holes need drilling and chiselling out carefully.

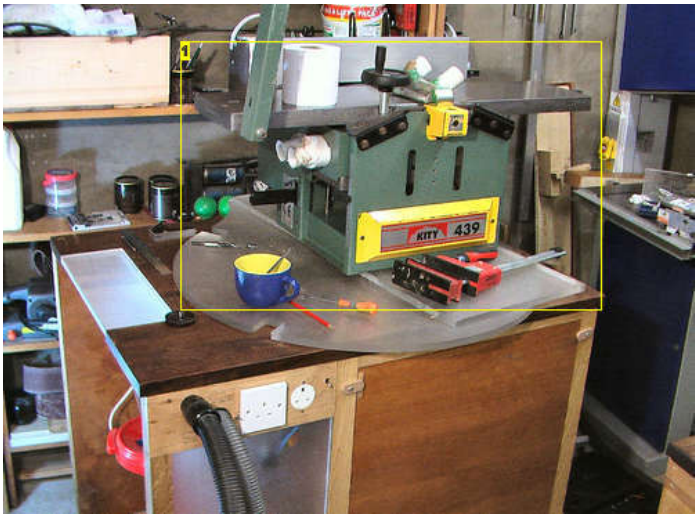


Image Notes
1. In testing. This planer thicknesser with modified dust collection ports, works surprisingly well with it, though I did not have that in mind when making.

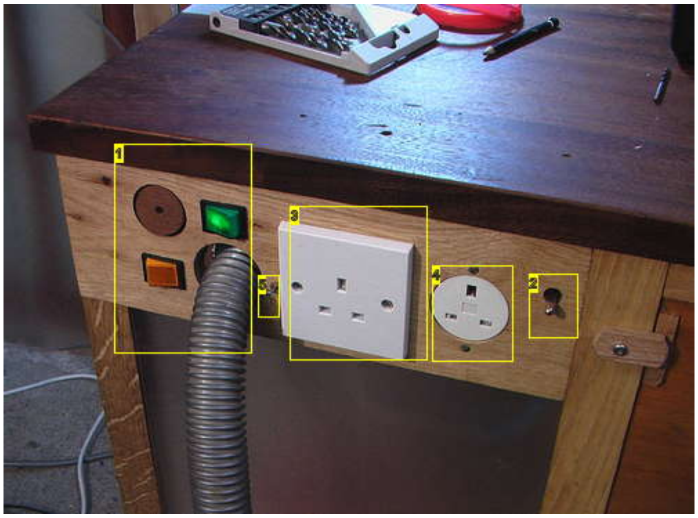


Image Notes
1. I bagged these little switches, which light up when they are closed. This is cool - green lit up indicates the hose it is above is on, orange indicates the currently blanked off vac is sucking.
2. Main power switch
3. Auto plug
4. Dumb plug socket
5. Toggle switch between 'vac on' or 'responding to auto socket'.

Step 15: In Use, Evaluation, Maintenance

Lets evaluate the DS in relation to the design goals which were:

1) Effective removal of dust from hand-held tools and bandsaw
2) Little or no noise
3) Provide strong but wheelable work surface

1) The removal of dust thus far is excellent. The dust is sucked up and separated by the cyclones into the collection barrels. Because the separation efficiency is so good suction remains very high - no regular cleaning filters or changing of bags required. Obviously the collection barrels need emptying occasionally, but being many times bigger than a bag or standard shopvac canister, this is an easy and infrequent chore. Thus far, I have only had to change a vacuum bag after I got carried away and let the barrel become full, which resulted in the dust quickly clogging up the vacuum bag and suction becoming very weak.

So yeah, it might be worth me trying to make some kind of warning sensor that tells me when the collection barrels are approaching fullness to avoid similar problems in future. I already put a viewing window into one of the collection barrels, problem is that the static causes it to be obscured with dust, so that's little to no help. Some of you have already made some good suggestions on how to overcome this little problem in the comments. Of course any other ideas are very welcome...

2) Noise wise I am better pleased that I expected to be. When the DS is all closed, shut up and operational, *I can't really hear the noise of the vacuums at all*! The noise of the air rushing through the hose is pretty much all that is audible. So jackpot on the sound front. I can't tell you how nice it is to be able to clear up the shop and suck up dust without a loud noise. It makes nice quiet, well balanced power tools more worthwhile ;)

Now bearing in mind there are many differing and complicated techniques of sound measurement, the audiophiles may want to look away now. In a blissfully and probably horrifyingly simplistic manner, I used a mobile phone with an in-built 'sound meter' to do my measuring.

Sound of both vacs out in the open - 85dB
Sound of one vacuum in the open - 83dB
Sound of both in the DS - 61 (but varies a lot depending on where the end of the hose is situated - the air rushing in at the tip is almost the only precipitable noise)
Sound of one in the DS - 55

3) The work surface is nice, functional, and sturdy enough to dance on. I do need to add a breaking mechanism to the wheels, so that I can lock it in place better.

Parting Thoughts

The DS has been a long project for me, with plenty of help, research and tweaks needed along the way. Still, it has come together in the end and with any luck this instructable will help you guys avoid some the mistakes I made. Already a number of you have said you will be making your own DS, so I look forward to feedback, build photos, and areas of development. If it improves the working environment (and health!) of one of you, my fellow makers, hackers and craftspeople, then great!

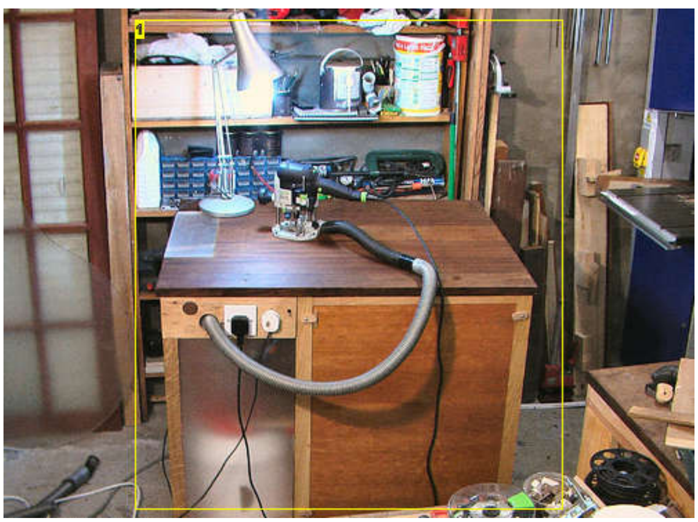


Image Notes
1. Typical DS application.The router takes power from the DS's auto switch socket, so that dust is automatically pulled away during use - nice! The lamp is plugged into the dumb power socket on the right.

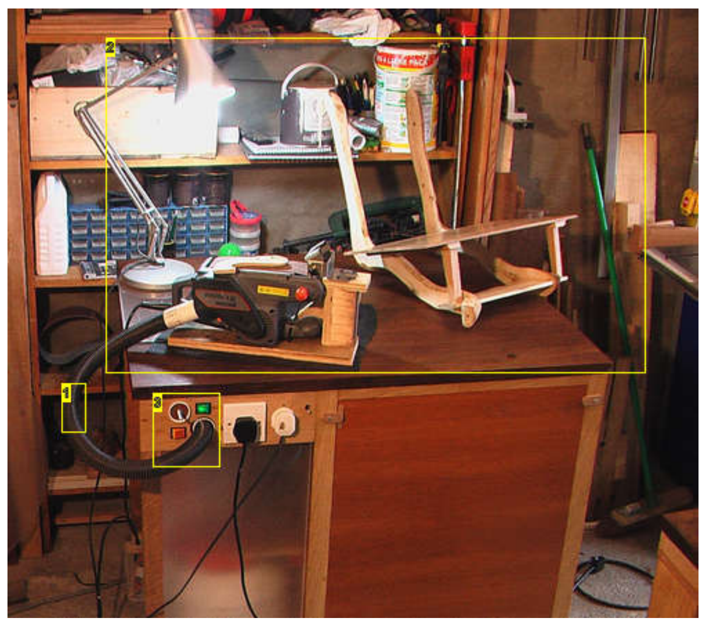


Image Notes
1. Keeping the hose lengths as short as possible reduces the air resistance.
2. Upturned belt sander is plugged into the 'auto socket'. Here it is being used to help shape some oak for a wacky table/shelf project.
3. Green switch is lit, so we know the correct hose is selected. The other is just blanked off for now.

Image Notes
1. One big barrel load of dust - Thank you DS!

Step 16: Resources and References

Dust Related Resources:

For more on extracting dust, modifying tools dust points, noise reduction, and a whole load of other bits'n'bobs check out my blog: *www.FloweringElbow.co.uk*

Bill Pentz's magnificent dust collection website: *http://billpentz.com/woodworking/cyclone/index.cfm*

A decent discussion of cyclone dimensions, height to diameter ratio etc. based on knowledge of ginning cotton: *Abatement of Air Pollution and Disposal of Gin Waste, C.B. Parnell, Jr., E.P. Columbus, and William D. Mayfield. in Cotton Ginners Handbookedited by W. S. Anthony, William D. Mayfield (1994)*

A doctoral thesis, by Jette B. Lange on the health dangers of wood dust. This contains a lot of references to good academic, peer-reviewed evidence and information - very useful if you are keen to research this area further. *Effects of wood dust: Inflammation, genotoxicity and cancer*

A table of wood toxicity published by Woodworking Australia: *http://www.ubeaut.com.au/badwood.htm*

Noise Control Resources:

A decent and comprehensive book, if a bit dry. (*Amazon* link): Engineering Noise Control: Theory and practice, Fourth edition, David A. Bies and Colin H. Hansen (2009)

Nice site for the basics of soundproofing: *http://www.soundproofing101.com/soundproofing_2.htm*

A corporate (Silex) sponsored (but still worth a look) document on sound attenuation: *http://www.silex.com/pdfs/Sound%20Attenuation.pdf*

An interesting Speaker Building website: http://www.speakerbuilding.com/content/1011/page_9.php

A Website called, 'Resonance Frequency'- more useful info from our speaker building friends - http://www.resfreq.com/usefulinfoonwood.html

Automatic Switch Resources

Fine Woodworking article that describes construction of an automatic switch using commercial (expensive) current sensor.
http://docs.google.com/viewer?a=v&q=cache:8CwHui3lOdwJ:www.finewoodworking.com/FWNPDF/011143066.pdf+Fine+Woodworking+current+sensing+switch&hl=en&
1BSk&sig=AHIEtbS2eSQxQ-xloBLiT3WRacLNzF-evA

An excellent patent of auto switcher that uses a home fabricated current sensor and a transistor. Has a good circuit diagram and a complete list of parts (towards the end).
http://www.google.co.uk/patents?id=x7UiAAAAEBAJ&pg=PA5&dq=dust+Auto+Switch&source=gbs_selected_pages&cad=3#v=onepage&q=dust%20Auto%20Switch&f=fa

A very simple patent of a triac using auto switch - not idea because it is a current matching circuit http://www.freepatentsonline.com/5099157.pdf

A discussion on an electronics forum I started when I was considering my reed switch method: http://www.electronicspoint.com/advice-needed-auto-switch-design-t225720.html

Bill of materials / things to look out for if you are planning a DS:

Enclosures: old fire doors, kitchen work top, scrap mdf, plywood, angle iron (bracing and joining), sand, lead sheet, thick steel (if you are a wizz with welding). Wood glue, silicone and acrylic sealant, screws. Heavy duty castors, bubble seal (like you get for draft proofing doors and windows).

Internal: old vacuum (can often be found dumped or skipped, with nothing wrong other than dirty filters, or over full bags), old vacuum hosing (loads of these get thrown out, here in the UK you will never need to buy it if you visit your council skip occasionally), compression latches, suitable sized barrels or other containers.

Electrical componants: this is mostly listed in the steps, but you should have no problem scavenging most items, although they will probably need 'rescuing' from old appliances.

Cyclones: This is the tricky part, look out for surplus or scrap polycarb from greenhouse constructions etc. May just be a case of buying the right sizes (I got mine from e-bay). I have no personal experience with it, bur you might also consider PETG plastic for the cyclone. It is nearly as tough as Polycarbonate (Lexan) but is easier to machine and apparently does not shatter with solvent even when under tension. The only real problem with the PETG, I am told, is that you need to buy the stress relieved stuff or it bends all over the place when you work with it.

Rough material needed for one cyclone with a little to spare:

Upper Body:
15mm acrylic: 2 of 250mm x 700mm (this is for holding together and mounting. It could be made from plywood or similar instead of acrylic)
1.5mm polycarb: 190mm x 1000mm (this is rolled into the 150mm dia body)

Cone:
0.75mm polycarb: 800mm x 800mm (cut and rolled up)

Air Inlet:
3mm polycarb: 210mm x 240mm (mitred into box)

Ramp:
1.5mm polycarb: 200mm x 200mm (cut into split circle)

Air outlet:
0.75mm polycarb: 200mm x 600mm (rolled into 75mm pipe)
[OR 160mm length of 75mm dia. pipe]

Hot melt glue to join it all together

I have included the cyclone SketchUp files below. They can be made into SVG files (flightsofideas's ible shows how) if you want to laser cut or CNC them - if anyone does this let me know how it goes.

File Downloads

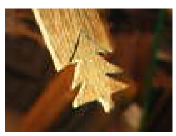
DS Cyclone SketchUp Files.zip (101 KB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'DS Cyclone SketchUp Files.zip']

Related Instructables

PET Soda Bottle Cyclonic Dust Separator by Nanotech Tech Tool

Mini Cyclone Bucket Dust Collector by steliart

Making a cyclone chip separator for a dust collector by tashiandmo



From Sewing Machine to Scroll Saw, a Christmas tale by bongodrummer

Removable Skirt Lampshade Covering by jessiecreations

A Guy's Guide to Dusting by jdege

Comments

50 comments Add Comment view all 89 comments

roamin_ronin says: Feb 24, 2011. 6:35 PM REPLY

This is only 20 USD

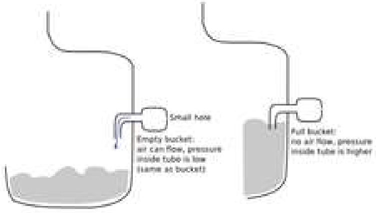
http://www.sears.com/shc/s/p_10153_12605_00924031000P

wiml says: Feb 5, 2011. 4:52 PM REPLY

Thinking laterally about bucket sensors: perhaps you could put a small tube into the collection bucket near the top, connected to some not-very-strong source of vacuum. When the bucket fills, the sawdust blocks the tube, making the pressure in the tube drop, which then ... um ... raises a flag, or triggers an electronic pressure sensor, or the like.

Or, alternately: isn't the interior of the bucket at below-atmospheric pressure? The tube could be connected to 'outside' air though a small hole. When the bucket is not yet full, airflow into the bucket keeps the tube below atmospheric. When the bucket fills past the tube, airflow stops. Let's see if I can attach a sketch of this idea... I can't decide if it'd be horribly finicky and impossible to implement, or if it would be perfect and elegant. :)

Electronic pressure sensors are around $15 new but maybe there's a good junk source for them...



bongodrummer says: Feb 7, 2011. 1:46 AM **REPLY**
Hi Wiml,
Interesting ideas, thanks! Things are complicated a bit because the storage barrels themselves are in a partial vacuum (which fluctuates depending on whether the end of the vacuum hose is blocked or partly blocked). It is necessary to maintain the seal on the barrel so that the cyclones work right. My feeling is that adding another 'not-very-strong source of vacuum' would open a whole can of worms (big malicious ones at that).
An interesting idea though, thanks for sharing.

jeff-o says: Jan 6, 2011. 9:04 AM **REPLY**
I wonder if you could put a small digital scale with a remote readout under the barrels. When the barrel hits a certain weight, you know it's time to empty it.

Any kind of optical sensor inside the barrel would be obscured just like the window, and other sensors are out because of the static. But yeah - weight would probably work.

DeadlyDad says: Feb 4, 2011. 12:33 PM **REPLY**
How about using a simple, light flap and a cherry switch, along the inside of the barrel at the 'full' line. Have a spring on it so that it normally sticks out when the system is off. When the system is in operation, the flap will be forced against the side. If the flap doesn't swing back out when the system is turned off, something is blocking it, and the barrel can be assumed to be in need of emptying.

bongodrummer says: Jan 6, 2011. 9:49 AM **REPLY**
Hay Jeff-o!

I am not sure I am understanding you with this. The barrels 'float' off the floor, so that the DS can be wheeled around. They are screwed onto the base of the cyclones - their lids are firmly attached so the cyclones and everything remain stable.

Or did you mean putting the scales inside the barrels? That might work, if they were inside some kind of plastic bag - but then again the partial vacuum created would probably disrupt readings...

jeff-o says: Jan 6, 2011. 10:49 AM **REPLY**
Ah, true. I forgot that the barrels were connected to the cyclones. Perhaps with a short flexible tube (flexible ducting?) between the two it would work.

bongodrummer says: Jan 12, 2011. 8:32 AM **REPLY**
A bit of flexible tube would get around that yes, although there is another problem with the weighing method, that was pointed out to me on one of the forums. That is, the material sucked up is often of very different density. Between different woods and plastics, and different shapes (ie shavings, fine dust, etc.) the weight of a barrel can apparently vary a lot.

jeff-o says: Jan 12, 2011. 10:28 AM **REPLY**
I was thinking of that. And yeah, if you're sucking up plastic and metal along with the wood then it could be a problem. But really, they shouldn't be mixed in the first place (sawdust can be used for other things!) And as for different density woods, unless you're doing a lot of work with ebony and cocobolo, I doubt it'll present much of a problem. In most cases, people will be using oak, pine, maple, and poplar. Set your threshold for a bucket full of oak sawdust and you'll be good to go!

bongodrummer says: Jan 12, 2011. 11:42 AM **REPLY**
I am not sure we can assume wood density is so homogeneous, but you are definitely right about keeping materials separate (one of the reasons I wanted two collection barrels). I have no first hand experience, but I can quite easily imagine the shape of the particles would make a fair difference though. I know a barrel load of shavings from the power planer *feels* lighter than say 3/4 of a barrel of proper sanding dust - I haven't actually weighed it, so I am just going from my feeling here.

But also consider: my Handbook of Hardwoods claims the weight of European Oak usually falls in the range from 640kg/m3 to 820kg/m3, having an 'extreme but possible' range of 600 to 900kg/m3. And that is within one species. Pine is often round 500kg/m3. That in mind, I think density issues would be worth considering with the weighing approach. If you calculated in a good safety margin though, I expect it would work fine as an indicator - barrels don't *have* to be full before we empty them after all.

jeff-o says: Jan 12, 2011. 1:39 PM **REPLY**
It's true, the barrels don't have to be full. So, you'd make a "best guess" estimate of what weight the barrel should be when it needs to be emptied. Then over the course of a few "empties" you could adjust the threshold up or down accordingly. I think you'd find the weight would, on average, be about the same assuming you use the same types of woods and processes on a regular basis.

bongodrummer says: Jan 15, 2011. 3:12 AM REPLY

Agreed.

kenbo0422 says: Jan 12, 2011. 11:07 AM REPLY

I guess with all the problems with densities, the best thing would be to do what we do every time we vacuum the house: Visually check the container and empty it prior to use. A bit old fashioned, but it works.

adambsmith says: Jan 20, 2011. 5:29 AM REPLY

bongodrummer,

Thanks, again for the great write-up. I've just bought some Lexan and am trying to build my own cyclone dust extractor using the information in you;r write up.

You wrote that you are using a hot melt glue gun to glue together the lexan when it is rolled up. I have been trying this but I an finding it very difficult to squeeze the glue out, and roll the plastic up into the right shape before the glue sets up hard again. Do you have any glue-related hints?

I have been debating using some epoxy resin (Araldite). I've have great results with this before, and it allows more working time, but I haven't tried it on lexan. Do you know if Araldite would work?

Thanks,
Adam

bongodrummer says: Jan 24, 2011. 2:08 PM REPLY

Hay Adam,

Good stuff.
In regards to the gluing, it is best to roll up the shape you want first. Once it is in the correct position, hold it there with a little masking tape. Now for the inside of the cone (I presume it is the cone you are struggling with?), you can peel back a little flap, and run the glue gun's nozzle inside the seam, making a nice long bead. Let the flap close and press the parts together. Should work well like that. For the outside seam, I did it in stages - undo a bit of masking tape near the top, pull back making a flap and inject some glue under it, hold together till set, then move on to another bit, etc. When you are done and the cone shape is secure, you can run one continuous bead along the outside seam, to ensure air tightness.

Of course all this would be easier if you can borrow an extra pair of hands for a few seconds to hold the cone for you while you glue it.

As you mentioned you will have bad luck applying the glue then trying to wrap up the shape, because the glue will have set before you have it aligned correctly.

I am not sure about araldite, I have a feeling that it might eat away at the Lexan, and/or make it brittle and discoloured - if you want to try it, best bet is to use some offcuts you don't need first and see what it does.

Hope that helps, any more questions, just ask. Take your time with it and let us know how it goes.

mauriceh says: Jan 9, 2011. 11:35 AM REPLY

You wrote:
" Quick and concise description of different types of silencers can be found here."
The HERE seems to be intended to be a link.
But, it does not work

bongodrummer says: Jan 9, 2011. 12:31 PM REPLY

Ooo, my first missing link. Well spotted, thanks - it got lost in a copy/paste edit somewhere along the way. Have removed it as it was a pdf hosted at http://www.silex.com/pdfs/ which does not seem to be responding any more. Will try again tomorrow, and replace if working...

bongodrummer says: Jan 12, 2011. 2:52 AM REPLY

Link working again and fixed in the ible - http://www.silex.com/pdfs/blower%20technology.pdf

brainmist says: Jan 9, 2011. 10:09 PM REPLY

Glad to see someone addressing noise and its hazards. You might also throw in that excessive noise exposure can lead to hypersensitivity to loud sounds (meaning you can no longer tolerate sounds you once ignored), distorted sound and diplacusis (one ear hears pitches differently from the other), and tinnitus (ringing), which gets louder and more sustained the more damaged the ear is. Hearing aids do not cure this: they just amplify the incoming sound, then send it through the damaged, distorted ear.

DIY-ers face an unrecognized risk; because no one oversees their safety, they may be exposed to chemicals without adequate ventilation, which can also increase hearing loss, both on their own, and in combination with noise. Carbon monoxide and other asphyxiants, solvents (such as you might find in carpentry stains and varnishes, cleaners, degreasers, etc), and pesticides can all increase your risk.

If you have a hobby that's noisy or fumy, keep things ventilated, get regular breaks, invest early in hearing protection (much, much cheaper than hearing aids!), and start getting your hearing tested on a regular basis. Even a fairly basic screening (by an audiologist) can indicate the early signs of hearing loss. Find an audiologist who knows something about hearing conservation for best results, and explain to them your concerns. And recreational noise affects hearing too; if you can turn it down, turn it down!

Maybe I should do a hearing loss prevention instructable...

bongodrummer says: Jan 12, 2011. 2:46 AM **REPLY**
Thanks for the info - go for it and write an instructable, I can add a link from this one ;)

kibukun says: Jan 10, 2011. 5:50 PM **REPLY**
Everything is better with lasers!

dcorbett says: Jan 10, 2011. 12:15 PM **REPLY**
WAY AWESOME!!! I loved the reed switch auto on/off idea. Plain to see you put some extra effort into this one.
Try ultrasonic for measuring the level in your bucket.
The transducer can be mounted at the top (to provide "analog" measurement), or on the side (use as ON/OFF or "dump alert").

bongodrummer says: Jan 10, 2011. 2:06 PM **REPLY**
Thanks. I must admit I had to do some reading to find out about ultrasonic sensors, and the idea seems good. One concern might be the dust flying into the barrel interfering with the sensor's reading, while the DS is in use?

Sounds like it could be worth pursuing though. Any ideas for cheap/salvageable sources? My first thought was the car alarm doodars that clip on inside at the edge of the windscreen - probably plenty of them floating around at scrap yards or still in cars with alarms that have been permanently disabled or taken out. Would that be any good? Other ideas?

I still want to try the simple idea of using grounded antistatic bags over the viewing window (as MadScott and wingman358 suggested).

kleinjahr says: Jan 9, 2011. 10:14 AM **REPLY**
Looks like you've got some sound ideas.
Might i suggest putting small wedges on the front door where the latches fall? They would help seal it up tighter.
One question, how do you change the air filter? It will, eventually, get blocked up and need to be changed or at least removed for cleaning.

bongodrummer says: Jan 9, 2011. 11:19 AM **REPLY**
The latches don't fall, but yes, small wedges are a good idea. In face I had already put one on at time of publishing, will do the other three when I get round to it.

Bearing in mind that the big filter comes after the vacuum's filters, and has an absolutely enormous surface area, it should be in there a good long time (at least a number of year). I can see the vacuums wearing out before the filter needs changing. When the time comes, it will be a case of unscrewing the lead sheeting that holds it in, pulling it out and putting a new one in.

mranderson says: Jan 10, 2011. 2:06 PM **REPLY**
If you want a float that might actually work, then I would recommend you put a handle on the float and then vibrate it, watching the point at which it settles. I actually imagine a circuit/motor that jiggles the float handle while the dust collection was proceeding, so that the ping pong ball doesn't get buried.

Once the ping pong ball hits a certain height, then you hit a limit switch and turn on a light, or a buzzer, or just check the handle position occasionally.

You would only need the float to check the last 20-30% of the collection bin height.

Nice instructable.

kleinjahr says: Jan 9, 2011. 3:20 PM **REPLY**
Sorry, difference in dialect. Where the latches fall is where they strike the door. Also called hatch dogs aboard ship.
While true the filter will last for some time, no reason to make it difficult to remove. My personal opinion and experience is to make it as simple as possible for maintenance. KISS, is always a good principle.

A bit of a laugh. Last time I told someone I'd do something when I got around to it, he promptly handed me a rountuit. A wooden circle with rountuit written on it. I've since passed it on.

brainmist says: Jan 9, 2011. 10:10 PM **REPLY**
0_0

That...is brilliant. I must make a rountuit. And carry it with me always.

srilyk says: Jan 9, 2011. 11:50 AM **REPLY**
This is an *excellent* instructable. Well written, good photos.

As far as a 'fill sensor', you have a couple of options:

1) a float like you have in your toilet - maybe using a ping-pong ball or something like that. I'm not sure how well this would work, but if your bins are in a fixed position, this may be a more ideal solution.

2) a scale - just grab a few springs and a maybe lever and a bin full of sawdust. Mark points for empty, full and maybe a few intermediate marks. If you use the lever style you could have a dial, or you could just hook a marker to the spring and have a linear gauge.

Those are the two things that popped into my mind first. HTH!

bongodrummer says: Jan 9, 2011. 12:29 PM **REPLY**

Hay Srilyk,
Thanks for your kind words, and suggestions.
I think 1) would be tricky, because there is still the problem of actually seeing the ping-pong ball or whatever you put inside the collection barrel. I am afraid I don't really understand idea 2). A scale would be nice - but how to prevent the lever from just being berried by the sawdust? I'm sorry, I probably completely misunderstood this one?

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wingman358 says: Jan 10, 2011. 8:26 AM **REPLY**

OP said: "...it might be worth me trying to make some kind of warning sensor that tells me when the collection barrels are approaching fullness... I already put a viewing window into one of the collection barrels, problem is that the static causes it to be obscured with dust, so that's little to no help.
"

There are at least two approaches to solving this problem. Either fix the static cling issue or try some other sensor idea.

Static charges form typically due to the triboelectric effect (think socks on a carpet). Since plastics are on one end of the triboelectric series and glass on the other, I would try replacing the window with glass. I'm no expert but glass might avoid a static charge accumulation.

Furthermore, since static charges accumulate only on an insulating material, you might try grounding the surface with a grid of wire. The grounded wire would neutralize any charges, thus avoiding static accumulation.

Check out http://en.wikipedia.org/wiki/Static_electricity specifically the **Removal and Prevention of Static Electricity** section for more ideas.

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wingman358 says: Jan 10, 2011. 8:29 AM **REPLY**

Maybe you can cover the window with a snippet of antistatic bag that a lot of electronics components ship in:
http://en.wikipedia.org/wiki/File:Antistatic_bag.jpg

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kleinjahr says: Jan 9, 2011. 3:30 PM **REPLY**

I think what srilyk means is a float in the barrel which would actuate a switch. Personally, I think it wouldn't float on the sawdust but be buried. The scale would probably be better. Think of a balance scale with the barrel sitting on the pan. Or you could rig a spring balance. As the barrel gets heavier it drops until it trips a limit switch, barrel is full, empty it. Of course you'd have to use flex hose for your connectors then.

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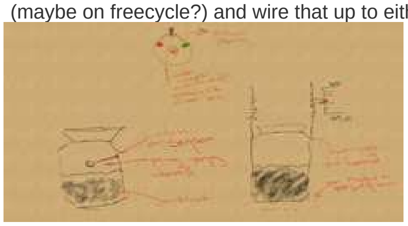
srilyk says: Jan 9, 2011. 3:25 PM **REPLY**

Hopefully this image helps give you an idea.

The float would work like the one in your toilet, attached to a switch or valve or something. I don't know if it would have a tendency to get buried in dust, though, so I'm not sure how well it would work.

For the scale idea you would attach the springs (or whatever) to the outside of the bin, or to a plate underneath it. Taking apart (or searching Google for parts of) an old spring powered scale should give you some pretty good ideas.

I just had another thought. After reading your blog it looks like you're not too scared of electronics - you could probably find an old digital scale (maybe on freecycle?) and wire that up to either light up a bulb or just cut off your vacuums - can't use up a lot of filters if you can't suck any more ;)



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macrumpton says: Jan 9, 2011. 9:17 AM **REPLY**

Very nice build.
I wonder if it would be possible to use some active noise reduction that would electronically invert the vacuum noise and use the result to cancel out the existing noise like the fancy Bose headphones do.

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bongodrummer says: Jan 9, 2011. 9:32 AM **REPLY**

macrumpton,
Nice idea. I did have a little look at that, but was initially put off both by the few things I read that mentioned the technology was expensive my lack of knowledge in this area. As it was I wanted to make a sturdy bench anyway, which fit well with the kinds of sound reduction used. Perhaps someone who knows about active noise attenuation could chime in here? It is worth investigating - maybe with the know-how a noise cancellation circuit could be put together relatively cheaply?

If you wanted to go 'all out' something like that to cancel out the noise of the air rushing into the end of the hose (which is the only real source noise when the DS is running), might be cool - if a little overkill.

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macrumpton says: Jan 10, 2011. 7:53 AM **REPLY**

A couple of thoughts:
Rather than figure out the intricacies of active noise reduction circuits, I think that getting a fairly cheap set of NR headphones or earbuds and just rewire the outputs to a small amp and speaker set (an old car radio and speakers should do) might work.

Also you comment about the intake noise made me realize that most of the noise (besides the motor) is from air turbulence, and doing things like making smooth transitions in and out of the areas where the air is being pumped might help quite a bit.

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karnold70 says: Jan 10, 2011. 4:48 AM REPLY
Completely awesome use of second-hand parts. Can hardly wait to make one of my own.

GordieGii says: Jan 9, 2011. 8:57 PM REPLY
Would this (http://www.leevalley.com/en/wood/page.aspx?p=30282&cat=1,42401) still be considered just a drop box?

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bongodrummer says: Jan 10, 2011. 1:48 AM REPLY
In my view, yes. Ok, it has a twist, in that the inlets are angled, but lots of fine dust will still come through. The spinning air inside will jostle up whatever is already in there a lot, every time you turn on the extractor. Don't get me wrong, it will certainly help, collecting about 85% of the waste material - that is a best case scenario, at low airflow rates. So it depends depends on what you connect it up to - the higher the airflow, the less useful it would be. According to Bill Pentz's research, at around 1000 CFM all the fine dust will get through, making it basically useless.

So yeah, it *might* help depending on your system, but is certainly not ideal.

Titus A Duxass says: Jan 10, 2011. 12:32 AM REPLY
Fantastic, saw this for the first on a UK forum.
Going to build my own version (probably a single cyclone variant).

I like the touches of humour that you've included.

I have nothing negative to say about such a good write up.

Thanks
Titus Andronicus d'Uxass

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jimbru says: Jan 10, 2011. 12:28 AM REPLY
Quite impressive instructable, very detailed and well documented. I really liked the theory parts that gives some insight into the "inner workings" of the dust collector.
With all the material used it must weigh several hundred pounds, but as it is on wheels I suppose it doesn't matter?
Great thing to have in your shop, I look forward to the day I can have a dust collector in my minute workshop.
Regards,
Jim

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projectbronco says: Jan 9, 2011. 7:38 PM REPLY
Very cool! I love how you made the cabinet have a functional worktop. You can never have enough work space.

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guy90 says: Jan 9, 2011. 2:30 PM REPLY
Spot on! thanks for the instructable

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pbbehrens says: Jan 9, 2011. 1:10 PM REPLY
Great design and instructable. What do you think of extending its use by adding a downdraft table that would replace the top or fit over the solid top for dust free sanding! A shallow box with a perforated top that attaches to the vacuum would do the trick. Of course, it would have to be very, very quiet, too.

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mcr2582 says: Jan 9, 2011. 12:51 PM REPLY
Amazingly detailed how-to! I wanted to share a similar "sound crystal" solution I used for my air compressor sound box. I used metal pipe, but I really like the cork idea!

http://www.artifacturestudios.com/blog/archives/985

JohnTrevick says: Jan 9, 2011. 10:40 AM REPLY
I was looking for a similar unit and ended up getting this:
http://www.leevalley.com/en/wood/page.aspx?p=63013&cat=1,240,41065

$45CND, nice package, no fuss.

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bongodrummer says: Jan 9, 2011. 11:01 AM REPLY
Yep, that auto switch looks reasonable. A lot more expensive than making your own. But it maybe worth it for some who are not confident with the mains wiring or cant get help with that aspect.

TheRevJester says: Jan 9, 2011. 10:23 AM REPLY
This instructable is a thing of beauty, thank you sir!

jordan.pollard says: Jan 9, 2011. 6:44 AM **REPLY**

Fantastic instructable!!!! Way to go!

It looks like some of your components were 3D modeled? Can these be uploaded or did I miss that here?

_jp

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