FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

100% AFTERMARKET SYSTEMS

The 100% aftermarket system is really where the right accessories make a big difference. The quality of the install has everything to do with the work that goes into it and the choice of the components themselves. Anyone who has an aftermarket system will tell you, it's easy to buy the wrong thing or just plain buy too much. What many who buy aftermarket don't realize is that there is no clear cut right or wrong, only the importance of choosing the right equipment for you.

So what's the right equipment? That is another training manual entirely that is ever changing. What it all really boils down to is the right blend of value. Value is a mixture of cost, performance, technology, ease of installation, and long term reliability. That's true of anything you'd buy if you think about it. What happens very often is that the person selling knows little more about them than the person buying. This is where the problem of misapplication comes to rise. If you can't attach some personalized approach to each car, then the aftermarket system will likely be no better (just maybe louder) than a comparable OEM system. That's what you want to avoid, giving a bad rap to the Aftermarket.

Let's layout the way a good, well thought out aftermarket system is built. First, there's the source. This isn't always the same as the headunit because sometimes there's ONLY a CD changer for a source, although not usually. Anyway, aftermarket systems begin with a SOURCE UNIT. Source units can consist of a headunit alone, a cassette headunit with an in-dash CD or a headunit with CD changer control and a changer plugged into it. The source unit is where it all begins.

From there we go to PROCESSORS. Think of audio processors like food processors. With these you can slice, dice, blend, puree', cut, and mix music which ever way you like. The average aftermarket system employs 2 main kinds of processing - EQUALIZATION and CROSSOVER FILTERING. The idea is that with these two things present in a system, an installer and/or the user can tailor the acoustic characteristic of the system to their liking in the car they've chosen to install them in. Again, here it isn't a question of right thing or wrong thing as much as it is the correct choice for the goal of the listener. Other types of processing include: DSP (Digital Soundfield Processing), Noise Gating, Frequency Contouring, Parametric Equalization (normally Octave Equalization is the standard method), Attenuation, Subsonic Filtering, Frequency Enhancement and many others. Basically processing let's the user take out of the music what they don't need and keep what they do want. Equalization happens to be the most misused processing technique in the car audio aftermarket.

Next generally comes amplification. There's literally hundreds of choices here because amplifiers come in different power levels as well as in different multiples of channels, all of which contain different features. One of the most common features to find in amplifiers is "built-in signal processing". This sometimes eliminates the need for an additional component outboard because everything is done from within the amplifier itself. Four channel amps with internal crossovers are very common these days as well as two channel amps with some sort of "bass boost". These give the end user more space in their car from fewer components, but more importantly "more bang for the buck". Amplifiers are also capable of playing full-range (which means everything between 20Hz-20Khz) OR bandwidth limited (for only certain frequencies, like subwoofers for example). This determines how many channels a system needs to be complete to have the whole 20Hz to 20Khz playing.

Finally there's the loudspeakers. These are probably the most critical component of how a system ends up sounding because they are critical in recreating all of those things like Image, Stage, and Ambiance. The frequency response balance of ALL the speakers together, along with the physical placement of the speakers, is the magic of good speaker selection. Mediocre speakers that blend well and have good placement will almost always sound better than great speakers unblended and in the less than optimum locations. Another thing about speakers, the factory locations are not always the best sounding locations, just what was feasible for the manufacturing process and overall finished costs. Speakers are an ever emerging technology that are surprisingly inefficient. Even the best speakers available today are LESS THAN 5% EFFICIENT. That means that of 100% music power put into them less than 5% of it makes it into sound, the rest ends up turned into heat. So as you can see, where that 5% goes is VERY important.

There are also many difficulties in the installation of these components. Equalizers have been known to induce HISS, Amplifiers to cause engine noise, Speakers to POP, FLUTTER, CRACKLE, and Bottom OUT, Crossovers to add DISTORTION, and plenty of other things. Often times these undesirable things are the result of poor installation or mismatches between components. This mismatch problem can even happen to equipment within the same brand name family. Installation problems are often VERY tiresome to troubleshoot and therefore there's many "quick fixes" available. The quick fix is just a Band-Aid for the real problem though which is either installation related or (in the case of really cheap equipment) poor component isolation between the power supply and the audio section of the component. With the car audio aftermarket, the term "you get what you pay for" stands true most of the time. That means not only the actual components, but the install accessories as well.

SUMMING UP AFTERMARKET CAR AUDIO

Basically the challenge in the Aftermarket, of car stereo anyway, is to do better than the factory did and hopefully for better value. The average new car in the 1990's is not cheap to own nor are they terribly original. They require a little personal attention to make them uniquely yours. Little things make a difference and Professional Installers will tell you that. Most cars are too noisy out on the road, too little in stereo volume, too narrow of a window in the areas of dynamic range and frequency response, and are guilty of being at times "cheap feeling". Do a little thinking, a little investigation, and you have a good chance at making the plans for a good aftermarket system.

One last thing about aftermarket systems. If you're not a Professional Installer, seek the advice of one when you need help. Never be afraid to ask for help if you have a problem, just don't wait until it's too late.

INSTALLATION METHODS

Headunits - *There are basically 3 types of mounting methods for aftermarket headunit installs and 3 types of electrical connections. These are all unique in their own ways, however if time is money (as it usually is in an install bay) the right fit and finish is the way to go. Here's the run down .....*

MOUNTING A DIN HEADUNIT INTO A FACTORY DIN OPENING:

This generally requires nothing more than inserting a headunit "cage" into the DIN opening and bending the tabs back to grab the dash trim edges. Once you finish that, mounting involves nothing more than sliding the headunit into the cage and attaching a rear support bracket. Rear support brackets that are supplied with OEM radios are called backstraps. Of course if the opening is DIN and the headunit is a shaft model, a DIN to SHAFT CONVERSION KIT is required to complete the mounting process in lieu of the DIN cage.

MOUNTING A DIN HEADUNIT INTO A NON-DIN, OVERSIZED OPENING:

This applies to a number of cars out on the road these days. The accepted method of mounting aftermarket headunits is with the use of the AFTERMARKET INSTALLATION KIT or simply "DASH KIT". These can be specifically designed for that one type of car, or designed to fit a wide range of vehicles with similar dash opening characteristics. The DIN cage installs into the kit, the headunit into the cage, and finally the whole assembly into the dash cavity. Rear support is generally accommodated by attaching either a backstrap to a sturdy sub-dash point or reusing the original rear support from the OEM radio. Sometimes rear support is attached directly to the kit body.

CUSTOM MOUNTING A HEADUNIT (CUSTOM TRIM PANELS):

The custom mounting is generally more time consuming and for a special reason. The customer may like his original 1956 Porsche dash uncut or unmodified, or maybe the Mercedes-Benz owner wants real factory Zebrawood trim instead of what trimpanel was supplied with the radio. Another popular request for custom mounting installations is called FLUSH MOUNTING. That's when the nose piece of the radio DOES NOT stick out of the opening at all, instead it sits level and flush with the dash trim. This looks VERY factory installed, that is if the factory would ever have chosen to do that type of headunit as OEM equipment. Custom jobs are more labor intensive and costly to get done, however the results are many times worth the extra effort.

FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

ELECTRICAL CONNECTION WITHOUT A WIRING HARNESS ADAPTER:

Basically this involves cutting the original OEM radio plug off and directly connecting wires to the new headunit wiring harness. The method of connection can vary from soldering (which is the best connection method), to butt connectors, crimp caps, and wire nuts. Hope to God you never hear about anyone still using wire nuts or crimp caps. Those are sure signs of amateur workmanship. Butt connectors are the preferred method of crimp style connectors while soldering and heat shrinking are the best connection that last the longest. In any case, there's a fundamental problem with cutting off the OEM plug, the new car warranty. Many times the car dealers aren't willing to honor any warranty service unless the car is the way they sold it. Modifications almost scream trouble at the dealer.

ELECTRICAL CONNECTION WITH A WIRING HARNESS ADAPTER:

This is a great method for any vehicle produced within the 10 or 15 years because the wiring harness adapters are available for nearly every car made now. It is a direct "mate" to the OEM radio plug and has wires that come off of it ready to connect to your aftermarket headunit wire harness. What you end up with is a harness that adapts OEM to Aftermarket easily and clean. Best of all is that you can unplug and reinstall OEM headunits in a matter of minutes. This is important to consider if the customer leases their vehicle or ever wants to trade it back in with the original radio. For the small additional cost, it is a real time saver.

ELECTRICAL CONNECTION WITH NEW/CUSTOM WIRING CONNECTIONS:

New and/or custom wiring connections apply to 2 areas of installation. Either the installer is too lazy or lacking the knowledge to determine the function of the wires in the OEM radio plug (possibly a do-it-yourselfer who's in over their head). The other would be if a Professional Installer is doing a big custom install, he may choose to use "fresh" power and ground wiring to the headunit, sometimes through an isolated power supply for noise immunity, and since the speakers connect to the amplifier and NOT the headunit, new speaker cables all the way around is usually the best choice. Since the factory wiring can be the cause of stray noises and the speaker wiring being of a small gauge is an issue, the new and/or custom approach is the best choice. The install time is fairly involved though because the installer has to create all new wiring harnesses for each run of cable in the car.

Dash kits (where necessary) and wiring harness adapters are the way to go about 90% of the time. When an install gets extremely custom, special trim panels and wiring is what makes up the other 10%.

SPEAKERS:

This area of installation is a broad range that can be summed up as front load or rear load. When something other than an EXACT OEM size and mounting hole pattern replaces the original speakers, we need modifications, adapters, or both. With speakers, there's really 3 ways to categorize installation procedures. Those are.....

- ***Direct Speaker Replacement With NO Modification:***

This is straight forward. It involves removal of a factory speaker (if there's one installed) and installation of an aftermarket speaker that fits into place exactly as the original would have. Not only do mounting hole patterns matter, but the actual depth of the speaker and how much clearance above the speaker cone there is (this is called GRILLE CLEARANCE) are also important to consider if it is to be a "no modification" factory fit.

- ***Speaker Replacement That Requires Different Than OEM Mounting:***

This type of installation is a little more involved because the object is to "fit a round peg in a square hole". Fortunately there are adapters to allow many of the popular sizes of aftermarket speakers to fit into factory accommodations. An easy and frequent example is the use of component separates in a factory speaker cut-out. An appropriate adapter in this case might be a 6 x 8" to 5.25" & Tweeter adapter, or maybe 4 x 6" to 3.5" and Tweeter. Many modern factory speaker openings are weird shapes and sizes or use adapters built in to the factory speaker frame. Direct replacements are sometimes either too expensive or simply un-available, so speaker adapters make it possible for the "round peg to fit in the square hole". The cost of purchasing these is usually more economical than making them from scratch.

FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

- ***Custom Speaker Locations and Mounting:***

Every car has an "optimum" location for speakers. This isn't always where the factory cut-outs happen to be. Custom locations are best left for the Professional Installer to "create" because it involves more than a few twists of a screwdriver. Even a factory location can be heavily modified to better suit the acoustic outcome of the system. In all cases, each one is necessary to approach individually to achieve professional results and IS NOT recommended for the do-it-yourselfer. Leave custom to the pro's.

AMPLIFIERS:

There's really only one way to install amplifiers, that's the right way. There isn't too many other options here. An audio amplifier uses electricity to convert DC power (Direct Current) into AC power (Alternating Current). In homes where the voltage levels are between 110-120 volts, it is pretty easy to create several hundred watts of power by way of the "lamp cord" wall plug-in electrical plug. The car battery is an entirely different story. The voltages are literally about 1/10th (about 12 volts) the "potency" of a home electrical socket. Voltage is but one of the components of power. So that virtually means that the other component of power, current, needs to be 10 times the amount to retain the same output power.

POWER = VOLTAGE X CURRENT
50% EFC. FROM AMPLIFIERS

This is a formula of Ohms Law, a group of electrical constants that we base electrical information on. Everything is relative with Ohms Law components. Those components that make up Ohms Law are VOLTAGE/CURRENT /RESISTANCE/POWER. They work in harmony to produce electrical work, what we call power, measured in watts. Since the source for voltage is the car battery when the car is NOT running, and the alternator when it IS running, we deal in smaller voltage values than at home. We also deal in larger and different current demands. This requires more demand on a car electrical system. For wiring, more conductor surface area is required. For charging, more current output. For batteries more storage, faster release. For the things hooked into the electrical system, there's chances for problem. That's why the right way is really the only way to install an amplifier.

The right way involves giving the amplifier all of the current ("juice") it needs to play correctly. An amp can never have too much current supplied to it, only too little. Wiring however CAN have too much current passing through it. Too little current "on tap" means it wants to work harder to gain the same output work levels. Harder work means more heat and more strain to attempt to do the same power. The problem is that heat means distortion and that destroys components. BOTH the amplifier and speakers it connects to can sustain damage if the distortion is extreme. Basically to avoid problems like this, the supply of "juice" to the amp HAS TO BE RIGHT, period! If it isn't right to begin with, all of the wishing, hoping, and praying in the world won't fix it. Amplifiers and electrical power work on the principles of physics which, as you know, we can't change, only understand.

FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

Check out the IASCA Wire Size Reference Chart to see how the length of power cable from the supply (the car battery) to the amplifier effects what its physical size must be to carry the same current ("juice")

Resistance = Length of wire/qual. of con.

WIRE SIZE REFERENCE CHART

AMPERAGE REQUIRED	TO 4 ft.	4 - 7 ft.	7 - 10 ft.	10 - 13 ft.	13 - 16 ft.	16 - 19 ft.	19 - 22 ft.	22 - 28 ft.
ZERO - 20	14	12	12	10	10	8	8	8
20 - 35	12	10	8	8	6	6	6	4
30 - 50	10	8	8	6	6	4	4	4
50 - 65	8	8	6	4	4	4	4	2
65 - 85	6	6	4	4	2	2	2	1/0
85 - 105	6	6	4	2	2	2	2	1/0
105 -125	4	4	4	2	2	1/0	1/0	1/0
125 - 150	2	2	2	2	1/0	1/0	1/0	1/0

The numbers in the boxes are wire gauge sizes. Interestingly enough, the larger cables with more current carrying capabilities are denoted by smaller gauge numbers. In other words a 4 gauge cable is larger and carries more current than an 8 gauge cable. Use this handy Chart to compare a run of 7 feet versus a run of 20 feet in a system that needs 40 amperes of current (Amperes is the unit of measurement for current).

7 foot run for a 40 ampere draw = 8 gauge cable
20 foot run for a 40 ampere draw = 4 gauge cable

An amplifiers current demands can be estimated pretty closely by taking the output power and dividing it by the supply voltage. Once you've got that number there's simply a question of how efficient the amplifier is. If it is generalized to be about 50% efficient (like the chart above is based on), multiply by 2. See below.

Output power rated at 300 watts / Car battery fully charged is 12.6 volts

300 + 12.6 = 23.8 amperes
at 50% efficiency, 23.8 x 2 = 47.6 amperes

So it will take 47.6 amperes to make 300 watts from a 12.6 volt supply if the amplifier is 50% efficient.

Easy, isn't it !

As current increases, cables need to be larger. That means power input and power output. That's right if you need 300 watts of power to go from the amp to the speakers, cable size is important there too, but that's an entirely different chart. Basically you can't have too larger a speaker cable, only too small.

Speaker outputs generally run at higher voltages, so current demands may be less. That means the appropriate speaker cable may be smaller than the power and ground cables, and it usually is. Truth is that, 16 gauge wire is sufficient for most installations. 12 gauge speaker cable is a good choice if the runs are long or if high output levels are in use, like in the case of high current "cheater" amplifiers being used in contests. Be in touch with the needs of the amplifier (provided it's a good one), meet those needs, and it will give the user good service throughout it's lifetime.

FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

Another thing about amplifier installation often overlooked is the ground path cable size. The ground needs to be OF THE SAME POTENTIAL as the power cable. This may not necessarily mean the same size because grounds are typically shorter runs of cable than power cable runs, but the important thing to keep in mind is that they are ELECTRICALLY the same. If you use the same size cable as the power (provided the power cable is the right size), you should always be okay.

One last thing that is important to consider with amplifiers is protection. Electrical protection in the form of a fuse (or a circuit breaker) and physical protection in the form of secure mounting with adequate cooling space. The fuse is there to protect the amplifier, the battery it is connected to, and the other electrical accessories connected to the battery. If too much current attempts to pass across a fuse, it creates heat which blows the fuse. Secure mounting keeps the amplifier and the electrical connections from being damaged while the car is in motion. A flying and powered amplifier is a dangerous thing. Finally, adequate ventilation for the amplifier let's it dissipate heat normally without "reheating" itself. To understand inadequate ventilation, just imagine the amplifier in a sauna. Sooner or later, it will begin to get hot and want to sweat. Since amps can't sweat, they just get hotter, until they finally shut down or fail entirely. Don't waste the effort put into calculating power and ground cabling by stuffing an amp into a sauna situation.

For more in-depth information about electrical considerations of power amplifiers, batteries, and charging systems, Scosche Industries publishes the Autosound Encyclopedia Technical Bulletins book. There's some very comprehensive information contained within those pages and much of it can answer questions about how much is too much, too little or just enough for a particular application.