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Have fun!

# Build Your Own Home Theater Projector



Yes you can build a high quality lcd video projector for a fraction of the cost of a consumer video projector. As a matter of fact you can build a high quality XGA projector for the cost of a light bulb for a consumer projector! (A light bulb for a consumer projector costs between \$250-\$600!) This project is fun and relatively simple. It can be completed in a few days if you have obtained your parts. In the following example the total cost was \$400, using all new components. You can save even more money by sourcing used components from Ebay...it's up to you. You can take your projector all the way to HDTV by using a high quality lcd panel. There are many advantages to building it yourself! You learn in the process and get to make it exactly the way you want. Your friends and family will be impressed to say the least, and you will have many years of enjoyment from your creation. The best part is when you need a new bulb years from now, it will only cost you \$15! This project can be fun for the whole family and would make an excellent science fair exhibit. This booklet should contain everything you need to get you on your way, but you can always find help at **[lumenlab.com](http://lumenlab.com)**. I hope you enjoy building your projector as much as I did!

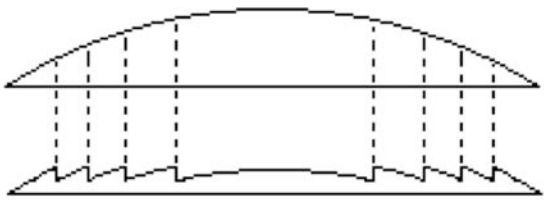
## About the Projector Lenses

### The Fresnel Lens:

*A thin optical lens consisting of concentric rings of segmental lenses and having a short focal length, used primarily in spotlights, overhead projectors, and the headlights of motor vehicles.*

The fresnel lens is simply a flat sheet of optical acrylic (plastic) or glass that has been embossed, molded or cut to have a series of concentric beveled circles (or beveled horizontal lines for a different type of fresnel) on its surface. When a light ray strikes the beveled edge it is bent at an angle to the bevel. The greater the angular degree of the bevel, the more the light ray is bent. All of these beveled circles acting together form a lens. Anyone who has seen a flat page magnifier has seen a fresnel lens.

Due to the fact that fresnels are a series of lines or circles, they do not make good optics for projecting real images. Some of the image information would be missing because a fresnel only imitates a spherical lens surface. The fresnel lens is however a nearly perfect lens for bending raw light; it is cheap and it is large, a comparable spherical glass lens would cost a fortune.

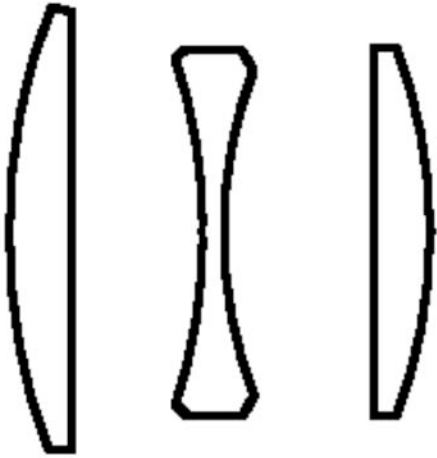


The Fresnel lens is divided into annular zones, each of which duplicates the contour of the corresponding zone of a regular lens. With the exception of the outermost zone, each zone of a Fresnel lens is thinner than in a regular lens. The steps between the zones do reduce the Fresnel lens' optical quality but for some applications the much reduced weight makes this a worthwhile tradeoff.

### The Projection Lens:

The projection lens is simply a magnifying lens in that it takes the projected image and magnifies it onto the projection screen. This can be accomplished with what is called a singlet lens (single lens). Problems occur when using a singlet lens, namely chromatic and spherical aberration, which is the tendency of a single lens to shift or distort the color information and the image information. To correct these aberrations, other lenses can be used to compensate for the singlet lens' problems. The most common lenses used in projectors today are triplet lenses. The triplet lens contains 3 lenses in total; a magnifying lens and two additional lenses that correct for aberrations in the magnifying lens. Fortunately, high quality triplet lens assemblies are widely used in overhead projectors and readily available.

The focal length of your projection lens is important to the construction of the projector, and should be matched to your collector fresnel lens. The focal length of our projection lens for this project is 320mm and the lens diameter is 80mm.



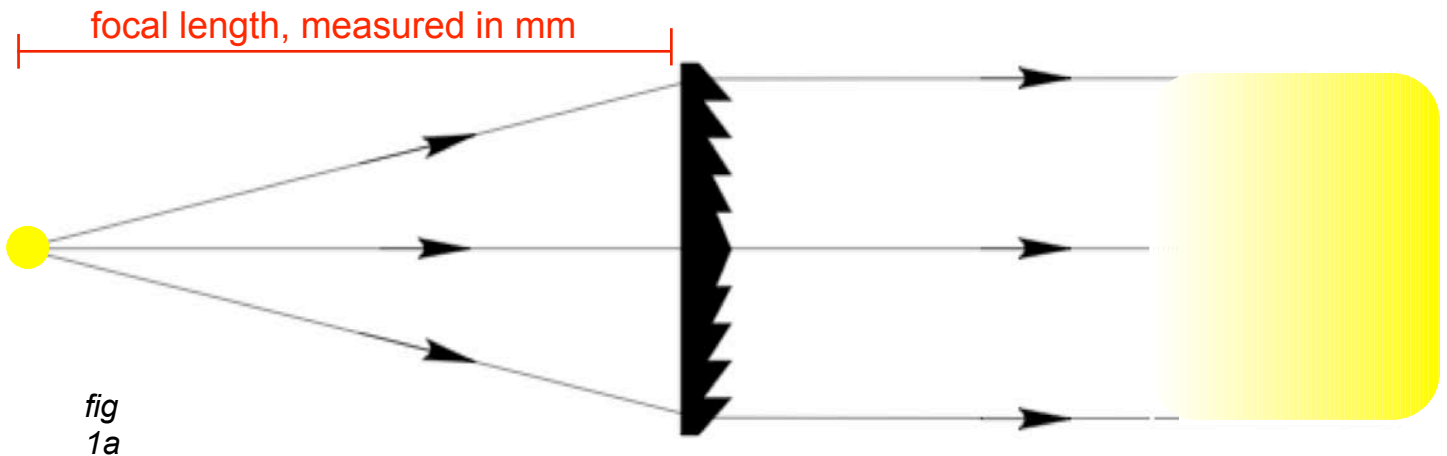
**Arrangement of triplet lenses.**



**Lens triplet assembly**

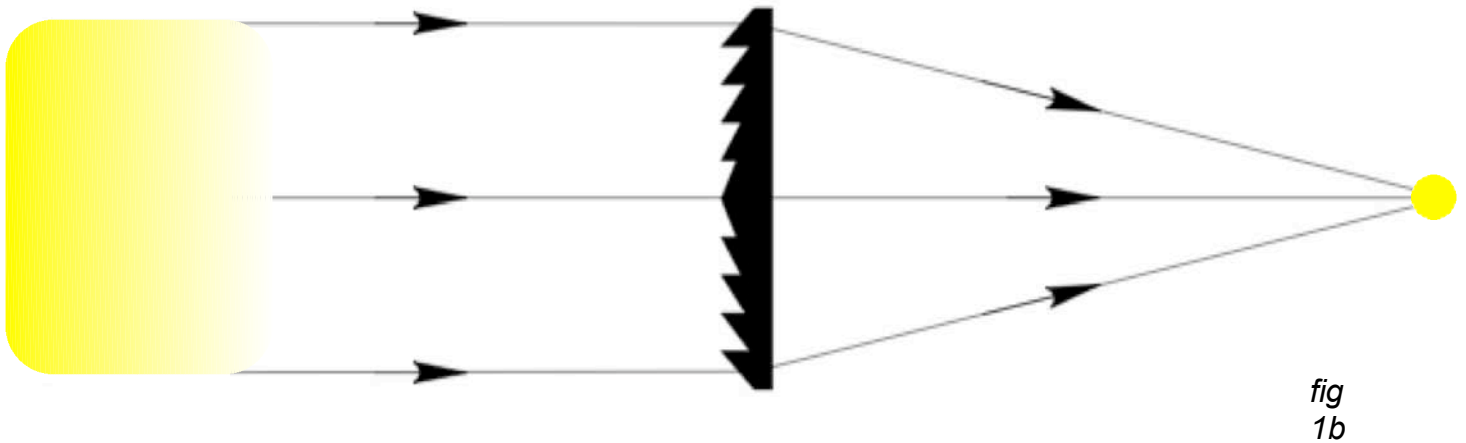
In our projector we need to control the flow of light through the projector. Anyone who has ever started a fire with a magnifying glass will know that the lens concentrates the sunlight to a point, thus concentrating the heat in the light. If you were to measure the distance from the lens to the point of light your magnifier focused, you would have the **focal length\*** of your lens, measured in millimeters. Imagine reversing the situation. We want to take a point of light (our bulb) and distribute it evenly over a large surface (our LCD panel). We want to use a point light source because we can accurately control the light with a fresnel lens to be distributed very evenly over the entire LCD module. This is where we will use our first fresnel lens. When using the fresnel lens this way we are using it as a **collimating or condensing lens** (*fig 1a*)

\*Focal length is defined as the distance from the lens to a point where parallel rays are focused to a point (diverge), traditionally measured in millimeters (mm).



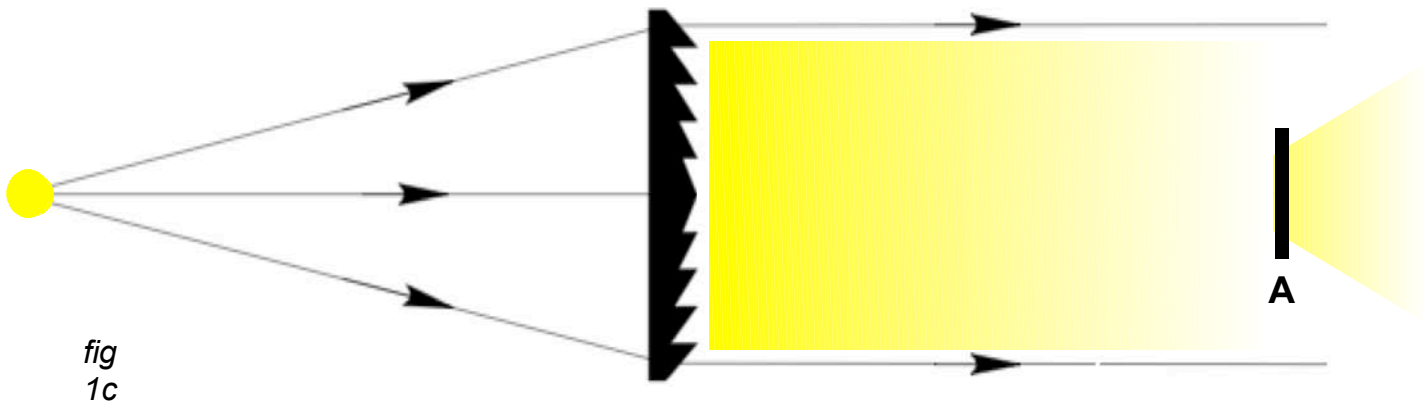
**A collimator or condenser fresnel lens**

By placing the collimating fresnel in front of our point light source we get a nice parallel (collimated) distribution of the light. This evens the light across the entire surface of the fresnel which ideally is the same size or slightly larger than our lcd panel.



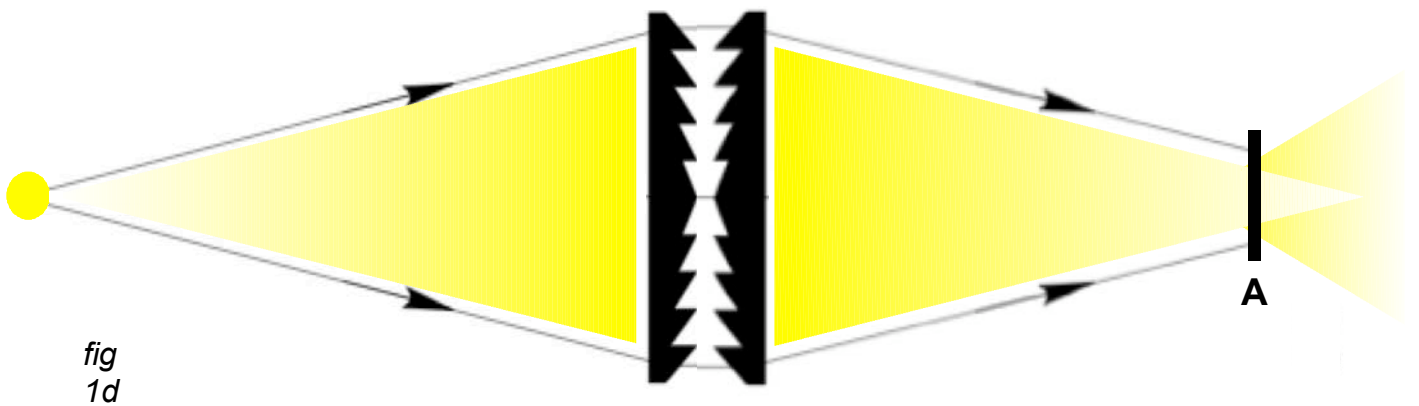
**A collector or field fresnel lens**

If we took our collimating fresnel and turned it around, we would have a **collector or field lens** (*fig 1b*). A collector lens bends diffuse light towards a point. This is useful for our projector as well because we want all of the available light focused on our projection lens. Otherwise much of the light would be wasted since it didn't pass through our projection lens. Figure 1c illustrates this point.



**Light loss without a collector lens**

We can see that much of the light falls outside of the projection lens' (A) area. We could solve this problem if we could use a projection lens that was as big as our object (LCD module). Since the projection lens needs to be a high quality optic (a 'real' lens) it would be prohibitively expensive to use, and nearly impossible to find. This is where our collector fresnel lens comes in. Figure 1d shows the best arrangement of a lamp, 2 fresnel lenses and a projection lens.



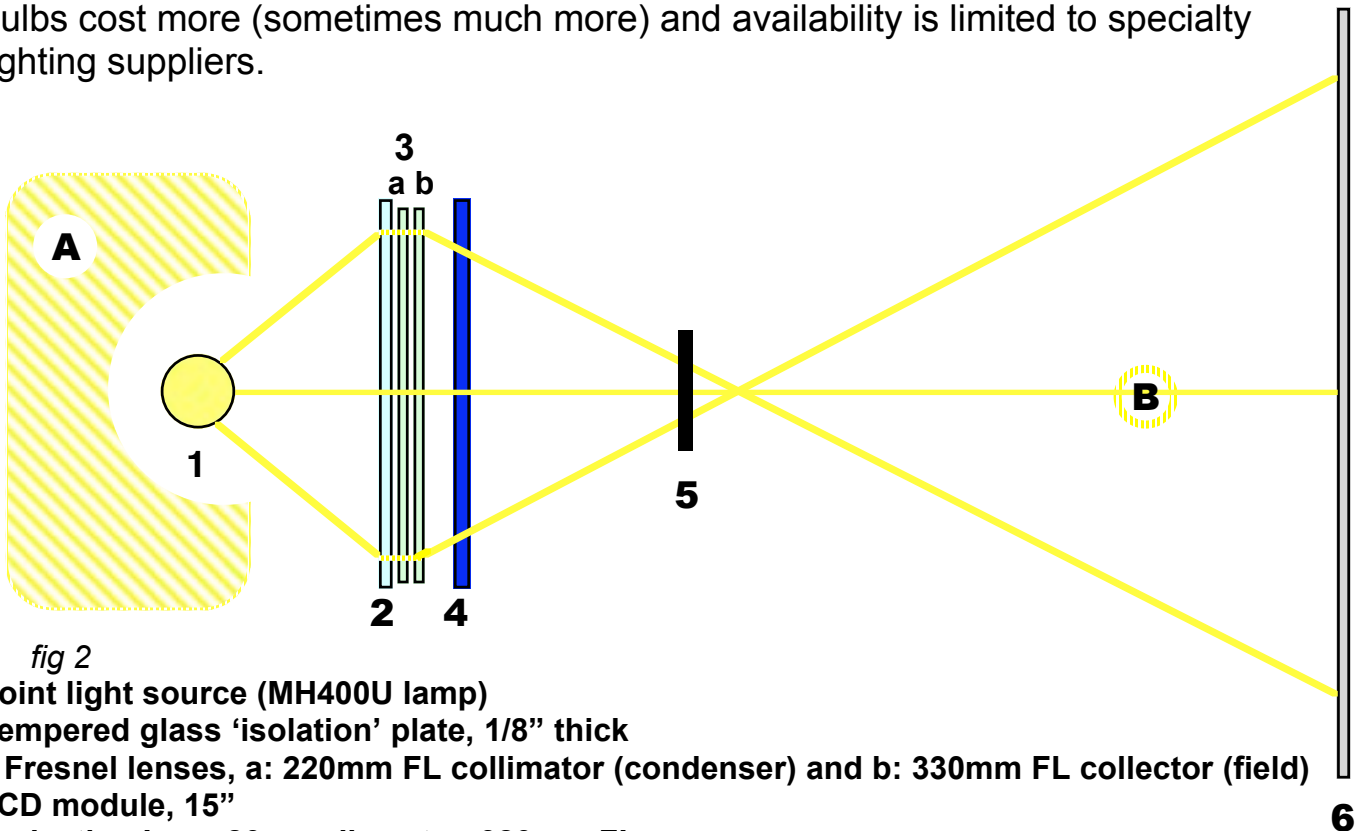
**Optimal light flow through the lenses**

Now we have all of the light focused through our projection lens (A).

## Simple 15" Projector Optics Arrangement

The design in *fig 2* is perhaps the easiest projector to build and the projection is quite good if attention is paid to optical alignment. In this case the glass 'isolation' plate (2) is to isolate the lamp's heat from the LCD module (4). Most consumer grade LCD modules have an upper temperature limit of 105°f (check your specs) so care must be made to ensure the panel doesn't overheat. We will discuss cooling system design later.

As you can see from area **A**, much of the available light is 'wasted', but this design is still adequate if using a large metal halide bulb. The bulb used in this design is the standard MH400U (400 watt, ~30,000 lumen, 4000K color temp, ~20,000 hour life span) bulb. The MH400U is cheap and readily available online and in most large hardware stores. The bulb costs around \$15-\$25. Much of the 'wasted' light could be gathered by the use of another optic called a **reflector**, which isn't used in this design. The fitment of a reflector to such a large bulb is impractical in this case, so we rely on brute lumen force to get enough light through the optics. By using a reflector we could use a smaller bulb with a lower wattage to obtain the same results, or better results even. The advantages to this are obvious; less heat, less energy used, smaller projector box, and possibly no need for the isolation glass or a large cooling fan (noise). The disadvantages are costs and availability; smaller metal halide bulbs cost more (sometimes much more) and availability is limited to specialty lighting suppliers.



*fig 2*

1. Point light source (MH400U lamp)
  2. Tempered glass 'isolation' plate, 1/8" thick
  3. 2 Fresnel lenses, a: 220mm FL collimator (condenser) and b: 330mm FL collector (field)
  4. LCD module, 15"
  5. Projection Lens 80mm diameter, 320mm FL
  6. Screen
- A. \*\*\*Wasted Light\*\*\*  
 B. Light path

## Selecting and stripping an LCD panel<sup>8</sup>

The heart of the 15" projector is the TFT LCD panel. The LCD panel is translucent, which is how we can shine a light through it and project the image created on the panel. If you're interested in how a LCD panel works I would suggest reading:

<http://computer.howstuffworks.com/lcd.htm>

'Raw' panels are available, but we will be using a LCD panel from a common computer monitor. While it would seem easier to buy a bare panel rather than strip a computer monitor, it isn't. The primary reason is expense. To buy a bare panel with the same specs you would have to spend several times the amount for which you can get a common computer LCD monitor. Strange isn't it? Thanks to market forces the assembled computer monitor is ubiquitous and cheap comparatively. New computer LCD monitors can be found for as little as \$125, but there are some issues you should be aware of before buying one. The first consideration is quality; that is, how good do you want your projection to be?

LCD monitors come in a variety of resolutions, contrast ratios, vertical sizes, response times and dot pitches.

**Resolution should be as high as possible.**

**Contrast ratio should be as great as possible.**

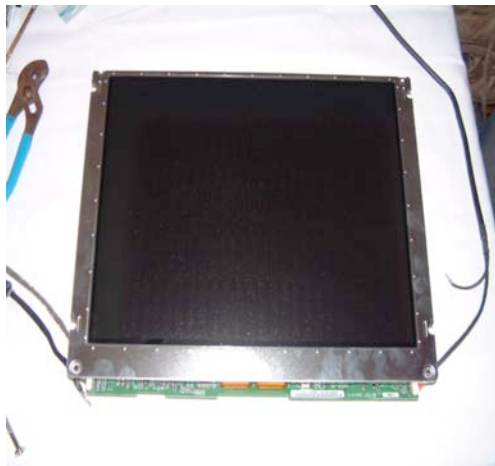
**Vertical size should be as small as possible. Dot**

**pitch should be as small as possible...in a perfect world.** Realistically excellent quality

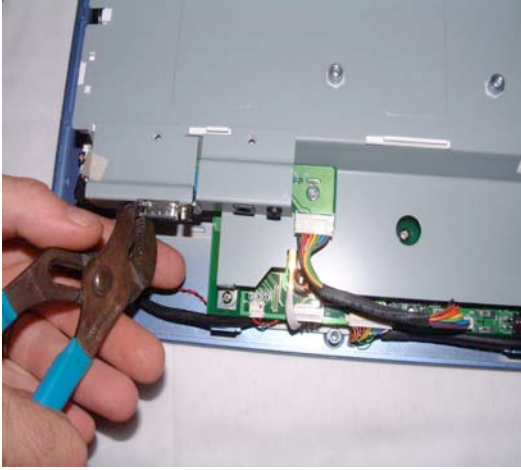
projections can be made with resolutions as low as 800x600 pixels (SVGA)...and many quality panels are available rather cheaply. For the 15" projector an excellent panel would be a 1024x768 (XGA) monitor with a 400:1 contrast ratio, 15ms response time and .28 dot pitch. The drawbacks of low cost panels meeting these specs are their size: 15" diagonal. The bigger the panel, the bigger the enclosure, optics etc. Naturally we'd want our projector to be as small as possible in most cases. Economics require us to use panels that are 7" or bigger; the cost skyrockets for high resolution sizes smaller than 7". A 15" high quality panel is very affordable, for the XGA panel mentioned above we'd pay ~\$200 new and as little as \$50 used as of this writing. The 15" CMV 1515 in the picture above (3a.) meets our requirements with XGA resolution, 500:1 contrast, 15ms response and .28 dot pitch. This panel may or may not be available in the United States at any given time. Most budget high quality panels are imported from China and supplies can be sporadic.



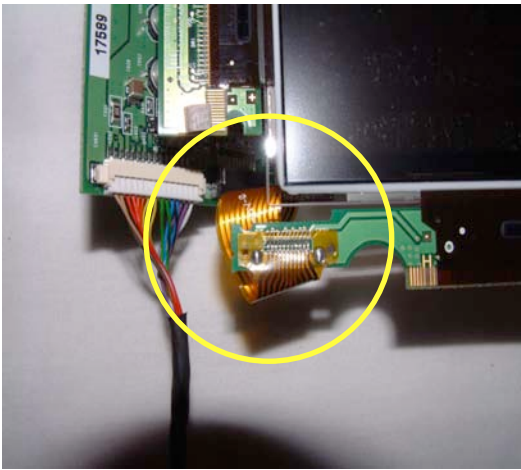
3a. A common lcd computer monitor



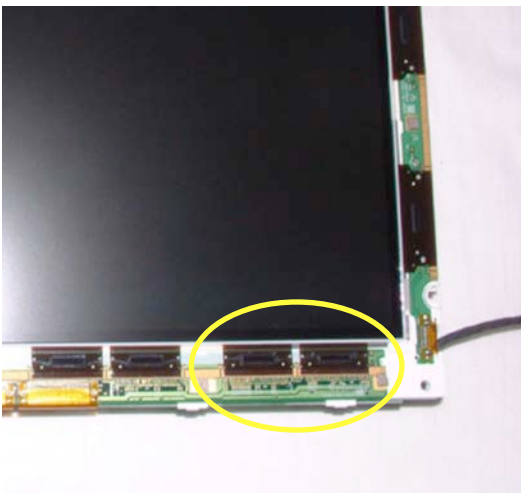
3b. A 'stripped' LCD monitor



Disassemble with care



Flat flexible cable can be a problem



Edge connectors are fragile!

Also of importance is a problem with the way that some monitors are designed. In order to make the monitors as flat as possible some manufacturers 'fold' the circuitry over the back of the lcd panel and then attach the circuitry with a short **flat flexible cable**. The cable may be too short to allow the circuit board to be moved away from the lcd panel, which would cause the circuit board to block some light through the panel. Lengthening this cable can be very difficult, although not impossible. It's best to stick with a panel that is known not to have this problem. Check with **[lumenlab.com](http://lumenlab.com)** for a current list of known panels.

Take care when disassembling the monitor. Be careful not to scratch the surface of the lcd on either side. The dark films on each side of the monitor are polarizers, they are necessary for the lcd to work properly, DO NOT remove them. The lcd is made of glass and can break easily. Never force anything. Remove the back light and all associated components in sequence. Remove the diffuser sheets if necessary, you should not have to peel anything! The entire disassembly should be like dismantling a sandwich.

When your panel is nearly stripped, start paying attention to the edge connectors. They are delicate and cannot be flexed very much. If one were to break part of your panel would not work. They are next to impossible to repair! At this point you should consider supporting the edge connectors. Many lcds are mounted in a metal frame. This frame can be used to support the edge connectors by applying silicone glue the the edge connector tops and gluing the metal frame to the connectors.

Reattach all the necessary circuitry needed to drive the panel, everything but the back light. Consider how you will mount this circuitry in your enclosure. If the monitor had adjustment buttons, you will need to integrate these into your enclosure design. Take your time with everything, when in doubt..stop! When your monitor is stripped you can test it's function by placing a light behind the lcd panel and powering it on with a signal source...cool huh?

## About the lamp



MH400U bulb, dirt cheap but 10" long

The lamp we are using is the ubiquitous MH400U metal halide lamp. These lamps are widely used in many commercial applications such as parking lots, retail stores etc. This lamp may not be optimal for projectors but it does have several advantages, and since our enclosure must be large due to our large lcd panel, we have room for the lamp. Another important consideration is the extremely low cost of this bulb, at this writing about \$15. Considering that this bulb puts out 30,000 lumens, has a very white color temperature of 4000k and lasts for 20,000 hours, it is a fantastic bargain. By comparison, the lamps in a consumer video projector have life spans of 1000-2000 hours and cost up to \$600 a piece! That's more than you would have to spend on your entire projector! **1000bulbs.com** should have everything you need.

You'll also need a socket (base) for your lamp. The MH400U uses a Mogul base, which costs about \$3. Additionally you'll need a ballast for your lamp. Metal halide lamps use a high voltage to create an arc that excites a mixture of gasses in a quartz envelope. The ballast is what transforms normal household current into the higher voltage. There are two types of ballasts you may consider, 'electronic' and 'coil and core'. Electronic ballasts are solid state, compact and lightweight, they are also much more expensive. You'd pay about \$125 for a 400 watt metal halide electronic ballast versus around \$35 for a coil and core. Understand that the ballast needs to be matched with the lamp. You cannot use a ballast for a high pressure sodium lamp with a metal halide lamp! You cannot use a 250 watt ballast with a 400 watt lamp!



Mogul base

In the simple 15" projector enclosure there is plenty of room for the large coil and core ballast, which saves us money. It does however add weight, but the enclosure is large and portability is not a big consideration.

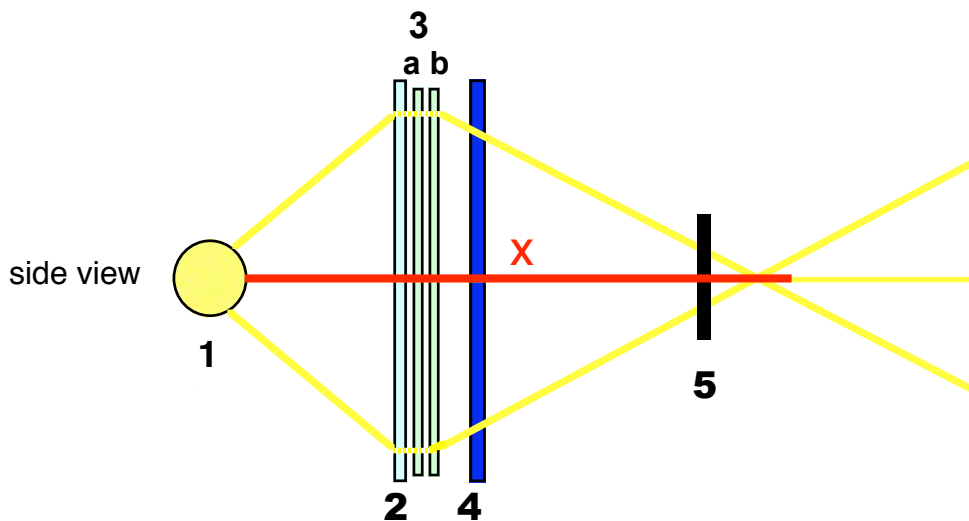


Coil and core ballast; big, heavy, cheap

**WARNING: Working with line voltages can be very hazardous. These instructions cannot teach you about 120 volt wiring and safety. If you do NOT understand basic 120 volt wiring STOP NOW. Metal halide bulbs can emit dangerous UV radiation if the outer glass envelope is cracked. DO NOT USE A DAMAGED BULB! These bulbs become hot and can burn you, use common sense and be very careful. Do not look at the bulb for any extended period of time, it will burn your eyes!**

## Putting it all together

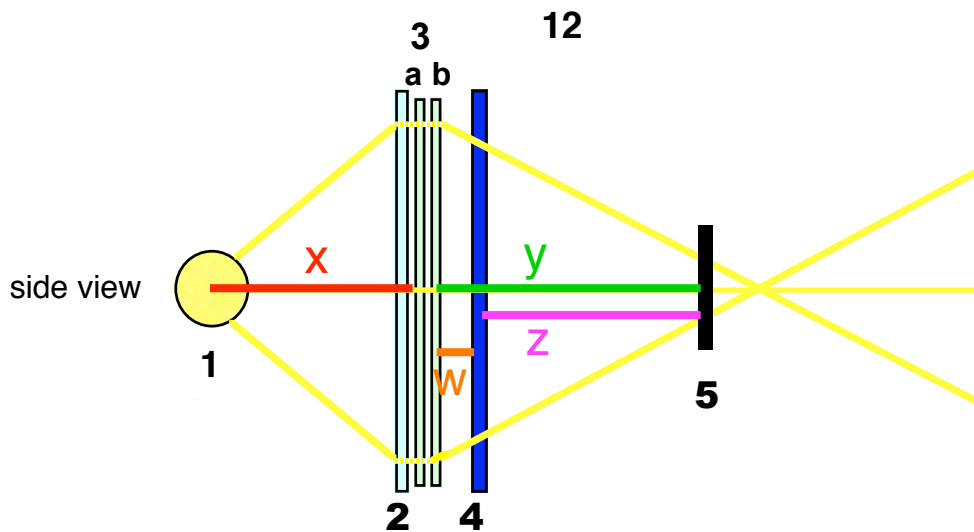
Let's refer back to our earlier illustration:



Number **1** is our point light source, the MH400U lamp. It is important that the lamp center be on center (line **X**) with the entire enclosure and at the focus of the first fresnel (3a). The fresnel lenses (3a+b) and projection lens (5) can actually be taken out of a used overhead projector, but I'd recommend getting new parts. Both fresnel lenses can be obtained as a single unit called a 'dual focus fresnel'. It is two fresnels that have been heat welded together to make the lens compact and perfectly aligned, perfect for our projector. Most overhead projectors have the 'single unit' dual focus fresnels. A dual focus fresnel is available from a few sources online for about \$25. Check with **lumenlab.com** for availability. The best dual focus fresnel lens has two different focal lengths, one for each lens. The lens facing the lamp has a shorter focal length of ~220mm, and the fresnel lens facing the projection lens has a focal length of ~330mm. This is advantageous because we can have the lamp a little closer to the lens, which means less light is 'lost'. Most of these lenses are 13"x13" square, but our lcd panel is a rectangle closer to 10" high. Therefore it is best to cut the top and bottom edges off of your DF fresnel so that the fresnel is the same height as your panel. This can be done with a dremel tool or router. Take care when cutting the lens, it may crack or get scratched easily. Our piece of isolation glass (2) makes a great mount for the DF fresnel; I used standard binder clips found in office supply stores. Never mount the fresnels on the lamp side of the glass, they will melt!

The isolation glass (2) should be a piece of 1/8" tempered glass cut to size. This is readily available at most hardware stores for a few dollars, but usually can take a week to obtain so plan ahead. Size the isolation glass 1/2" shorter than your enclosure height. This is so that the glass can sit off of the bottom by 1/2" which is necessary for the cooling circuit (explained later).

The projection lens (5) is an 80mm diameter, 320mm focal length lens triplet as are available for overhead projectors. It is important the the projection lens be centered to the other lenses and the enclosure (line **X**). Projection lenses are available about \$25, check with **lumenlab.com** for availability.



So we know that **1** is our MH400U lamp, **2** is our isolation glass, **3a+b** is our dual focus fresnel, **4** is our lcd panel and **5** is our projection lens. If our DF fresnel has a rear focal length of 220mm, we would position the center of the lamp 220mm away, as represented by line **X**. If our DF fresnel has a forward focal length of 330mm, we would position our projection lens ~300mm away as represented by line **Y**. The reason for this is because we want to use the entire projection lens' area, not just the center. The illustration shows that the projection lens is positioned slightly *before* the focus of the forward fresnel lens.

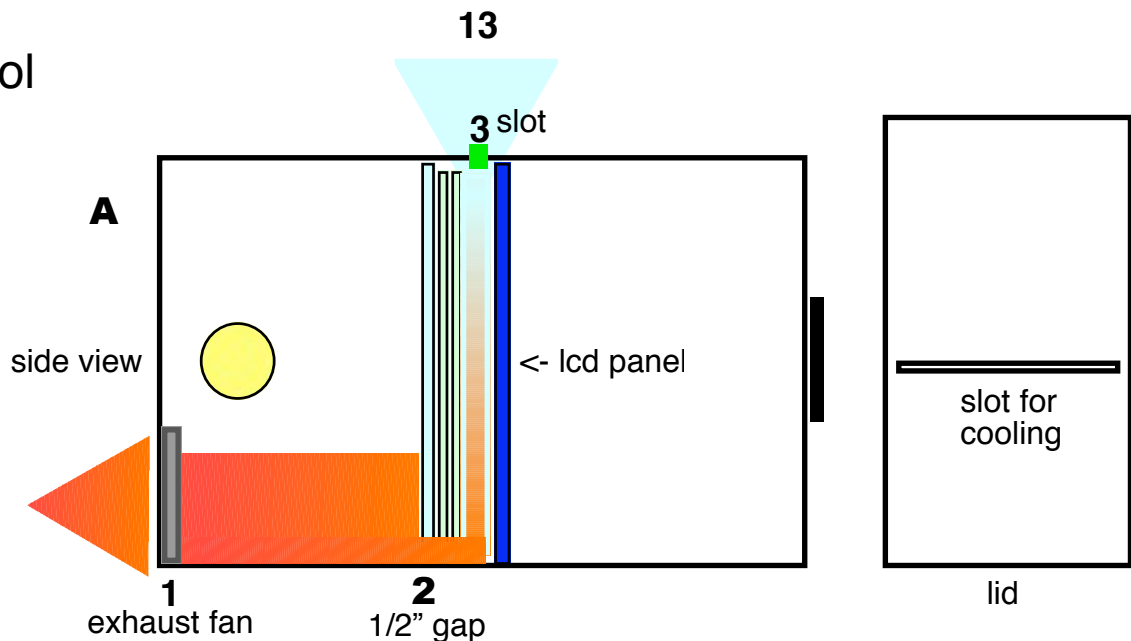
Our projection lens may have a focal length of 320mm, which means our lcd panel should be positioned roughly 290mm away from the projection lens as represented by line **Z** (the greater the distance to the screen, the closer the projection lens moves toward the panel and vice versa). We leave a gap of 10mm between the DF fresnel and the lcd panel as represented by line **W**. This is desirable because if the fresnel lens is too close to the panel, the grooves on the fresnel lens will be projected too. If you have circular lines in your projection your fresnel is too close to the panel. If you are making a focusing mechanism for your lens, you'll want about 50mm (~2") of movement in the projection lens which would accommodate virtually every usable setting in which you would use your projector.

A slight adjustment to the projection lens is needed for different screen distances to focus the picture. If you are making a permanently installed projector you can ascertain the exact positioning of your projection lens and mount it permanently in that position. That's how I have mine set up, I only need about 1/4" of movement in my lens because my projector is permanently located.

Also of note is that there is some tolerance in the focal lengths of the lenses. If you have lines in your projection because the fresnel is too close, you should be able to move it back more without a problem, but you may need to adjust the positions of the other lenses. Also of note is that some people claim to have had good success with splitting the fresnels and putting the forward fresnel *in front* of the lcd panel. Generally this is considered a bad idea but even some commercial projectors are made that way. The point is to not get locked into rigid ideas here, experiment and have fun!

Because the optics invert the image on the LCD panel, the panel will be mounted upside down and flipped from left to right. Basically you want what used to be the front of the panel facing the light, and turned upside down.

## Keeping it cool

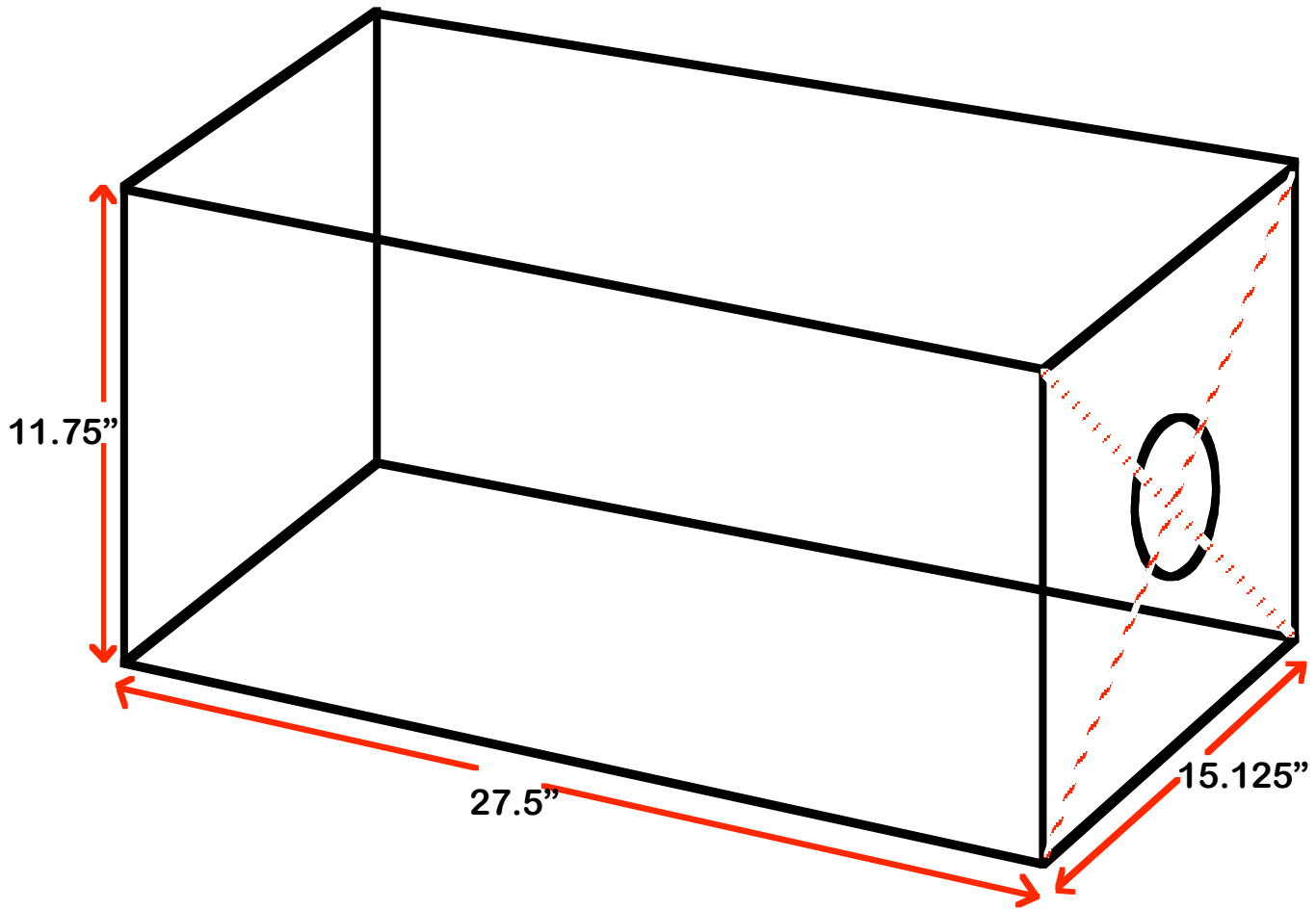


In the 15" projector I designed a cooling system that only needs one 120mm exhaust fan (1). The fans are readily available online from computer shops and surplus warehouses for about \$5. I would not use a fan smaller than 120mm for this project. The fans are available in 120 volt or 12 volt, use whichever is more convenient for you. It is critical that the lcd panel does not exceed 105f during operation, so have your meat thermometer handy when testing. I specified that you should have your tempered glass cut 1/2" shorter than your enclosure height. This is to allow cooling air to pass under the glass at point 2. Cut a 3/8" slot most of the way across your enclosure lid to admit the air (point 3). Not much light will escape from the slot (3) but use a piece of air conditioner filter cloth on the underside of the slot to block light leakage and keep the panel from getting dusty from the incoming air. (To control light leakage from the fan you can use a louvre. Better results can be had by using a louvre on each side of the fan facing the same direction.) In designing the cooling system this way, the lcd panel gets top priority. A large volume of air travels through the gap between the fresnels and the panel, cooling both simultaneously. DO NOT put the fresnel lenses on the lamp side of the glass, they will melt! With this design I can keep my panel at a constant 95f during operation. I suggest putting your meat thermometer in the top slot to observe the panel temp over several hours of operation until you are CERTAIN it can maintain a constant temperature.

If you're using a wood enclosure I would recommend that you use aluminum flashing on the interior of the lamp side of the enclosure. This is prevent any scorching from the lamp. Keep your wiring away from the lamp. Secure all wiring to make sure it doesn't move and end up on the lamp. Leave a space of 2" at least between the back of the lamp and enclosure. Pay careful attention during the first few hours of operation for fire hazards. If carefully designed and maintained the projector should run for many years safely.

It is also advantageous to use two power switches in your projector; one for the lamp and panel, and another for the fan. This would allow you to run the fan when you shut down your projector to cool the lamp and panel for a few minutes. Another fancier option is to use a simple countdown timer on your lamp circuit that runs the fan for five minutes after you shut down your projector. Search the web for 'countdown timer' if you have the skills to utilize one.

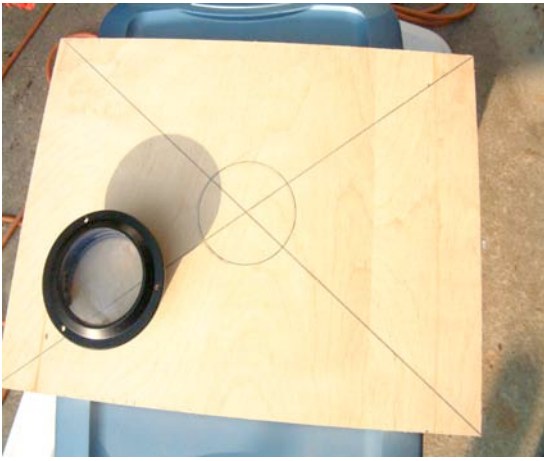
## Building the enclosure



## Simple projector enclosure design based on a 15" lcd monitor

The dimensions given are outside dimensions using 3/4" plywood, to ascertain the interior dimensions subtract 3/4" from the overall dimensions. The dimensions given are to serve as a loose guide; your components may vary in size and you should carefully measure all of your components BEFORE cutting your enclosure.

The lens needs to be perfectly centered. To ascertain the center, draw lines diagonally on your front piece as is indicated in the drawing by the red dotted lines.



Centering the projection lens



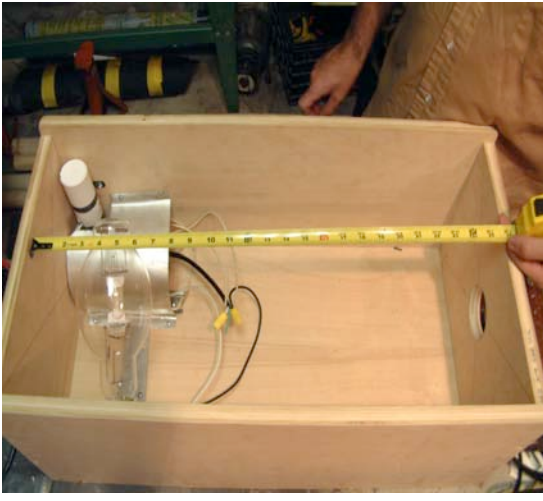
Cutting the hole for the projection lens



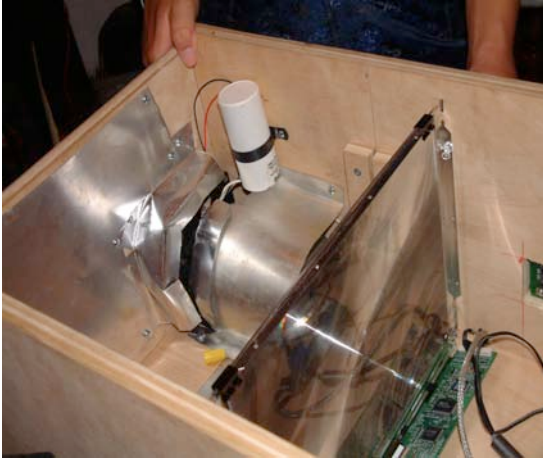
Finishing the prototype enclosure. Note there is no focusing mechanism. I didn't need one for this projector because I knew the distance to my screen and my projection lens has a flange that allows about 1/2" of travel forward and backward for fine focus. If you plan to use your projector in a variety of settings you should make the panel that the projection lens is mounted on movable by about 2 inches.



Mounting the ballast, and mogul base. Note the base is mounted at an angle. This is necessary in my enclosure to put the center of the lamp on center with the optics. Note the center reference marks on the back panel.



The enclosure is a little over 2' long. Note the aluminum flashing added to shield the ballast from the lamp heat and to provide a duct that channels air over the ballast on it's way to the exhaust fan.



Panel has been added and shielding added to protect the 120mm fan from the lamp. The panel is held in with push pins until the alignment is established. This picture was taken with a fresnel in front of the lcd to confirm or disprove what others have said about their results with this method. I don't recommend it but try for yourself if you're curious and have fully split your dual focus fresnel.

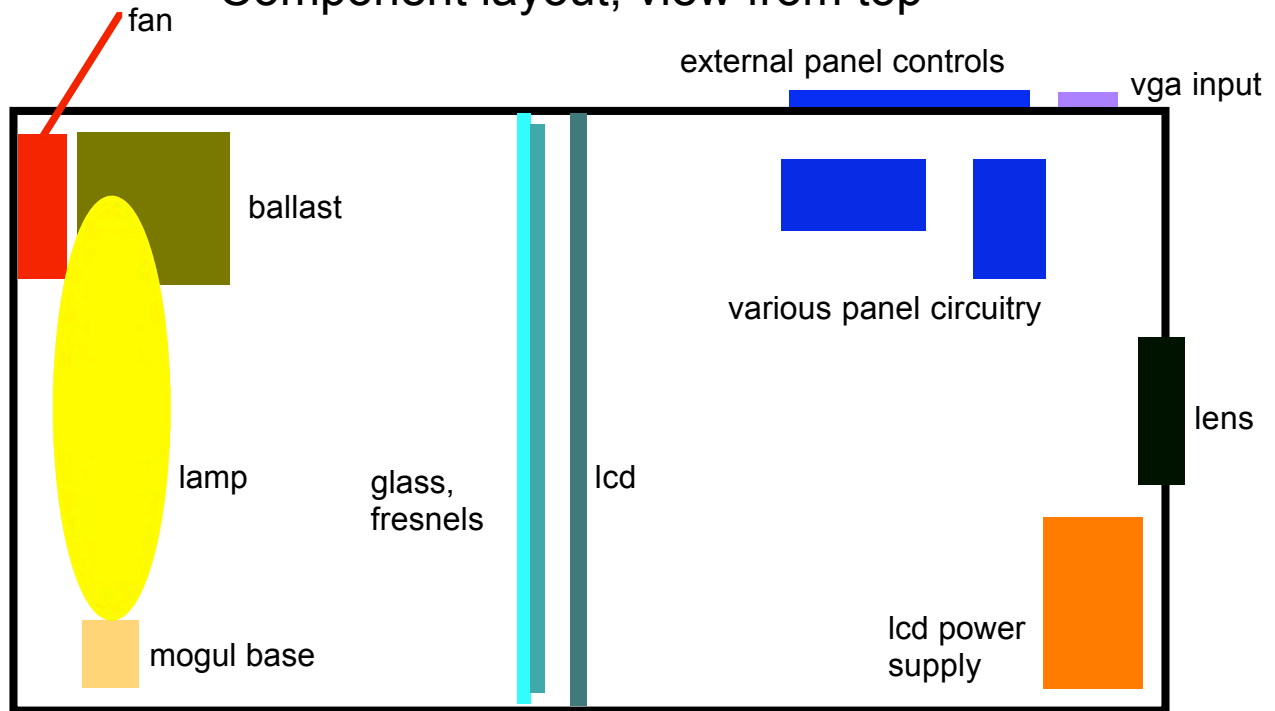


Mount the electronics in a logical way.

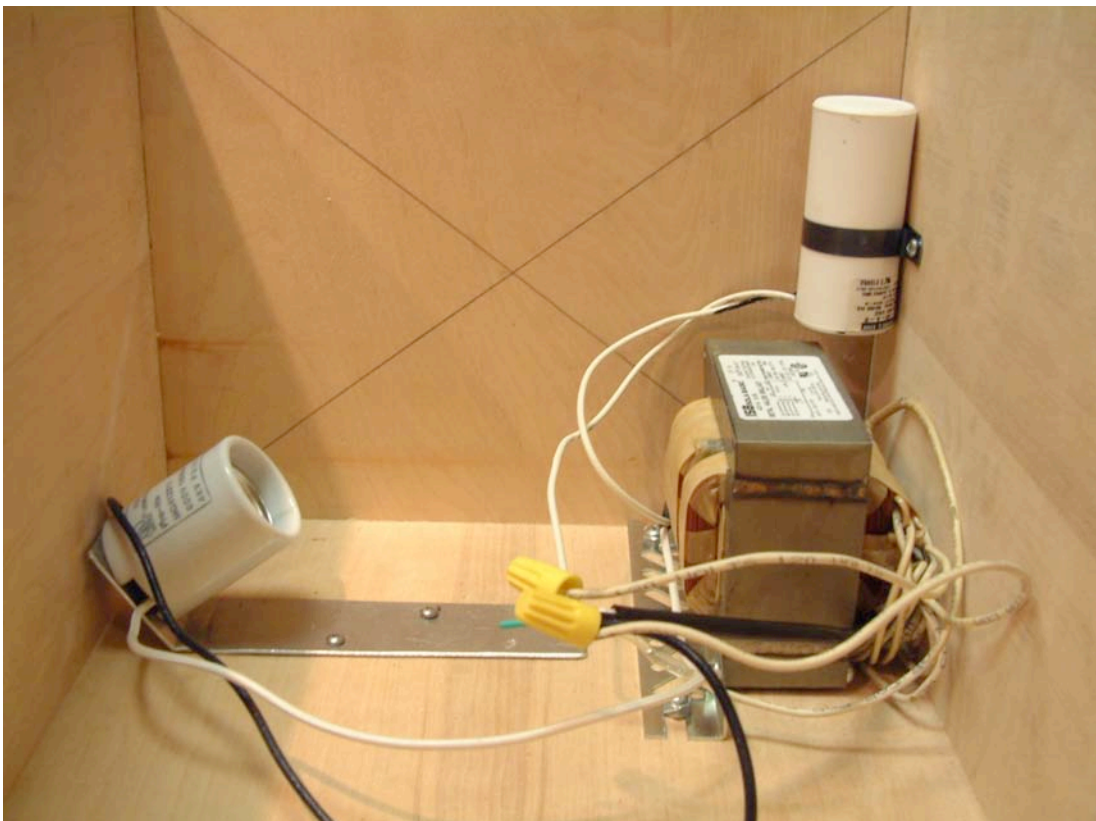


Monitor the temperature during testing closely using a meat thermometer. Be careful not to scratch your lcd panel with the thermometer. The temperature in the photo reads 110f, too hot!

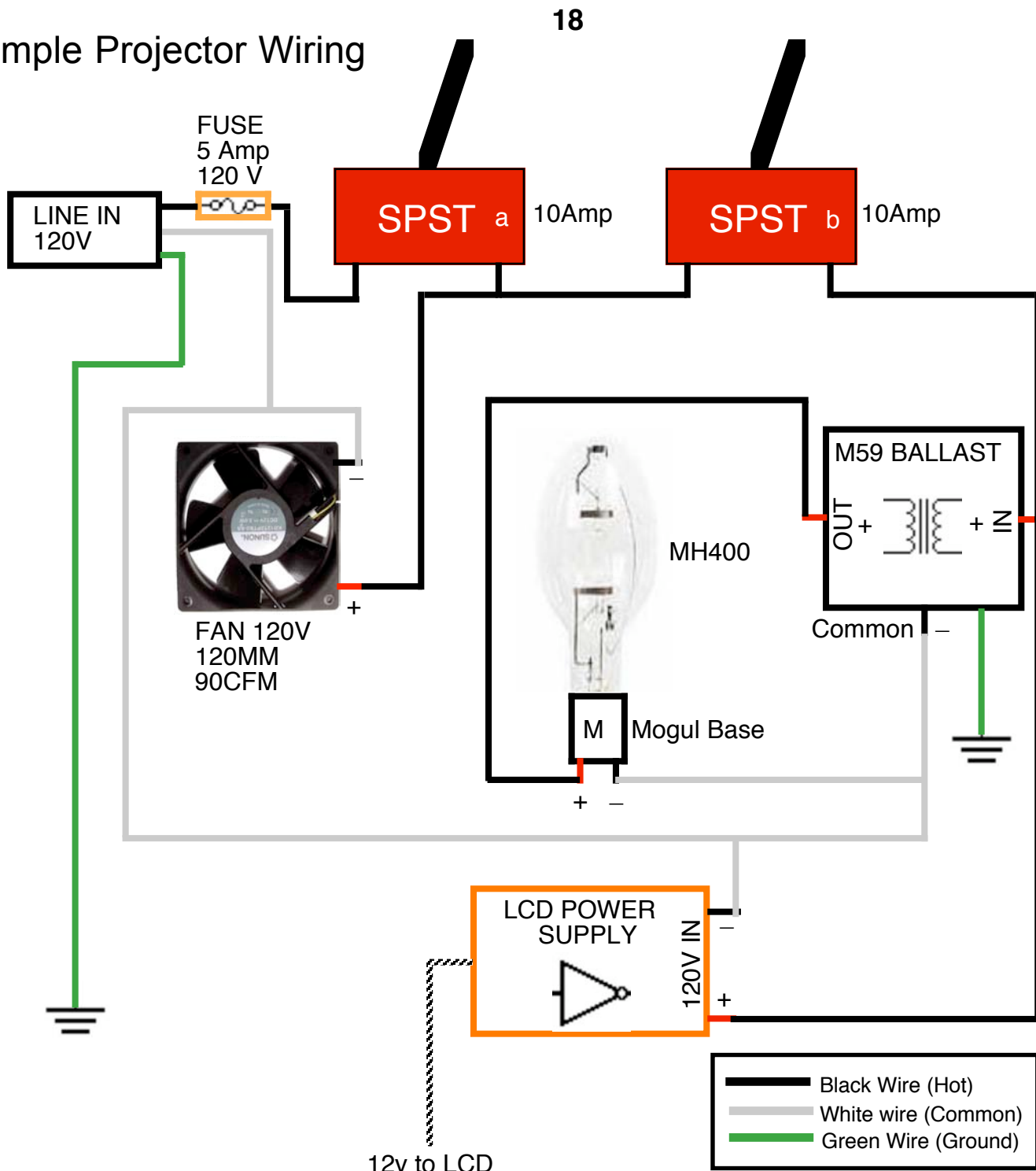
## Component layout, view from top



This is how I layed out the components in my projector. Your panel may have different components but the idea is the same. The lamp is actually mounted at a 45° angle, this is to keep the lamp arc on center with the optics. Below you can see the mogul base mounted at the 45° angle. The fan has yet to be installed in this shot.



# Simple Projector Wiring



This wiring scheme makes use of a dual switch interlock. The interlock makes it impossible to start the lamp without powering on the fan first. You should also let the fan run for about 5 minutes after shutting down the lamp to continue to cool the enclosure.

**YOU ARE WORKING WITH HIGH LEVEL MAINS VOLTAGE. TAKE EVERY PRECAUTION TO AVOID INJURY AND/OR DEATH!**

Always unplug, and turn switches off (and remove the fuse) before working with the internal wiring. Also use caution when working with the ballast and LCD power supply, transformers used in these devices are capable of storing very high levels of power that can cause serious injury and/or death! Always follow instructions for ballast wiring, and when in doubt seek advice/help! Lumenlab is NOT responsible for your safety!

## Types of screens

Discussions and opinions on screen types and materials are abundant and hotly debated. The bottom line is; a flat-white, smooth wall is for all intents and purposes a nearly perfect screen. Screen materials can have various properties to enhance the picture, namely 'gain', contrast and color correction. A very light grey screen can improve contrast in low contrast projections, the trade off is a lower gain screen. Gain is a screen's ability to increase reflectivity in the line of viewing. Of course no screen can reflect more light than the projector can make, but it can reflect that light directly back at the viewer rather than diffusing it as a flat white surface will. The disadvantage to this is a lessened viewing angle and 'hot spots'. Gain is usually increased by adding a silvery surface or glass bead to the screen material. Many have made high gain screens themselves by experimenting with various silver paints or gesso combinations. Older lcd panels have what is called 'green push', meaning they have a slight green tint to the picture. Adding a bit of yellow to the screen material can compensate for this. These types of screens shouldn't be necessary if you are using a quality lcd panel and good lighting in your projector. Halogen lamps are bad for video projectors because the light is yellow rather than white. Fluorescent bulbs can't make enough light and aren't point light sources. Metal halide lamps are capable of high output and very white colors and are the lamp of choice for video projectors. Use of proper lighting and quality lcd panels should negate the need for a fancy or expensive screen. (Screens can cost many thousands of dollars.)

If you're interested in a fabric screen there are many options available to you. The material used for movie screens is available from sources online, but it is quite expensive usually and the benefit isn't tremendous over a common material called 'blackout cloth'. Blackout cloth is a heavy material used behind drapes to block incoming light. It is a white or light grey rubberized fabric. It has a cloth side and a very smooth flat white side that makes an excellent screen material. Blackout cloth comes in various widths and is readily available at fabric stores for about \$6-\$7/yard. The fabric store may have several types so look for the whitest possible, but you may want to obtain a sample of very light grey to experiment with. While you're there you may find some silvery materials that may make a good screen. Try to obtain samples of these and temporarily mount them on your wall or blackout cloth screen so that you can observe the various effects of different screen materials.

Adding a flat black border to your screen can greatly enhance viewing as it tends to minimize off screen distractions. Black felt works well and is available at fabric stores. If you are using a painted wall you can simply paint a flat black border around your screen area, but felt looks a bit better. Using a black border can be challenging if you use your projector for mostly 16:9 wide screen movie presentations; when you switch to a 4:3 aspect ratio your black border will be in the picture. My set up is geared toward wide screen presentations so I occasionally have problems when I need to project a 4:3 presentation. You could have 2 screens, one for each type of presentation, or you could have a screen that rolls up and down depending on the type of presentation you are projecting. Or you could simply have a large 4:3 screen that you use for both types of presentation, but the results won't be as good as a black bordered 16:9 screen. If you use a fabric screen you can build a light wooden frame for it or you can get fancy and buy/build a 'tubular motor' which would allow your screen to roll up and down at the push of a button.

## Important considerations

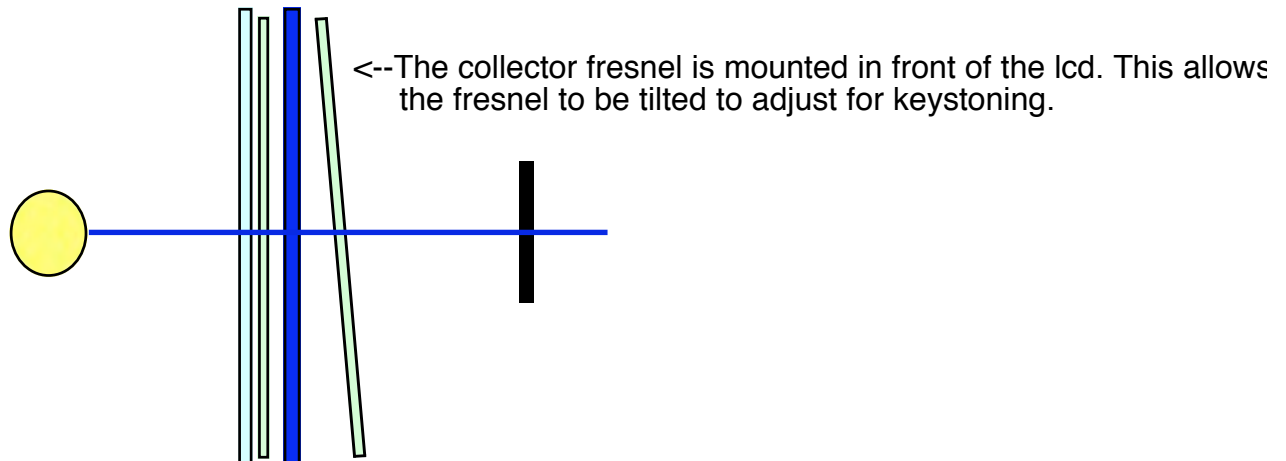
Depending on the monitor/panel you choose you may only have VGA (computer monitor) inputs. This basically means that you can only send signal to your projector with a computer unless you have a dvd player with a VGA output (available online for \$50 and up). LCD monitors are available with VGA and composite (standard rca) inputs but they tend to cost much more for no apparent reason. Having VGA inputs only isn't so much of a problem though. You can use your computer's video card to 'passthrough' video if you have such a card. You can also obtain dvd players that have VGA outputs. Probably the best option is a 'line doubler' or 'external TV box'. These are relatively cheap devices that have several types of inputs (VGA, composite, s-video, coax) and a VGA output. They may come with a TV tuner and remote as well. Your video projector is a high resolution device capable of displaying 1024x796 pixels or higher (or lower) depending on the monitor you selected. This is important to note because television resolution is a mere 320x240, and has 'scan lines'; that is, a TV only displays every other line of information for each scan pass it makes. If you were to simply project a television signal through your projector your image would be small and you would see these scan lines, in other words it would look pretty bad. This is not a limitation of your projector but rather a consequence of the old TV broadcast technology. At any rate the line doubler fills in these scan lines and can sometimes up-scale the resolution of TV broadcasts to your projector resolution, 1024x768. While the picture won't look as good as a digital medium like DVD, it will be acceptable. Line doublers such as KWorld's 'TV box' do all of this for around \$60. Needless to say video tapes will have this same problem as they are designed to be played on a television. To get good results you'll need the line doubler or a computer video card that does the same thing.

Ever notice how dark it is in a movie theater? This is to keep incidental light from reflecting off the screen which would wash out the picture. It is a consequence of forward projection that the screen will reflect ambient light. That said, it is very important for you to use your projector in the darkest possible room for best results. If you have daylight leaking around your blinds it will wash out your projection. Light that is behind the screen isn't so much of a problem but it distracts your attention. This is important to consider when building your home theater. Many people put their home theaters in their basement because it is the darkest room in the house.

Our projector like most commercial projectors use a fixed projection lens rather than a zooming lens. This means that the only way you can control the picture size is to move the projector closer or farther away from the screen. A zoom lens is a complicated and expensive component. As of this writing there is no acceptable zoom lens for our projectors. Many people including myself are working on a solution to the zoom lens problem by experimenting with various optics. As it stands you'll need to carefully consider where your projector will be located. Using the optics in the simple projector, your picture will be approximately 7' wide if your projector is located 10' from the screen. You could use a longer focal length projection lens to make the picture smaller but you would have to find a matching fresnel lens. Your enclosure size would also be increased. It is a market reality that quality fresnel lenses other than those used for overhead projectors are quite expensive. You can however make your picture smaller using your computer software or your lcd monitor's controls, this does however decrease the resolution.

## Keystoning

If you have your projector ceiling or floor mounted, you will be projecting at an angle to the screen. The result of this will be what is called 'keystoning' which is that the image will be narrower at the top or bottom. If this is the way you plan to mount your projector you will want to use keystone correction. One way to adjust keystone is to use your lcd panel's trapezoid adjustment function if your panel is so equipped. Another possibility is using software to correct keystone. If not, you're fairly well limited to using the forward fresnel lens in **front** of your lcd panel. If you do so, you can tilt the forward fresnel to compensate for the angle of projection. While I haven't recommended using a fresnel in front of the panel, many people have had excellent results doing so. It is imperative that your lens be absolutely clean and scratch free, and perfectly flat. To achieve this you can mount the forward fresnel in a metal frame or affix it to a piece of glass. You will have to mount the lens 1/2" or more from your panel to avoid the fresnel artifacting in your picture. If you decide to do this it will also change the relationship between the lenses, so you'll have to recalculate your lens distances. Not really a big deal but think ahead and save yourself some time.



## Adjusting the panel's controls

Your lcd monitor probably came with adjustment controls. Always leave your contrast and brightness controls at their maximum. You may also have color adjustments as well as size and position adjustments. You can adjust these controls to suit your taste. In certain cases your panel may be slightly larger than your fresnel lenses, but you can usually adjust your panel to trim off the edges of the image if so desired. Also periodically check your panel's controls, occasionally they may revert to their defaults. If your projection looks suddenly dim, it is most likely that the contrast setting defaulted.

## Parts list

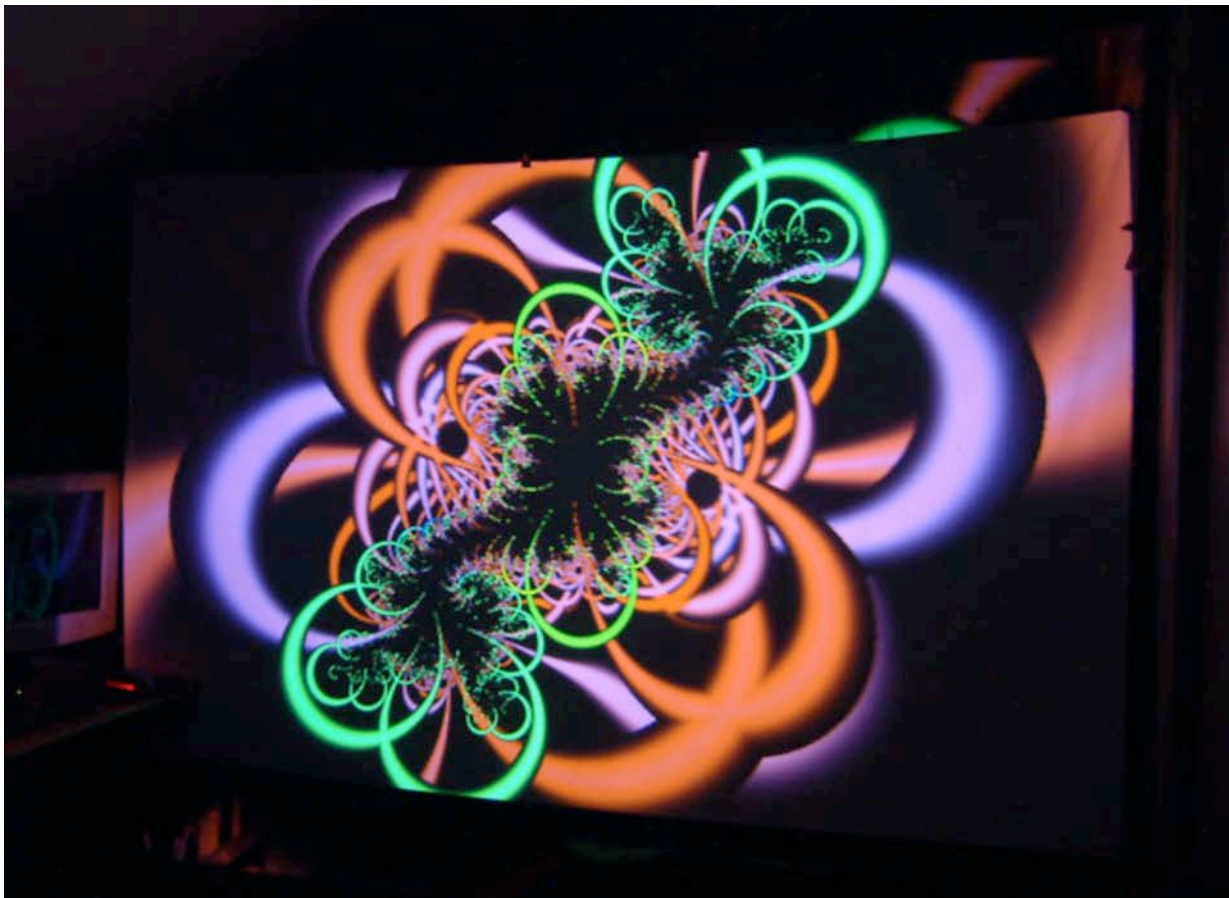
- 1 MH400U 400watt metal halide lamp and base
- 1 400watt metal halide ballast
- 1 Projection lens triplet
- 1 Dual focus fresnel or 2 single fresnel lenses, focal lengths: ~220mm, ~320mm
- 1 15" LCD panel
- 1 Piece tempered glass
- 1 120mm Fan
- 1 piece 1"-2" x 5" .125" Aluminum strip for lamp base bracket
- Several small pieces of aluminum flashing.
- Various electrical: switches, wiring
- Enclosure material: wood, metal, mdf etc.
- Fasteners
- Air conditioner filter cloth
- White wall or screen material

Next page: Some initial results from my Simple 15" projector. If you are printing this material you may want to tell your printer to stop at page 19.



above: Spirited away with my friend Scott.

below: Fractals





Quake III, really big

## Conclusion

I hope this project is as fun and rewarding for you as it was for me. My family and friends have enjoyed our prototype projector for months without a single problem. The total costs for this prototype projector was \$400 with all new components. The CMV1515 lcd monitor was \$225. Of course you could spend much less or more depending on your selection of components. Some have built decent projectors for as little as \$100. This projector can be completed in about 2 days time if you have all of your components and materials at hand. Even at \$400 this projector is a great bargain. A comparable XGA projector could cost thousands, and the bulb for it alone could cost near \$400. I won't have to change my \$15 bulb for many years! You also get a big 'wow' factor out of this projector. Your friends and family will be impressed to say the least. Of course the most fun is sitting back with some friends and a big bowl of popcorn and enjoying your own movie theater.

Please be safe and use your wits when engaging in a project such as this. Always put your safety first!