How to build loudspeaker enclosures

You can build a pair of really beautiful loudspeaker enclosures, just like the ones shown on this page. All you need are a few standard domestic hand and power tools, and the ability to follow some simple techniques.

by GREG CARR

Photo 1: the finished loudspeakers, with and without the grille cloth.

C. Wright Mills noted that when the price of an item has nothing to do with the decision to purchase, then the buyer is among the super rich. Few readers are likely to be in this category so, when it comes to choosing loudspeakers, price inevitably forces a compromise.

In fact, it is not difficult to tie up $10,000 of your capital on a pair of top-of-the-line loudspeakers, and that is not the top price if you are looking to get rid of some burdensome cash. No, dear reader, let's get back to the world in which the vast majority live, the world of hard choices and compromise. Sound familiar?

In any well designed stereo system, the loudspeakers, as a general rule, comprise a cost as high as the rest of the equipment combined. Additionally, their quality varies far more than any other component in the system. As such, careful consideration should be given to their selection.

Unfortunately, we can rarely afford the loudspeakers we would really like to have. However, if you are willing to build your own enclosures, you can have a far better loudspeaker system than would otherwise be the case! If you have a place to work, a few basic tools, patience and a willingness to follow the instructions herein, there is no reason why your loudspeaker enclosures should not be as well built and as good looking as any on the market.

In fact, your choice of finishes, sizes and shapes expands considerably if you build your own!

Designing Enclosures

The design of enclosures has been greatly aided by the original research conducted at the University of Sydney by Messrs Thiele and Small. Prior to their work, enclosure design had been, to a large extent, by rule of thumb and a lot of trial and error.

Thiele and Small replaced the guesswork with mathematics and revolutionised enclosure design forever. Now all reputable raw frame loudspeaker manufacturers publish "Thiele-Small Parameters" for use by designers. These parameters, when plugged into formulae, enable the designer to manipulate enclosure size, porting and performance to achieve a desired result.

The main drawback is that the formulae and parameters are not simple and, as a consequence, are beyond the scope of this article.

Fortunately, most manufacturers publish enclosure plans based on Thiele-Small parameters which provide considerable scope for the do-it-yourself enthusiast. If a suitable design is not available from the loudspeaker manufacturer, then a professional engineer should be consulted. Two such designers are: L & C Electro Acoustics, 50 Nowranie St, Summer Hill, NSW phone (02) 799 6742 and Mr. Richard Priddle, 123 Pacific Rd, Palm Beach, NSW phone (02) 919 5494.

A "prove the point" project

For many years I had wanted to upgrade my loudspeakers but couldn't afford any of the better quality commercial systems available on the market. Enter Mr Ian Muir of Emu Constructions in the Blue Mountains, west of Sydney. We discussed the problems of home loudspeaker builders and recently decided to build a pair of loudspeakers using standard domestic hand and power tools, and utilizing simple techniques. Most of what follows is a generic series of instructions which can be incorporated into any enclosure construction you choose.

On the other hand, if you want some enclosures built just for you, Ian Muir is one of the best for the job. You can telephone him on (045) 67 2195.

Selecting the driver

The Altec Lansing Model 604 duplex loudspeaker has been a standard for the music recording industry since World War II. In fact, the current-model Altec Lansing 604-8K serves in many recording studios as a master monitor.

This loudspeaker is a 15-inch (38cm) bass unit with a concentric horn tweeter mounted in the middle, hence the term 'duplex'. Not only is the quality of the reproduced sound extremely accurate, but they are also highly efficient, creating 100dB at a distance of 1.2 metres with an input of one watt!

Given that funds for amplifiers are generally limited, high efficiency is a highly desirable trait. At an average listening level of 80dB, there is headroom of 40dB using a 100 watt amplifier. That amount of headroom enables the use of a compact disc player with no worries of overloading either the loudspeakers or the amplifier — unless I want more than 120dB SPL (sound pressure level) in my living room!

The 604-8K loudspeaker can be obtained from Altec Lansing (Australia), 133 Alexander Street, Crows Nest. Telephone (02) 439 488. The raw frame loudspeakers cost $2730.00 retail and all other materials for the enclosures add about $250.00. Therefore, for less than $3000, I have a pair of loudspeakers in beautiful enclosures which would cost more than twice as much from your friendly hifi shop. That is an excellent deal!

Photo 2: accurate mitre cuts can easily be made by clamping a straight plank to the panel and using this to guide the sole-plate of your power saw.

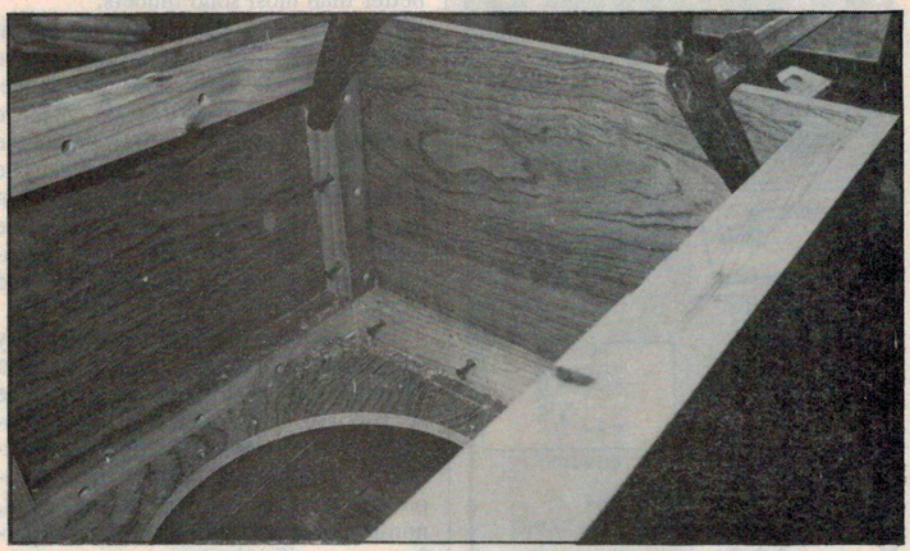

Photo 3: the partly assembled enclosure. Note the use of 45mm square cleats along the inside edges. The cleats should be glued and screwed into position as outlined in the text.

The enclosure design

Mr Richard Priddle has designed a smaller than standard enclosure for the 604, the performance of which is quite flat down to 40Hz. The volume is 167 litres (5.9 cubic feet) and is moderate for a driver of this size and performance. This is an ideal combination of loudspeaker and enclosure and has been adopted by several Sydney recording studios for their master monitors. You can contact Richard at the telephone number given above if you wish to use his design.

The enclosure is of simple modern design and makes features of the loudspeaker, vents and crossover. There is an added plinth on the base and all front and top joints are mitred. The grille cloth is stretched over a simple

frame and clipped to the front baffle. With or without the grille, the finished loudspeaker is indeed a handsome unit (see Photo 1).

Selecting the timber

The most economical material for constructing enclosures is a high quality particle board. There are many different types of particle board; some are suitable only for construction applications while some types are suitable for building furniture.

The finer particle, denser, multilayer boards are the most suitable for loudspeaker enclosure construction. The Brimsboard people make a 7-layer veneered panel of excellent quality and this is ideal for the job. Their panels are dense, rigid, machine well, and their acoustic qualities are unsurpassed. Furthermore, they hold screws and glue better than most solid timbers.

I selected the Brimsboard panels at Brims Distributors, in Fairfield (phone (02) 632 7583) and chose panels veneered in African Rosewood. I have never seen a more beautiful wood; the grain pattern looks like marble. The panels are veneered on both sides, but one side had more features than the other. For this project the most practical sheet size was 2.440m x 1.220m and 18mm thick.

The internal bracing was provided by 45mm-square pine, and this was used to assemble the panels and to brace the Brimsboard panels to render them non-resonant. It is important that the bracing be straight and square. The completed enclosure must be strong, rigid, non-resonant and airtight if it is to perform to specification.

To mitre or not to mitre

From the photo of the finished enclosures, it is obvious that the edges are mitre joints. Now most home builders consider that mitre joints are strictly in the province of the professional cabinet maker who has the necessary specialised tools. They further think that they should venture no further than butt joints and use veneer strips to cover the edges. As we have just indicated, such notions are incorrect.

The supposed advantage of butt joints is that cutting the panels and edge veneering is easier than cutting and aligning mitre edges. Of course, mitre joints look infinitely better and, to overcome the difficulties, Ian Muir and I have devised a few simple techniques. The resulting mitre joints take no more time and care than well made butt joints which require edge veneering.

Below is a guide for making accurate mitre cuts.

Setting up the circular saw: it is imperative to have a blade that is suitable for veneered particle board. Note that ordinary combination blades will chip or splinter the veneer on Brimsboard or any particle board.

If you happen to have a panel blade, it will be adequate provided it is sharp. Unfortunately, panel blades have been superseded by tungsten carbide tipped blades. If you must purchase a suitable blade, the description given in the list of tools is adequate.

Making accurate and straight cuts: first set the saw to make accurate 45 degree cuts by cutting scraps and adjusting the saw tilt until two bevelled cuts make a 90 degree joint when placed together. Use your square to judge the accuracy of the saw adjustment. Once done, mark the tilt indicator on the saw for quick resetting.

The method for making accurate long mitre cuts is to use a long straight plank (2.5m x 300mm x 20mm — see bill of materials) to guide the sole-plate of the saw (see Photo 2). You can obtain such a plank by cutting off a 300mm-wide strip from a plain piece of Brimsboard. The factory milled edge is accurate and, by clamping the plank to the panels, a rigid accurate guide is obtained.

Note that masking tape should be placed over the cut line as shown in the photograph. This further ensures that the saw will not chip or splinter the veneer. When removing the tape, peel parallel with the cut panel and out from the edge to prevent the tape from pulling away pieces of veneer.

Assembling mitre joints

Photo 3 shows a partly assembled enclosure. Note that there is a 45mm square cleat along the length of every inside corner. These cleats are screwed and glued in position. The screws serve to draw the mitre joints into position and to hold them firmly until the PVA glue sets. Result — an extremely strong and rigid construction!

The procedure is as follows: First, spread woodworking glue along one side of a cleat and carefully clamp it into position inside the bevel of one mitre joint. This done, screw the cleat to the panel at 150mm intervals and remove the clamps.

Next, spread a liberal layer of glue on the bevel and adjacent cleat side. You can now carefully mate the bevel of the next panel with the cleated panel and clamp them together. Finally, use

screws to secure the new panel to the cleat as before and you have a completed mitre joint!

Proceed in like fashion with all panels.

Order of assembling panels

Because you will be working inside the enclosures for much of the time, ease of access to the cleats and panels is important. Carefully consider the order of panel assembly which will be determined by the design of the enclosures.

The enclosures pictured in this article have mitred edges where the front sides and top meet; the back and bottom panels were butt jointed. The bottom uses a plain piece of Brimsboard and is fitted inside the surrounding panels against the cleats and screwed from the outside. The order of assembly was as follows: the two sides to the front baffle, then the top, next the back and finally the bottom.

Some notes on screws

Each enclosure for this project required about 200 screws, so let me give you a few hints to save your wits! First, always use 'twin fast' or particle board screws with Philips or Posidriv heads. They are harder and stronger than most wood screws and the cross heads ease insertion of the screwdriver tip.

It is also a good idea to purchase hardened screwdriver tips which can be inserted into the chuck of a good variable speed drill. Using your drill to drive the screws will ease this task considerably, but be careful not to drive the screws all the way through the panels! The screws are used only for the purpose of clamping the panels to the cleats. Once the glue sets the screws are superfluous.

On a similar theme, each screw requires the drilling of a separate hole. In fact, for this project, it is necessary to drill a pilot, anchor and countersink hole for each screw. The countersink was necessary to give the 50mm-long screws a 10mm bite into the panels.

The easy way to do all this is to purchase a special purpose drill bit. The General Type Adjustable Screw Drill allows individual adjustment of the anchor, pilot and countersink, and a collar provides an accurate depth stop. Such a tool will save you many hours of tedious bit swapping.

Most enclosures have a grille cloth to hide the loudspeaker. However, there is a trend towards making a feature of the driver and crossovers in some designs. Photo 1 shows the enclosures with and without a grille cloth.

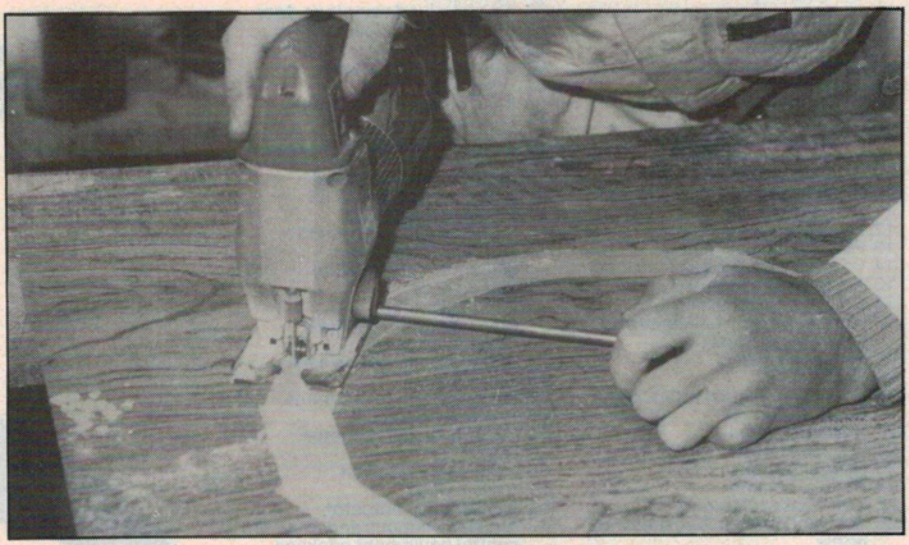

Photo 4: use your jig saw to make the cutout for the loudspeaker. Note use of masking tape to prevent chipping of the veneer.

If you want a grille cloth, simply make up a suitable frame and staple the cloth to the back. The frame can then be fastened to the enclosure using Velcro strips.

Finishing

Any imperfections in the joints can be filled with a colour matched wood filler. If you were careful in sawing and assembly, the gaps to be filled will be insignificant.

Use a fine garnet paper to sand the enclosures to a smooth finish. If you have a high speed orbital sander (10-20,000 rpm), use 280 or finer grit garnet paper. The Brimsboard is already well finished and needs only light sanding.

The veneer should be sealed and I chose *Satin Estapol*. The finish, however, is largely a matter of individual taste.

The final product

The completed loudspeakers come up in a very pleasing manner and their performance is equally impressive. Richard Priddle ran a frequency sweep to determine their range and cut off points. Measured in the 'far free field' their frequency response was 45Hz to 16kHz +/- 3dB and 42Hz to 20kHz +/- 5dB.

Subjective listening tests showed why these loudspeakers have been a standard reference monitor for over a generation. They are excellent and I look forward to many years of great stereo listening. In terms of value for money, they cost about $3,000 all up and there is no doubt they would compare favourably with loudspeakers in the $10,000 bracket.

In other words, the exercise proved to be well worthwhile. EA

BILL OF MATERIALS

Below is a comprehensive list of all other materials used in the construction of the project:

- PVA glue
- screws: 10 x 50mm, 'twin fast' or particle board, Phillips head or Posidriv
- Wood Stop putty to match colour of veneer
- Satin Estapol
- R2 fibreglass insulation
- 50mm masking tape
- grille cloth to suit
- 12mm staples for staple gun
- No.280 garnet paper
- 25mm matching veneer strips

Tools

- circular saw, 7-1/4 inch or larger
- saw blade, tungsten tip, 10mm alternate top bevel with 60 or more teeth
- measuring tape
- F clamps x 2
- saw horses x 2 or a sturdy work bench
- planks x 2, 5mm x 25mm x 2.5m
- electric drill, variable speed
- jig saw
- hammer
- plank, straight and true, 2.5m x 300mm x 20mm (see text)
- staple gun
- drill bits
- Phillips or Posidriv bit for drill
- Countersink wood bit for screws
- square
- hand plane