

# ***SPIRIT*** DESIGN



# **Lasers as an aid to modelling**

**By Chris Pearce**

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# **SPIRIT** DESIGN

**PO Box 7033 Cranbourne North 3977**

**email:- [chrispearce@spiritdesign.com.au](mailto:chrispearce@spiritdesign.com.au)**

**Website:- [www.spiritdesign.com.au](http://www.spiritdesign.com.au)**

**Ph 03 9702 9751 Mob 0414 971 302**

*These notes are a guide for anyone who maybe contemplating creating a kit and would like to have it laser cut but don't have the finances, resources or the time and effort needed to learn how to use a laser.*

*Although you don't have to know all the ins and outs of the laser workings a little basic knowledge is helpful in understanding when designing kits.*

*0 Scale Models and some notes courtesy of Brunel Models*

## Theory:

A laser produces a coherent, collimated and a very thin beam of light less than a tenth of a mm in diameter. Laser cutting/etching uses the attributes of a laser to apply heat in a very small area to burn, vaporise or melt through the material. Industrial lasers usually have power in the range of 200 watts to 1000's of watts.

For model kit manufacturing you need a laser wattage between 20-100 watts maximum. A small laser such as my 40 watt is more than ample for the materials we hobbyist use but will not have enough power to cut steel, etc. Conversely to cut steel requires over 1000 watts plus a machine over \$250,000.00 and the industrial laser cannot scale down its power enough for cutting/engraving on materials used in modelling.

I can cut most modelling materials of varying thicknesses to 9mm for MDF. However materials containing chlorides (eg: PVC) cannot be cut. See Notes on what can be cut or engraved for information.

## Typical Laser Equipment.

A common CO2 laser cutter/engraver.



## Issues to consider

The laser cuts at a slight taper (since the laser beam is conical rather than cylindrical). Due to the taper, one side of a laser-cut part (the side facing up during laser cutting) will be slightly smaller than the other side. The taper is almost unnoticeable in material up to 3mm; the thicker the material, the more noticeable the taper.

The edges of some materials including wood and paper may char from the laser (Acrylic and ABS do not char.) Styrene and some plastics melt and can rejoin to themselves so a second cut is employed.

You may want to adjust for the kerf (the thickness of the laser beam), which is about 0.2mm. For example, if you would like a hole to have diameter of 10mm, then draw a hole with a diameter of 9.8mm in your drawing. If you would like a circular part with a diameter of 20mm, draw a circle with a 20.2mm diameter (These numbers are approximate and can vary depending on the material and its thickness).

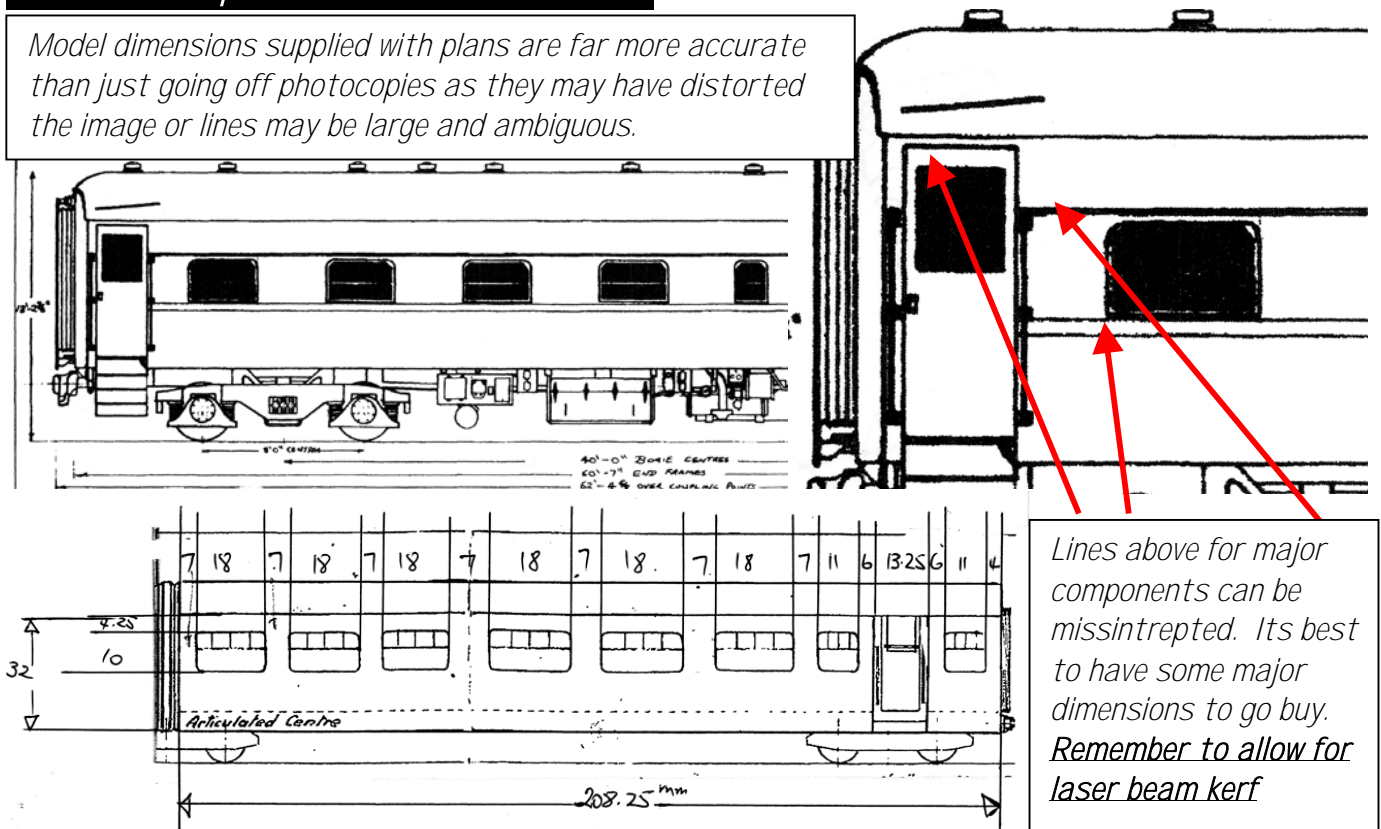
## Laser beam attributes

Vector engraving depths can range from barely marking the surface to going all the way through the material. I try to control the depths you require by varying the **Power** versus **Speed** versus **DPI** and **Lens height**. However I may not achieve the exact match required as there may be other variables (materials) that cause problems but will try my best to achieve what you need. Industrial lasers are the same.

Raster engraving is slower and more costly, and is used for engraving bitmaps (.jpeg or .gif files of logos, photos, etc.), text, and filled-in areas. The laser blasts away one pixel at a time, similar to the printing process used by inkjet printers. The depth of the engraving is specified by the gray-scale colour of the pixel (black gets engraved the deepest, grey is engraved to medium depth, and white is left un-engraved).

## Artwork Requirements for the Laser

Model dimensions supplied with plans are far more accurate than just going off photocopies as they may have distorted the image or lines may be large and ambiguous.



All laser work requires drawings either supplied by the customer or drawn by myself, which incurs a fee listed under costings. You can save money by providing proper vector based drawings, which are readable by Corel X3 (versions 7-13).

Some other makers CAD drawings can be imported in with minimal problems. Formats that usually come across fine are: .cdr, .cmx, .eps, .ai, .pdf, .dxf, .dwg, and wmf. Extra researching of the prototype, tests on new materials or interpreting ambiguous drawings will incur costs. Only Windows PC files can be accepted, for all others please allow for testing.

Maximum drawing size is 600mm x 300mm. Please allow 10mm all round your drawing so that I can hold down the material being lasered.

Line thickness and colours are used as a way of guiding the laser as to whether it cuts or engraves the material. Available colours for drawings are black, red, green, yellow, blue, magenta, cyan, and orange.

Vector cutting: cut lines (all the way through) should be shown as red where possible. These are shown as 0.01mm in cad or hairline in Corel software or the minimum your software will allow. This is known as a vector cut. Your drawing should explain what depth you want in mm. Maximum possible is 9mm in MDF.

Generally I use red to cut but if there are multiple cuts or scribing I use orange as a cut through as this is the last colour in the laser list. The laser cuts in the following colour order (black, red, green, yellow, blue, magenta, cyan, orange). I can however over ride this, e.g. I could use a red hairline to release the windows from the body and green to do matchstick boards and orange to cut the side from the material. There is plenty of flexibility, just let me know what you want.

Rastering / engraving: generally speaking is a solid area that is engraved away from its surrounding material and solid black is usually used to represent this but takes a lot more time on the laser. The Spirit Design logo above is a good example of a rastered logo. If you want more than one depth of rastering / engraving it can be separated by the use of shades of black (black to grey to white).

No Drawings Provided: in some cases you might not be able to draw what you want and will leave it up to me to produce laserable drawings. Prototype drawings or sketches can be provided in most formats, eg Tiff, JPEG, Ai, DXF, DWG, etc. or just plain paper plans. Good clean high contrast copies are desirable. When in doubt please contact me. CD's and DVD's of large files are better. Drawing and research costs are charged. Please see costings for further details.

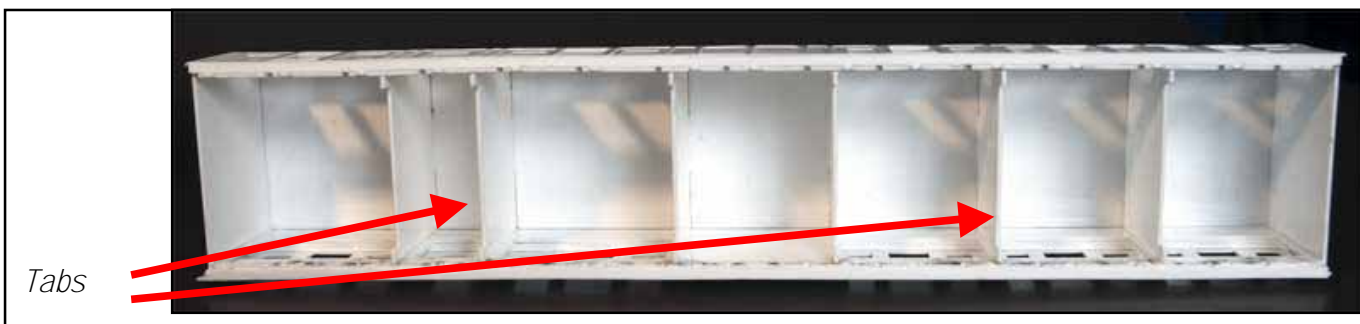
Special note for Corel users: please check that you don't superimpose multiple cut lines on top of each other as the laser will cut the same line twice. This is a common 'Gotcha' that arises from duplicating items in drawings.

## Design considerations

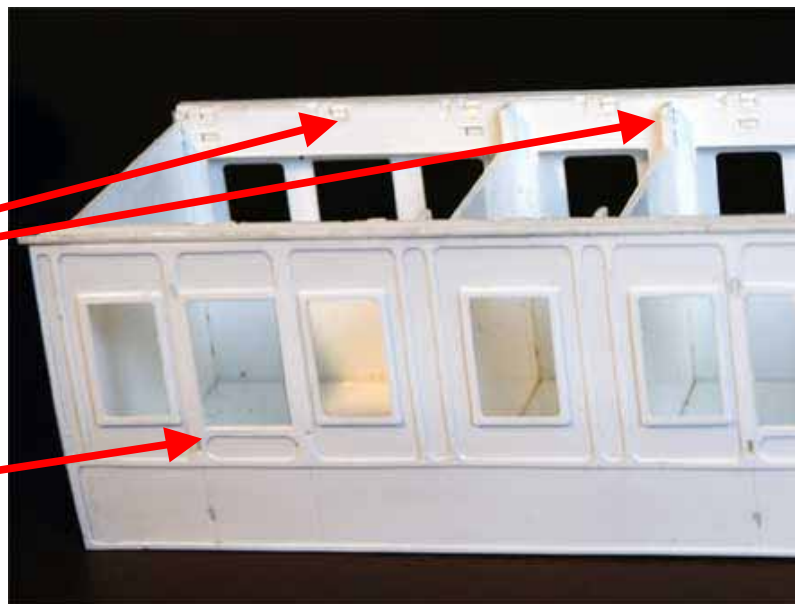
What you need to consider is type of material (eg: styrene, ply), thickness of material and how you will construct it. If you have built a number of etched brass kits you will have some idea of how you may design what is effectively a kit. There are some fundamental differences, however, such as not being able to fold up styrene or ply. For buildings and rolling stock bodies for instance it is a good idea to design it such that it automatically "squares" itself up.

### Tabs

This example of an O scale NBB coach shows one method squaring up partitions and ends before gluing by the use of tabs.



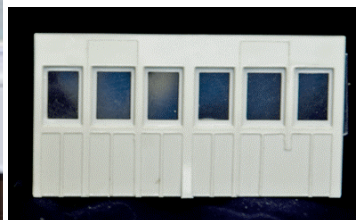
*This photo of the end of a 0 scale LNWR coach shows tab construction technique and using the door handle and hinge holes to assist in lining up the overlay on the carriage side.*



*Tabs*

*Holes - use a pin to line up.*

*Unlike brass etching you should use layers of different thickness to construct relief such as for this coach side.*

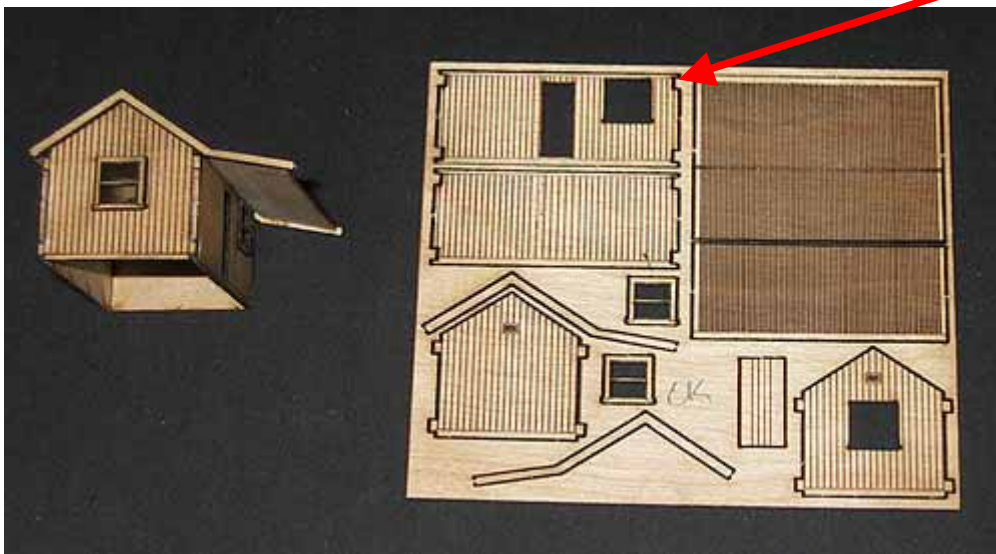


If the finish end material is very thin and has to cover a large area, in this case 0.8mm 3ply spanning a large area a simple tabbed MDF interior was employed to add strength and to keep walls square and flat.

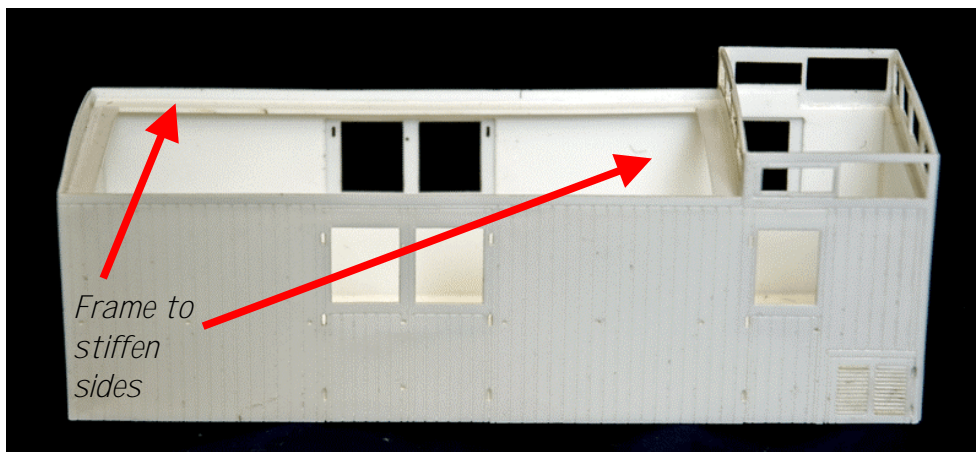
These photos show how a tabbed inner MDF former helps square up the kit on an N Scale VR 30ft Goods shed and provide a solid platform to glue the 0.8mm ply to.



An N scale Victorian Railways 20ft Portable Station released by Spirit Design. This kit employs a simple use of a couple of tabs to help true up the sides and aid the modeller in minimising construction time. Because the walls don't span a large area no inner skeleton is needed for support.



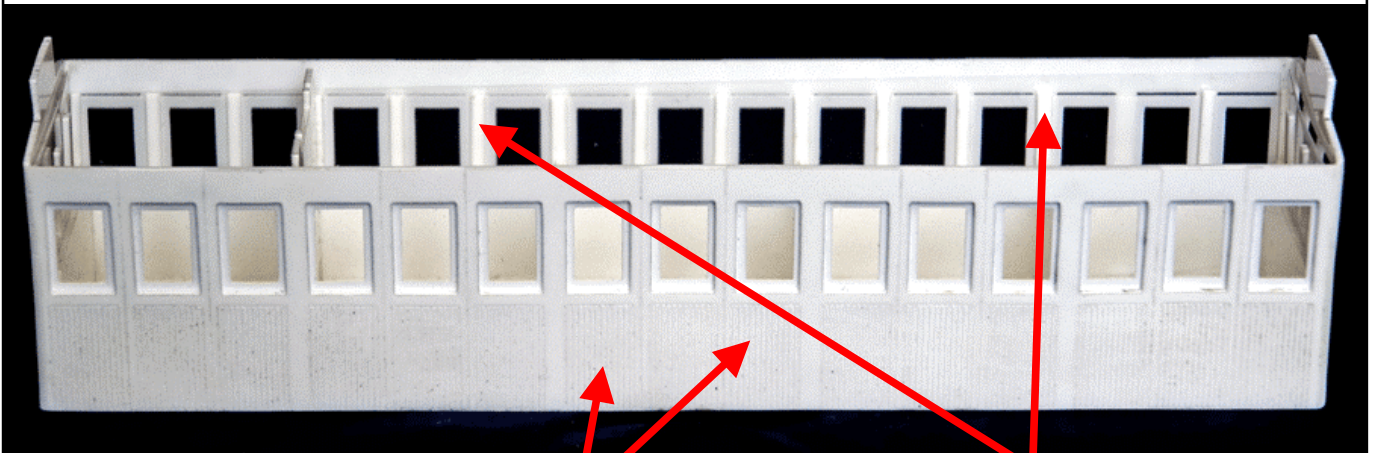
An O scale Victorian Railways Z Van. The outside walls of the van are made of 0.75mm styrene to provide the right scale depth for the windows. Inside walls of 1mm are used to stiffen the outside walls and a frame around the inside top to stop the walls from bowing inwards.



## **Window and glazing**

Techniques are demonstrated in the photo below.

*This is a 0 scale NBB "Puffing Billy" coach body constructed using an inside "frame" to facilitate the droplights and glazing. The vertical panelled sides are simulated by engraving vertical lines using the laser.*



*Inside frame for glazing and droplights.*

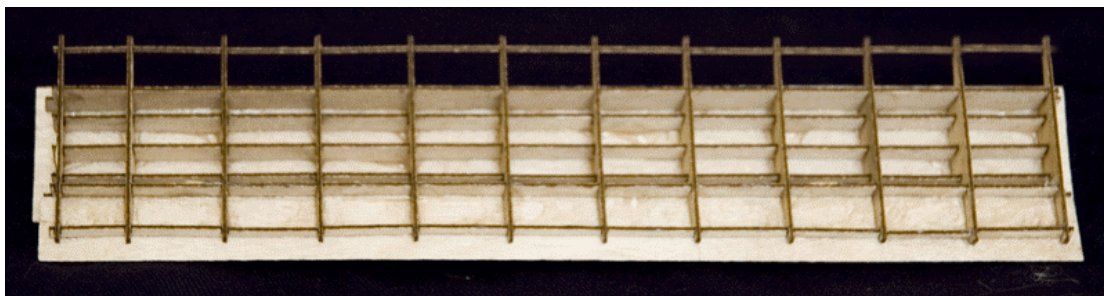
## **Roofing.**

*Another area that needs special consideration is roofing, as this is probably the first thing that most people will see on your models. The only way to achieve correctly formed roofs is to use an internal frame of ribs and cross members as support.*

*This photo is of the underside of roof for a coach constructed out of styrene like an aeroplane wing.*

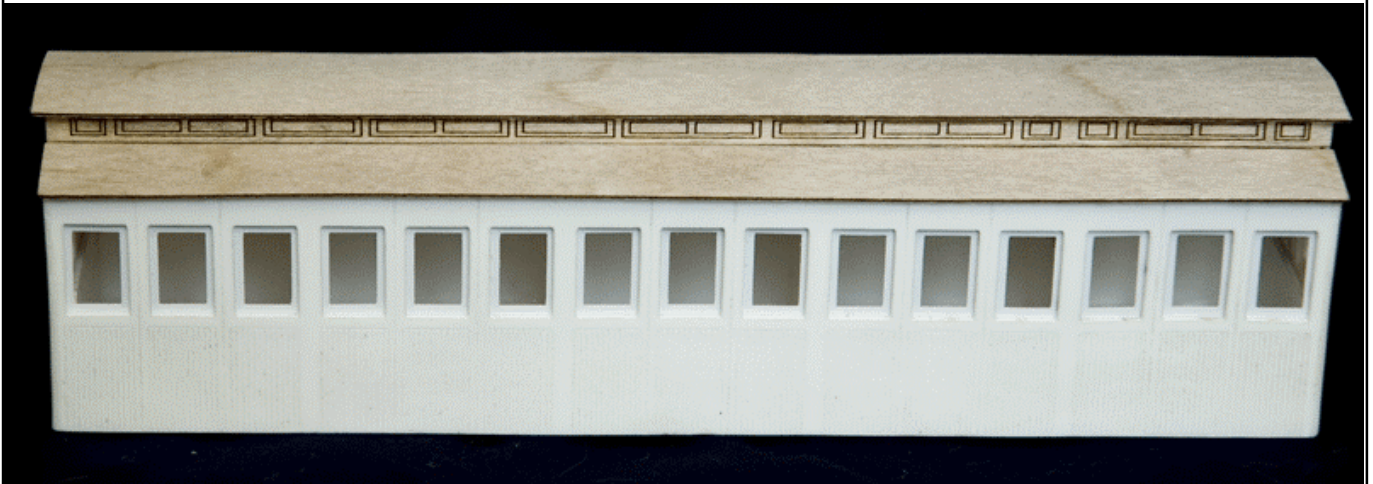


*This photo is a view of a clerestory roof for an 0 Scale coach (NBB) constructed out of ply.*



*Sometimes you may need a composite use of materials to avoid distortion when using certain glues. As styrene is prone to warping when used in large amounts the coach construction below got around this by utilising a plywood roof instead.*

*O scale NBB coach with ply roof. Styrene is not strong enough and is prone to distortion when glued when used to construct a roof.*



*The windows in the clerestory roof can be cut out and framed with an overlay frame and opaque glazing glued behind them.*

## **Material Considerations**

*When building or designing your kits you may need to use a combination of materials to get around problems with certain materials.*

*Note: Generally Plastic thicknesses are nominal and can vary by up to + or -10%. I have no control over this or what the manufacturer of these compounds decides. Wood is generally closer to specs in the professional modellers suppliers. Ordinary hardware supplied timber will vary a bit but will be the same dimensions across the sheet as opposed to acrylic below.*

### **Acrylic sheets:**

*Acrylic sheets are prone to dimension variations in thickness. A 3mm x 2400mm x 1200 mm can vary between 2.7mm to 3.3mm thick from one side to the other. However it cuts and etches extremely well but is very brittle.*

### **Styrene and ABS:**

*Styrene used widely by modellers can be cut and etched but it has a tendency to melt and rejoin where the cutting is taking place. A second cut is usually employed to get around this. As a consequence lasering costs are higher because of the extended times employed. Thin styrene cuts with one pass and is very useful in kit building. It is not as rigid as some other modelling materials and may need multi layering to produce a stiff structure. ABS has similar characteristics as styrene. Excessive half etching the material (corrugations) will cause the styrene to bow because of the heat related stresses introduced into the material. Be sparing with the glues used on these products. See Glues for more details*

### **Softwoods:**

*Balsa and Basswood cut and etch very easily with slight discolouration of the wood. This can be cleaned off with water. Most other woods require a bit more effort to produce the same result. Generally if it cuts easily with a hobby knife then the laser will have no trouble with it.*

### **Paper based products:**

Paper, cardboards, matt boards, specialty papers (brick paper) and most forms of this cut extremely well and have been used in modelling for over a 100 years now. They are easily glued, painted and assembled. Excellent product for all facets of kit building.

### **Medium Density Fibreboard (MDF):**

MDF cuts well but does char a bit when using the thicker board. The maximum I can cut is 9mm. Smoke stains from lasering can be removed with a wet cloth or by sanding. Idea for internal bracing of kits.

### **Foam core/Gator Board:**

Foam core and GatorBoard will cut easily, but the inside foam between the paperboards does melt a bit away from the edges where the beam passed through. Foam boards are lightweight and make excellent structure strengtheners.

### **Polyethylene or Acetates:**

Polyethylene (chopping board) and acetate both cut well. Acetate usually used as window panes in models buildings.

### **PVC based materials (major no-no for lasers):**

All PVC based materials release chlorine gas when lasered resulting in hydrochloric acid being given off as a by-product. As this is extremely harmful to the sensitive and expensive equipment, I will not laser it.

### **Cloth and materials:**

Cloth and fabric materials can be cut and etched but as this is not a major focus trials to ascertain settings will be required. Testing costs are chargeable. See Costings for further details.

### **Plywoods:**

Ply is often the most useful material when styrene would not produce a good result (eg: the NBB roof). Ply comes in various qualities of which the most significant factor for lasering is the glues used to bond the layers together. Some glues require considerable heat to cut through with the result that the ply can be seriously charred or even catch fire. Others cut quite well. These are usually marine plys. If you wish to use ply please send me a sample for testing. The thinner the ply the easier it is to cut. It can be glued with standard wood glues. Excellent kit modelling material.

## **Glues**

Glues can play a very important part in the construction of kit manufacturing.

### **Styrene glues:**

Most styrene glues actually dissolve a layer of the styrene and should be used sparingly. When gluing layers together it must be remembered that they can continue to dissolve the styrene for days afterward and distort or melt it even though it looked OK initially.

On the positive side styrene is an excellent modelling material and there are a number of excellent references to modelling with it. These include: *Carriage Modelling Made Easy* by David Jenkinson (ISBN 1 874103 32 1) and *Styrene Modelling* published by Evergreen (ISBN 0 9678369 0 5).

## **Wood glues:**

Most wood glues are PVA based and can be used on both paper and wood products with no ill effects at all. Some of the more modern PVA wood glues for MDF and similar materials are quick drying and sandable which allows very fast assembly of kits during warmer months. Triton Wood Working glue is an excellent choice here (usual disclaimer).

## **What can be cut or etched.**

<b>Material</b>	<b>Engrave</b>	<b>Cut</b>
Plywood	Yes	Yes
Hardwood	Yes	Yes
Softwoods	Yes	Yes
Balsa	Yes	Yes
Bass wood	Yes	Yes
MDF	Yes	Yes
Wood Veneer	Yes	Yes
Matte Board	Yes	Yes
Plastic	Yes	Yes
Acrylic	Yes	Yes
<i>Delrin (not tested yet)</i>	Yes	Yes
<i>Cloth (not tested yet)</i>	Yes	Yes
<i>Leather (not tested yet)</i>	Yes	Yes
<i>Marble (not tested yet)</i>	Yes	
Melamine	Yes	Yes
Paper	Yes	Yes
Mylar	Yes	Yes
Cardboard	Yes	Yes
<i>Anodized Aluminium (not tested yet)</i>	Yes	
<i>Tile (not tested yet)</i>	Yes	

## Costings.

As a general guide:

All laser work requires drawings either supplied by the customer or drawn by myself, which incurs a fee listed below. You can save money by providing proper vector based drawings, which are readable by Corel X3 (versions 9-13).

Some other makers CAD drawings can be imported in with minimal problems. Formats that usually come across fine are: .cdr, .cmx, .eps, .ai, .pdf, .dxf, .dwg, and wmf. Extra researching of the prototype, tests on new materials or interpreting ambiguous drawings will incur costs. Only Windows PC files can be accepted for all others please allow for testing. Maximum drawing size is 600mm x 300mm. The laser work you require consists of a number of charges. Some of which you can offset by doing your own research, drawings or supply of non-stocked items. The minimum charge is \$33.00 including GST.

Laser cutting/etching time (dependant on material thickness and characteristics when cutting or engraving) and different material changeover times.	\$1 per minute
Setup charge per new job (includes ½ hour drawing/research allowance)	\$25 per hour
Material costs (plastic, plywood, acrylic, styrene, MDF, paper etc)	\$various
GST Government charge	10%
Handling fee (to pick many small items out of the laser bed, not normally charged) However if you supply a material I haven't tried lasering and it requires testing to find its laser values then the handling fee is charged.	\$1 to \$5
Research and drawing required for lasering	\$44 per hour
Postage plus Registered Post at buyers expense.	\$Aust Post Charges

## FAQ's

**Question:** What size is the maximum drawing that can fit on the Laser bed?

**Answer:** 600 mm x 300 mm is the maximum size that can be handled.

**Question:** What is the maximum depth you can cut?

**Answer:** Each type of material has its own characteristics. MDF can be cut to a maximum of 9mm, styrene cannot be cut to this depth successfully in one pass because of the heat generated causes it to melt excessively. You can do multiple passes of the laser over some materials to get a reasonable product. This increases the time the laser is active and thus increases overall costs. Please contact me if in doubt.

**Question:** Can I supply my own materials?

**Answer:** You can supply your own material but is usually more cost effective to use the stock I have. Also MDF, plywood and some glued together composite materials only laser well if they are freshly made. Bunning's turns over its wood stock more frequently than some sources so you would normally be guaranteed fresh supplies. I have a good range of MDF, Plywood, Micro Plywood, Styrene, Balsa, Acrylic, Polyethylene and cardstocks. Any material not normally cut or etched by me will require testing and there is a small fee to ascertain the best settings for Lasering.

**Question:** What can't be put through the laser?

**Answer:** Some materials cannot be lasered for a number of reasons. PVC produces Hydrochloric gas when cut, which damages the laser. Materials similar to this won't be used. Also ones that produce dangerous chemical gases when cut. Please be aware that you should not send material to me for lasering until I have approved it or have tested a sample.

**Question:** How many items of my drawing do I have to order?

**Answer:** You can order as little as 1 item to 100's

**Question:** Do I need artwork?

**Answer:** Some form of artwork is needed whether you supply it or I draw it the laser needs it to produce your items. See Drawing guidelines.

**Question:** What is the time frame for a turnaround of a customer job?

**Answer:** Typically you should allow 2-3 weeks from receipt and acknowledgement of your order as this is a hobby I do during my spare time. Things that slow down the process are hot weather, family and work commitments, unavailability of materials, waiting on external suppliers of specialist supplies. Other things that can slow the process down are ambiguous drawings, other research and drawings required, other orders ahead of you. There are many factors that are sometimes beyond my control but I will keep in contact with you via email or phone.

**Question:** Postage?

**Answer:** Whilst every care is taken packing and posting your order I am not responsible for the work once it leaves my care as I have no control over the vagaries of the Postal System. As a result of past problems all mail will be sent registered post as it gives both you and I a better chance that it will arrive safely. Orders over \$100.00 should be insured as well.

**Question:** Pickup?

**Answer:** Personal pickup can be arranged if the items are large or for a visit.

### Laser cut examples

