Wendy CARLOS

What comes around Goes Surround!

Adventures in Surround Sound, from 7.2 to Quad

(personal and historical notes, basics, and acoustic realities often forgotten)

= Contents =

Table of Contents

Go to the **wendycarlos.com** Homepage

(**Note**: all the images will open a large view in a new window when you click on them. To return to the text, just close the new window.)

Go to Pt. I

(Top of the Page)

Back to the Wendy Carlos Home Page

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= P a r t 1 =

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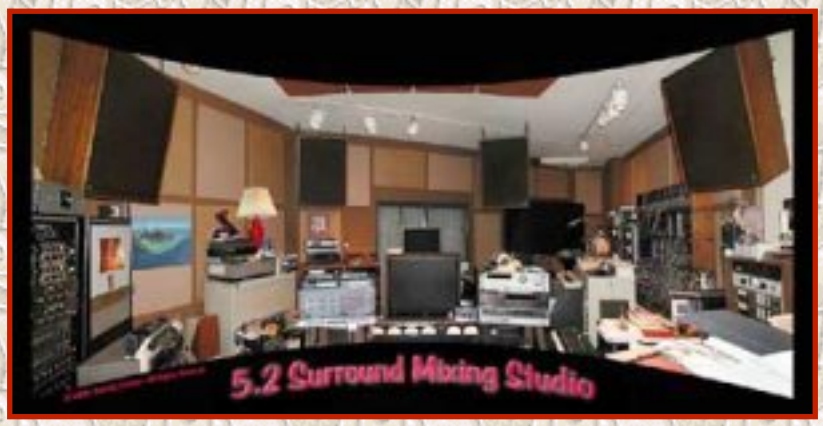
Introduction



5.2 Channel Surround Mixing Studio
(click image for a **huge** view!)

Finally it seems to be happening! In 2001 we don't yet have Hal (check back in another 100 years ;^), but we do have a distinct buzz-on about Surround Sound -- for film soundtracks, DVD's, and for music creation and mixing, as the new DVD-A standard is designed to implement. To me it seems like it's taken forever. I'd nearly given up hope that a practical surround sound system would reach the public in my lifetime, anyway. Those of us who lived through the big Quad Boom and Bust of the 70's are gun shy, expecting another stillborn standard, based more on hype than reality, and something valuable gained for effort expended. Just a few weeks ago I checked in again on what's become available online in web pages around the globe. Well, welly, there's a good representative amount of information starting to appear already -- on

Quad, 5.1 (five full-range channels and one sub woofer with one tenth the range, or ".1", total = 5.1), and several other options. Yeay, this is a healthy sign! Could it be?!

(**Note**: This next section contains an historical note on my own first encounters with surround sound. Click HERE to skip forward to some of the basics on surround audio, which we'll be discussing on these pages.)

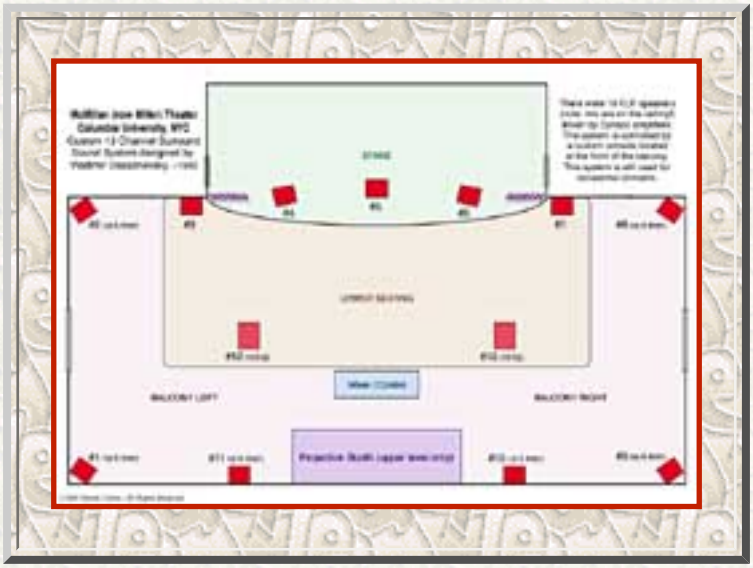
Okay, I have reason to be more skeptical than most of you reading this. My first experimentation with surround sound took place way back when I was still in college, studying music composition and physics. For me, surround sound predates the Moog Synthesizer. At that time there was no technology one could readily purchase to do more than the same old two-channel Stereophonic Sound that seems to be going on, like forever. Of course just TWO tracks was big news those days. So I had to build my own first "quad" tape recorder. Four channels, recorded on four tiny tracks, using two quarter-track tape heads in what we'd call a "semi-staggered" array. The hardware was from Viking of Minneapolis, bless them. They allowed even a very financially challenged student to save and purchase some very practical tools with which to record and playback music and sounds. I had to find a way to synchronize the four bias oscillators, and also constructed (from scratch) a sturdy wooden enclosure to mount it all in. It had a handle on it (since broken off), so it was "portable." At 45 pounds, I leave it to you to decide how realistic this description was.

Custom Viking Four-Channel Tape Recorder

Above you can see it with the cover removed. I was astonished how good it still looked when I discovered it in my parent's basement some dozen years ago. I've cleaned, reworked and adjusted it, gotten it to work well again, another surprise. This is the machine that I made my first multichannel recordings on. I took it with me to several concerts given in Providence and at Brown University, and made quite a few "amateur" surround recordings, experimenting with microphone and speaker placement, since there were few to no books on the subject. I learned a lot about what works and what doesn't by uninhibitedly trying every crazy idea out for myself.

My early electronic acoustic music compositions were created with the custom Viking, and when I came to New York City to Columbia for Graduate Work in composition it came along with me, need it or no!

But by then I had begun to use Ampex professional tape machines. Peter M. Downes, a good older friend who made custom recordings in the Providence area, generously let me borrow his 2-tk Ampex 351 and Magnecorder for one entire summer, to create the sounds for Episodes for Piano and Electronic Sound. My four-track Viking was used on that work, too. But the prestigious Columbia-Princeton Electronic Music Center had many professional Ampex machines, including three (!) that made me drool: 1/2" four-track 300-4's -- cool! "How ya' gonna keep 'em down on the farm," I learned quickly how to use these sturdier, better sounding tools, and the little Viking sat unused most of the rest of the time, except to record a few more live concerts. Later it was moved back to my parent's house when I relocated, and I forgot about it for nearly 25 years. Hey, there were **new** "toys" to explore!



McMillin (now Miller) Theater's 13-Channel Surround System

One of those "toys" was not so much a device as it was an idea: multi channel surround sound. As the luck of timing would have it, my favorite professor, composer Vladimir Ussachevsky, had recently designed and installed a wonderful new sound system in Columbia University's McMillin Auditorium (as it was then called). The diagram above is a plan of the auditorium, showing in red the 13 speaker channels that had been mounted and wired into a unique installation. I still drool about the wonders one could produce at large scale in the new field of multidirectional audio. There are actually 19 speakers, as the balcony interfered with producing sound at both levels from once source apiece. So channels 1, 2, 8, 9, 10 and 11 required two speakers each, one upstairs, the other down (which are superimposed in this plan view). The rest are single speakers per channel. There are also two, #12 and #13, that were mounted up on the ceiling, facing down! The KLH loudspeakers for channels 4, 5, and 6 were stored backstage, and had to be brought out when

needed, then positioned as shown (connectors were nearby). One oversight: there should have been two more, above the exit doors (mid-wall between #1 and 2, and also #8 and 9), at the exact sides. Live and learn.

It was all fed from a small room located near the upper speaker 1, which contained sturdy metal shelving with an appropriately large number of Dynaco power amps, a Stereo-70 for the double-spkr channels, Mono-60's for the rest (got pretty hot in there!). Tie-lines led down to the small electronic music studio, Room 106, in which I composed most of my electronic music as a student (it's now used as an office). The studio contained 5 to 8 Ampex tape machines at any one time, the outputs of which could be fed out to the hall's system. I continued my experimentation with surround sound, finding out what worked as planned, and the many more ideas that simply didn't work. A good "woodshedding experience", I learned a lot, and had a lot of fun with it, as you might imagine!

(Top of the Page)

Nomenclature and Full 7.2 Monitoring

Since the 60's I've been using four or more channels on the mixdowns of most of my performances and compositions. It's been a life's desire to get some of this surround music into the hands of music listeners. And that may very well be happening soon. I also discover I've accumulated quite a few "barnacles on the hull" from working in multichannel sound all these decades. I'd like to scrape some of these off onto the next generation to figure out what the $%#* to do with some of them! That was the major motivation for creating this web location. We'll be referring to speaker arrangements (very important, that) and the several output channels a lot on these pages. So let's show the near-standard labels we'll be using. Here's the same image at the top, smaller and with labels in red pasted over the front of each speaker. The two subwoofers are down below this view, on the studio floor one step below the level of this shot, and so we've just positioned arrows that show where they physically are located. There's nothing surprising going on here, but we wanted to define our terms clearly.

Speaker Locations, 5.2 Channels

Actually, this view with labels does not fully describe my studio's monitoring setup. (Please note: there's a good 12' between the back of the console showing at the center bottom, and the old 45" video monitor, the C speaker on top, right in between LF and RF. This Cinerama-like WA view "squishes" that distance together, while it also slightly exaggerates the space between LS and LF, RS and RF.) There are four more speakers that are not seen in this angle, driven by another two channels of amplification. These are located to the rear on both sides of the mixing space, where they form a blurry impression of diffuse information behind you and to the sides, surround channel information. I've been using some modest Pinnacle speakers and a small stereo amp for this job, as all surround information of this kind is deliberately narrower, in frequency range and dynamics, than what the other channels reproduce. For DVD or LaserDisk playback, the "rear" information from either Dolby Surround or discrete 5.1 tracks is fed to these channels, as well as some mixed to LS and RS.

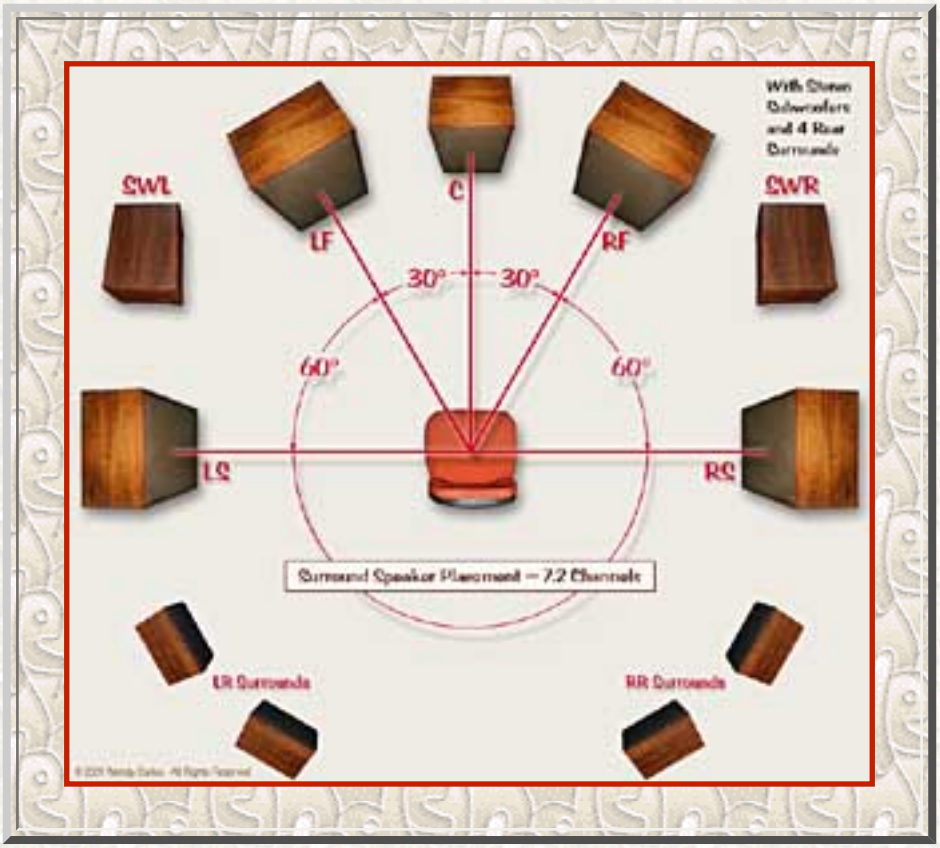
But for music mixing, these small rear speakers are driven by auxillary channels, usually ambience and antiphonal parts, or processed reverberation and echo effects. When used, the extra channels raise the total channel count to 7.2. That creates a very impressive soundfield, you bet, and regularly astonishes visitors here who've never heard that many channels before! Since 7.2 is really just an extension of 5.1, we'll handle the latter on this web page. Just bear in mind that it's likely at one time or another that you may encounter another two or more channels, and that these fully "behind you" channels are not as important as the other five plus. You can create a similar directionality by manipulations of the signals fed to the primary five surround channels.

There are also cinema systems in which the additional two channels of 7.1 or 7.2 are used as screen speakers, much as the Stereophonic Sound for Cinerama and (70 mm) Todd/AO were developed in the 50's. Here the new channels are added to the front, at the screen's mid-left ("left-center") and mid-right ("right-center"), forming: **L-LC-C-RC-R**. In these cases the surround info is generally the same LS/RS pair as in 5.1 Surround (or Todd/AO's plain mono surround), reproduced over side and/or rear "house" speakers. There have also been films made with a Dolby-matrix encoded Center-rear channel. That's just a quasi-channel derived using what we're calling the LS/RS stereo pair, and represents a pretty modest overall addition, **IF** you've already gotten the rest of the channels optimized.

When I was working on the six-channel sound mix for my score to Disney's **TRON**, I had to cheat a little, and used the system as you see it below while sitting back further than usual to check balances. That allowed the five main Klipsch speakers to monitor all five screen channels, while several other rented speakers served as rear surround channel monitors. Later I added the four small Pinnacles for that less-critical task. You can do the same thing if you encounter a need to mix to five screen channels by moving the side speakers inwards towards the front, or by relocating your seating position backwards a few feet to check balances. BTW -- it sounds wonderful even even if you don't move back, a really stunning WIDE sound! That will

collapse to screen width in a theater, of course...

In a good theater you can expect many speakers to be used for the surrounds, distributed about the auditorium's side and rear walls, even (bad idea) the ceiling! Dolby recommends many speakers to create an even "omniphonic" distribution of surround information, most helpful when there's only a single channel, as the LCRS of the Dolby Stereo matrix makes available. With the stereo surrounds of our latest discrete digital audio you won't need so much non-directional diffusion. But two additional screen speakers can be marvelously effective. If done properly with a really **BIG** screen, **L-LC-C-RC-R** provides precise images from the screen, more subtlety of position, and is less affected by where you sit. Given that screens have shrunk continuously since the mid-60's (multiscreen multiplex mania) the distinctions are probably lost. Mixing all dialog and most screen effects in mono to the center has done even greater disservice to film stereophony, IMHO.



Speaker Locations, All 7.2 Channels

Above you'll see the full 7.2 channels, in an imaginary overhead view (that "burnt orange thing" in the center is my actual studio chair), of an idealized studio similar to the one shown in the photos above. Gradually we're going to work backwards, going downwards in complexity and number of channels, until we reach classic quadraphonic sound (and a couple of amusing variations), and the best way to configure THAT 30 year old system. There's really nothing new in the idea of creating music albums and film soundtracks on multichannels, certainly not since Disney's 1940 breakthrough animated feature, **Fantasia**. This film pioneered the idea of surround sound

("Fantasound," no less) and stereophony with a six channel auditorium presentation using four optical tracks (three of audio, the fourth was for front/rear steering). Credit William Garity for most of the engineering, the same excellent engineer who helped design their legendary multiplane animation camera. Our tools have become a lot more sophisticated and easier to use since then. Audio quality is remarkably better as well, nearing the theoretical maximums for human hearing and physical acoustics. It's how we'll use them that will determine their success in the marketplace, or not, like the quad boom and bust of the early 70's. It's up to us.

This is the place to mention, for those interested, what speakers are being shown above. I became very attached to the Klipschorns when I was in college. My music professor, Ron Nelson, had a pair of them, with a central non-corner version in the middle, a common method of using Paul W. Klipsch's horn-type speakers. If you put one in each corner in many cases they would be more than 90 degrees apart. The derived center speaker helped to fill this gap somewhat. Anyway, Rachel Elkind and I tried two horn versions in the brownstone studio when we first move into there. Unfortunately, with the shape of the room the corner placements were really impractical. That would have positioned them either behind us, or very far away in front. The dealer suggested we try the newer "Cornwall" type (yas -- that Klipsch model name means you can "use them in a **corner** or along a **wall**" -- no comment!). We made careful comparisons for several weeks.

What we learned is that if you made up a 3 dB loss for the Cornwalls, and then did not exceed their already hefty maximum excursion, the sound was nearly exactly alike between the corner horns and these compromise versions. We were going to have four channels, so loudness was no worry at all, not with such high-efficiency speakers that 2 watts would fill a room! Anyway, I got attached, as I said, to these venerable designs, and aside from a few upgrades we made later, have used them ever since, a reliable yardstick I can trust for all my work.

The lowest octave, though, was always a bit weak with the Cornwalls. That was the only other tradeoff. For years I tried small equalizers in the monitor loops to "correct" for this. But at the time Jim Jensen at Sterling Sound did his usual fine job cutting my **Beauty in the Beast** LP masters I found a much better answer: "Say, what kind of low end speakers are those, Jim?" Velodyne Subwoofers? -- Yowsah! These are active feedback, servo-corrected speakers. I could spend a whole page singing their praises. Simply the only game in town, far as I'm concerned. The servo feedback corrects any and all errors. If only this trick worked above a certain frequency (around 300 Hz), all speakers could be near-perfect. Alas, it doesn't, as the piston-like action of the deep bass motion gives way to more complex vibrational modes, and no one feedback spot can correct for the whole cone. Oh, well, where it does work, why not go for it?

You'll read below that I had to decide between one 15" Subwoof, or two 12" units. This was settled by trying out both carefully with a lot of my own program material. Then the store allowed me to try it here, and there was no argument. The servo made both sizes very very similar in sound. The large size was slightly louder. But

two 12's were ever better, and there was actually some directionality gained. So you'll see above and just below the setup the way I have it, with **SWL** and **SWR** located midway between the **LS-LF**, and **RF-RS** pairs. Works great!

This is also a good time to apologize if I've overlooked someone's favorite surround sound configuration or idea in this very incomplete essay. Every opinion herein rests on several reasonable experiments and follow-ups carried out over a lifetime. That certainly in no way implies any pose of "infallibility." But at least what errors or missing concepts will be found here ought be in the "second and third orders of subtlety." And I encourage each of you to try things out, discover like I've discovered, **what actually works for ear**, and what is only **visual chauvinism** at work again in audio -- where it sure doesn't belong. That's why I now have to turn a skeptical eye on many of the sillier ideas being hyped as "fact." Factoids" is more like it, or Urban Legends (question: are there any **sub**urban legends? How about rural?). For myself, I'll stick with what's presented here, at least until something better comes along, the old scientific method: zeroing in very slowly on what's very probably true...

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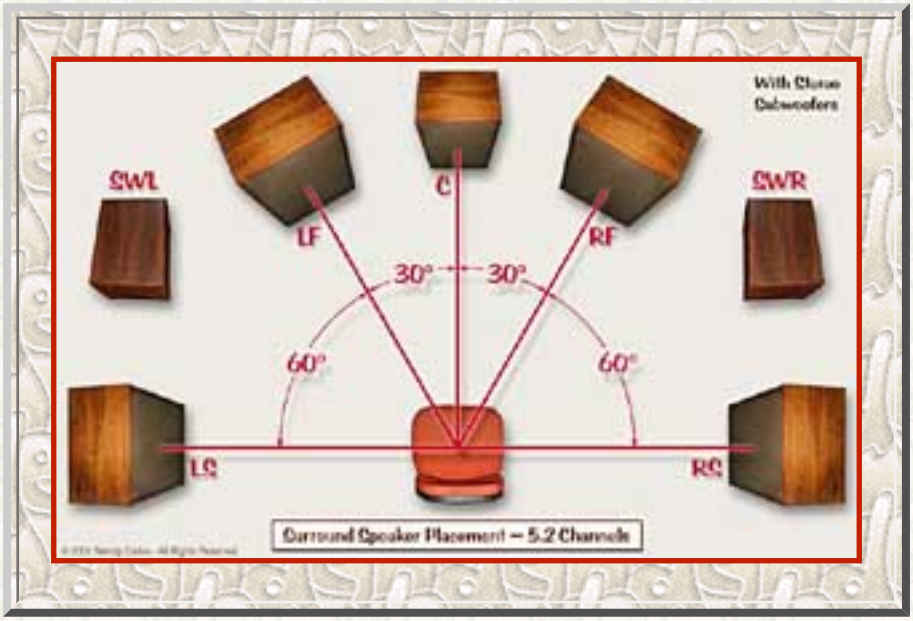
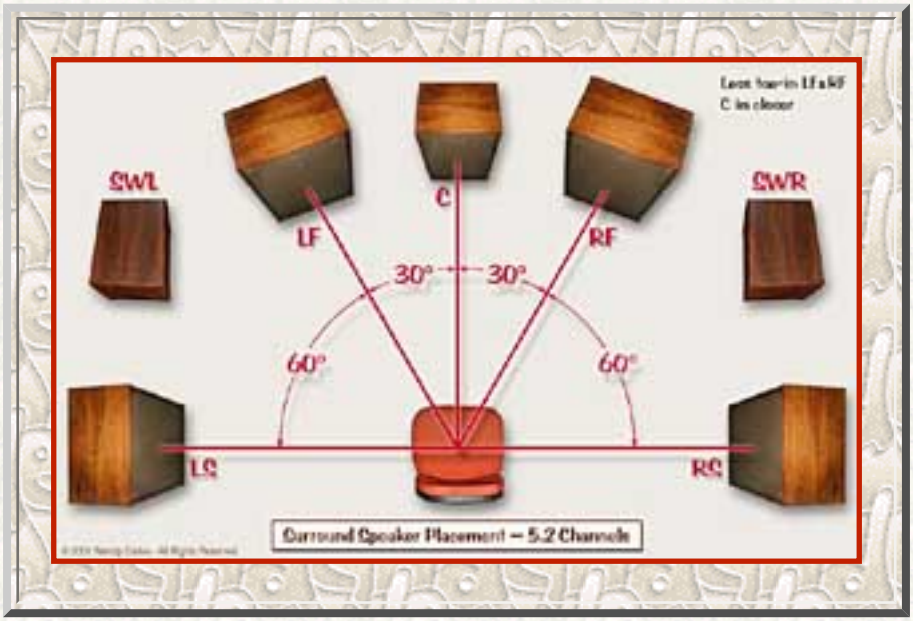
The Main 5.2 Channels



Ideal Surround Speaker Placement -- 5.2 Channels

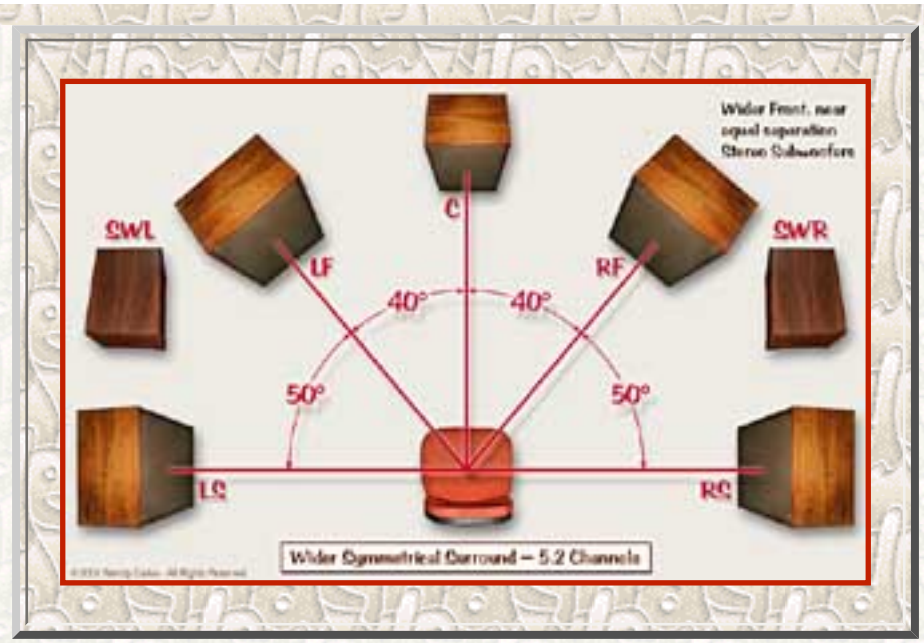
Fine, let's for the time being forget about those extra two channels. Here's the above view of our idealized monitoring system. The main speakers, LS, LF, RF, and RS, are equidistant from the listener and positioned at 60 degree separations. LF and RF are bisected by C, which can be a slightly smaller speaker from the same family of speakers, since the bass frequencies are often routed to the bigger speakers. But that point becomes moot when you have subwoofers. In this case I made a trade off for two smaller subwoofers instead of one larger one. With careful A/B comparisons I learned that the bass was nearly the same when the two smaller units were working together as a team as with the single larger unit. But there was,

contrary to what I had read, a small amount of additional directionality present with the two subwoofs compared to one. Yes, on steady tones and those with slower attacks you heard little difference. But on transient waves, hard attacks, dynamically changing signals, you began to perceive a small amount of stereo effect with the two, **SWL** and **SWR**, as shown above. I went with that arrangement, you may prefer the other choice, while the cost is similar.



Modified Front Speaker Placement -- 5.2 Channels

I've seen setups more like the one above. What's different from the view just above is that the **LF** and **RF** speakers have been rotated not to be so toe-in as before, and the center speaker has been brought slightly closer in, more as many three channel monitors are located in mixing theaters and even small home theaters. It's not a big change, and is one we'll pick up again below. If the listening room is not as deep as it is wide, these mild repositionings will be appreciated. The sound will not be greatly affected at all, unless you can compare the two setups one immediately after the other. Then you may hear a slight reduction of the in between imaging. But it won't be any worse than when you listen to two-channel stereo from slightly off the exact center spot. It's not going to destroy the surround sound field, but I bring it up as it has become somewhat common.



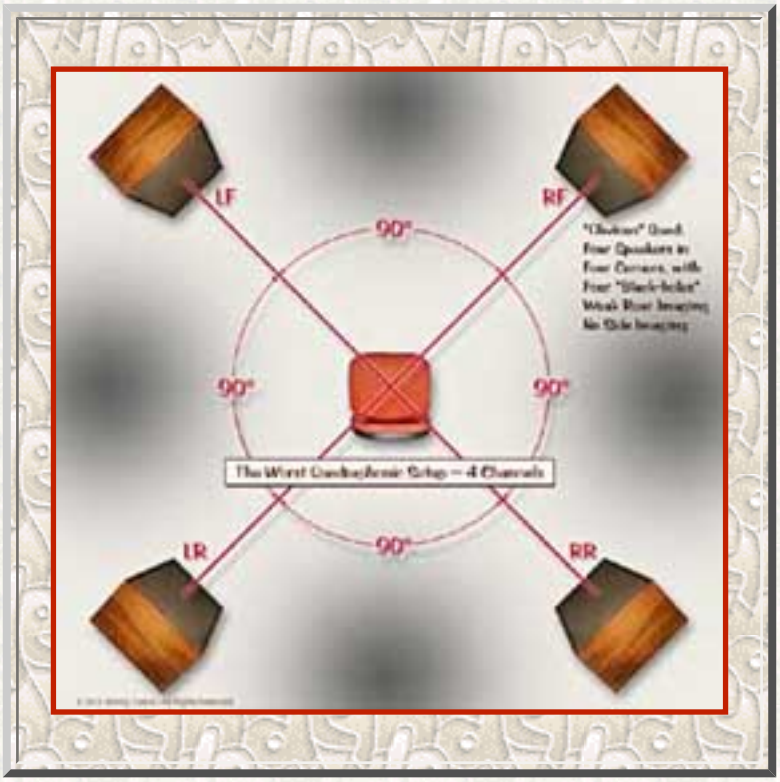
Symmetrical Surround Plan -- 5.2 Channels

On the other hand, there is also good reason for making the opposite modification of the front channels, like the symmetric plan above. The 180 degree surround arc of sound has been nearly divided into four equal angles, five discrete channels of sound, plus stereo subwoofers. My personal experience suggests that instead of going with the mathematically exact division, yielding all angles of 45 degrees, this version is slightly better perceptually, with 40 and 50 degree angle pairs. It's probably splitting hairs, but try both and see if you don't agree. We have a slightly more acute perception of angular displacement of sound positions when both ears are nearly balanced, facing a central sound source in front. (It tends to follow a cosine curve function in front of us, with a maximum acuity at zero degrees straight ahead, falling off towards the sides. Behind us our external ears reduce the absolute value of this function by about 50% or more.)

The above plan positions the **LF** and **RF** channels somewhat closer together, nearer to **C**, favoring that most sensitive area. This setup obviously requires a good, active center channel. Here I've shown the same smaller **C** speaker as before. The subwoofers take care of all the bass frequencies you could stand, so that's not much of a compromise. Notice that for monitoring just four channels of "quadraphonic" material, the missing C channel would leave an impossible "hole in the middle" between **LF** and **RF**, if the above configuration were chosen (40 + 40 = 80 degrees apart -- yikes!). If you have to check on a lot of 4 channel material you'd be better off with the first or second layout above. But for 5.2 channels of music, this one's unbeatable -- **have yourself a ball!**

(Top of the Page)

Digression I -- Classic Blunders to Avoid



The Worst Quadraphonic Setup -- 4 Channels

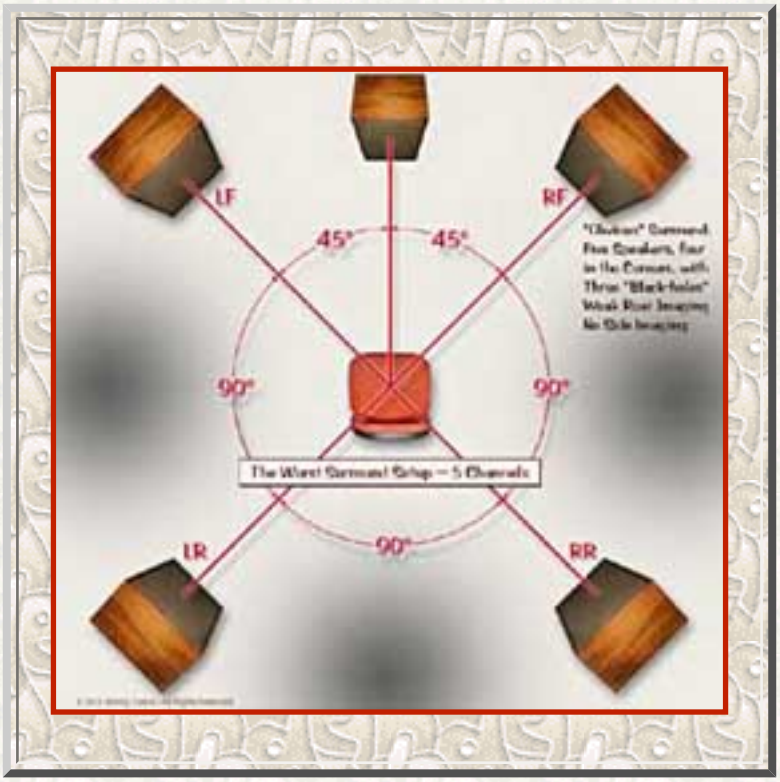
Sometimes the eye can fool the ear into thinking things are fine and jolly, when they ain't. We can all count the four corners of a typical room (har-dee-har, my studio is semi- trapezoidal, and has SIX corners!) or studio. When the first quadraphonic sound was being introduced in the early 70's guess where they put the speakers (you've had enough hints)? Yup, just like the image above, one for one. It also seemed like a nice, democratically evenhanded approach, we have 360 degrees to split up, let's see now, 4 goes into 360... And we get this "classic" setup in name only. It's a complete blunder of the job, about as bad an arrangement for surround sound with four channels as one could devise. If there is but one lesson to be learned via this introduction, it's the graphic one visualized above.

Take a look with your foolish eyes once again. 90 degrees is a pretty wide angle to try to fill with two speakers. Even from the equidistant "sweet spot" as the seat above is located, you will find images tend to vanish when they are midway between the speakers. You have another classic going on here, stereophonically speaking, a "hole in the middle." Add the two other channels and what you get is FOUR holes in the middle. You end up with sound that can only be precisely heard from but four spots. Everywhere else is an omniphonic spread of hard-to-point-to vagueness. It gets worse. Try listening to a normal stereo system (about 45 to 60 degree speaker separation) with your back to the speakers. Hmm... the stereo sort of collapses inwards, doesn't it? I'm not trying to lay any dogma on you. These are simple matters to try out with your own ears, as is all the stuff on this page. We all were surprised to learn how things are not so obvious as we first think they'll be.

And it gets worse again. When you face forward, you can hear any speaker located

in front of you, and follow it as it moves to the exact side, either side, whereupon it will sound like it's moving back in towards the middle again, but without the same precision when the speaker moves behind your head. Again it works on both sides the same way. All stereo relies on the fact that our ears will hear "ghosted" virtual images of sounds located between any no too widely separated loudspeakers, if the distances, phases, and sound levels are correctly adjusted. But aside from some very clever tricks heard from exacting positions and setups, you normally won't hear sounds come from outside of a pair of speakers.

The result is that you can image sounds rather well in central locations, with speakers moved to each side a bit, but those speakers set the maximum width you'll be able to reproduce well. Think about those two speakers behind you in the view above. Their sounds are towards the center, just like the front pair. So there's nothing that sounds like it's coming from the sides. The only way to fill in the side "hole" is by locating a speaker there, one on each side works splendidly. After you have normal stereo there is no better place to locate the next two channels than exactly to either side of you. That also works when you add a 5th channel, as the latest surround sound systems do. Like this:



The Worst Surround Setup -- 5 Channels

This view is of the worst possible use of five channels. Now one of the black holes in the middle is filled in, leaving just three of them. The sounds up front are fine, wide and very decently positioned. There are no sound to the sides of those speakers, though. Everything comes mainly from within this right angle of two 45 degree sectors. What about the rear channels? Well, they will be heard, of course, but the

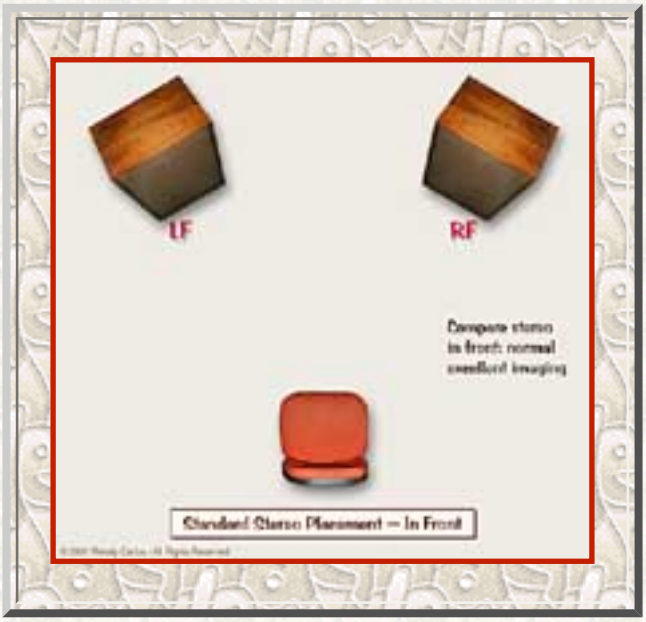
stereo will be poor compared with that in front. Not only is there no central rear speaker, but the back positions are, like before when you tried this yourself, not definitely locatable. Any poor stereo effect is narrowed when it's completely behind us. Those two channels are being wasted, just as they were with most quad sound in the 70's. Little wonder an honest public might be less than impressed, when confronted with the truth of their own two ears.

The first four channel setup I had, when my studio was in the brownstone, as shown in many phonos on our website, was exactly as the first of these two views shows you. That was folly on my part, because I should have known better, having made many four channel recordings years before with that custom Viking tape deck. I tried placing microphones in that same shape, then the speakers when I played the tapes back. I tried all of them way up in front in various shapes. I tried a "diamond", with one channel up in front, one directly in back, and one on each side. That was much better, but the holes in the middle were irritating, and I was never sure if a certain sound was exactly in front of me, or exactly behind me. Once more I beg you to try this all out for yourself. You can certainly record two channels at a time, and see what happens when the two speakers are center front and center back, then again one on each side, and so forth for each possible pairing. Play the recording in the dark or with your eyes closed. Invite friends and other sophisticated audio buffs to listen with you and compare notes.

Again, you don't have to take my word on this issue. David Greissinger, the brilliant head designer for Lexicon for more than 25 years wrote several scientifically researched papers for the AES (Audio Engineering Society), the AAS (American Acoustical Society), and others in the 80's and more currently. He stumbled upon the very same discoveries which Rachel and I had back in the early 70's (check out our new bibliography at the end of these pages). Our lesson was painfully learned and was independently reproducible, to boot. We had to rehire the same strong electrician / handyman to return and relocate the rear two speakers, positioning them up at the sides (a compromise, speakers that high up can leak over the head slightly to the opposite ear), as you can see in the wider photos of the brownstone studio. The mistake was too painful to live with, and we had to admit it and go with what our ears were telling us. When I moved into here I didn't make the same mistake. Did it even better, as I have a lot wider space. You can see how the channels are located way above. In an arc, 180 degrees wide, like those old Cinerama Screens. Then you more or less split the angle into three parts, so the channels are located at roughly 60 degree intervals. Or use the more symmetrical arrangement above. What's that old line?: "Try it, you'll like it!"

(Top of the Page)

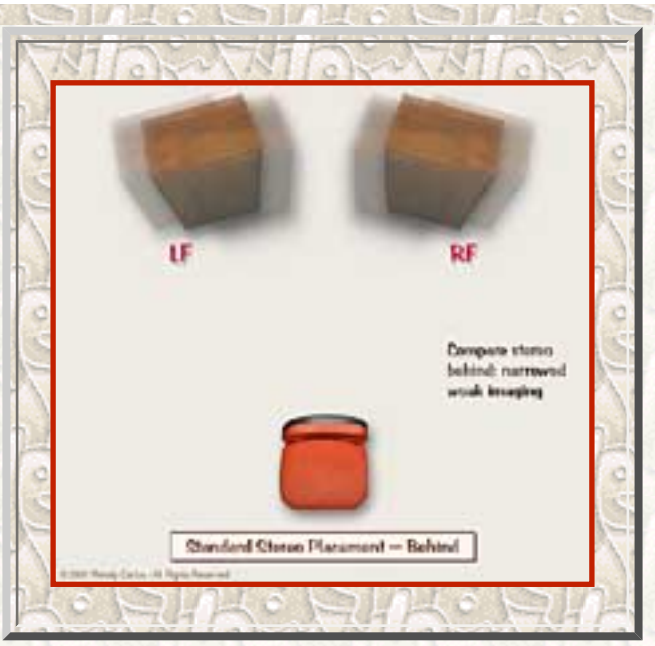
Digression II -- Listening Test to Try yourself



Standard Stereo, both speakers in front of you

There's something most valuable I learned during a valiant failure to become a Physicist. Well, more than one, like keeping a wary, skeptical eye out for deception, or the even more common, self deception. But a lesson that holds in any field at all is a willingness to be proven wrong. You are much more likely to discover crumbs of truth if you don't prejudge what you expect to find too closely, relying instead on reality-checks and experimental tests. Unlike a few sites I've seen that preach to the bleachers, I want you to check out what I'm trying to describe here, not merely take my word on it. Beware the newest Great Prophets who claim possession of "the one true path." All of these ideas here contain a margin for error, a tolerance, and have been verified experimentally, not idle philosophy. You can alter things to a degree away from what's here, before things will weaken or fall apart. And you may discover even more refined ways to handle each situation.

A very modest test is shown in this digression. You ought be able to try it without any special equipment or setup, at home or in the studio. One of the key reasons that many of the original suggestions about Quadraphonic Sound in the '70's failed to live up to their hype could have easily been found by a curious person who was unwilling to go along with the party line. Consider the four speakers, one per corner, concept given in the previous digression. How does sound from the front two channels get perceived, and is this much different from the rear two channels of "obvious quad"? Try one pairing at a time. Pick a few good CD's that exhibit excellent sound, separation, and imaging/ambience. First sit as shown just above, the usual way, centered in the "sweet spot". Okay, note what you hear, essentially all the sound in front. Now swing your chair around, so you're facing away from the speakers, like this:



Face the other way -- both speakers behind you

(well, the chair is rotated around)

This view is a pretty accurate metaphor for what you'll hear when you rotate your chair around by 180 degrees. All the sound now is located behind you. Keep the same music playing as above, listen, then switch the way you face back and forth several times to compare the differences you hear. The speakers won't really edge closer together when you face away, nor ought the directional information become oddly blurred, but that's certainly the way it sounds! I was rather shocked by this test when someone suggested it to me. We had experienced the same problems with the crummy initial layout we'd made in the brownstone studio, and knew something fundamental was going on. But this elegant A/B comparison is such a simple way to demonstrate the principle. The way our ears are constructed we "funnel-in" sounds easily from in front and sides with our built-in "ear trumpets." Whatever comes from behind is masked by those same bio-trumpets, robbing crucial mid and high frequencies especially, the stuff of directionality.

Ever watch a cat rotate its outer ears while listening intently? Theirs are even larger proportionally than ours, and the horn effect must be highly noticeable. They also have better muscle control over them than we do, so they can redirect the aiming points to a large extent. It can't be done simultaneously, but watch them listen to a repeated, continuing sound, and how quickly they are able to zero in on the exact direction. They can adjust to, and adapt better than us in front/read comparisons, so would undoubtedly come up with a significantly different plan for Feline Surround Sound...

But we're interested in an optimum plan or two for Human Surround Sound. Since the back of our heads is not nearly as sensitive to sound directionality and nuance (not to mention a poorer frequency response, and unfortunate interference as sounds move away from the rear of one ear towards the rear of the other), we ought not "waste" too much effort trying to obtain what we can't: a uniform sound field. That's where so many surround concepts fall down, assuming we humans can hear

in 360 degrees and follow it all accurately.

Go on to Pt. II

(Top of the Page)

Back to the Wendy Carlos Home Page

Wendy Carlos, SurroundSound1

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Wendy CARLOS

What comes around Goes Surround!

Adventures in Surround Sound, from 7.2 to Quad

(personal and historical notes, basics, and acoustic realities often forgotten)

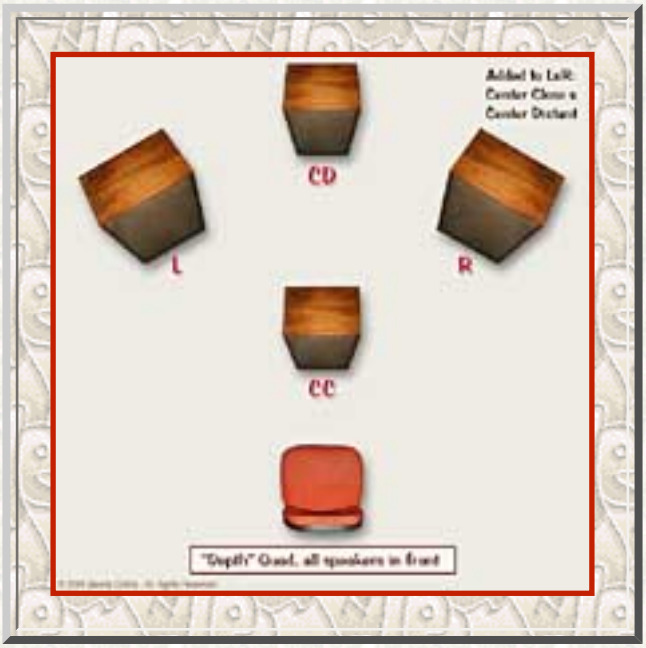
= P a r t 2 =

Go to the Surround **Table of Contents**

Go to the **wendycarlos.com** Homepage

(**Note**: all images below open a large view in a new window when you click on them. To continue the text, close the new window.)

Digression III -- Other Surround Options



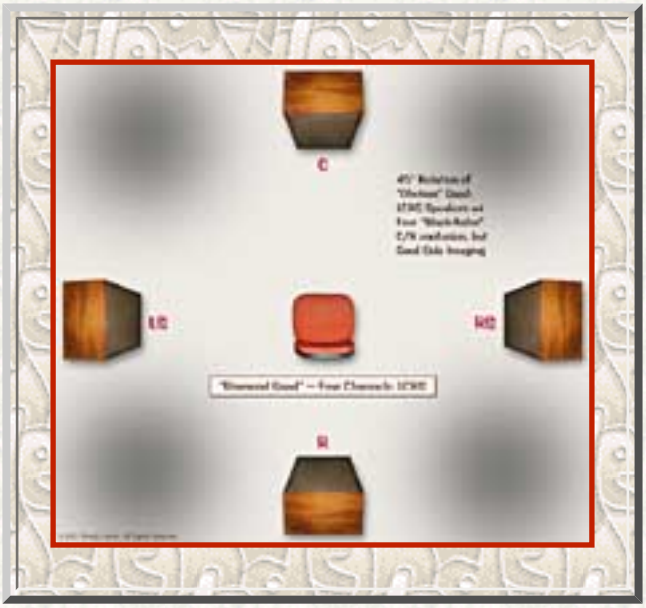
"Depth" Quad -- a good old idea

No sooner had stereo been introduced to the masses in 1958, there were fools like me thinking about the next steps. The late, great Bert Whyte (who recorded some of the finest stereo masters for Everest records, remastered now on CD) wrote a monthly column (in Radio/TV News) that praised three channel stereo. He had campaigned in 1956 for a home medium with three tracks, especially after Wilma Cozart and Bob Fine had thoughtfully arranged a secret demo for him of three-track orchestra recordings they were making for Mercury Records. Those first mentions on stereo in Bert's "Certified Record Review" had electrified me, and began my path that led to my first Switched-On recordings. But four-track equipment came about more easily than three (just double up two quarter-tracks as I did on my little custom Viking deck). The question arose: "where do you put the extra channels?

Above is one rather fascinating idea I read about and tried with that Viking recorder pictured way above. The microphones are positioned in front of the sound sources in a similar diamond shaped pattern. The left and right channels are moved wider apart than you'd use with 2-tk stereo, and the center is filled not once but TWICE!. There's a mike that's really up close to the musicians (assume this is a music session), and another further away than the left and right pair. For playback you duplicate the positionings as you see here. If a person were to walk about while speaking, in and around the microphones, there would be an uncanny ability to judge exactly where s/he was at any moment if you listened with this "Depth" Quad arrangement. It may not work over a very wide angle, it's certainly not as "surrounding" as some of the other schemes here. But it is a charming way to duplicate a soundfield in startlingly realistic ways. Those of you who can try it out will be happily surprised at the reproduction.

Note: the close speaker would be best if mounted rather low, so the center distant

track will not be blocked. The mikes don't need the same finesse. It's effective to deepen the positions even more if you have the room. I first tried it with a deeper than wide arrangement, and that was pretty cool. The mikes are just as important as the speakers, and we have another page devoted to this side of the equation. Clearly this is not the place for the way most of us work today: panning and repositioning a multitrack source in the mix. Depth Quad works best with one mike per speaker. You can try more than four channels, but of course, dovetailing the additional channels to either side of this one. How about four more, in pairs, to either side of these here, one close, one distant, total of eight -- gotta hear THAT someday!



"Diamond Surround Quad" -- a poor old idea

Here's another "diamond" arrangement for four channels: Left-Side, Center, Right-Side and Rear (similar to what's called: **LCRS**). Offshoots of this one have been widely popular, as it is the basis for the Dolby Stereo matrix that we've all enjoyed many times (Dolby carefully moves the sides up front). Electro-Voice was an early advocate of the above, but this was before "logic steering" circuits simulated full stereo separation. Sansui used a similar plan at the core of their decent QS quadraphonic system's "Regular Matrix." But they finally adopted the much worse "obvious quad" layout scheme, in a rush back to the corners, feh. Most of the ill-fated quadra-phonies made the same mistake, although they added logic circuits to help enhance the limited separation (nothing filled in the big "holes"). CBS/Sony had a worse scheme called "SQ", which needs a bit more space to speak about, so we'll put that tale on a related matrix-wars page **HERE**. There's additional tech background on matrix surround systems **HERE**.

Not many four channel systems stayed with this "diamond" plan. There were problems. The angle between adjacent speakers is a rather unrealistic 90 degrees. Ever hear stereo with the speakers that far apart? Yep, no "fusion" between them, a hard to ignore "hole-in-the-middle", as it's usually called. With the "Diamond Quad"

scheme you get four of those black holes, four large sectors in which no sound source seems to be located. One might place "filling in" speakers with fancy logic circuits that derive the best-guess signals that would be expected when the actual channels are outputting a particular pattern. Klipsch did this with his Heresy speakers to fill the large gap in the stereophony that two corner speakers caused. We spoke about that earlier, and, yes, my center speaker is one of those Model-H for heresy designs: meant only for along-the-wall placement, and not the bass response of the bigger monsters.

But without four more speakers to try to fill in the holes (eight in all!) this idea doesn't work too well. Another problem is that when you face forward it's difficult to tell what's coming from exactly in front of you versus exactly behind you. (The most reliable way is swing yourself around sideways, then the other two channels become ambiguous -- and so forth.) You can conduct the blindfold tests I used to amuse (bore?) guests with. You need a tiny noisemaker, like the toy metal "crickets" or "clickers" that novelty shops sell. Blindfold the guest, and move the cricket all around, making the sharp click sounds from every direction you can think of. A weaker chirp right in front and below is nearly never heard as coming from there. And behind is often confused with in front. Even with discrete channels, you'll really only detect three of them at a time if you adopt the plan above, a poor old idea we can dismiss, at least in this form. (It will return with Dolby Stereo, a different story, covered below.)

Dolby Stereo -- Making the "diamond" work

With several modifications from the above "diamond", we obtain a much more effective plan, one that's at the heart of most motion picture stereophony, from Fantasia's **Fantasound**, through the early 50's **CinemaScope** films, and ending up with **Dolby Stereo™**. The Left and Right channels have been moved back to the front. In this case they're rather closer together than you'd choose for music, keeping in scale with the widest screen a motion picture would be projected on in a room of

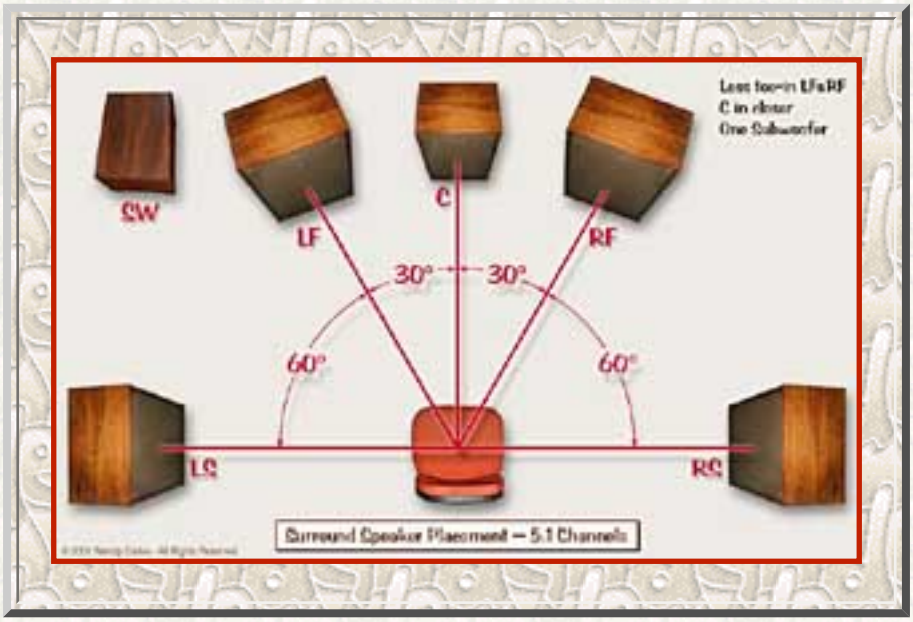
these proportions. That constraint produces screen-left and screen right as the widest positions. Everything else not on the screen is suggested by a monophonic "Surround" channel, played on as many speakers as you can manage. There are designs that avoid some of the "comb-filter effect" that playback of the same signal on multi speakers will introduce, and other ways to diffuse the signal so that it becomes omniphonic, hard to locate, just a vague impression of sound from the sides and rear, without any accurate positional clues.

Dolby Stereo is not really multi-tracked. All the mix ends up on a standard stereo pair, usually called: **Lt** and **Rt**. What is to be heard from the C channel will eventually end up as an identical signal at the same phase in both Lt and Rt (the so-called "sum" signal). What is to be heard from the surround channel is mixed into Lt and Rt at the same level, but 180 degrees out of phase (the so-called "difference" signal). As long as only one or two sounds are to be located simultaneously at any given moment, a special circuit called "logic" steers what signal goes where, and reduces the crosstalk inherent in all "matrix" methods. More than two sounds at once, and you get a vague blur of sound all around. For the particular purposes of film sound, especially when the engineers have monitored through the matrix and can judge the final results, it can do a reasonable job of suggesting a real four track experience. For music it's a tradeoff, often a major one.

But the monitoring setup shown here is not designed just for listening to pseudo-surround sound. It works splendidly for discrete four channel presentations. Since the surround speakers are usually smaller and less wide-range than those in front, you must bear that in mind when recording music and sounds for playback with most systems. Usually a single subwoofer is added, and this ought improve the overall results and visceral "impact." That's why most of the setups we'll be discussing employ at last a single subwoofer. The standard philosophy is to position it anywhere practical in the room, as low bass is not too directional. Some engineers like to play pink noise over a subwoofer that's placed in the listener's position, then walk around and find a place where you hear the low rumblings best for that room. And that's where you put the subwoofer. There's more to be said about this, but let's first move over to surround schemes better suited for music.

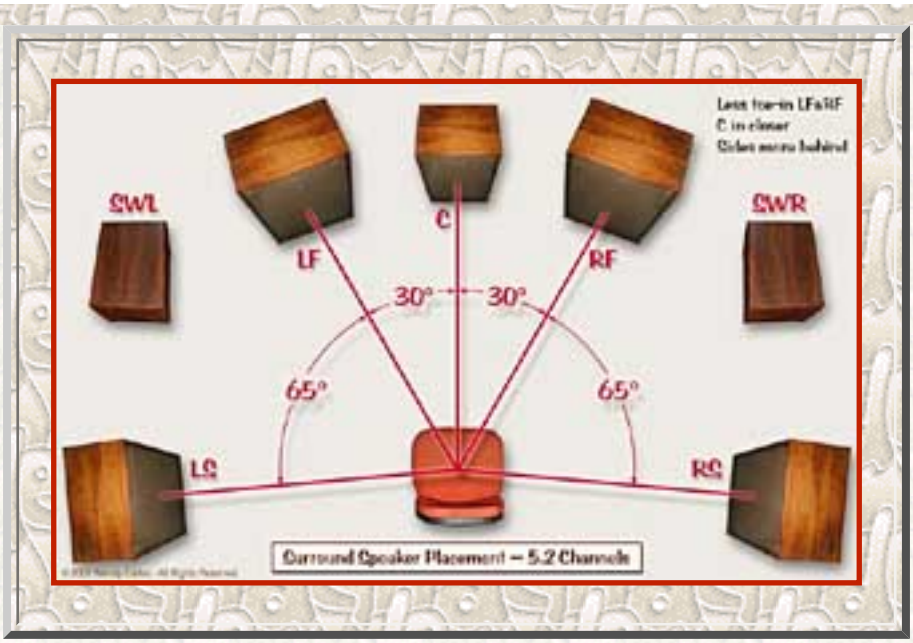

(Top of the Page)

5.1 Surround Sound for Music



Typical Surround Monitoring Setup -- 5.1 Channels

Now this is the monitoring arrangement I hope each of you has or will have, to check out your surround mixes. Note that this time we have a single subwoofer (position not critical), as most setups are arranged that way. You lose only a little compared with stereo subwoofs, since most low bass is omnidirectional (but not all -- hard attack bass sounds do establish small directional clues...). This is a variation of our initial plan. The LF and RF speakers have been rotated slightly for less "toe-in." That's because you'll probably want to allow several people in the room to hear what's going on, and many listeners don't like to have their stereo speakers too angled in these cases. There are good arguments that suggest that more toe-in has notable benefits, but this is a topic for another discussion. Similarly, the center speaker is moved slightly closer to the listener, as it will be so in most movie theaters, home theaters, and professional studios. (Often LF, C and RF will be placed along a straight wall, hmm...) (I should note that with very short, sharp transient sounds there is a detectable change with as little a variation from equidistant spacing as six inches. But this is usually **not** easy to hear with normal music program, up to 2-3 feet, perhaps. Be aware that the theoretical optimum is best, but also realize that you can bend the rules slightly with little harm, most of the time.) There is equipment that can correct for such differing distances by adding a 1-4 ms. delay to the too-close speaker(s). Your preference still ought be for as close to equidistant from the listener (for all channels) as you can manage. But even without delay circuits the modest change you see above will not have a major damaging effect. Since it is also quite popular, we present here it for your consideration, along with the caveats. Next let's look at a more equivocal modification...



Maximum Side/Rear Separation Setup -- 5.2 Channels

Here you see a fairly common variation that many studios are happy with. The front speakers are as they appeared in the previous layout, less toe-in, center speaker more inline with the LF and RF speakers. I've also shown the room with stereo subwoofers, as my room has them, in the original views. But here we've made a slightly larger tradeoff. The two side speakers, LS and RS, have been moved rearwards. In this case we've not gone very far, they are both a mere 5 degrees rearwards of the position above. If you try this for yourselves I think you'll discover not much change. The side channels still sound reasonably to the sides (you're losing a little of the ability to position sounds to the exact sides -- a compromise). But you'll find that the effects that you want to locate rearwards remain rearwards a little better if you shift your head about while working. Once you stop moving either setup is fine, but when you move your chair back from the console in this new setup the side/rear sounds will stay more rearward than before, at the price of extreme side positionings.

We're splitting hairs here, I admit it. Still, you don't want to go too far with this variation. More than 10-12 degrees rearward bias on LS and RS, and you create the same old problems, losing more than you gain, don't fool yourself. Try it out in several rooms using different program material with lots of side and rear activity. (You'll also get into trouble enlarging those two 65 degree sectors any further, see the next section.) There are convincing arguments to be made that this might be a pretty decent compromise to make in many studios, and in many theaters and homes. You can be fooled by the visual impression, thinking that the first variation has only front and side loci, the second adding a little rear. Um, sorry not true. The first setup can create a completely convincing wrap-around effect, which will only vanish if someone is moving greatly, or decides to sit at a steep angle to the room, sidesaddle. Then the sound will remain confined to the one hemisphere. People sit sideways all the time with the foolish four corner positionings described above. Watch them squirm and twist about, trying to figure out: "speaker, speaker, who's got the sound?" With an arc of sound they don't do that nearly as much. And you won't want to, either.

Once you hear well-mixed music on either of these systems, you'll see why surround is as much better than stereo as stereo is better than mono (nuts, I've revealed the final conclusion on page five, you can go home now... ;^). By avoiding "wasted" channels that satisfy visual impressions, you work **with** the way our hearing apparatus is designed, not oblivious to it! When it comes time to fill in the room with more sounds which even a moving side-facing listener can hear as surround, it's time to take the next step, to 7.1 or 7.2 channels. Or you might add the two channels halfway in between the LS-LF pair, and the RS-RF pair. This particular expansion will stabilize the soundfield, better than any five channel system, if you must move side to side. Suddenly we're slipping along an infinite regress, because once you have seven main channels, you might want another five to produce the perfectly cylindrical field of 12 channels (but whichever way you now face, a third or more of those channels will be "wasted"). How about 12 close up channels, with 12 more further away to gain the special dimensions of "Depth" Quad, described above? And there are always ceiling speakers like Ussachevsky investigated in McMillin/Miller, and IMAX provides in their theaters. It never ends! Let's try to be happy with what we've just gained, and save the next step for the future...

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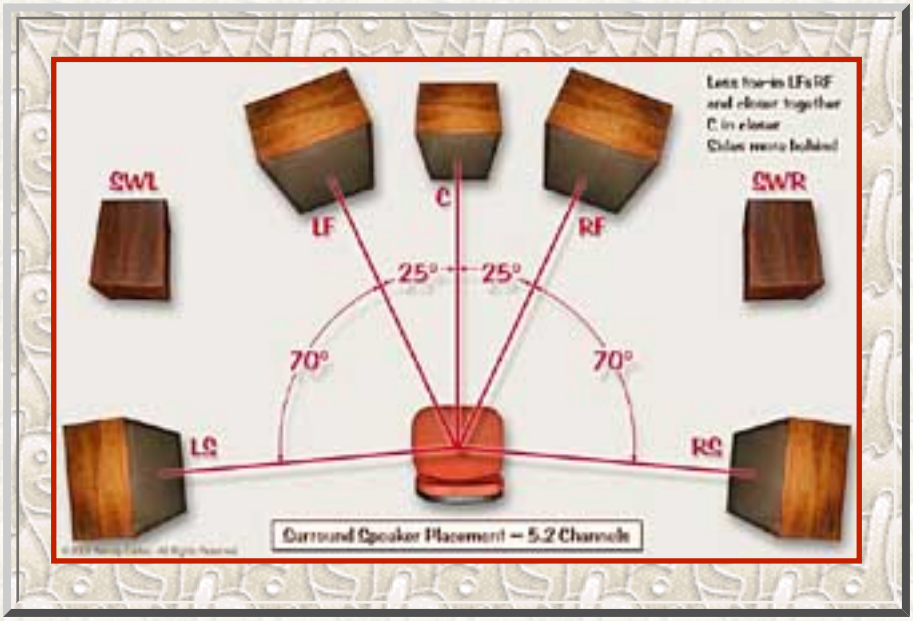
5.1 Surround Sound for Films



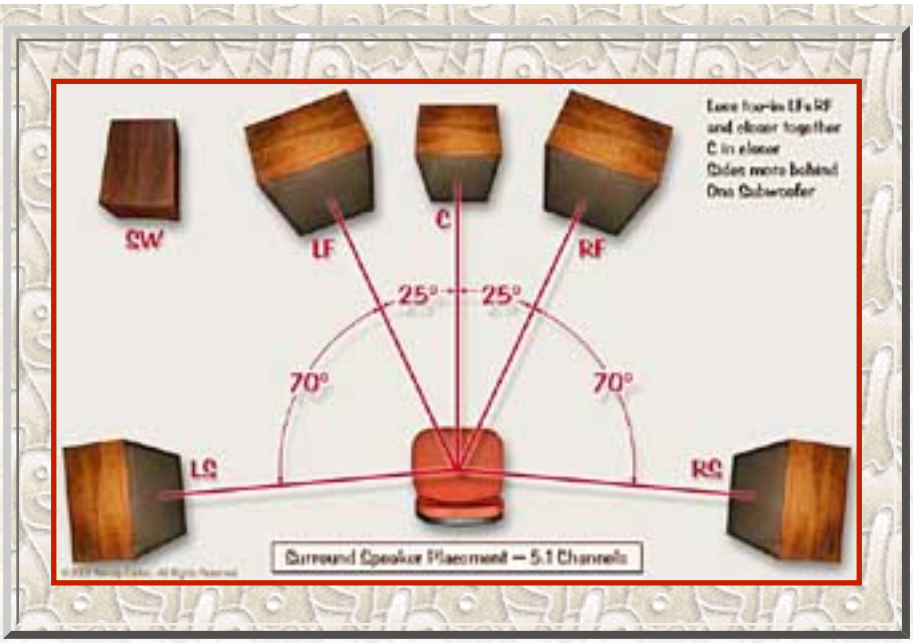
Filmsound: Reduced Front, Wide Rear -- 5.2 Channels

Right, for music we want a wider front image, as the 30 degree separation between LF and C and RF produces. For film work that's usually not the ideal way to go. It's just a small modification, though, to move in the LF and RF channels as shown here. This is a 25 degree version. Some theaters with smaller screens might require only 20 degrees or less. Whatever value represents the most likely way your particular audience will hear your results ought determine the way you'll want to setup your monitoring space. Right here we have an excellent compromise for both music and film mixing and monitoring, but one that favors the film soundtrack to

purely musical use. It will also be practical in larger home installations, where the rear wall behind the viewing chair or sofa prevents any rear speakers anyway.

The one weakness here is the two angles of 70 degrees, LS to LF, and RS to RF. Those are about the maximum separation between any two speakers if you expect imagery from in between each pair to "fuse", and not create "holes" in the soundfield (90 degrees is certainly too wide). That's one of the reasons to prefer about 60 degrees between each channel, except the fronts, where it probably ought be somewhat smaller (remember, our most acute directional hearing is up front). It's surprising you never hear suggestions to divide the whole semicircle by five channels equally, placing the LF and RF even further apart, or about 40 to 50 degrees between each channel (no "holes" at all) as was described earlier. It would certainly work for music, whereas you'd need a 90 degree wide screen (curved?) to cover that LF-C-RF distribution! For home theaters the single subwoof version shown next may be an ideal starting place.

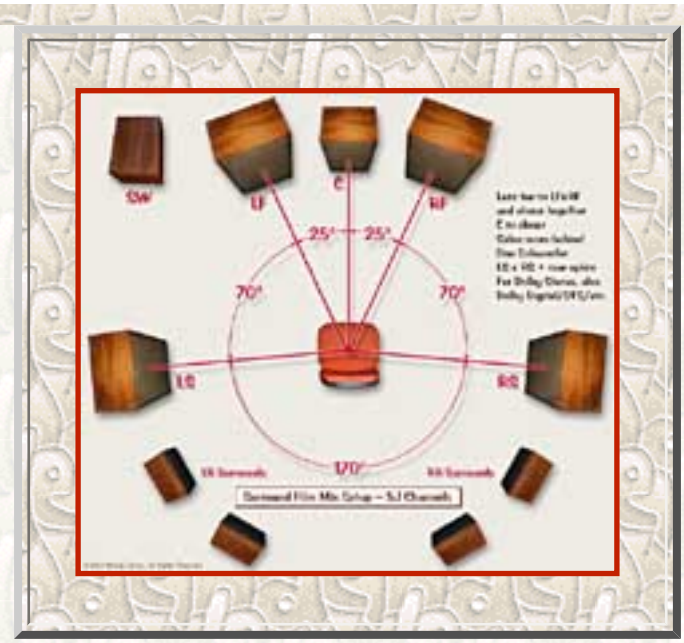
It need not be pointed out that we're not following any engraved set of "rules" here. You won't break any laws of any country or religion if you prefer to mix your music tracks using a narrowed front soundfield, or monitor your film mix with a front field so wide no screen this side of Cinerama and Omnimax will be capable of covering it. Some engineers have reported that they find they can hear with more accuracy when the speakers are wider than the screen, more like the suggestion above. Panned dialog and effects might not match exactly, but as these nuances have been forgotten about (dammit) for over two decades, you can ignore it, too. When mixing for films it's not often you'll encounter two subwoofer channels. The so-called "Baby-Boom" of six track (70 mm) roadshow prints of only a very few major films since the late 70's have used a pair of subwoofers. These were the former midway screen channels, LC and RC that mixers had stopped using when Dolby Stereo became the major soundtrack method. Since 70 mm had the extra tracks these often were chosen for low frequencies, only. Or the extra two channels would be used for Surround Left and Surround Right, and were then called "Split Surrounds". Most theaters, though went with the next plan.



Most Popular Surround Setup -- 5.1 Channels

Now we have again a single subwoofer, as the very name for the newest digital sound systems describe it: 5.1 channels, the .1 being taken for that channel that only covers about a tenth of the usual audio spectrum. Logically many of us have gotten used to calling the stereo subwoofer/effects channels "another .1, for a total of .2", in other words, according to the convention you've been reading on this page: 5.2. Most older theaters have not yet doubled their subwoofers, and so you'll probably want to check your mixes with the plan just above. There's still one small problem, if your goal is film mixes more than music. With music you'll often want to be able to place a few instruments into the side channels, LS and RS. Solos work very well once the speakers are not behind you. It just feels like you're up close to the stage, near the band or orchestra, a very common way to hear music.

For that reason the music monitoring setups above are best served with single side channel speakers. Since now we're discussing film soundtracks, the goal changes. And to best provide the most dramatic sound locations and movements in a movie theater you might want to do a mild version of what LCRS soundtracks did for the single "S" channel -- multiple speakers. We can add several on either side, to the rear of the main LS and RS speakers, so that we obtain this next pleasing arrangement (again, note the 70 degree weak-links, something common to most soundtrack setups):



Full Film Mix Surround Setup -- 5.1 Channels

Note that the LS signal is being fed also to the two or more LR Surrounds, ditto for the RS signal to the right. If you won't be playing full range, wide dynamic sounds over the LS and RS channels, all these can be smaller surround speakers as has become typical in theaters since the 70's, well, even back 20 years before that. Then you can replace the large LS and RS speakers as shown above with something that matches the other rear speakers. Your choice, and also depending on what equipment will be used in the final theaters, a best guess. Since many modern theaters have sufficiently wide range auditorium speakers to play nearly as wide ranged (dynamics and frequency response) as the screen speakers, perhaps the setup shown above will be the most useful way to hedge your bets, and not compromise what you do in the mix.

For those of you who are only going to be listening, perhaps at home, this is still a very practical "target" plan. You'll probably only have a single pair of the LR/RR speakers, these might be dipole designs, and they will get the same signal as your side speakers, perhaps at a somewhat reduced level. It's once again a matter of "trust your ears". Take an approach and try it out. You can't beat the practical lessons gleaned from experimenting with several alternatives before you decide the leave things more or less permanently in place.

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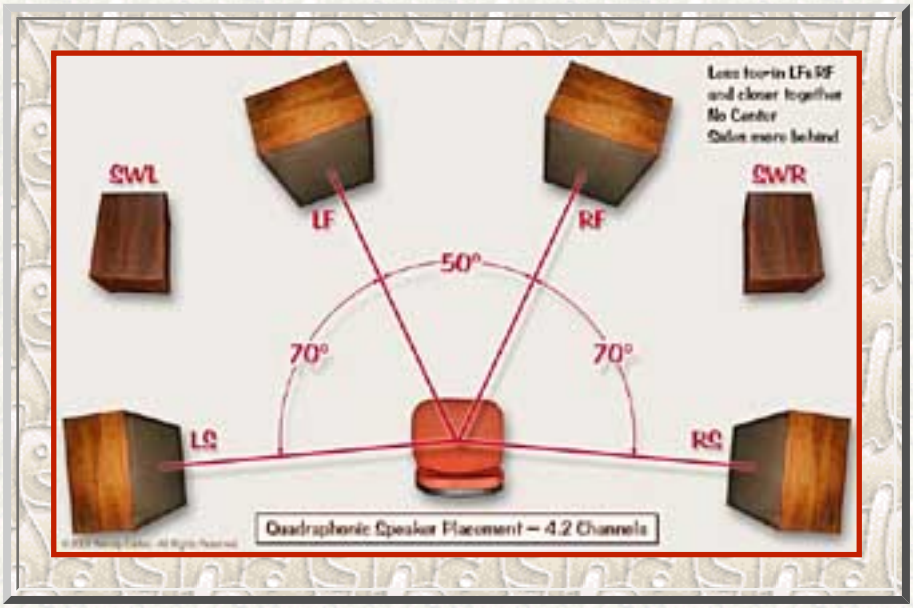
Optimum Quadraphony



Typical Quadraphonic Setup -- 4.2 Channels

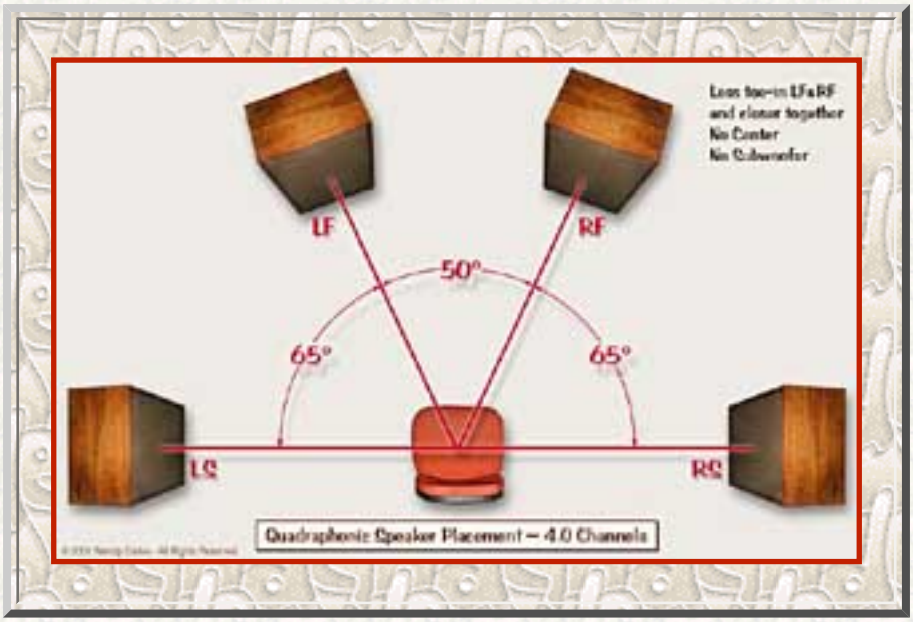
Ah, the glorious days of Quad! A time of breakthroughs in audio, enveloping sound all around you, a band performing right in your own living room, audio that has not been matched since! That's not quite the way it was. Unfortunately there were two major dilutions which quickly dissuaded most listeners from taking that expensive step of doubling up on speakers and amplifiers. The advertising promised what the reality wasn't able to deliver. One of the problems was that most of the recordings released in albums marked "Quadraphonic" were actually only stereo. They relied on one of a handful of "Matrix Quad" bootstraps to turn the actual stereo two track recordings into four separate signals for your quad amps and speakers. In truth, they were out to get something for nothing. Pure corporate greed and larceny, nothing new here. We'll cover the matrix story elsewhere. Just keep in mind that in limited cases, like the use Dolby put it to for film soundtracks, such a scheme can be useful, especially when constraints prevent a real discrete method from gaining widespread use.

But for most music applications the truth is not far from what your brain is telling you: it won't work. Well, it still can create some nice, pleasant musical effects. And with certain kinds of music the very best "logic decoders" can do somewhat better than that. Let's ignore the question since there now are several fine systems available to present excellent multichannel surround to the home listener, the newest being the DVD-Audio format.

The second major dilution that crippled the early quad systems is the faulty plan of distributing this doubled information in a way we can readily hear and appreciate. The folly of "Obvious Quad" has already been covered up above, in Digression I. That provided the second of the "one-two punches" that spelled the end of quad. Until now. This time we've started by basing the music surround systems on the well-proven film surround designs. We're not as likely to fall into either trap, as we will

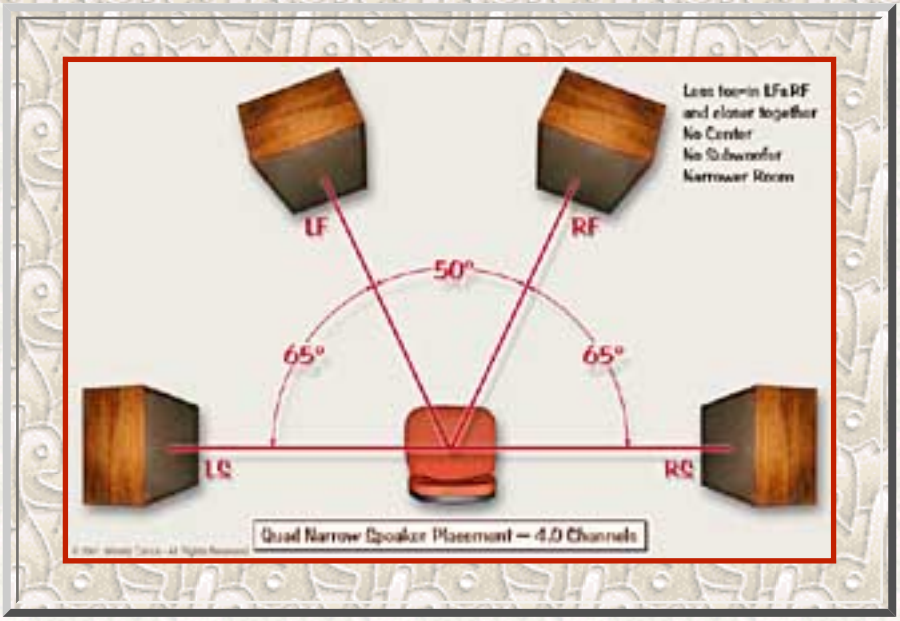
have truly discrete channels of very high fidelity indeed, and will distribute these channels around the room in an extension of good filmtrack practice. For musical purposes there's still a lot to be said for four track versions, or Quad. Most home systems don't have particularly good center speakers, often making do with the "phantom center" that any ordinary stereo can do. And many musicians seem less interested in plopping the vocalist automatically in a center channel, and don't even have much need for that channel.

Above is a really effective way to monitor and listen to Quadraphonic recordings. Had this been the way it was done in the 70's, and had the manufacturers avoided their phoney early matrix systems, quad might have had a real chance to survive. Think of what a wonderful backlog of masters we'd have now to place on our new DVD-A's!



Minimum Basic Quadraphonic Setup -- 4.0 Channels

There are two changes in the next plan. Many homes and studios don't have subwoofers, so we've left them out. Won't change the directionality one whit, a matter of wide fidelity rather than stereophony. Also we've placed the side speakers back to the theoretical optimum, directly opposite one another on both sides. For music this is certainly the preferred choice, and the original quad was nearly always a music, not film sound, method of reproduction. Since we've covered the LCRS four channel systems like Dolby Stereo above, now we're looking at home music systems, and the studio setups for making and monitoring such recordings. The other change you may consider to favor music reproduction is to restore an equal 60 degrees between each pair of channels, back to where we started above.



Narrower Basic Quadraphonic Setup -- 4 Channels

But wait a minute, before doing that, let's consider if your listening space is rather narrow for either of the plans above. What should you do, reduce all the speaker spacings all around, or just narrow in the width of LS and RS? We've taken the second approach here, as the change is not a large one. Certainly a smaller scale of any of these plans will work well. You could enlarge one up to the sizes of an auditorium, much like the Theater on Columbia University's campus, described at the beginning of this essay. In our plan above, however, we've narrowed our room somewhat, about 15% from the above variations. And we're going to leave those front two speakers at a 50 degree spacing, since now we'll be moving the LS and RS speakers inwards. So all the speakers have effectively been scaled in sideways from the original 60/60/60 spacings so ideal for music.

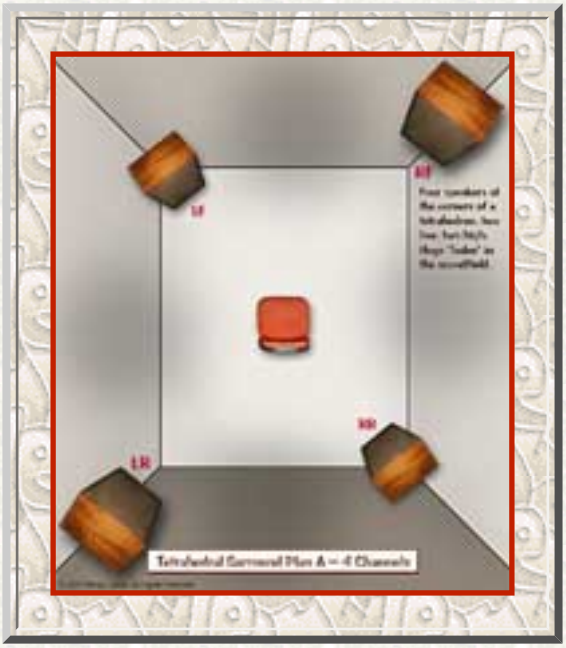
Yes, it's true that the side channels now are several inches closer to the listener than either front channel. For this modest difference, no harm is done. You can add a millisecond or two of delay to the LS and RS channels, much as we mentioned above regarding a too-close C channel (remember, at the average speed of sound of 1100 f/s, you'll need about 1 ms. delay roughly for each foot of "inwards" correction). But that may be overkill when the change is so small. You listen to stereo often when the distance to the left and right speakers have a foot or more difference, and yet you still hear stereo. I discovered while trying this out, moving the big Cornwalls in different spots before the final choice was made, that side speakers a bit in can be rather cool when listening to plain old stereo over all channels. If you put the left track on both LS and LF, LS down a couple of dB from LF, and do the same with the right track on RS and RF, something really effective happens, a kind of "ultra-stereo."

It's just the serendipity of the situation, almost something for nothing, which I'd never have guessed "ad hoc", without stumbling on it first. You obtain something rather better than the usual stereo, approaching, but certainly not reaching, the subtleties of true quadraphonic surround sound. It's nice to learn we won't have to discard our stereo-CD's after becoming surround-ready. You can take my word for it on this,

although, once again, I'd much prefer to have you work it out for yourself, do some experimentation. And it may inspire you discover an even **better** way to go!

(Top of the Page)

Quadraphonic Folly



Tetrahedral Surround Plan A -- 4 Channels

Now and again the suggestion of "Tetrahedral" channel placement arises, Phoenix like, from the ashes. It usually goes like this: "Say, if we've got FOUR separate channels, why not create a 3-D solid of sound, using a FOUR-sided tetrahedron! We can place one channel in each of the four corners of the 'hedron, use a microphone with four directional elements aiming in each of the four directions, mount the speakers the same way. Then we can have sounds come from any direction at all!" Great! Certainly is a lovely notion on paper. Except there's something worrying here: a speaker in every corner. Haven't we already seen that no matter how obvious an approach this is, it comes up as an argument with "holes" in it, to turn a phrase?

If four independent channels are insufficient to cover a flat 360 degree plane, certainly there's little hope they can cover MORE than that, like a spherical 360 sound space. Good grief (you're right), there's no hope at all (they don't), it sounds lousy. A favored configuration is the above "Plan A" (from Outer Space...? ;^). Note how the LF speaker is located down on the floor, then the next channel, RF is mounted up high in its corner, and around we go, down, up. Neat, huh? Compare the result with the folly of "Obvious Quad" in Digression I above. Only now the angle between each speaker is more than 110 degrees. You liked the big holes in the middle with 90 degree spacing, you're gonna LOVE it -- nearly 120 degrees of pure emptiness! We've destroyed what little "fusion" there existed before in front, as the pair along any wall must span the full diagonal length of that wall. No surprise to find black holes all over the place.

Evenso, there are some benefits to **record** with such four-element microphones, like the famous Calrec. By matrix manipulations of the sum and difference type we can "extract" the equivalent of a directional mike aimed in any spherical direction. You can capture an event with many recording channels, four per soundfield mike, and then later trim and fine-tune the mike aiming points. No, you can't effectively reposition the mikes, but it still is a most flexible scheme of event capture. If you have enough channels of monitoring, perhaps eight or more (Octophonic Sound, anyone?), and place these into a more modest configuration, you might be able to come up with a workable soundspace of environmental sound.

Tetrahedral Surround Plan B -- 4 Channels

But if you're stuck with only four channels for reproduction, there's not much more you can do about the up-down, or "third axis". Here's another scheme, Plan B, above which tries to square the circle, trisect the angle, invent perpetual motion, and on down to oblivion. Is it just me, or isn't this one kinda nervous making? I mean, would you mind having a large loudspeaker suspended right over your head, aiming down at you? Great for "the voice of God" effects! Of course one of the six channels in IMAX theaters does exactly this. At least they have five other tracks, so the main expanse of the screen is better handled that the above plan, with only three channels left to define 360 degrees. Yes, that's gonna lead to more of those blackholes, who says we haven't discovered "all the missing dark matter" in the Universe?

In any case, I've put the cart in front of the horse here. Our hearing apparatus is very weak at detecting up-down movement and locations. I could have added another experiment to try in Digression II above. It's easy enough to do. With your two channel stereo turn your head over to the side by 90 degrees, one ear aiming down, one up. Now listen to the two speakers, one effectively "above" your head, the other

"below". What's wrong with this picture? Do you hear much separation? Close your eyes and listen carefully. Play some "ping-pong" stereo material, or have a friend rotate the balance or level controls so the sound definitely moves back and forth between the speakers. How's it sound? Straighten up and compare. Unless you do have an extra ear on top of your head, I suspect you'll come away from this a little less excited by the prospects of 3-D spherical surround sound. I was. The test here works better outdoors, where there are no clues from reflections on walls or ceiling. More honest test that way, unless you have an anechoic chamber handy.

The other suggestion for a test, with a tiny noisemaker, a "cricket "or "clicker" should be repeated here. Have the sounds be moved from below to above at the same left-right angle. See what differences can be heard. Try it outdoors. Compare with front rear motion or arbitrary jumps, and near to far motion and jumps. We have to be sure about what we can easily detect and what we can't. Our eyes will deceive us, both ways: we can hear "phantom center" sounds between two speakers equidistant from us, our eyes tell us the space is empty. Our eyes see speakers above and below, but our ears are not so sure it's mostly guesswork. It's by coming up with concepts that look good to the eye we blunder both ways. We come up with plans that can't be heard well, and never consider the plans our ears will really enjoy. It's another case of how easily we can fool ourselves, especially if we've invested a lot of time and money in an idea resting on acoustic folly. Please trust your ears as you navigate these rocky narrows. Do everything "double-blind", with verification by others who seem to have excellent hearing. Find out what works for you, in any case, even when the lights are out, and it's every ear for itself...

There are other very important issues for good surround recordings that we've not been able to cover here. Many of the techniques and philosophy that go into fine (2-track) stereophony will carry over directly into the newest wrap-around systems. If any of the better available setups, like some of those above, is adopted as the basis for our favored system, instruments can be placed in many more apparent positions than ever possible before with two tracks. Attending a live concert in a superb venue like Carnegie Hall, and sitting fairly closely, you'll hear a wide arc or "curtain of sound," and many acoustic reflections and reverberation coming at you from all directions. Your ears will pick up the original sound placements up in front easily, and will certainly hear a large part, but not all, of the ambient information. Such clues of size of the room and shape are the ones to try to capture on a recording. Don't worry about some theoretical ideals of "completely reconstructing the listening space." You can't. Not even with 7.2 channels, you can't.

So don't fret about what will be lost, don't assume you can recreate such effects unambiguously "a posteriori," using a multitrack master and a fine surround mixing studio. Go back to the basics. Get the overall balances between the sounds right, that's not going to change. Set the equalization and wet-dry mods where they sound best, the same as usual. Let the reverb come mostly from the side channels, along with at least some of the instruments (don't waste LS & RS just on reverb/echo).

Some reverb or ambience ought be heard from the front, too, and probably it should use shorter delays and decays, and a bit less level. You can use neat toys like Psi-Networks (for 90 degree constant phase shifting) without worries of incompatibility and corruption as existed with all the pseudo quad matrix schemes: SQ, QS, RM, etcetera (I'll have more on matrix networks and early quad systems and my trial by fire with SQ in a related page here soon). You can use the widening of "sound-shuffling" processing to great effect on 5.1 channels, it's nothing to be tossed aside just because we're working with more than two channels. The transition to full surround is simply a move to a superset of everything else we already know, from creating, engineering and producing, to the "all-enveloping" new playback systems at home. We don't have to begin all over again. This is NOT rocket science!

I've been mixing most of my music in surround sound since the early 60's, and have saved all the master tapes in good condition. Now that DVD-A has been standardized, I expect to have a LOT of fun making these available to you. Yeay!! I love the liberating feeling to compose FOR surround, actually conceive it as a part of the creative process, not something slapped on later like a coat of paint. 5.1 or .2 is going to be WONderful for the recording arts and sciences. Much much more important than 96k/192k sampling idiocy at a hype-y 24 bits. (Did you hear that? Did I hear what? You know, the tighter ambience, contoured timbral nuance and extended silky imaging? Oh, right, of course, I was just about to mention it: a SPLENDID new suit of clothes, your Majesty!) Spend that extra DVD bandwidth wisely: **give us multichannels!** Ahem. That's something everyone can hear as an improvement. Let's not "blow it" this time, people, defending some theoretical folly or visual chauvinism, as was done in the 70's. Let's get it together this time.

Pep talk is over. Hope you tend to agree. Be back again with more soon. And thanx for reading all of this!

--Wendy Carlos

Go on to Pt. III

(Top of the Page)

Back to the Wendy Carlos Home Page

Wendy Carlos, SurroundSound2

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Wendy CARLOS

What comes around Goes Surround!

Adventures in Surround Sound, from 7.2 to Quad

(personal and historical notes, basics, and acoustic realities often forgotten)

= P a r t 3 =

Go to the Surround **Table of Contents**

Go to the **wendycarlos.com** Homepage

(**Note**: all images below open a large view in a new window when you click on them. To continue the text, close the new window.)

Jousting at Windmills

Billboard

An "Infamous" Whistle-blowing Letter to Billboard

Looking back on episodes like what follows from today, I wonder what ever possessed me. I must have been HATED for a few of the things I did in good conscience, like this whistle-blowing. Certainly you realize why Don Quixote is a poor role-model. Try to tell that to a young, alert person who's out to: "save truth, justice and the American Way..." Phooey. BTW, Since Surround Sound 5.1 is really just Quadraphony with an added front center

speaker and a distinct sub woofer channel, the experiences with quad are completely applicable to the latest surround sound systems. Suddenly 30 year old events are important and fresh all over again, and what follows is not so much quaint "history" as it is "background reading."

As luck would have it, I was signed to an exclusive contract with CBS Records (long before Sony took it over), when the first Quadraphonic craze hit. There was a close connection between CBS and Sony even back then, and Sony had (through a long, devious route) become interested in a surround system which CBS Laboratories in Stanford CT had fooled around with in the late 60's, abandoning it eventually. This was an interim, shortcut method to fit (encode) four channel audio masters onto an ordinary two-track record, then reconstruct the four (decode) on playback. Ben Bauer, an extremely talented engineer and delightful person, had led his CBS team through various alternatives in the late 60's, only to decide none of them really worked. He recommended that the company wait for a genuine four channel home delivery system to evolve, that this wasn't it.

Poor Ben was surprised a year or two later to get a call from an executive over at "Black Rock", the CBS headquarters in NYC, asking about "this new four channel sound stuff." The executive had just been grilled by some of his contacts in Japan, who had found this abandoned "matrix quad system" (as it was called), and thought it looked like an easy way to expand sales. They wanted the USA offices at CBS to assemble some prototype recordings that used the system, and would in return send the NYC offices some tests they had been trying out in Japan. There was a buzz-on, and Ben was asked to comply. He had already proven that all such bootstrap methods, trying to get something for nothing, were doomed to failure. But now he was going to be required to do it anyway, or at least invent a few tricks that would satisfy the home office, and which they could send to the Japan CBS offices. He hoped it would then all fade away with that.

We got called into the fray soon enough. Here we had one of the hottest classical albums ever made, and it seemed a natural for a new quadraphonic version. Rachel Elkind took a couple of long calls from the heads at Masterworks division (no doubt John McClure, perhaps also Tom Frost and Clive Davis), and suddenly we were in trouble, too. I'd been making four channel surround masters for a dozen years by then, and knew a little about surround sound. We'd been the news bytes about several of the majors, as they began pioneering this newest home audio idea. We learned that JVC in Japan had been developing a clever idea that actually *could* squeeze all the necessary information into a conventional LP -- four discrete channels.

JVC Japan was pushing forward with their **CD-4**, an honest, if complex quad method which was loosely based on Jerry Minter's early Stereophonic LP's (two track stereo) of 1958: place the extra information as a super high frequency tone that is FM modulated, more like radio than stylus in groove records. Minter had taken the (mono) "sum" mix of Left and Right, **L+R**, as it was called, and recorded that in the usual way. He took another mix, a "difference" of the two sides, **L-R** (which means the R was phase-flipped 180 degrees and added to normal L), and modulated a 25 kHz tone with it, yielding the radio-like signal. That was mixed with the mono sum to make the record. Since 25 k is above most human hearing, you couldn't hear this tone. But an ingenious, inexpensive add-on circuit picked it up, detected it, and mixed it back in a simple circuit (called a "matrix") to obtain the original two tracks, **L** and **R**.

Mono listeners just heard the mono mix (so it was compatible). Clever idea. Anyway, JVC was doing this stunt twice on a stereo LP, getting four distinct tracks from it.

The good idea was never trouble-free. Early on we were given some of their special equipment and cut some albums using the cutting facilities they'd set up in the USA. (It was amusing how several CD-4 doors opened after the letter below was published... ;^) The JVC method was generally a bit noisy, prone to distortion, and was delicate to install and operate. But it often sounded quite good, too, when treated with some TLC. Sony had tried and given up on such a high-strung design. Can't say I blame them, it was a major engineering campaign for JVC, and for RCA, their US affiliate on the new "QuadraDisks." Sony/CBS instead continued with their blood-from-a-stone pseudo-quad designs, much as Sansui, yet another Japanese company, was doing at the time with **QS**. Ben Bauer came up with one of the best choices of a poor lot, and **SQ** was born.

A hasty appointment was made, and Ben came to our studio downstairs in the brownstone one afternoon in the Summer of 72, with a bright, sharp engineer named Dan Gravereaux. They brought with them the latest "encoding" and "decoding" equipment they had thus far produced. We were given some copies of the very first titles that CBS would be putting out in the new scheme, and photocopies of a few detailed technical articles which described the methods and history behind SQ. Their "job" obviously, was to convince us to go along with their scheme. The background scuttlebutt I've related above was only learned a couple of years later. I felt bad for Ben, who was obviously such a nice, urbane man, with great charm and knowledge.

But I also felt bad for us. We spent the next several weeks trying to get what we could from the SQ hardware. It was pretty gruesome. I guess for many producers and engineers SQ was adequate. It could handle a kind of ping-ping pong-pong stereo, as I called it, as long as you simply pan-potted a few locations around the periphery. It was impossible to have natural or simulated instrument leakage: the same sound heard over more than one or two channels. A ghost center effect, something I'd used for years, was out of the question. It would gather up on the final Left track, and cancel out on the final Right track. Other combinations, like diagonal splits, were even worse. Baloney!

A Saber-cut to the Heart of the Matter

Out of curiosity and pique, I came up with an amusing, barbed demonstration track in quad that made our point with a razor-sharp sabre. The track sounded like a few minutes of a large group of people at a cocktail party, yatta-yatta-ing away all around the room, recorded cleanly in discrete quadraphony, hard to follow any one conversation. BUT -- when this clever little "nasty" was fed into the SQ encoder something strange happened: nearly all of the voices slowly faded away into a soft background sputtering, leaving but one voice that could be heard! And that was the voice of our good friend, Bob Schwarz. He cheerfully deadpanned, in his wonderfully rich radio announcer's voice: "Hi, are you enjoying the party? Me, too. But where did everyone go? That's odd, I couldn't hear myself there in the discrete. But now I can on the matrix. There must be something funny going on with these matrix systems, don't you think?" Then everyone else's chatter faded back in. Deathless silence from the CBS people we played it for. Priceless moment. (Also stupidly naive and showoff-y, not something that would ever be

mentioned in a good class on Diplomacy... ;^)

Sansui QS had the same Achilles Heel, also the older pioneering RM. **All** of the Matrix-Quad systems do, for they all toss away half of the information. It's referred to in the original 1972 letter below.

We knew CBS's company plan, and we had just mixed our S-OB multitrack tapes once again to real surround, before getting the new equipment. There were a great many "tricks" we would have to use to cover my "impertinent questions," to continue doing nothing more demanding than what I'd already been doing for years. These tricks were conscious, deliberate clever workarounds, and you really had to think twice at every step about what you were doing, and what would get translated reasonably well, and what wouldn't. Or just try to be satisfied with the old Double-Ping-Pong, as we'll describe next. This is not the place to go into these additional SQ-encoding kludges. I'll post some of the details eventually, some scans of my notes and diagrams that were necessary if you were to avoid getting bitten by the severe creative and musical compromises that SQ would require. (**Note**: the first few diagrams are already uploaded and ready to peruse on the next surround page.)

I found Sansui's QS scheme somewhat more to my liking. It suffered somewhat in front separation compared to the CBS, but when the two-track versions encoded by Sansui's QS system were played back on ordinary stereo equipment the results were very close to the way Rachel and I had been making two track stereo masters from all our four track masters for a few years. CBS's SQ design was just plain "weird" when heard on normal stereo, except if you restricted the placements to normal two tracks up in front, like close mikes over a band or orchestra, while the "rear" channels were distant reverb hall-sound channels. For that it was fine. Also Enoch-Light variations on unsubtle ping-ping pong-pong mixes worked well, especially on the latest "Logic" decoders, which rode gain automatically, trying to enhance the miserable separation of all matrix designs. Light would place antiphonal instruments only in the exact four channels, not much in-between, and that kind of limited quad was reasonably well served by the matrix systems with logic steering.

CBS had no sooner put out our "Switched-On Bach" in an SQ edition, that we were able to hear it on their best decoder. The result was depressing, very much a warped joke version of what we'd made. Well, it was on all but **one track**: the Two-part Invention in F. That one worked quite well. Why? Because it had come from the only mono master on S-OB, the first track recorded (I had "stereoized it for the first stereo release). So we were forced to use pan-pots to walk and jump the mono Invention all around the room, to the exact four speakers, not much in between. It's effective in small doses, I guess (the Invention is short), and quite a few people wrote rave reviews about the SQ version. I wanted nothing more to do with it. CBS refused to use the "competition's system", the JVC QuadraDisk, which had been improving steadily. I was signed to the wrong company! (**On the other hand**, to be perfectly fair, the JVC system had great trouble handling many high frequency sounds on **Sonic Seasonings** and some of our other masters without audible distortion. We cut a few careful tests on CD-4 and had to throw in the towel -- our music was just too demanding -- ouch! You'll detect that we'd decided to wait it out by the second letter below. And, well like, it's only taken a quarter century! ;o)

If we'd signed with RCA initially, as we nearly did, things would have worked out differently. We'd have put out many of our albums in genuine quad (discrete, meaning honest four ins and four outs), and neither of these letters would have been written. Then it would have been upsetting when CD's first were introdiced an absolutely NO ONE took advantage of the four channel format they offer (still do). Yep, a plain old CD can store about half stereo's maximum time, or 38 minutes of pure quad! Bet you didn't know that before -- it's never been implemented on CD-players or in the studio, to the best of my knowledge! Stuck between greed or honesty, we took the path that many (most?) artists probably would not: we cut off extra royalties from sales of SQ versions, and demanded our pseud-quad S-OB be withdrawn! This was a big financial sacrifice for us, just a small studio with not many artists, but it was the only ethical thing we could do.

There might be poor souls out there who would think the mild chewing up of S-OB by SQ was "the way it was supposed to sound." We wanted no part of deceiving the loyal fans we depend upon. I did the same sort of thing when the early "copy protection" schemes for digital (ca. 1986) appeared. They wanted to slip a deep notch filter into all CD's, with nasty results to the music (a few high piano notes would nearly disappear, fer pete's sake!). I was depressed by how few other artists signed the protest petition circulated widely at the time through the major recording organizations. Is greed just "the Amuhrican Way?" (Have mentioned this before, on the Disknotes page.)

Anyway, in 1972 I wrote off an infuriated letter, reprinted below, warts and all. (Lordy, the execs at CBS and long suffering Ben must have been **apoplectic** about it!) Billboard magazine had been running an excellent coverage of the ongoing "matrix vs. discrete" debates, so off to them went this "letter to the editor." Don't know what their editor made of it, but he printed it, one of the longest they've ever published, a full page. I've been told it created quite a "tempest in a teapot," and helped damp a bit of the Wave of BS that flowed out of the matrix fiasco. I hope so, I really do hope so...

(Top of the Page)

General News

Letters to the Editor

Moog Soundings

(the title the editor came up with for my letter...)

Dear Sir,

Thank you for your particularly comprehensive and clearly unbiased reporting especially with regards to quadraphonic sound. As one person involved in quadraphonic sound ever since the technology became practical, I have been excited to see the general interest now rapidly growing in this method of "super stereo." But no one in our industry can be anything but apprehensive if not confused about the many contradictions, ridiculous claims, putdowns and hysterical confounding of facts that has made mockery of all the recent quadraphonic meetings, public exhibitions, publicity and press conferences.

The crux of all confusion seems best indicated by the so-called "Great Matrix Debate." Most of the reports you have presented over the past year or more have centered on that kind of "my system's better than yours" game. Well and good. The business and creative elements of the industry are perhaps Billboard Magazine's primary concern. And this group has a right and a need to be told about the technology available, in not overly technical a manner.

It is no secret that we all stand to gain a great deal once successful quadraphonic hardware becomes standardized. But nowhere has anyone really attempted to state a few simple generalities which, like it or not, ought govern our choice. Make no mistake, the choice for quadraphonic systems is ours not the technical developers and laboratories currently engaged in this sort of research. Whatever we, in fact, adopt to promote, build home units for, use to produce our records, our tapes, our artistic sound paintings i.e., the "software" of quadraphonic will become the system. All other systems will then phase out, deservedly or not.

Pioneers

If we may look back to the similar birth of stereo in 1958, it was the few bold pioneers: record companies, producers, and phono cartridge manufacturers, who literally forced the standardization of the Westrex 45/45 stereo-disk system. Otherwise we would still be debating the theoretical impossibility of this system, and, as some now joke back to mono--we would still be a non-stereo industry, likely much smaller than now (thanks to the stereo revolution).

If I may be permitted an opinion, the only present need we have is as that 1958 period, a workable system. As long as it possesses no unnecessary theoretical limitations, but only has a few "bugs" (perhaps lower level, slightly less playing time, and the like), we ought adopt it as we did in 1958. A few years will iron out those bugs, again as we discovered with stereo.

Unfortunately, most quadraphonic pioneers today are not willing to accept this small price for a very healthy future. They believe, many quite sincerely, that we can "boot-strap" ourselves into instant quadraphonic. Humbug!

When Rachel Elkind and I began our new "Sonic Seasonings" album, we planned for quadraphonic and recorded all the materials in quadraphonic. That master, like "Clockwork Orange" and most of our other product, is already mixed in four channel surround. We tried to process this master on all the known matrix systems, and a few not so known. I am most unhappy to report that the results were catastrophic most of the time, and ho-hum for the rest.

And this was using the latest state-of-the-art matrix equipment, a magnitude better than home matrix equipment. Our "Switched-On Bach" was released in the best of the matrix systems, CBS's SQ, and we later discovered that, despite some critical acclaim, it is a pale mirror of the quadraphonic master. Worse, the musical balances are irrevocably bastardized so that, at many times, solo lines are obliterated by accompaniment.

Columbia has generously agreed to withdraw this album. If you should come across any remaining copies of the SQ version, *avoid* it like the plague! -- a strange sentiment for profit consciousness, but in the long run we believe it is the only valid decision possible. (Please note, re: the recent plea for compatible discrete/matrix disks, they would be exactly as inferior on all non-discrete equipment. Let's not allow ourselves to be conned by glib claims to the contrary for this ridiculous comprise). No other TEMPI product will be marketed in quadraphonic now for a while until a non-matrix system is accepted as an industry standard. Perhaps the JVC/RCA carrier disk is the answer. It is a "workable system" at least.

Discrete

Admittedly some product on matrix disks sounds perfectly fine. Indeed, a master remixed for a "ping- ping-pong-pong" quadraphonic will, in general, produce acceptable results on most of these systems (which despite mathematical differences tend to sound very alike). The strong loss of separation and phasing alterations/ interactions of all these systems is universally acknowledged. One reads with disbelief in your pages the number of people who rationalize such alterations as desirable. The dilutions do make a ping-ping-pong-pong master sound more diffuse and less gimmickry than the same would sound in pure quad. This latter we now find termed "discrete."

For "discrete" product to sound natural and acceptable to most people, we will all have to learn as we did in stereo, to produce master 4-track tapes with ambience, cross-relations and shifting phases of all kinds. There are, unlike successful matrix masters, many families of mixes possible which will attract even the most naive consumer, who, let's admit, has been less than excited by any of the matrix systems. Oddly enough, the ingenious matrix systems could play an important role in allowing producers to mix discrete masters with far more directionalities than the ordinary recording studio quadraphonic console permits. We can all profit in the end.

Possibilities

So I come across as another one of those mad discrete thickheads. I'm sorry, let's look at the reasons. You need not agree with me in a decision to wait for discrete and may prefer to go with a stop-gap measure of matrix quad. Again, well and good. Pragmatically you are probably safe. But, people, let's not "cut off our noses to..."

1) The theoretical maximum separation for a symmetrical matrix system is 4.8 dB; none attain it. Most barely attain a 3 dB. If we wish to, we can trade-off left-to-right separation for front-to-back or vice versa, as several systems do. But after all the effort the industry has expended for the 25-35 dB separation of stereo, how can we now rationalize being forever happy with 3-5 dB?

2. A two channel stereo system with about 4.5 dB separation is scarcely different-sounding from mono on two loudspeakers--unless the listener is in the exact center (as on earphones). Then

the stereo effect is just noticeable. Don't take my word, try it next time you are in a studio. Have the engineer set up a cross-mix of a stereo master, any master, to give 4.5 dB separation. Then move about a little and listen. Compare it to a mono tape on the two speakers.

3) Matrix (forgetting the mathematical type) means "system of intermixes." Three signals can be mixed in several ways to give three new signals. These new signals can then be re-intermixed to produce the original three unless we throw out one or more. The 4-2-4 matrix for quadraphonic discards half of the new signals. No *de*coder is possible in this case. That's a misnomer. *Re-en*coder would be the correct terminology.

4) Most consumers at home would object to listening to records from one fixed spot, and no one else in the room would occupy it at the same time anyway.... a shift of a few feet causes a measurable change of loudness of sounds from a loudspeaker. For quadraphonic, the balance shifts more than the available matrix separation, i.e., despite smokescreen claims to the contrary, even an educated ear could not tell matrix quadraphonic *from mono* over four speakers with minor exceptions, except from the center of the room. N.B. with well mixed discrete just about anywhere in the room is usable.

5) In a few systems, like the basic SQ, the left-to-right separation is strongly favored, while front-to-back deteriorates to an essentially inaudible amount. These systems cannot be differentiated *from stereo* over four speakers except from the center of the room, again with minor exceptions.

6) Clearly, unless we are willing to depend on the ignorance of the consumer, which is indeed a sad fact, some enhancing logic is absolutely essential for matrix systems. Thanks to the kind help of CBS Laboratories, we at TEMPI were given a long opportunity to hear and work with the latest Logic-SQ equipment. Compared to all other systems, including SQ *without* logic, it is the only system which even begins to sound like a quadraphonic master, for some material. Our "Switched-on Bach" SQ disk still was awful this on equipment far superior to all available home systems.

7) We investigated the cause of the mysterious missing parts for "S-OB." It turns out, and this has never been in print before, that *every matrix quad system has an infinite number of signal combinations which cancel out when the matrix master is encoded, and can never again be recovered.*

8) To prove this important point, we produced several quadraphonic mixes *which vanished* when encoded, leaving only a very soft sputtering! The SQ was by far the most tricky matrix to find such complete examples for, but it too, succumbed. Imagine never knowing just what part of a meticulous mix will be lopped off, or severely attenuated, by the time it gets to disk. This seems eminently more important than any position- shifts that may occur.

9) If one is cautious, he can avoid these troublesome combinations. We already know that pan-pot and ping- pong-ping-pong are safe, if artistically limiting. But they do work on sophisticated systems, such as SQ with logic. Other systems are less fussy, but sound so like mono in the end that you might well ask: "is this trip really necessary?" and would you mind giving up 80 percent of possible quadraphonic effects permanently?

10) A highly sophisticated logic is already on the drawing board stage at CBS Labs and others. By breaking up the sound into say, octaves, and using logic on each band separately (not unlike Dolby-A in concept and certainly cost) a result indistinguishable from discrete quad 95 percent of the time is theoretically possible. Of course, a critical listener may still be annoyed by the

"pumping" effect inevitable on gain riding devices as logic requires.

11) The previously mentioned cancellations during making the matrix record cannot be removed, how ever. Progress in quadraphonic recording and mixing will be severely limited. I, for one, would prefer not to have to carry a calculator and vector scope, or an encoder / decoder pair around with me, to cheek out feasible projects (and also worry about additional cancellations in mono playback). The quadraphonic masters for "S-OB" and "Sonic Seasonings," "Clockwork Orange," etc., do *not* encode properly because we refused to limit ourselves in these ways. The phase and amplitude shifts that make sophisticated quadraphonic possible here work to confuse and disable encoding. And what you can't encode never gets to disk so the new logic systems are no help.

12) Finally, these logic schemes, clever as they are, become, in fact, more complicated and expensive than the carrier system decoders so put-down with heated prejudice by the many individuals Billboard has faithfully reported on. Without committing myself to the obvious front-runner of carrier systems, JVC/ RCA, may I add:

a) The complaints of new cartridges necessary, less playing time, lower signal level, etc., are so similar to 1958's anti-Westrex propagandizement that one wonders what the commotion is all about. A lot of current high-quality stereo cartridges work fine, and that's more than the mono cartridges of 1958 could do for stereo. Ironically, lower signal levels are *also* heard on most matrix disks, due to asymmetrical level peaks from the matrix (which cannot be inconspicuously limited during cutting) so the overall level cut is reduced. In 1958, the same complaint was made about stereo, don't forget.

b) CBS Labs originally developed a carrier disk. It was aborted *temporarily* due to the limitations of available plastics and other reasons. The newest record materials already are not affected by even fairly abusive playing on cheap phonographs. A carrier system then is possible. Dirt, not wear, may cause trouble. If you think you've worn out the carrier, just reach for the record cleaner! In any ease, again this is all old crying a la 1958, and the situation is nowhere near as bleak as Westrex 45/45 seemed. Then there's still the option of converting the Teldec video disk to a quadraphonic disk of four or more hours per side!

e) Actually, even the carrier systems are "matrix" systems. The two left channels are mixed, ditto for the right. But two other mixes are made for the carriers to hold. In not discarding two of the four new signals carrier disks gain their superiority. Since no information is lost, the cancellations mentioned earlier do not occur and one can record with freedom.

d) Some have apparently heard discrete product of poorly mixed masters. May I point out that the gimmicky quad pinging and ponging is no more inherent than it was in early stereo days. And the "blend" control of those days was quickly abandoned as more sophisticated records were made. Is that not analogous to the present cry that "matrix is more natural?" It's a great big BLEND switch! Still, there is a place for blending in quadraphonic, and if a producer finds a particular matrix quad system provides a pleasing "surround" on say, the string tracks, I see no reason why s/he ought not use it. And a different system might be used for the echo signals, while the rhythm and vocal might be the best pinpointed in direct non matrix form. With a discrete release available we can have the best of all worlds! Any matrix blending will be done in the recording studio, under artistic control of the artists, producers and engineers. But a permanent blend of all signals indiscriminately at home? I don't think we'll need it and certainly not want it in a couple of years. Until then, *caveat emptor!*

Sincerely,
W. Carlos
New York City

== August 5, 1972; Billboard Magazine, Page 6 ==

(**Note**: In the same issue of Billboard magazine,
Brad Miller, of the **Mystic Moods Orchestra,**
placed a five-inch tall ad drawing reader's attention
to the above letter, with big letters:

"IT'S ABOUT TIME THE TAIL STOPPED WAGGING THE DOG!"

(Brad had been another surround sound enthusiast and pioneer.
He also championed a very reasonable system of Quadracasting
four discrete channels over an ordinary FM transmitter. The FCC
hemmed and hawed, and Quad faded away. It could have all come to
fruition a quarter of a century ago! Perhaps now 5.1 will carry on.
Thank you, dear Brad, wherever you are, for
your constant support and understanding...)

(Top of the Page)

In May of 1974 there had been some change of the status of Quadraphony, which was still very much in the news of industry record and engineering magazines and the like, if not in the perceptions of the public. I tried to summarize the situation in a much shorter new letter, again to Billboard. I don't remember if this one was also printed by them, as I found only a Xerox copy of a typed manuscript in my files. We clearly had made the copy and then sent the original off to them. It's quite possible that by then the initial interest had waned, and the letter was never published before this web page.

It still contains some anger, and youthful hubris but not so much as the first one. You'll see that by now I'd done my homework, and could toss-off a better grab-bag of terms, exact specifications, and evidence. It amused me, when I just found the photocopy in a dusty old file folder, to discover that way back then I was pushing for the same kind of configuration that I had just documented on the earlier pages. Can't say I'm not consistent. (You'll also notice that I end with an irrelevant "dig" about the way surround multi channels are often labeled. On my old console A-B-C and D correspond to the far left sweeping through far right outputs, nice and symmetrical. Some of the setups I've seen are Byzantine, like the way it's done for DTS masters, say wha...?) Of course the whole surround sound vehicle

never completely got off the ground before now. So these issues have become timely again in 2001, some 27-28 years later! (The more things change, the more...) For historical sake, I'll include the second Billboard letter below.

More Switched-On Quad

Dear Sir,

Back in mid 1972 you graciously allowed me publication of a rather lengthy letter about the then state-of-the-art of quad sound. This continuation of that filibuster will be briefer, but a lot has happened in the meantime which ought be said. since we have yet to come up with a standardized name like: Stereophonic, or Monophonic, and although I personally prefer: Quadraphonic to the others, Quadrasonic, Quadriphonic, Quadrasound, Tetraphony, etc., let's for now simply call it by the informal: "Quad."

Frankly, I think all of us in our industry really **do** deserve some sort of recognition for sobriety or altruism. By 1972 and into 1873 there was still a lot of hyped advertising with exorbitant, exaggerated, confusing, and often untrue claims made about one particular system over all others. There is still some of this nonsense going on, but by and large the various manufacturers and sellers of quad hardware and software have mellowed into more refined, objective ideas in their promotions. The truths about this marvelous new medium are at last being heard. Integrity has won out, while behind the scenes, a great deal of research and development is producing valid breakthroughs now reaching the marketplace.

The Situation in 1972

Two years ago there were several Quad methods under discussion, and at that time **none** of these systems was really very good. In comparisons of identical recordings we made, under carefully controlled conditions and double-blind, both electronic and acoustic music, we heard how the various systems altered and corrupted our masters. It was like: SQ versus Switched-On Bach. Some comparisons:

RM Matrix: produced very decent Stereo playback, indistinguishable from stereo Quad playback, and occasionally lousy Mono playback. Much information was lost during encoding.

RM Vario-Matrix: occasionally was fine for its intended quasi-quad, but ambience and balances were poor, and much information was lost.

SQ Matrix: produced mediocre Stereo playback, (with both rear channels "folded-in" to equally ambiguous center-fit 1) , indistinguishable from-stereo Quad Play and usually lousy Mono Play, and much information was lost.

SQ Logic: occasionally was fine for its intended Simulated Quad Play, but ambience and balances were poor, the first logics were slow-acting and "pumped" (newer are much better), but again much information was lost.

CD-4: produced very decent Stereo and Mono Plays, but quite noisy and often distorted Quad Play, which frequently had a muffled quality, although no actual information was lost.

In general, all other matrix schemes were even worse than RM (Sansui originally called it QS) or SQ in most respects' and CD-4 was the only available non-matrix schemes. All the quad disks had somewhat lower levels than standard Stereo discs. The CD-4 at that time had theoretical reasons for the reduced level, and both SQ and RM have frequent out-of-phase peaks (rather higher than normal stereo) which require a more cautious cutting level. Audibly, despite what the V.U. meters might have said, they all sounded softer than Stereo, in any event (with a few rare exceptions):

So, at that time, I felt the safest decision was to develop a "super-stereo" mix-down from our quad masters, and sit out and wait until videodisk technology suitably modified, or CD-4 type records yielded results which could be called 'high- fidelity" as well as Quad. Also, since the matrix theory as a whole permanently discards one-half of the Quad material, I believe it is actually Pseudo-Quad. Perhaps "discrete" quad was originally a term dreamed up to hide the fact that "discrete" is really the only genuine Quad. I second the suggestion that we rename discrete: "true Quad", and matrix: "Simulated Quad", not unlike the old ruling about mono masters "rechanneled for stereo".

The Present (New Developments)

But now it is 1974 and the situation has changed A few "Simulated Quad" methods, notably SQ, have developed special mixing console adapters/ rechannelers which prevent any mixing combination which would cancel out (partially or wholly) -in matrix-encoding from ever being produced. The producer and engineer can call for all the usual positionings, echo returns, and the hike' but only the SQ-safe ones will go through "directly". The others will in fact be altered from the intended positions, and added along into the mix with no level drop. The matrix-limitations are still there, perpetual motion still doesn't exist, but at Least you no longer need worry about that. Simultaneously a "true Quad" master can be made on a four track recorder, for Q8 cartridges, CD-4 disks, or any other discrete release now or in the future. All in all, it's a most commendable effort, especially for simplified and non-critical applications.

Much more exciting is the discovery that the one preexisting "true Quad" method, CD-4, has not been sitting idly by. Since in theory this remains a **workable system**, it was "only" a matter of time & dedication, genius, money and effort before really High Fidelity Quad records (and we all want those) could be cut. The surprise for us all is that these goals have recently been attained. Although CD-4 presently remains a delicate affair, with top-quality equipment and critical adjustments required at ale points in the chain, it works very well under good conditions.

In March Rachel Elkind, my partner, paid a visit to Tom Nishida at the west coast "JVC Cutting Center". She brought along a new quad master she had produced recently, and I engineered of a very demanding piece of music by Eric Siday. He utilizes traditional and electronic sources together for genuinely exciting results that would place severe demands on **any** system. In our A/B comparison of the test disk Mr. Nishida cut for Rachel, it was next-to-impossible for us to be certain which we were listening to: master or disk. Only the presence of slight surface noises and a couple of clipped peaks gave any indication. At last even Eric was convinced. And he had found the A/B comparisons with the leading matrix system dismally easy to differentiate, so unfaithful was it.

We also have learned that CBS has taken delivery of CD-4 equipment. Quietly, this giant too, is experimenting with perfecting a high fidelity "true quad" record, as are many other companies. With the newest modifications (several major; a few minor but with great improvements, such as new cutting stylus shapes) it is at least conceivable that records worthy of the small but not unimpressive audiophile quad market could be in stores by Christmas. The not so critical lower-priced phonograph users would still be best served by that new SQ-mixdown type Pseudo-Quad record, at least until less delicate and expensive Hi-Fi "true quad" hardware is developed.

But don't throw away your old matrix encoders yet - or ever! As I mentioned in my last letter, these devices borrow two fantastic concepts developed back in the late 50's by pioneer Ben Bauer: 90° phase shifters and matrices. And those concepts, if used in unorthodox groupings, will be significantly important for those of us who wish to push open the limits on our new generation of 'True Quad. In a very real sense we all are the winners after only a few short years now passed.

Speaker Placement as a Limitation

With the dawn of "true Quad" presently before us it might be appropriate to suggest one more relevant observation. From 1961 to 65 I was involved with a small group of experimenters working with the then unnamed and primitive four channel techniques out of which our present "Quad" developed. We must have tried just about every conceivable microphone and loudspeaker placement during those years. It ;s ironic to look back now and realize that one of the first tried and least successful was our dear friend. one speaker in each corner -- 360 degree surround-sound. It would be out of place to get into a technical discussion as to why this idea which really sounds "obvious" and "natural" was not so optimum for human-style two ear listening. What is important is that there are a great many placements which give the aural illusion of 360 degree sound, and most of these do not have speakers physically behind the listener'

Actually, those who have lived with quad speakers in each corner now must realize that it gives us four of those old stereo bugaboos. "hole-in-the-middle". Instruments and voices simply refuse to blend with 90° separation between mikes and speakers (mainly the latter). I won't pretend that the final placement we preferred back in the early 60's is the ultimate answer? But many people are using it now in their homes and studios: four speakers in a deeply curved 180 arc, or 60 degrees between each -- like an old Cinerama screen! But the most fascinating thing is that it not only eliminates those four holes-in- the-middle' but, with no particularly involved mixing, it gives a completely convincing illusion of sounds Behind, To the Sides, Above, Below, Near, Far -- a solid curtain of sound!

Speaking from personal experience, Rachel and I have, in the five years of records between our "Switched-On Bach I & II" returned to this deep-curve speaker configuration. we audition all quad tapes on it, we mix to it, we use it to show off quad for our friends and business associates. Though this is a limited sample group, we have found:

1) **Everything** is easier to locate, including mistakes (which one can fix before a master leaves the studio).

2) We have been able to record a live orchestra on all four channels (not echo-only on rears) without an unnatural sense of being in the middle. The reverb seems to come from all

around, *even behind*, however, yet the placement of each instrument or section of instruments is unbelievably well-defined in a three dimensional space unattainable with either stereo or one speaker per corner quad.

3) For less traditional records it is not difficult to give the convincing effect of instruments all around you, including dead behind and ahead, or directly at each side. All of these are exceedingly poor on the standard quad speaker configuration.

As farther evidence of 1), listen to any matrix quad, especially one that uses logic, using the 180 degree arc of monitors. The old limitations, pumping, instabilities, and the rest are at once exposed to the ear. In a way this improved speaker configuration really requires that truly discrete recordings be used.

Forgive the cliche: "Try it, you'll like it!" But I can't help but recommend that we begin mixing for and playing quad for our customers using this simple variation and watch us all benefit the great results. For those who are fond of naming things, we'll want to call the channels: Left Side, Left Front, Right Front, Right Side, all in a row, or as simple as A-B-C-D!

Sincerely,
W. Carlos
New York City

== May 10, 1974; Sent to the Editor, Billboard Magazine ==

(Top of the Page)

Go on to Pt. IV

Back to the Wendy Carlos Home Page

Wendy CARLOS

What comes around Goes Surround!

Adventures in Surround Sound, from 7.2 to Quad

(personal and historical notes, basics, and acoustic realities often forgotten)

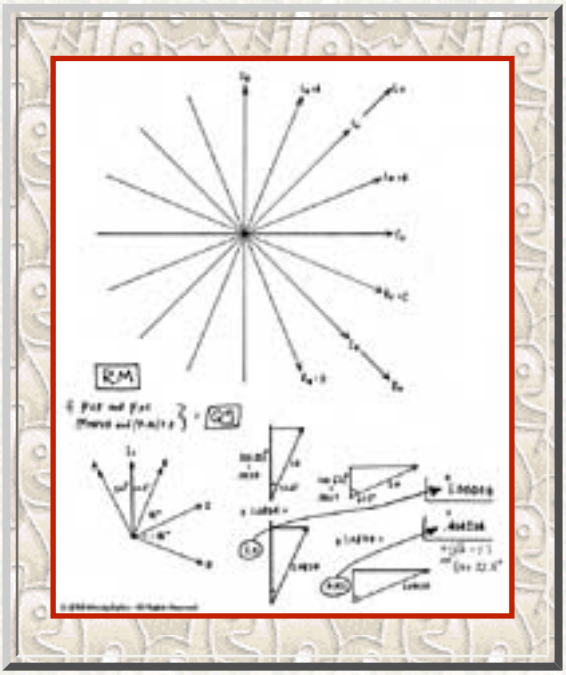
= P a r t 4 =

Go to the Surround **Table of Contents**

Go to the **wendycarlos.com** Homepage

(**Note**: all images below open a large view in a new window when you click on them. To continue the text, close the new window.)

Matrix "Quad" Systems



The RM (Regular Matrix) System

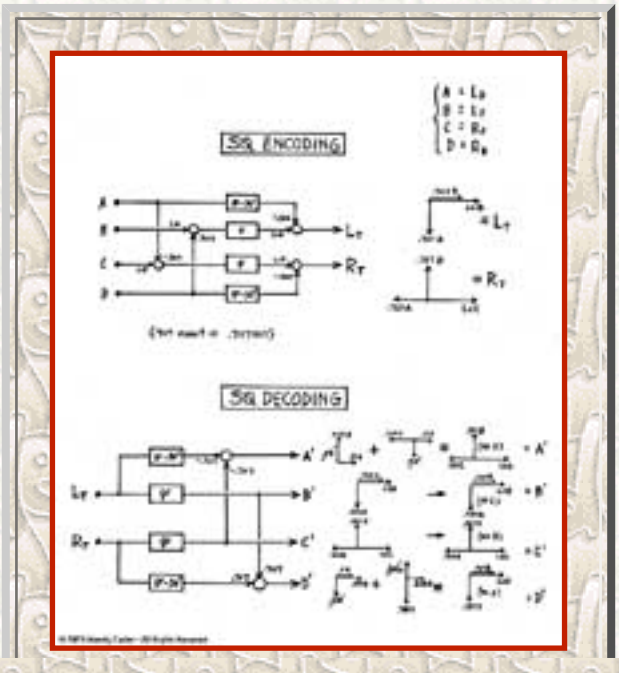
To he first notable matrix encoding system that was suggested led directly to something that eventually became called the "RM" or Regular Matrix. In this case the name certainly fits. Above, when you click, you'll find a nice new scan of one of a trio of sheets I just located calculating the vector math of this particular system, and SQ and QS as well below. I can't go into the mathematics of it here and now, perhaps soon. I will point out that on the above sheet the fan shape is an overall vector diagram of the levels of each channel, how they are distributed with respect to the center front, which is exactly to the right, the "reference" angle. If you want a little extra detail, the box below will inform slightly more. I'll add a Bibliography soon for even better background information.

Some Slightly "Tech-Tawk"

On the SQ and QS sheets there are also basic schematic drawings of the general circuit used, which is somewhat more complex than the RM originally was, so needed clarification here. You can see at a glance that these are not particularly complicated circuits, at least leaving the Psi-Networks out of it. Even if you added those, there would be far less "stuff" that the average home gear of today: clock, tv remote, CD player, computer. It's from an old discrete component era for the most part, when even an elaborate receiver had but a handful of transistors, and only a few dozen resistors and capacitors and so forth. To the right of these circuits you can see other vector diagrams. Again to the right horizontally is the reference angle.

Backwards horizontally is the "out of phase 180 degree direction". Up vertically is 90 degrees CCW vector, while vertically down is 90 degrees CW, the exact out of phase opposite of the straight up CCW vector. Some of you will already be familiar with this kind of graphic solution, and will pick up what was going on here. There's a note to myself that with the addition of the all-pass filters (known as a 90-degree quadrature pair) or Psi Network (also called a J-Network), the RM can be converted exactly into a QS matrix. And vice-versa. Certainly "Logic" Circuits and enhancements for separation beyond the pitiful 4.8 dB maximum (that's at best, most of them had only about 3 dB separation) were needed, some "gain-riding logic" had to be provided to imitate the completely enveloping soundfield of glorious discrete surround sound. What **really** was needed was what we've only recently standardized: DVD-A multichannel audio disks!

RM enchanted me in a different way, though. Here was an extended plan which followed closely the simple fold-down method I have been using since the mid 60's to derive two-tracks of Stereo for final release, when most of my master mixes have been designed and realized as four channel surround sound. It was during the production of Sonic Seasonings that Rachel and I really got excited about this elegant way to collapse the soundfield into normal stereo. I've reported before, and so has Rachel in the liner notes, that at times we had to double-check what we were listening to, as the two channel reduction could often mimic true surround sound, when played back on the same setup. Anyway, RM represented the underlying pattern that our method was a subset of. Kinda cool, and the fact that at times you can be fooled like this suggests that there is more to this field that anyone has yet explored. I think it's time we tried, don't you?



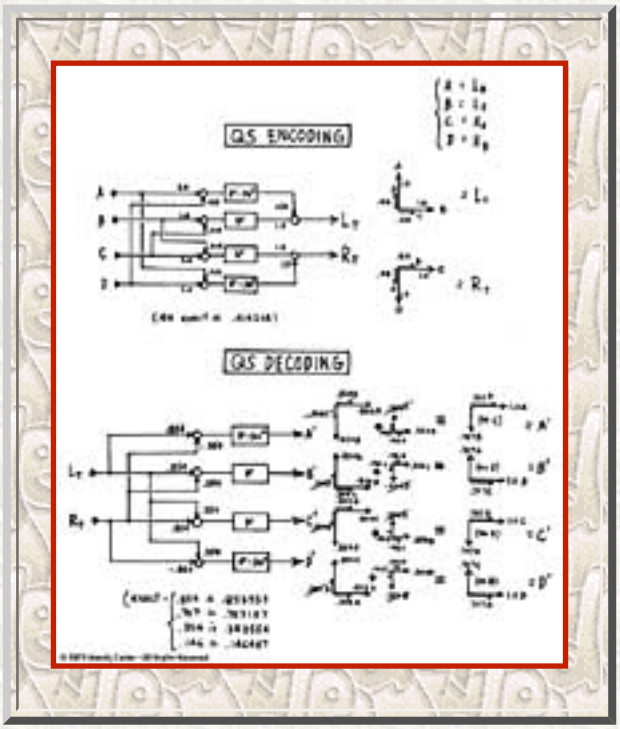
The SQ (Stereo-Quad) CBS/Sony System

Since Ben Bauer came up with the ideas behind the SQ matrix starting in the late 50's, it's hard to date the final system historically. I'll simply place it after the Regular Matrix since the final configuration that the system became know for was decided upon at that time. In any case, this is not intended be be an historic document, and there is some overlapping in the designs, which obviously were treated rather secretively at first. Once again, this is one of the three drawings that I had neatly recopied for my own analysis, of what to expect when using the CBS system. You can see the simplicity of the basic networks in their purest form. (Note: my silly use of "exact" for numerical values in these charts merely meant: "more exact," what I used to calculate my tables and charts.)

So-called "logic" circuits added a lot of additional circuitry to the decoder (the encoder remained the same, except for the additional kludges CBS Labs designed to allow at least some way to do the "forbidden" of SQ encoding. These got fairly elaborate. Perhaps I'll add a couple of examples in a future update, if there's enough interest. The original CBS Logic Decoder was a pretty compromised affair, we thought. It pumped and glitched, and created an appalling instability around the room. I usually ended up just turning it off, going with the basic matrix. Of course there was only 3 dB's of separation now between rear (they didn't know about side channels) and front. Essentially that's like no quad at all. Is it any wonder these schemes failed?! Really, isn't there a lesson or two to be learned here?

Finally, at the last gasp of SQ, a new kind of logic circuit showed up, called Tate Logic. It was released only in the Fosgate 101a, to the best of my knowledge. This new design didn't ride gain, but shifted the matrix's coefficients while decoding so that the strongest signal was channeled correctly, the adjacent leaking channels receiving some of the opposite phase signal added in instead, canceling the crosstalk. So these secondary sounds sort of "scurried" into another channel for a moment (still only two simultaneous sounds at a time could be steered) which yielded a minimum amount of leakage from the dominant channel. It all happened very quickly, readjusting from second to second. There were few swoops during the attacks of new sounds, and since we tend to judge direction by the attacks more than steady portions of a sound, it could create a much better simulacrum of true discrete sound.

Again it depended on the program material, and that kind with a minimal amount of polyphony, with clear solos darting from speaker to speaker, not too much in between, not too much ambience or reverb, both of which would drift, it was not bad. Tate logic chips then were licensed to Dolby Labs. Friends in high places there told us about it, and we all agreed this was the ideal marriage for both. Film soundtracks usually impose simpler demands than music, not too much happening at once, unless it's meant to create an overall effect, a blur all around. Tate logic is adept at this trick, as has been proven by the several thousand films mixed that way since 1977's Star Wars unveiled the welcomed new system.



The QS (Quad-Stereo) Sansui System

In point of fact, Sansui's QS matrix came out of the Regular Matrix (and later, vice-versa, too). The first versions of RM had some less desirable properties in regard mono compatibility, and maintaining an adequate channel separation between any adjacent speaker pair. QS attacked these with the introduction of similar Psi-Networks as Ben Bauer had developed to enhance the SQ matrix. There were quite a few differences, and certainly it would be a stretch to suggest that the resulting recordings were compatible in any way. RM and QS maintained the compatibility of their origins, but SQ stood out against them both. I think Bauer had been thinking mostly of classical masters he had heard early on at CBS records, which invariably used the one speaker in each corner "obvious quad" configuration.

So these masters usually had the orchestra or smaller ensemble recorded in the usual way up in front, and two distant mikes much further back picked up the hall sound for the rear two channels. For this notion the SQ matrix is a clever idea, and perhaps is the best one could hope to come up with given the restraints of only two actual channels of final output. I've heard it sound pretty all right under those conditions, nothing to write home about if you've heard the real thing, but something mildly interesting that might attract the attention of a small user base who listen to only a certain restricted kind of recording.

Sansui came up with its own excellent separation enhancer, called "Vario-Matrix." It sounded surprisingly decent, the images wandered a little, but you were not aware of any annoying pumping, especially of the front-rear variety (the circuit instead varied the playback matrix's sum and difference coefficients, thus its name). The Tate system described above for SQ is quite similar to Sansui's Vario-Matrix: both alter the matrix values from moment to moment to keep the dominant sounds, primarily

their attack portions, located near their correct positions, and the leakages are canceled out as well as can be accommodated at the same time.

Sansui QS variation of RM, is probably the best of the matrix systems. It arrived a bit too late to make much of a dent on the progress of surround sound in the 70's. By 1974 either the SQ system had been adopted by CBS-loyalists, or the true quad (discrete) QuadraDisk had become the favored choice of the RCA wing. Some small independent companies went with the QS matrix (not wishing to side with either CBS nor RCA!), and a couple even experimented with several systems, going so far as releasing alternative versions in competing systems. But that was rare -- while artists had the least choice of all. Sad to admit (it's mentioned in my second letter to Billboard), the QuadraDisk was often not the highest in fidelity, certainly not at first, and if misplayed the ultra high frequencies could be damaged: goodbye quad. It took care and a some engineering savvy both to cut and later extract the most from the complex JVC system. I had a lot of fun with it, learned to coax it into working fairly well, and longed to release some of my music using CD-4. We had some test QuadraDisks cut for us by JVC, but CBS balked. The QS matrix would also have been preferable, compared to SQ's unwelcomed limitations on recording and mixing. CBS said no. With the provisos on lack of robustness and slightly compromised fidelity, the QuadraDisk remained our first choice of available systems in 1974, as it was the most honest. And now so is the DVD-A.

I think it might be appropriate here to point out that the way I ended my second letter is still true in 2001, and forms the basis for the first section of this webpage. **Let's get the speaker arrangements optimal from the get-go.** If we had adopted some of the sophisticated circuits and concepts that were generally wasted in effort to make pseudo quad good enough to fool an audience, we would be creating much better stereophony and surround sound masters today. With the ultra fine audio quality and phase coherence of CD's and even better DVD-Audio disks, these old ideas ought be looked into again. Several early 20th century ideas also ought be reintroduced, like Blumlein sound-shufflers, neat arrays of spaced coincident microphones, or newer digital devices for mimicking the effect of binaural over loudspeakers (pioneered by the excellent Lexicon CP-1, CP-3 and DC-1 series). We can do some very KEWL things with such collections of tools! It's an exciting opportunity, let's work together on it. If no one's interested, you can bet I'm gonna try, anyway. And I'll report back to you here if anything interesting comes along! :^)

--Wendy Carlos

(We've come a long way!
Click for larger view)

(Top of the Page)

Psi-Networks

The matrix systems depicted above, as we've seen, rely on what's called a "Psi-Network" (or "J-Network). It's a real shame that this concept was so closely tied to the pseudo-quad brigade, that when those compromises faded, so did most other interest in these circuits. So let me make take a moment here to set the record straight. Things are confused by another name for this all-pass filter audio tool, the "Hilbert Transformer" (a fine, if technical description, in this case implemented digitally (with C-Sound) can be found at this link). I've also encountered one more name: "Dome Filter," a somewhat older term from the days of analog circuits. (I've not yet been able to obtain a copy, but I note a tempting paper that describes dome filters, that's available through NTIS.) Whatever the name, they show up in unexpected places. I ought mention a wonderful sound transmogrifying device I've been using since the mid-60's: the "Klangumwandler," or Frequency Shifter. Only recently I learned that inside one of these you'll find a few psi-net circuits.

Harald Bode, an skillful pioneer in the engineering of electronic music (i.e., the Bode Melochord), designed and invented several unique Klangumwandlers. In the early 60's Vladimir Ussachevsky (electronic music pioneer and Professor of Music at Columbia when I got my MA in composition) asked Harald to construct a couple of them for the Columbia-Princeton Electronic Music Center. That's where I first saw one, and made good use of it on the first music score I ever composed, for Bob

Shaye's clever, amusing early short film, **Image**. It was screened in November 1999 at the Whitney Museum of Modern Art's retrospective of 20th Century art and film. I attended that with Bob, and smiled to hear the "sins of my youth," including some venerable old frequency-shifted harmonica melodies Bob played himself for me. Truly kewl!

Later Bob Moog constructed for me a wonderful custom analog Klangumwandler from Harald's designs, which I've used for years. (You can hear it nicely on the slow, rich tutti sections of my 4th Brandenburg realization, mvmt. II -- it's in the new boxed set.) Anyway, these units took one kind of advantage of what can be most accurately described as "90-degree Constant Phase Difference Networks." Now THAT's a mouthful! (But descriptive...) Other neat musical uses were suggested by Benjamin Bauer, prior to his including two pairs of them in the SQ matrix (see the Bibliography below, the first two papers listed). It was a clever way to design a pseudo-quad system, as without them the results are even more disappointing. Ben's first ideas, overlooked in the quad hyperbole of the 70's, are still valuable today.

If you pass a mono signal through a psi-net pair, and patch the outputs through stereo speakers, you'll hear a widened image, completely filling the space in between the two speakers. That's pretty special already, so bear with me. To finesse the effect you need another classic audio tool, called a Sum and Difference network. Those are used to record with classic MS (Mid-Side) stereo microphones, the earliest stereo LP cutters, current FM stereo radio transmitters and receivers, Dolby Stereo soundtracks, stereo TV/video, and many other audio processes we now take for granted. Quite a list, for this popular audio "swiss army knife!" If you combine psi-nets with ~~swiss arm~~..., I mean, sum/difference networks, and some other stuff I can't go into here, you'll be able to work some minor miracles in stereo sound. I've used similar methods a lot in my own work, in lot's of ways (listen carefully to Tales of Heaven & Hell). It's a rich resource for our newest DVD-Audio multichannel surround recordings.

I'd love to go into the details, but have already become **far** too technical in this section for a general web page essay (apologies). I need not say that experimentation is necessary, since it takes a subtle, experienced "touch" to get the most benefits. It's not quite "plug and play," and for that reason alone it may remain delegated mainly to the more adventurous surround sound investigators. But there truly are worlds to explore here!

--Wendy Carlos

(Top of the Page)

Bibliography

Here are a few good resources and references, in no particular order, for those of you who'd like to investigate these related topics further. Some of the following papers are rather technical, others not so much. I'll try to update the list occasionally as I locate other sources and pertinent references. These all shed light on some of the important background material that goes into Surround Sound of many kinds. Since this web page is certainly not a "paper in a scientific journal," I've tried to remain more informal, anecdotal, and have not dotted the text with many footnotes and qualifications. What I've tried to do is help you learn about the "bottom line," conclusions implied and to be drawn from well documented material. Any mistakes, memory lapses, or omissions are my own error, and I apologize for them.

You may be surprised that some of these topics happen to go back quite a few years (note Blumlein). This certainly isn't virgin territory, even if the technology for wide-dissemination of high quality surround audio is recent. I believe most of this material has simply been forgotten or ignored in the newest rush towards surround sound and music. Many self-proclaimed (ahem) "Master Surround Sound Mixers", don't seem even vaguely aware of what's really going on here. Yet they've gotten some excited press, speaking as superficial "experts," and are responsible for a lot of confusion, misunderstanding, and plain rubbish. Hey, people, it's Caveat Emptor, like deja vu, all over again! ;^) Enjoy!

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14. Lipshitz, S., "Stereo Microphone Techniques -- Are the Purists Wrong?", J. Audio Engineering Society, vol. 34, no. 9, pp. 716-744 (Sept. 1986). Also a special "Stereo Mic Technique Demo", Dolby C (or B) Cassette is available from AES and the author. (**Very** recommended -- WC)

--Wendy Carlos

Go on to Pt. V

(Top of the Page)

Back to the Wendy Carlos Home Page

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Wendy CARLOS

What comes around Goes Surround!

Adventures in Surround Sound, from 7.2 to Quad

(personal and historical notes, basics, and acoustic realities often forgotten)

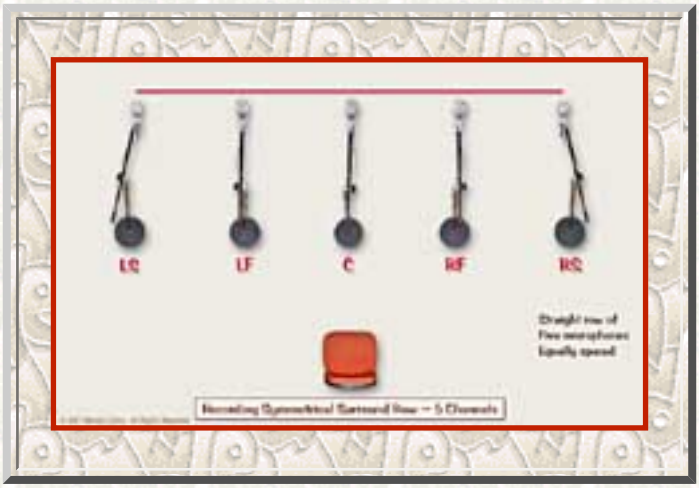
= P a r t 5 =

Go to the Surround **Table of Contents**

Go to the **wendycarlos.com** Homepage

(**Note**: all images below open a large view in a new window when you click on them. To continue the text, close the new window.)

Recording in Surround

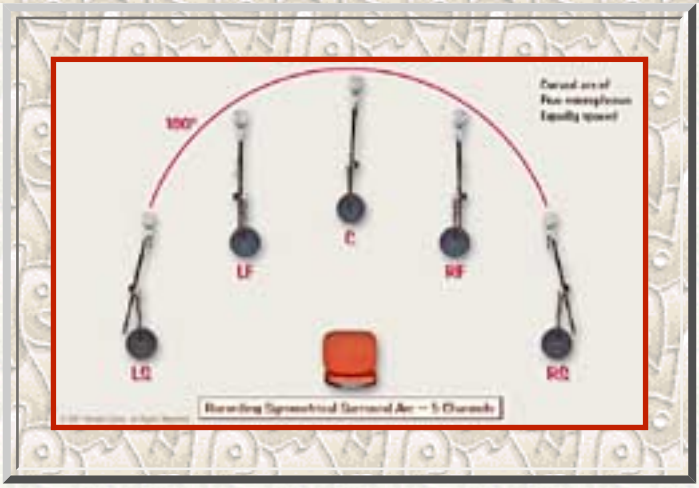


Five Microphones in a Straight Line

Okay, let's go through the ways one might record a live surround audio session, as a remote or in the studio. Most surround recordings will probably be created during the mixing process, from multitracked sources. That's the same with most stereophonic recordings, and we'd expect to continue with new surround mixes and remixes of older albums. But live recording in the simplest, truly elegant way, tends to produce the most convincing surround recordings. And the lessons learned from doing it directly will act as the best inspiration for what's needed during those elaborate mixdowns.

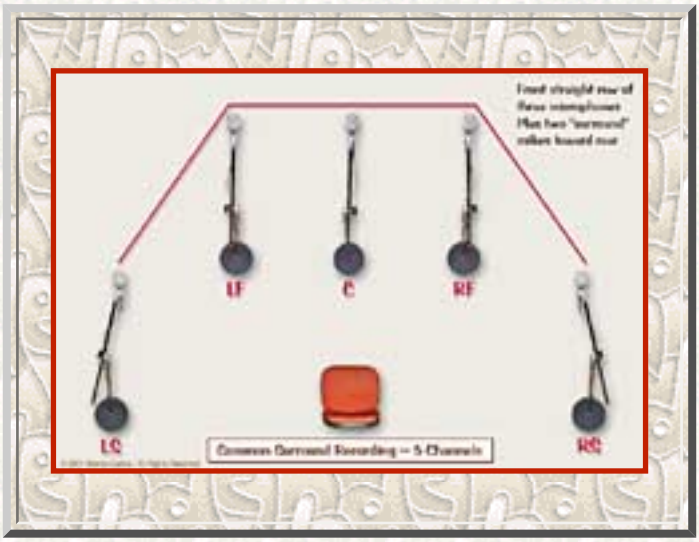
The first plan above is what I think most of us might want to try among our earliest attempts to record in surround sound. There are five microphones, one per channel, and they're set in a straight-line row as you see here. The mikes can be of several patterns, omnidirectional work well, while cardiods, even bi-directional microphones can be setup this way with great effect. If you've ever fooled with a decent variable pattern mike you know that there's not a huge difference in the sound quality, but more in the way the ambience and intensity of instruments gets recorded. In a bright room you'll probably want a narrower pattern. But in a warm, rich hall or environment, omni's can be pretty special. I've shown a KM-86 Neumann unit in these diagrams, as it's an excellent switchable pattern microphone.

The row of mikes is situated in front of the performers, near or further away much as you'd do for stereo sessions. There might be another group of mikes set up much closer with larger ensembles, which you'd mix in with these main five to enhance or "sweeten" a few of the sources, if needed. I'd suggest trying the ol' kiss principle (keep it simple stupid) for at least some of your earliest experiments, and adjust the mike heights, distances and separations, even mike type, to do the fine tuning. In a classic way the results ought sound pretty wonderful, if everything else is done properly.



Five Microphones in a 180º Arc

There's a slightly different approach, which you see here. We can place the same five microphones along a curved path, perhaps a full 180 degree arc. The mikes might all be "aimed" straight ahead (if not omni's), or angled outwards somewhat, if the performance to be captured is from a large ensemble. Note that the spacing, as with the first arrangement, is pretty close to equal spacing between all pairs of adjacent channels. The reason for trying this variation is inspired by the ideal way the speakers will be situated on playback. Since we've seen earlier that a semicircular speaker plan is hard to beat, it would only make sense to try a similar configuration while recording. We'll look at a few of the ramifications down below. Otherwise, what applies for the first plan will be pertinent for this second version. Early Stereophonic film soundtracks for Cinerama, CinemaScope and Todd-AO often used this arrangement, before most stereo films were mixed into stereo, using panpots and the usual bag of studio tricks.



A Common 5-Channel Microphone Array

Another way those early Stereo film tracks were recorded was more like this third version. In most cases the rear-side "surround" track was finally recorded to a single

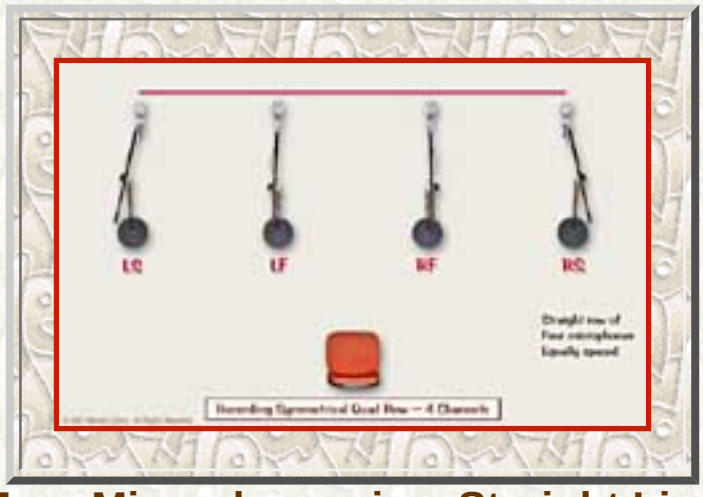
mono track, so a single microphone placed further away from what the camera was looking at was common. This works pretty well, and seems to be a favorite with many five channel surround recordings of classical music. When the LS and RS channels are thought of as rear ambience channels, which is kinda wasteful, but, hey, it's a common notion, the above microphone positioning seems very logical, indeed.

Then the frontmost three channels record a typical closer-miked stereophony, and that's where all the instruments would be heard. The remaining two channels would be picked up with fairly distant mike positions, and so would be relegated to capturing and reproducing the "hall sound", most of the reverberation and echoes from instruments located up front. The spacing then might be different from the first two plans, with equidistant mikes for LF, C and RF, and a much greater distance to both LS and RS, although they would be about the same distance from C, and fairly widely separated.

I think it's mostly a sad way to throw away most of the intense realism and drama that five channel surround audio can provide. If those two channels that cause the most problems, LS and RS are no longer placed behind the listener, then the matching mikes need not be so distant, some of the instrumental forces can be distributed to favor these channels, and the magic of multichannel can be a lot more exciting. I've drawn the third plan to match closely the way many surround systems will be laid out, and for music use, if not film (where the screen IS up in front, not wrap-around Circarama, fer Pete's sake!), this can be a very effective way to go, indeed.

(Top of the Page)

Quadraphonic Recording



Four Microphones in a Straight Line

There are many musicians who've recently commented that a front center channel is not that important to their music. They've heard how well two decent channels can create "ghost center" effects, when sounds are directed equally to both LF and RF, so see less reason to add more complications to their music mixes by adding a fifth

independent channel. at C. This is just a revisiting of Quadraphonic Sound, of course. I've used such a layout for most of my multichannel music, too, as five channel tape recorders were always rather scarcer than "poultry dentistry." So what to do but enjoy what you have, not mourn what you don't have, and may not even need. Meanwhile the rules are changing again for DVD-A's: many multichannel choices have become available.

Anyway, I LOVE the promise of the added C channel, and will not try to rationalize a four-track maximum here, it's now but one choice. At the same time, four channel masters can be "decoded" to extract the in-phase matching level signals which were placed on LF and RF in the original mix, so that the home listener will have unique signals on their new C channel speakers. Many listeners combine their surround system to serve both music and home theater functions. And perhaps still a majority of these home systems do NOT have a discrete center channel, relying on the good old "ghost center" effect. If the speakers are close together to serve a video screen, there won't be a big difference between having a real C speaker or just one of the virtual kind. In that case we really are back to Quadraphony, but doing it the right way.

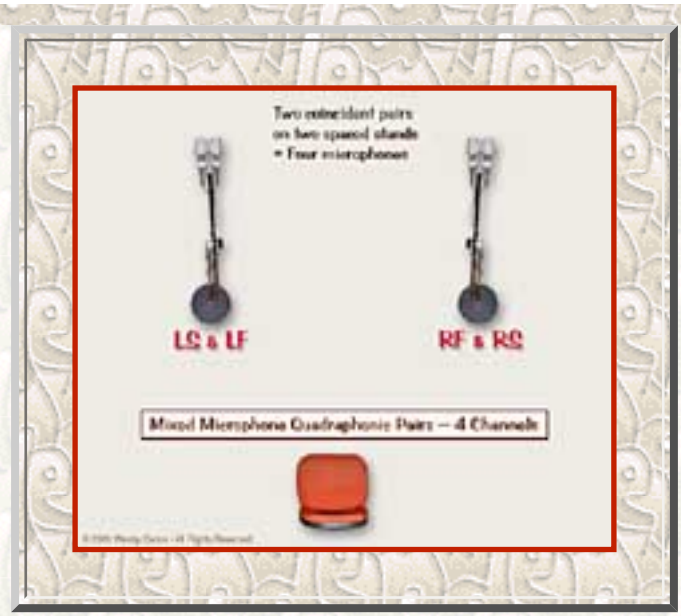
The four-microphones in a straight line above is what we will probably want to try for our first four channel surround sessions. We'd probably also try a curved arc variation, too, as in the second plan above. Again the mikes can be of many types and patterns, omni or directional, and the same observations of the first plan will apply here, too. The mike stands are a little further apart, to cover the same overall width as before, but that's about the only difference. And there well be the same observation to make down below, if the speakers are not to be placed in a straight line ahead (I've not gone into this earlier, but it is another option to consider, even if it compromises the "wrap-around effect" on playback), but are located in the optimal semicircle.

Creative Quad Recording -- 2 Spaced Mikes + 1 Coincident Pair

When I first began to make remote recordings with that old Viking four-track recorder you saw earlier (and a simultaneous Ampex two track reduction, to play on the local FM radio station and cut stereo dubs for everyone else), I found myself often considering the compromises of the intrusions you might make on a live performance. You really didn't want to annoy everyone, performers and the audience, with a maze of tall mike stands, and lots of cables trailing all over the floor. So it was reasonable to use the same coincident pair mike setups as we had in our two-track remote sessions. At the time I was unaware of the theoretical reasons coincident microphones produce much better, "tighter" stereo images than spaced pairs can do. Stanley Lipshitz authored several fascinating AES papers with audio demonstrations some years back, the definitive one in September 1986, and makes the case very well for NOT using separate, spaced stereo microphones.

Anyhow, there's an opposite side of the coin, too, which Lipshitz mentions. Spaced mikes capture a much better impression of the spaciousness and sound character of the recording environment, at the cost of sharply focussed images. That's why many of the finest recordings of live performances combine BOTH coincident and spaced pairs. But you have to be careful, or you can get phase-cancellations and other disturbing results with multi-microphone pickups (a good rule: let one mike per channel dominate somewhat, don't set them near equal level). On two channels there are a limited number of choices. If we record with multitracks more opportunities arise. The first I thought of is shown above. Trying to avoid a forest of mike stands, my curious audio friend and mentor, Peter Downes, and I mounted a couple of cardiod mikes on a single center stand, then added two extra mikes on smaller stands to either side. We also tried one of the new all-in-one stereo mikes on that center stand. Same idea, two channels from a center position, two from the side mikes. The outer two could be omni or cardiod, the front pair would be directional, cardiod or bi-directional (both work well).

Note how it resembles a three track session to the observer and musicians. And on playback you hear precise imaging between the LF and RF speakers, from the coincident pair, while the other channels are not so sharp in position, but create a marvelous "sense of place," and spaciousness. It's a lovely way to record in four channel surround. You can also extract a C channel later on from the center channels, or use more directional mikes and locate a third mike element along with LF and RF, aimed carefully apart. So this plan can be expanded to include five surround channels. (No, I'm not gonna get into the subtle distinctions between one-axis coincident mikes, versus near-coincident or even slightly spaced "ORTF and NOS like" configurations -- there are subtle trade-offs to each. The images here are just for reference.)



Creative Quad Recording -- 2 Spaced Coincident Pairs

On the other hand, for a major symphony orchestra and chorus Peter and I recorded for broadcast (the Berlioz' Requiem it was, instrumentalists and singers located all around a large cathedral, a perfect subject for surround sound!), this three stand method was not going to work. There was an aisle down the middle of the church, and no place to locate a center stand. No problem, we just shifted over to the above variation. Now both sides of the large orchestra were recorded onto four channels from two short, unobtrusive stands, using TWO coincident mike pairs, a U-48 (facing forwards) and B&O ribbon (facing more to that side) on each stand. (Here's a case that is not directly applicable to five channels, unless you want to add a single C mike between these two stands -- hey, that might work!) You can assume correctly what the results were: excellent side imaging, less defined positions in the center, a good wide sense of spaciousness. What a blast!


It gets even better than that. We needed more mikes to cover the widely spaced forces, and the Viking deck had two inputs per channel -- eight of 'em! (Well, it used to sound impressive...) So we sneaked in a Schoeps cardioid coincident stereo pair on one tall stand up in front of the main chorus and soloists, which gave excellent focus and positioning (Peter was as crazy as me about trying new ideas out). Then for the auxiliary two choruses and brass ensembles located to the sides, we hid two more omni U-47's, way off to the left and right of the cathedral. So those extra mikes were configured rather like the previous setup above which uses three stands. Still we were not too intrusive, you had to look carefully to see the mikestands dotted around. The theatrical Requiem is composed for major antiphonal forces, and everyone was being very authentic about this unusual performance. It was a marvelous recording experience, one I've never forgotten.

I visited the "scene of the crime" exactly a week ago by amazing coincidence, the first time in some decades, and took the above photos of this beautiful church (as usual click each for bigger views). It's the Providence Cathedral of Saints Peter and Paul. The orchestra and main chorus filled the front spaces completely, the antiphonal brass sections were placed near the side altars (a wedding party is rehearsing in the left one in the photo above) and two additional choruses were over in each side transept, barely visible here. There's also a view of the front of the cathedral, with its sturdy brownstone towers, and the left side facade and entrance. We setup just inside here, carting everything in through this doorway, placing the tape machines on a table in the side passageway. (At the time this plaza consisted of busy city streets and sidewalks.) We'd been able to assemble four Ampex 621 powered speakers (amazing sounding devices for their day), so I was able to monitor with a 120 degree arc of speakers, while Peter and his wife, Maggie, were singing in the main chorus for the Berlioz.

We used a similar setup several times again during my final years at college, and also when I had moved to NYC for graduate school, when I could get away to help Peter with other thorny remote recording sessions. The final remote session we did together was an even more elaborate quad session in the Atlantic City Convention Hall Auditorium (wotta huge barn!), but I've rambled on enough here already -- that's another story for another time...

(Top of the Page)

Multichannel Recording Quirks

Recording "Depth" Quad (diamond configuration)

Early in this web resource you'll find reference to a long-forgotten suggestion of how to use four tracks for much greater stereo realism, which we've called "Depth Quad." We saw how such a recording could be played back, with a "diamond" arrangement of speakers, all of them up in front, adding a center **close** and a center **distant** channel to a wider than usual L and R stereo pair. Let's view the setup to record such a master. It's pretty straightforward. The mikes are in essentially the same locations as the speakers will be. They will probably be spaced further apart, to "scale" up to a larger performing space than our home playback room is likely to be. No matter, it's a one-to-one correspondence.

I realize it might look a little silly here, when I threw in the chair from my studio again to give it scale (ick, the perspective doesn't quite match, nevermind...). But smile as you might at sitting with a mike or speaker in your face, you ought try it out for yourself sometime. After all, we won't see any commercial recordings available using this idea anytime soon ;^)... you'll have to roll your own. It reproduces an uncanny sense of depth, much better than anything we're used to, or about to get used to. But there are tradeoffs as well (not much overall width, and no wrap-around, depth-cues confined mainly to the center). I'm not actually recommending this as our new multichannel system. We'd need at least eight channels to do a convincing job with depth, as described before. And THAT many channels does seem to be premature for the moment. Keep it in mind, though, for a future stage of audio evolution...

Performers and 5 Microphones in Straight Lines

Every good idea has its down side, too. Above we looked at some microphone arrangements that are simple and effective. I'll stand by my suggestions for the optimum final playback arrangement: five channels in a deep 180 degree arc. Still, we might go for the straight line arrangement to record a live performance. It's simple and presents a less cluttered appearance to the performers and audience. Or try one of the alternates described above, with fewer mike stands. Fine, here we have recorded a hypothetical live concert, a small chorus with piano accompaniment, something you might very well get a chance to record in your hometown. Everything goes according to plan, and we bring the master back to our studio (you may guess where this is heading). Start the playback, and here's what we hear:

Reproduces with Illusory Curved Arc Configuration

Suddenly what emerges nice and cleanly out of the monitors is what you see here: a chorus all around in a semicircle, the piano up front and center. It's dramatic and

makes for an exciting listening experience. BUT -- it's not what you began with. The relocated five channels have "warped" the soundfield from straight across the front to a wraparound virtual chorus, depicted here. If you go the other way around: curved mike locations (the second diagram above), playback with five speakers in a straight line, the opposite "warping" will take place. To maintain the original configuration of the ensemble, you have to match plans for both mikes and speakers. And in this case, I think you'd hear that a deeply curved pickup of a straight across performance would tend to waste some of the realism of five channel surround, as the LS and RS channels wouldn't be doing their fair share. If surround music is to catch on with the public, let's show it off properly!

Anyway, it is called the recording **arts** and sciences, isn't it? There's no reason to apologize for the creative side of the act of recording, what effect you must have on the results. There is also no such thing as 100% accurate reproduction, and never will be. If the final product is good fun and an absorbing listening experience, if it conjures up an idealized "real" performance, expanding your own listening environment, who cares? My use of "warping" above is mostly a self-effacing tease. Don't fret the lack of exact match between "whatguzzinta" and "whatcumzouta." The goal is to create the **illusion of life**, the illusion that everything's identical, and just like making films or animation, you use whatever artifice it takes (those being very artificial art forms).

The reason the speakers ought be situated in one of these simple 180 degree curves is simply to present the maximum audible directional clues, with least wasted or ambiguous information, to the human hearing apparatus. Sometimes you may actually capture nearly what occurred in front of the mikes, and the listeners will hear it that way (depth quad does that in a limited way, and so can binaural sound). Most of the time it will be more complicated than **1:1**. But isn't this what cutting edge recording OUGHT be all about, "creating" and "recreating" all mixed-up together, producing wonderful listening experiences that can't be obtained in any other way? Everyone heard the improvements of stereo over mono sound in the 50's and 60's (and two track stereo is very artificial). Everyone does NOT hear the purported "angels on the head of a pin" improvements of gross oversampling and redundant data wasting. Properly done, there will be equally obvious "impact" as stereo had, when we advance to multichannel surround sound. Stick around and join the adventure!

--Wendy Carlos

Go on to Pt. VI

(Top of the Page)

Back to the Wendy Carlos Home Page

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Wendy CARLOS

What comes around Goes Surround!

Adventures in Surround Sound, from 7.2 to Quad

(personal and historical notes, basics, and acoustic realities often forgotten)

= P a r t 6 =

Go to the Surround **Table of Contents**

Go to the **wendycarlos.com** Homepage

(**Note**: all images below open a large view in a new window when you click on them. To continue the text, close the new window.)

Shoulders To Stand On

(or: "How Bert Whyte Turned Me On to Multichannel Music")

Go To Column One -- An Unusual Concert
Go To Column Two -- Irresistible Invitation

We all have to get our start and the "flame of inspiration" from somewhere, or it may never occur at all. And each of us who creates anything, of large or small value, will be found standing on the shoulders of the giants who came before us. I find myself often looking back to those pioneers who set the stage for my own life's work and contributions. I owe them an unpayable debt. But as Robert Heinlein, the great SF writer, once observed in replying to the question, "How can I ever repay you?", "You can't. You pay forward." This has been borrowed recently as: "Pay it Forward," so may already be familiar to you. It's an insight not to forget.

Among those who got my own wheels spinning in the direction of music making and audio engineering is the writer of the next two sections below. I was in grade school when the columns first appeared in what was called: Radio and Television News (later: Radio/TV News). It was a hybrid magazine of many related topics, which began by aiming at those who built, repaired, and tinkered with sound and video equipment. The magazine became much more varied than its name might suggest. There were unusual "do-it-yourself" construction projects (who "does it themselves" these days?), reviews of the technology of the day, early computer articles, theremins and music making devices (yes), and even a monthly recorded music column called the "**Certified Record Revue**." Wotta name! The reviewer was **Bert Whyte**.

In the decades since that column appeared, many folks have asked me just how I got started, why did I pursue what then was once a nearly unknown field? This webpage is a partial answer to those queries, and I hope you will get a taste of the excitement Bert so ably put into words, which captured and enthralled me, even though I was only a kid. If the seeds of curiosity in matters musical and scientific / technical were already within you, this kind of gusto is seductive. Look how long I've remembered these columns, and would have loved to see them again somehow.

To cut to the chase, it was on the ubiquitous eBay web auction site than I stumbled upon most of a year's worth of issues of R/TV News around the summer of 2000. I'd discovered a few other antique bits of nostalgia previously, and had bid on a few bargains, sort of fun. This one was a shot in the dark, I couldn't remember the exact year (it was 1956), and I hadn't seen the original dusty old issues since starting college and discarding a lot of stuff in my parent's cellar. This time my gamble paid off, and in the first shot I hit the target -- both reviews were in two of the issues (June and September) I'd obtained -- BINGO!

I'd forgotten most of the details by now, of course. And all the old ads -- how quaint. But the first reading brought it all back, and still seems worth a little adrenaline. Gee, there was a take-it-for-granted interest back then in non-superficial music (how sad

the narrowed choices of the present -- devoid of human expression, a dusty desert for heart and intelligence). I don't know how many of you will share in my feelings, but here goes nothing. Take a read below and see what sparks are conjured. Think about how it would feel if mono audio was all you ever heard. Oh, yes -- I did eventually meet Bert Whyte and his wife, Ruth. That was at the 1969 NYC AES show, when The Well-Tempered Synthesizer had just come out. Bert knew Mark Aubort, a master audio expert who was then also the USA importer of the first **Dolby A-301** units (we were among the first studios to use a few on our multitrack and mixing sessions), and we all were introduced.

"**Oh, BOY**, am I happy to meet you!", I greeted a cheery, rotund, pleasant looking man somewhere in his middle years. Ruth was a little shyer, but quickly Rachel and I learned that she had also been Bert's collaborator for years, the assistant engineer to him on those legendary Everest stereo recordings of the late 50's and 60's. (Ya gotta hear their recording of Respighi's "Roman Festivals" on a big system! **EVC 9018**) We chattered about a lot of things, made far too many jokes and **puns** (even spelled backwards, "a nup is a nup... "), but only after playing mutual admiration society. I praised the columns (and others later, like "Behind the Scenes" in Audio magazine) for jazzing my interests in matters musical and multichannel, and Bert and "Ruthie" praised S-OB and the just released W-TS. We went out for a lunch together, and a good industry friendship was kindled.

Rachel and I drove out to see the Whytes several times during the 70's, to their home plunk in the middle of Long Island (a town aptly called: Centereach), filled with so many cool "toys." Then Bert and Ruth came to have offbeat dinners with us, long visits at Rachel's brownstone, where soon after we relocated the studio. Tapes were brought by the visitors either way, to enjoy together on our big systems. Music of all kinds was discussed, played and dissected, from Carly Simon and Dave Brubeck, to Eugene Goossens conducting the LSO playing Rachmaninoff. We didn't get together so often in the 80's for the usual reasons, when you're not living in the same town (or even when you are...). By the early 90's Bert investigated and wrote about another versatile surround sound idea: **Ambisonics**. Sadly, it has never gotten its day in the sun, either. I'll add more about it on these pages soon. Then just as all their ultra hi-fi Everest recordings were being released for the first time on CD around 1993, Bert became sick and died. He did see the initial tests of the audio transfers and new graphics for the first few, I'm pleased to note. Ruthie and I continue to speak on the phone every few months; we love to chatter with one another about music and audio and life.

I do believe Bert would get quite a kick out of seeing these particular two columns appear on this website, a concept he never got to explore. You'll discover in reading below, perhaps, that the "push" to get multichannel sound is nothing new. Here it was for true three channel stereophony. Two decades later a fourth track was added, and quad got run up the flagpole. And now 25 years beyond that we're about to add yet a fifth track (and ".1 of a track," for the subwoofers!). Have things changed so much? I hope one thing **HAS** changed. Both three channel and quad went nowhere (you heard it here first *wink*). Bert's barely contained excitement and "news" below

turned out not to be prophetic (at least basic stereo came out two years later). Quad was messed up by ignorance and record company greed. Sound familiar? I wonder if in another three to five years we'll look back on 5.1 plus Surround Sound as merely the most recent failure to move past two tracks (need it or no)...?

(Top of the Page)

Column I -- An Unusual Concert

By BERT WHYTE

A FEW months ago, a very interesting and significant hi-fi sound demonstration was presented in San Francisco. Picture this scene if you can . . . you are sitting in a great concert hall and the San Francisco Symphony is about to perform the Overture to the "Marriage of Figaro" by Mozart . . . conductor Enrique Jorda raises his baton, gives the downbeat and the first bars of the familiar music reaches you. As you listen, you note the precision of the first violins, they are all bowing together in near perfect unison; observing the woodwind section you focus your attention on the flautist and the pure sound of his instrument comes to you from the middle of the orchestra where he is sitting. Your eyes and ears move back to the right where several contrabassists are busily sawing away at their ponderous instruments. As the score develops, you are aware of the constant activity of the instrumentalists.

Now we are about two-thirds of the way through the work and at the beginning of a crescendo, suddenly you can't believe your eyes! The musicians have stopped playing and have laid down their instruments, but the **music continues to its triumphant conclusion!** You are as bewildered as everyone around you, when three floodlights illuminate three huge theater-type speakers placed at equal intervals across the back of the stage, and another flood shines down upon the familiar heads, reels, and tape of an Ampex tape machine and you realize you have been hearing a **three-channel stereophonic recording** of the work that has just been "played"!

A moment later a narrator assured everyone that this is in fact, the truth . . . that right from the very beginning of the Overture the musicians were merely pantomiming their playing in concert with the tape which had previously been recorded! "Oh come now," says the True Audio-doubter, ... "do you mean to say the realism was so great that everyone was fooled ? You must have had some inkling that the reproduction didn't sound 'quite right' and that it had a mechanical quality."

Now friends, this situation actually existed at that demonstration, and in subsequent numbers, other stereophonic trickery was shown. Now whether the same sense of realism was perceived after the audience knew there was stereophonic reproducing equipment on the stage, I don't know. However it is well known that there is an interrelationship between the eyes and the ears when both senses are used simultaneously as in listening and looking at a live concert. The eyes and the ears can easily deceive you. With the musicians going through their motions in perfect synchronization with the stereotape, if there were differences, the mind was not psychologically prepared to accept these differences.

With three-channel stereo the highest pinnacle of the audio art to date and with the demonstration under absolutely ideal conditions, the difference between live and recorded was of a very small order at any rate and the mind of the individual listener, having preconditioned itself to the fact that it was going to hear live music, accepted what it heard and saw without question. To further the deception so that even the most astute music lover or knowledgeable hi-fi fan in the audience would find nothing amiss, very special machines and recording techniques were utilized. The Ampex machines were special three-channel Model 300 units, modified to use half-inch wide tape, instead of the one-quarter-inch standard width. This eliminates what was one of the problems with the original one-quarter-inch three channel machine, the deterioration of the signal-to-noise ratio. With less than 45 dB signal-to-noise ratio in the standard machine, at high levels some sharp-eared hi-fi fan would have heard the tape hiss, and even in a preconditioned state, he would ultimately realize that he was not hearing live music.

The half-inch wide tape allows each of the three channels a much wider area with subsequent improvement of the signal-to-noise ratio. The tapes made before the performance had to resort to special microphone techniques. No omnidirectional pickup here . . . all recording had to be very close-up and as non-reverberant as possible, otherwise you run into double acoustics, in other words, in a normal recording session you want some of the hall reverb in your recording to lend "liveness" to the sound. If that had been done at this demonstration, it would have spoiled the illusion desired since you would be playing back the recording in the same hall and you would have produced double reverberation.

The speakers used were the Cinemascope type developed by Ampex in conjunction with Jim Lansing and have extremely broad coverage. With their exceptionally high efficiency, it was found that 30 watts of power was sufficient to cover the audience of over 3000 people. Now the crux of this whole thing is this, among those 3000 people were many hi-fi fans who no doubt were vastly impressed, to say nothing of the

many people who had never heard real hi-fi sound let alone three-channel stereo! Undoubtedly many of these people, affluent or otherwise, will want to know if there is anything available that will give them this three-channel sound in their homes. The answer of course, is yes, but you must be prepared to pay roughly 2900 dollars for a standard Ampex three-channel machine, and set up three amplifiers and three speakers as well. Assuming some millionaire indulges himself in one of these rigs, do you know what will be available to him on three-channel recorded tape? Just one reel of some organ music. There may be one or two others somewhere but I have no knowledge of anything outside this one commercially-made tape.

I'm a lucky guy. I'm one of the few people who have had a three-channel Ampex stereo machine in his home. And Ampex supplied me with not one but four or five different tapes. I lived with that machine and it was one of the biggest thrills I've ever had in audio, but even the fabulous sound of three-channel stereo begins to pall a little when you hear the same music continuously. The lesson to be learned from this demonstration is this . . . stereo whether two or three channels is here to stay. The public is impressed and the public likes it and will buy it if a way can be found to get the cost of the equipment down to an approachable level. The Ampex 612 was, of course, a big step in the right direction and if the production rate and availability of two-channel stereotapes can be stepped up, they will enjoy a brisk market. But going one step further, why not take the final plunge and try to produce a marketable three-channel system. Two-channel stereo is great, but nonetheless there are many people who have difficulty in perceiving its depth and directional qualities. With a three-channel unit the fact that you have something **different**, something that sounds incredibly alive and natural is immediately apparent even to the most untrained ear. It is well known that a two-channel stereo system using very modest amplifiers and speakers, will sound better than some of the most expensive and elaborate monaural systems. With three-channel stereo you can literally, "get away with murder" in the matter of speakers and amplifiers and even with units no better than are found in today's inexpensive tape recorders! Knowing a bit about the economics of producing tape recorders, I say that the logical step up to three channels is neither technically difficult nor financially unfeasible.

The big problem to overcome is the matter of the recorded tape. But that was the problem of two-channel recorded tape and it has been largely overcome and the situation will be well in hand by the end of this year. Many people, some of them placed very high in the music and audio fields, feel that monaural tape is now merely a transitional thing, and that stereo will be the medium used for music on recorded tapes. I'm inclined to agree, but why stop there ? Why not start beating the drums for three-channel stereo, which believe it or not, I feel has a larger sales potential than anything in the field of home music entertainment. The fact that three-channel sound is so startlingly better than conventional sound, leaves open avenues for some smart manufacturer to produce a complete packaged system at a price the public can afford. I sincerely feel that three-channel stereo is in much the same position as was television some years back. It's new, it's different, it's good and, like television, I think there are plenty of people who would be willing to pay the initially higher costs for the

privilege of hearing it before it reaches the price level of the masses. As to the music . . . well you just see how fast the big record companies will produce three-channel stereo, when they smell a new market.

As a matter of fact there is an even easier way of getting the necessary music. I don't have to tell you about the success of the various record clubs . . . it's an accomplished fact and they are growing bigger all the time. If one of the big ones, like the "Record of the Month Club" were really on the ball, they would get themselves three channel tape recorders and record everything they do in the stereo medium as well as on monaural tape and offer the resultant tapes on their usual subscription plans. I'd join instantly and so would thousands of others.

These big clubs have the money, they have no restrictions on what they record and actually this would be the ideal time for them to start, since they are slowly recording the standard repertoire. This would make a more easily assimilable choice of music available on stereotape. This is when they are recording the Dvorak 5th, and the Tchaikovsky 6th, etc. For the most part, the big record companies would be reluctant to record these warhorses again due to the plethora already in the catalogue and while no one wants to discourage them from recording their current repertoire, you can readily understand that it would be easier for them to sell, say, a Beethoven 5th, rather than a "Mathis der Maler" by Hindemith, if-- they could justify the cost of recording a new Beethoven 5th just to have it on stereo. Since most of them would probably not change their recording plans, (at least not initially) due to the cost factor, the logical method of supplying the "warhorse repertoire" on stereo tape would be through the clubs.

Well, it's a fascinating subject but I'm running out of space. I'll conclude with this. If a club comes out with a subscription plan which would guarantee the release of a certain number of three-channel stereotapes each month, and someone puts out a three-channel stereo system for around a thousand dollars (and I think it can be done for far less) this I'd like to sell, and given proper demonstration facilities, I'd have writer's cramp taking the orders!

Equipment used this month: Pickering "Fluxvalve" cartridge, Pickering arm, Components Corp. turntable, Marantz "Audio Consolette," two 60-watt McIntosh amplifiers, Jensen "Imperial" speaker, Electro-Voice " Georgian," and Ampex tape equipment.

KHATCHATURIAN
GAYNE BALLET SUITE
MASQUERADE SUITE
Philharmonia Orchestra conducted by Aram Khatchaturian.
Angel 35277. RIAA curve. Price $4.98.

This is the fourth performance of the "Gayne Suite" to appear in the LP catalogue, and is by all odds the best. For a starter, the composer himself is conducting, and while it is true that some composers make awful botches of conducting their own

scores, such is decidedly not the case here. Rather, Khatchaturian adds a new dimension to the work, in an interpretation entirely different ;n concept from that of the other conductors. To my ears at least, there seems to be a great deal more material in the score than my previous experience with the work would indicate. I would say that Khatchaturian, secure in his grasp of the work, manages to imbue his colorful score with considerably more power and vigor than the other conductors could summon. *(continues, including several more reviews...)*

RADIO & TELEVISION NEWS

Comment: for many year we tried to get an orchestra excited to pull off a new version of a similar stunt as Bert describes here. This time we wanted to have an ensemble of about eight synthesists on stage at the rear, actually replicating a big symphonic work. And then the musicians would put down the instruments, but the sound would continue. It would be provided by us, of course, and would show how far the technology and performance mastery of it by good musicians had come, to replicate and surprise an audience into thinking it was "the real thing." But no one seemed interested. I still think it would create a smashing stunt and make a genuine statement. Bert was also ahead of his time. Three track stereo never got much past the stage he describes above, and what continues below, from a few months later.

(Top of the Page)

Column II -- Irresistible Invitation

By BERT WHYTE

I DON'T know quite how to begin this month's column. Regular readers will recall that in the past two issues I have been promising some sensational news concerning three-channel stereophonic sound. This "scoop" was promised for this, the September issue. Fortunately, the news will be presented this month, but unfortunately it will be nowhere near as detailed a report as I had hoped to bring to you. As I have said in previous issues . . . writing a column two months in advance has its drawbacks and in this case there was many a slip 'twixt the cup and the lip. Don't get me wrong! This will still be one of the most sensational, provocative and industry-shaking announcements in the brief, but spectacular, history of high fidelity! However, I know that if I were not bound by certain restrictions, this report would have had twice the impact. Perhaps, remembering the obstacles and frustrations I encountered during the labor-pains and birth of binaural and two channel stereo, I have tried to go too far too fast, in an effort to circumvent these difficulties. I guess I'm just a hot-headed Irishman, boiling with enthusiasm for hi-fi in general and stereophonic sound in particular, with a burning desire to help bring this fabulous sound to fruition and make stereo available to everyone! Well, restrictions notwithstanding . . . what I've got is great and a big step forward, so here goes . . .!

You will recall I reported on the 3-channel Ampex demonstration with the San Francisco Symphony, and then got up on my soapbox and blithely asked why not 3-channel sound for the home? I acknowledged the multitude of difficulties such an undertaking would entail, daydreamed a little . . . and then got down to the brass tacks of what would be necessary to bring 3-channel stereo to commercial reality. In summation it was concluded that even if there were large numbers of people who could afford the great expense of existing 3-channel tape machines, or even if a relatively inexpensive 3-channel tape playback machine became available, they would all be quite useless without a source of recorded 3-channel stereophonic tapes. Yessir, we were right back at the old bug-a-boo . . . without a continuous source of good recorded tapes the stereo balloon would never get off the ground. I use the words "continuous" and "good" advisedly . . . drawing on the experience with binaural and two channel stereo, where a good many enthusiasts of the early days rushed out to buy the necessary equipment to play stereo and then were subjected to the frustration of having only the most sporadic trickle of tapes released, and even these were generally of very indifferent quality. Some of the most inane, rankly "gimmick" type repertoire was thrust upon these poor souls with the excuse that it was "stereo" which made everything "all right"! I must insist that this is a ridiculous attitude.

Generally, if a person thinks highly enough of his hi-fi to indulge himself in stereo equipment, he is usually a few cuts above the average in musical discrimination and stereo or not . . . he wants either good classical or good jazz material . . . sensibly chosen repertoire, performed reasonably well by professional executants of known reputation, and it goes without saying, the highest degree of technical excellence in the tape he buys. Happily, the days of the "gimmick" releases is about over with 2-channel stereo since the advent of the stereo tapes by RCA Victor and other forward

looking companies. I think a lot of people have learned a lesson and the buyer of 3-channel stereo will be a more cautious fellow than his 2-channel predecessor, and the same can be said of the recording companies who, as you shall see, will offer tapes of genuine musical substance with the added plus of 3-channel stereo, rather than issue tapes where the stereo "effect" is the thing and the music merely subsidiary.

So, realizing the problem confronting three channel stereo for the home was largely a question of recorded tape availability, I decided (without much hope of success I admit) to sniff around the recording companies and ferret out as much information as I could on the possibilities of their producing 3-channel stereophonic tapes. Being a reviewer one naturally gets to know a lot of people in the recording industry, so at least I had the advantage that I wasn't approaching this thing "cold turkey"! My first inquiries were treated about as I expected.... Boy, you should have seen the raised eyebrows! I guess most of them figured I had flipped my lid, and I could see the prevailing attitude was that I was strictly for the birds! Not that I blame them very much. While most outfits have been recording 2-channel stereo for some time, few had released any as yet and here I was madly yakking about 3 channels! I must admit things were more than a bit discouraging and I was about to concede that 3-channel stereo was still quite a few years away, when I got the first faint flickering of hope! One of the big record clubs had been recording 3-channel stereo for some time . . . **but not for the purposes of issuing the results in the form of recorded tapes!** They were using a technique which was fairly common with 2-channel machines in making monaural tape masters for subsequent disc transfer . . . that of post-mixing. In other words after the actual recording session, the engineers would play back the 3-channel tape and then, mixing whatever percentage of each channel they wanted, they obtained the desired monaural signal which was recorded on a standard monaural tape machine. It is not my purpose here to debate the pros and cons of this technique, but one fact is of course quite obvious . . . here is a source of 3-channel stereo tape, since there is no law that says one has to post-mix and use the 3-channel master for no other purpose!

While this certainly was encouraging, it didn't help too much as I drew a blank as far as being able to determine if the release of any 3-channel material was ever contemplated. I would have pursued the matter further (even though my contacts with the clubs are second and third person since I do not review their products), when I got a phone call that changed everything. "Would you care to hear some white labels (test pressings) of some new material tonight?" inquired the feminine voice with the soft Texas drawl.... Would I! This is tantamount to offering a man dying of thirst a bucket of ice cold spring water! Naturally, I like to avail myself of every opportunity to observe and hear the work of the professional recordist in his native habitat. The caller was the very charming and talented administrative director of Mercury Records, Miss Wilma Cozart. I was to meet her and Mr. Bob Fine, chief engineer of Mercury in Studio C in the 5th Avenue, New York headquarters of Mercury Records.

That night, I had no sooner stepped through the thick soundproof door of the studio

and was shaking hands all around when my eyes riveted themselves on the familiar sight of an Ampex 300 tape console with the most unfamiliar addition of oversize tape guides, tape gate, and capstan and capstan roller designed to accommodate the half-inch tape that was threaded through the machine. A wild thought ran through my head and I looked at my hosts who by now were both wearing big grins. "Could this be a 3-channel stereo setup?", I inquired rather warily of Mr. Fine. Both he and Miss Cozart laughed and said that knowing of my interest in stereophonic sound they had rigged up a demonstration that I might find entertaining. By Gadfrey if that wasn't the understatement of the century! Studio C is a room about 35 ft. wide by roughly 60 feet deep and with a nice 20 foot ceiling. Near the entrance is the glass enclosed control booth and at the far end a big curved projection screen that receives its images from the projection booth high in the back end of the room. Behind the screen are three monster Jim Lansing theater speaker systems, driven by three 60 watt McIntosh amplifiers! This studio is ordinarily used to score movie films for various types of multi-channel sound, including Mr. Fine's own "Perspecta" sound process. Being obviously all set up and prepared for me, Mr. Fine punched the start button on the Ampex and the big reel of half-inch tape began to feed through the tape gate. In a few seconds a slight increase in tape noise over the normal background told me we had reached the "live" portion of the tape and an instant later my astonished ears heard the purest, cleanest, most fabulous sound I have ever encountered as the speakers gave forth with the striking opening bars of "Tabuh Tabuhan," an exotic work by Colin McPhee . . . a new Mercury release featuring the Rochester Symphony Orchestra conducted by Howard Hanson.

The disc is reviewed later in these pages and it is an outstanding recording in every respect . . . but good as it is, it was pallid in comparison to the incredible realism of the 3-channel stereo. I am sincere when I say I was literally stunned with what I was hearing. It was hard to believe the Rochester Symphony Orchestra wasn't there before me on the stage. No, that isn't quite correct really, because in many ways this was far better than the real thing! I mean it . . . it would be a rare seat in a rarer concert hall where all that I heard on this stereo tape could be heard equally as well. The most startling aspect, of course, was the infinitely greater sharpness and delineation of the inner orchestral details. This was quite unbelievable and I heard things on the tape that were but tenuous hints on the discs. String tone? You've never heard anything like this! Even in the highest registers of the first violins there was no screech, no eardrum piercing edginess, rather there was a smoothness only previously encountered in the confines of the concert hall. The richness of the second strings, the mellow throb of the cell), the dark sonority of the contrabass), all were vibrantly alive with realism. The contrabassi were especially spectacular. Ordinarily even on good records and through good hi-fi equipment, the bass viols have a sort of "voom-voom" sound . . . low enough in frequency to be sure, but without much character. Here on the 3-channel stereo, you can begin to appreciate the throbbing power they generate, and you can perceive the individual tones and timbres of each string, you can feel the deep resonance, hear the higher harmonics, detect subtleties and nuances of bowing and fingering impossible to hear on a disc.

With 3-channel stereo, brass sonorities are breathtaking. Trumpets have a clean brightness equaled only by the real thing. And with this brightness there is a roundness and fullness of tone, a sense of swelling power not found on discs or on regular tape either. In staccato and other rapid passages, there is no blurring or fuzziness whatever . . . all is sharp and incisive. Trombones have their characteristic blare, but again with a rounder, fuller tone, and when they are guttural and growl "way down in the low frequencies," you can still perceive the timbre of the instrument . . . it isn't lost in muddy distortion as on so many discs. The woodwinds are quite extraordinary. The stereo probes extremes of the various instruments in a fashion almost totally alien to discs and monaural tapes. The characteristic breathiness of the flute and piccolo is almost palpable in its liveness and realism. Vibrato is noted to a much greater extent than on the other media. The clarinet, bassoon, oboe, English horn, are heard with exceptional purity of tone.

Returning for a moment to the brass, that most difficult of instruments to record&emdash;the French horn is heard on stereo as a very clean, full-bodied and richly resonant sound. Its heroic sound, embellished by the spaciousness of stereo is a thing of unearthly beauty. Percussion on 3-channel stereo is best described as awesome. On bass drum not just the whump and the thud is heard, but the tone as well. More than this, you can feel the tremendous power as the sound envelope hits you. Tympani are super clean, crisp, and precise, and you can feel the tautness of the stretched drumskin. It is also a great deal easier to discern whether the tympanist is using hard or soft mallets or bare sticks. Snares, whether gut or wire, are easily distinguished, cymbals, gongs, bells, triangles, xylophones . . . the whole percussion battery can be heard with a cleanness and articulation not possible in anything but 3-channel stereo.

The directionality of the 3-channel stuff I heard was fantastic and actually I was surprised at the degree of superiority over two channel stereo. With tri-stereo, it was not necessary to stay in a more or less circumscribed spot, to obtain the maximum directional effect. Positioning oneself right or left of the center line naturally threw into focus the instruments which prevail on one or the other side of the orchestra, yet there was little difficulty in perceiving the interplay between the various choirs. Best of all . . . the "hole" (in the middle --ed.) which is more or less apparent in many bi-stereo tapes, was no longer evident. In fact this elimination of the center "hole" with the third or middle speaker seems to have much more significance than I would have believed. With the three channels no matter where you stand or how uneducated your ear, it is completely and instantly obvious that you are listening to stereophonic sound. Probably the most important aspect of the third channel, however, is not the increased "right-to-left" directionality that it affords, but that it adds the new dimensions of "front-to-back." This is truly the crux of the case for 3-channel stereo . . . the attainment of depth for a true three dimensional sound. The third channel is cumulative in its effects, and the totality adds up to the fact that when it is combined with two other channels, it is markedly superior to the two channels alone. The addition of the depth makes the illusion of presence complete and unless you hear tri-stereo, you won't believe the fantastic difference that third channel makes in

terms of musical realism.

"Tabuh-Tabuhan" came to its triumphant conclusion and I was sitting with mouth agape when I suddenly woke up and started firing questions. IS there any more . . . Is this just experimental . . . etc., etc., ad infinitum! Well good people, **here is the thing that is going to stagger you!** Mercury has been recording 3-channel stereo since the beginning of the year and already has built up an impressive backlog! This is a continuing program and everything Mercury now records for disc is also recorded in tri-stereo! WHY is Mercury doing this? They are recording 3-channel stereo **with the intent and purpose of releasing recorded tapes for public consumption!** No, I'm not kidding you . . . it's a fact ! ! !

What repertoire is now available you ask? Sad to relate my friends but, at the moment, nothing is available. Oh yes, like I said, they have tapes all right . . . that same evening I was treated to parts of many works. Dorati and the Minneapolis doing the Brahms "Third," reviewed in these pages last month, the same conductor and orchestra doing Tchaikovsky's "Cappricio Italien" which I reviewed two months ago, Paul Paray and the Detroit Orchestra doing Debussy's "Iberia," the same conductor and orchestra in new items like Chausson's "Symphony in B Flat," and some Wagnerian works, Dorati again with Richard Strauss' "Till Eulenspiegel" and there are many others. As you can see, I was literally drowned in gorgeous tristereo and I can tell you that this was the hi-fi experience of a lifetime. It was simply an overwhelming thing and I hope that before too long others will be able to experience the same thrills. I said nothing was available at the moment and here are the whys and wherefores. Remember, I told you this material was all on special half-inch tape instead of the standard quarter-inch. Reason for this, of course, is that the wider tape and the extra width of the gap in the three special heads will afford a better signal-to-noise ratio which is important if quiet tape dubs are to result. So that's the first reason . . . non-standard tape width. I suppose that if some millionaire were to indulge himself with a tri-stereo Ampex 300 modified for half-inch he might be able to get a stereo tape dub from Mercury.

Quite obviously, if Mercury is to release this 3-channel stereo, the economics of the matter dictate that 3-channel **quarter-inch** tape will be the medium. Now here is the rub . . . the number of 3-channel quarter-inch Ampex units that have been produced is quite minute. To my knowledge there is but one unit on the whole East Coast! Again it is obvious that although Mercury could dub its half-inch stuff down to one-quarter, this machine-to-machine at regular tape speed hardly constitutes a method of quantity production. So the problem is really one of duplication.

I have been given to understand that Mercury is trying to work out a feasible method of quantity production and if they are successful, they hope to be able to release some tri-stereo this fall or winter. I might add here, that like any new development, initial costs will probably be fairly high although every effort will be made to keep the tapes as reasonable as possible.

By now the thought has probably occurred to you that even if the Mercury tapes

were ten cents each and plentiful as potatoes, they wouldn't be much use to you without a tape playback machine which could handle 3-channel stereo. And so we have come full circle and we are back at the other end of the problem. I think everyone will agree that the prime problem with 3-channel stereo is tape availability. Now that we know at least one company is doing something about it, it is safe to assume that other companies will soon follow suit. So having gotten a good start on the tape problem, there is now the question of the tape playback and who makes it and for how much? I wish I could give you more information about this. . . for the affluent there is of course, Ampex. For "Joe Doakes, music lover," I cannot give much encouragement beyond this . . . one company, well known for its inexpensive "component-type" tape machines has gone so far as to build prototype 3-channel, 1/4th-inch heads. If successful, and there is every reason to believe they will be, these heads would be available with their regular production tape mechanisms and as a replacement or addition to heads in existing units. What will these units cost? I have no way of knowing but the fantastic figure of "under $200" has been bandied about and if this were to be true, it means that with three of the most modest amplifiers and three small but reasonable quality speakers a 3-channel stereo system could be had for about 400 to 500 dollars. This still isn't chicken feed I'll admit, but I will guarantee to you that it will sound better from a musical standpoint than the most expensive and elaborate single-channel system. So there you have it friends.

We are on the threshold of fabulous 3-channel stereosound, years earlier than we had any right to expect. That there are still problems to be solved with both tapes and machines is evident, but at least a start has been made and if the hi-fi public will get behind the idea and show the various manufacturers that they are really interested . . . you'll see the problems cleaned up in short order. I will watch the progress on this matter and try to keep you well informed.

As you can see, this important report was quite lengthy, but I certainly think it was worthwhile. In consequence of its length, we won't have much space for reviews so I'll make up for it next month with literally no introductory yak and as many reviews as we can squeeze in the column.

Equipment used this month. Components Corp. turntable; New Weathers viscous damped arm, cartridge, and oscillator; Marantz audio consolette; 2-60 watt McIntosh amplifiers; Jensen "Imperial" speaker; Electro-Voice "Georgian" speaker; and Ampex tape equipment.

MOZART
CONCERTO # 13 FOR PIANO AND ORCHESTRA
CONCERTO # 20 FOR PIANO AND ORCHESTRA
Julius Katchen, pianist with New Symphony Orchestra of London conducted by Peter Mang. London LL1357. RIAA curve. Price $3.98.

Another London contribution to this Mozart year, this recording is especially welcome for the fine version of the "13th Concerto " which is not heard very often. Katchen is

in fine form here with vigorous and well paced readings. His phrasing and dynamic shading seem much improved over some of his recent work. His tone is quite big, but fortunately he avoids excesses like percussive harshness. His reading of the "13th Concerto" certainly is the best that is presently available. *(continues, including several more reviews...)*

The opinions expressed in this column are those of the reviewer and do not necessarily reflect the views or opinions of the editors or the publishers of this magazine.

RADIO & TELEVISION NEWS

Comment: And this seems to be as far as three-tracks ever went. I never learned why Mercury and the other companies mentioned never took this to the next stage. We can assume that two track stereo provided enough problems for listeners less than two years after these columns were written. Bert wrote a second column for the same magazine starting a year later, called "Sound on Tape." It reviewed the newest stereo prerecorded tape medium, which actually could sound very good. Tapes continued for many years, giving rise to prerecorded cassettes and good old eight-track cartridges. But stereo LP's became the major release medium for stereo, and it couldn't provide three distinct channels in any direct fashion. The center channel, by the way, has remained ignored until the newest 5.1 surround disks appeared, DTS, Dolby Digital, and now DVD-A's. Used well the C channel fills the front of the soundfield nicely, and is a worthy addition that has been waiting in the wings for only half a century!

(Top of the Page)

Go back to Pt. I

Back to the Wendy Carlos Home Page

Wendy Carlos, SurroundSound6

webmaster@wendycarlos.com

The Wendy Carlos
D I S C O G R A P H Y

(Listed with most recent albums towards the top. Hit **Reload** to be sure you're getting latest update of this or any other page, or even better, **trash your cache**. Click on any cover image for a close-up view.)

Note: Due to major changes in the music business, we unexpectedly lost our ESD distrubution, leaving us stranded with few good options. We expect to have news on a new set of releases of Wendy's albums, plus a return to regular additions on the site as soon as possible. Until our new arrangements are complete, we're leaving this page with the last updated links, which can still find copies (where available) through various sources. Meanwhile, thank you sincerely for your many concerned inquiries and patience, good friends.

Our Newest Releases!
Other Currently Available Titles
Help about web-ordering CD's
Temporarily Out of Print Titles
Other Albums -- their status
Lost-Record Hunters note
Updated: **Disc Notes**
Return to Homepage

Warnings: unauthorized CD's

New 20-bit Hi-D releases on East Side Digital (and other available titles):

Album Cover	Title and CD Number	In brief	In depth	Hear/ buy
	**Rediscovering Lost Scores** **= volume one =** Includes music for Kubrick's **A ClockworkOrange** and **The Shining**. *= ESD 81752 =*	**Released Spring 2005** **= Brand New Album! =** 32 tracks of unique filmmusic, tracks you have asked us about, unavailable in any form -- until now.	Learn all about **this** ESD album	Click this CD to audition and buy
	**Rediscovering Lost Scores** **= volume two =** Includes music for Kubrick's **The Shining** and Disney's **TRON**. *= ESD 81762 =*	**Released Spring 2005** **= Brand New Album! =** 29 tracks of unique filmmusic, tracks you have asked us about, unavailable in any form -- until now.	Learn all about **this** ESD album	Click this CD to audition and buy

	**Switched-On Bach 2000** (The 25th Anniversary sequel to S-OB, in a new ESD CD release. **Optimum Remastered Edition**.) *= ESD 81732 =*	**Released Fall 2004** This 1992 CD commemorates the original S-OB, in vivid new surround realizations -- the progress of 25+ years!	Learn all about **this** ESD album	Click this CD to audition and buy
	**By Request** (Music as you requested, an album created to satisfy our faithful fans. **Optimum Remastered Edition**.) *= ESD 81692 =*	**Released Fall 2003 = First Time On CD! =** Beautifully restored from the original 1975 1/2" masters tapes, in a deluxe 20-bit edition.	Learn all about **this** ESD album	Click this CD to audition and buy
	**Secrets of Synthesis** (Wendy narrates and demonstrates the inside story ofhow the music is created. **Optimum Remastered Edition**.) *= ESD 81702 =*	**Released Fall 2003** Optimized original 1986 masters, in a deluxe 20-bit edition.	Learn all about **this** ESD album	Click this CD to audition and buy
	**Soundtrack: TRON** (A groundbreaking score combining orchestra, chorus, with both analog and digital synthesis **Optimum Remastered Edition**.) *= Disney 60748-7 =*	**Released Early 2002 = First Time On CD! =** Optimum remastering in Hi-D 20-bit, complete with many bonus tracks. And check out our new filmscore CD.	Learn all about **this** Disney CD	Click this CD to audition and buy

	**Switched-on Bach II** (The delightful sequel to the original S-OB, in our new **Optimum Remastered Edition**.) *= ESD 81622 =*	**Released Spring 2002** Beautifully restored original 1974 masters, in a deluxe 20-bit edition.	Learn all about **this** ESD album	Click this CD to audition and buy
	**Switched-on Brandenburgs** (2-CD set of all six of J. S. Bach's Concerto Masterpieces, in our new **Optimum Remastered Edition**.) *= ESD 81632 =*	**Released Spring 2002** Beautifully restored original 1979 masters, in a deluxe 20-bit edition.	Learn all about **this** ESD album	Click this CD to audition and buy
	**Switched-on Bach** (The Triple-Grammy winning album that launched the synthesizer, in our new **Optimum Remastered Edition**.) *= ESD 81602 =*	**Released Fall 2001** **A Classic, Better Than Ever!** Beautifully restored original 1968 masters, in a deluxe 20-bit edition.	Learn all about **this** ESD album	Click this CD to audition and buy
	**Well-Tempered Synthesizer** (Long sought after, finally available on CD, in our new **Optimum Remastered Edition**.) *= ESD 81612 =*	**Released Fall 2001** **= First Time On CD! =** Beautifully restored original 1969 masters, in a deluxe 20-bit edition.	Learn all about **this** ESD album	Click this CD to audition and buy

	**Beauty in the Beast** (The kaleidoscopic adventure into timbre and tuning. Unavailable since 1987, now on our new **Optimum Remastered Edition**.) *= ESD 81552 =*	**Yes, it's available again!** **Released Fall 2000** Beautifully restored original 1987 masters, in a deluxe 20-bit edition. Includes an in-depth Computer Music Journal article.	Learn all about **this** ESD album	 Click this CD to audition and buy
	**Digital Moonscapes** (Music for the major moons of our Solar System and the Cosmos. Debut of The LSI Philharmonic, now on our new **Optimum Remastered Edition**.) *= ESD 81542 =*	**Released Fall 2000** Optimumally restored original 1984 masters, in a deluxe 20-bit deluxe edition, using the original artwork concept rejected by CBS.	Learn all about **this** ESD album	 Click this CD to audition and buy
	**The Switched-on Boxed Set** (4-CD set, with bonus tracks, 2 colorful books (over 200 pages), **the** definitive **Deluxe Collectors Edition**.) *= ESD 81422 =*	**Bach & Baroque Synth Fans--the set you demanded!** Hear it all as never before. Ultra 20-bit audio, many lavish extras. Includes **ALL** of Wendy's Bach and Baroque performances!	Learn all about **this** ESD album	 Click this CD to audition and buy

	**Sonic Seasonings & Land of the Midnight Sun** (2-CD set, with bonus tracks, in our new **Optimum Remastered Edition**.) *= ESD 81372 =*	**= First time on CD! =** Optimum transfers of the original 1972 1/2" SS master tapes. Plus the first release of a 1986 companion work.	Learn all about **this** ESD album	Click this CD to audition and buy
	**Clockwork Orange** (the complete Carlos filmscore, including all of TimeSteps, in our new **Optimum Remastered Edition**.) *= ESD 81362 =*	**First time ever on CD!** Optimum transfers from the original 1972 1/2" and 1/4" master tapes. Includes two newly available tracks. And check out our new filmscore CD.	Learn all about **this** ESD album	Click this CD to audition and buy
	**Tales of Heaven & Hell** (featuring Clockwork Black) *= ESD 81352 =*	**Something new & fun** If you dare--enter this roller-coaster funhouse of truly scary musical drama, including themes from **CO**.	Learn all about **this** ESD album	Click this CD to audition and buy

To go directly to **East Side Digital's** page of Wendy Carlos releases, CLICK HERE.

Notes on auditioning/purchasing the albums above:

All of the above albums and audio examples are available to browse, and you can conveniently purchase albums at the **Amazon** webstore (this link takes you to ALL their Wendy Carlos album listings, in one place). We're linking each album to them directly above because currently Amazon provides their familiar fast service with decent discount pricing. It's easy to go directly there just by clicking on any of the small CD images to the right above. Alternatively, you may prefer to purchase in a local music store, or browse an online store of your choice. For example, you can try **Barnes and Noble** or **Borders**, (we've placed some clickable icons below for your convenience).

Once online type in "Wendy Carlos" and pick Classical/Popular Music and choose the album you wish. Currently some of the albums are found in the Classical bin, others in Popular or even under the Soundtrack categories (usually, if not always, the whole list comes up under: Wendy Carlos). Note that there are several imported editions (at much higher prices) near the end of the Amazon artist listings. We recommend the upper, later versions instead.

(Clicking one of the small CD images in the upper right column above usually bypasses these steps, and links directly to the Amazon page for that particular album, where you may also audition the music on most titles before buying.)

BARNES&NOBLE.com amazon.com the new Borders.com

For **Reviews**, **Liner Notes**, and lots of interesting **Background Info**, click the appropriate "Learn more about". Quite a few of your questions on general topics about Wendy Carlos albums are answered on the Disc Notes page. To listen to audio examples on the above CD's, and to purchase, click one of the small CD images.

Please understand that we have no control over the music sellers including those that can be linked from here, and we have no responsibility for their actions or policies. We have experienced only minor problems, and find them to be very reputable dealers. Always use common sense, however: a credit card is best way to order, and expect that with the many albums ordered and sold, occasional errors can be made, and you may have to contact them about it. (You might like to know that virtually all online sellers except amazon buy from the same wholesaler, who ships **for** them.)

A few sites allow anyone to "mount a soap-box," via reviews of widely varying quality/relevance, some very genorous, a few quite off-the-wall mean. These can be fun to read, but beware of the hit-and-run pundits, those who refuse even to reveal who it is making the pronouncments. The artist biographies at these web vendors are often sketchy and dated, and some contain notable errors. Hey, what they do best is to sell CD's at prices lower than most record

stores -- approach the rest with a wink of skepticism.
(P.S.: In some searches you may come up with non-Carlos albums. So, for example, please note: "Sonoric Rituals" is NOT by Wendy!)

(Top of the Page)

Temporarily Out of Print (commentary on several earlier editions.)

	**Peter & the Wolf** (with Al Yankovic) *CBS/Sony MK 44567*	An original, improbable pairing of artists. The CD included an original Carnival of the Animals, pt. 2. The result is musical humor in a very fresh new way. **Learn more about this album.** Recently **out of print**, according to Sony Music (stay tuned).
	**Disney's TRON** Soundtrack *CBS/Sony CBS 37782*	First CD release was through Disney, in early 2002, including many never-before released bonust tracks! **Read more about it here!** Also see our all new album: **Rediscovering Lost Scores** volume two (Ignore those horrid pirate CD's, dubs from old cassettes, being sold by some sources for big bucks.)

(Top of the Page)

Never released on CD and currently unavailable

The Shining - Most of the score has never been released, and was not included in the final film version. So to those of you who have heard or like the soundtrack, to quote Jolson: *"You ain't heard nothin' yet!"* Most of the film was scored (as is Stanley's habit) using "needle drops" (generally, selections from commercial recordings -- check the film credits for a list, as this may be the music you're responding to). We provided the film's title music, the dark music for family's drive up the mountain, and several textures within the film -- that's all that Kubrick used from our hours of tracks. A long, familiar story.

The textures were not much to hear by themselves, and were wisely not included on the original soundtrack LP (Warner Bros. LP 3449). As for all the fine music that we wrote but wasn't used, some of it it sits in a "legal limbo", while other cues should make it into a forthcoming ESD Collection of my film score music. But it will have to wait until the more straightforward CD releases are completed.

Good news about the score to The Shining: With the 2005 release of our newest two albums, **Rediscovering Lost Scores, volume one and volume two**, most of our score for The Shining, much of it unavailable until now, can be heard in Hi-D sound. The first volume includes the earlier studio tracks created for Kubrick from 1978 through late 1979. Volume two includes many orchestral tracks, and several tracks which mix live and electroacoustic sounds, created as the project wound down in early 1980. As the notes explain, some of these tracks will be very familiar to those who know the film, but in more richly orchestrated versions than were finally chosen. And others depict a lost worlds of possibilities for the film left unexplored on its release. READ MORE ALSO HERE.

Woundings - The film score from the yet unreleased (in USA) British antiwar film, has been unavailable until recently. We're pleased to announce that much of the music from the score is now included on our newest Hi-D album, **Rediscovering Lost Scores, volume two**, above. The film has been shown in the States at several independent film screenings, to excellent acclaim, and should make it to video/DVD (it IS available in European editions, region 2 encoding, as of early 2005). We'll let you know here if it does become available on a region one encoded disk, for North America. (**Addendum in June '05**: this film **is now available** on a Sterling DVD, region one encoded, # 40730, under the title: "**Brand New World**." Google that name and "DVD" to find a copy. Movies Unlimited as of this writing lists a bargain price for the disk. Click their "Search by Title" button to the upper left, then type in "brand new world" to see if it's still available there. This is for your information only, as we neither control nor receive any royalty on DVDs.)

Currently Unavailable Music - There were a couple of volumes of **Bach's Greatest Hits**, which CBS assembled on their own during my years there, and a few other similar collections, (we learned of these years later, and have never seen or heard them). Two of

my earliest compositions from graduate student days at Columbia University were included on an early LP from Turnabout, TV 34004S, called simply: "**Electronic Music**". One of these, a composition for live piano and tape, plus another related work, were included in new performances by Phillip Ramey on the 1975 **By Request** album (available in a new Hi-D remastering).

Good news about the score to A Clockwork Orange: With the 2005 release of our newest two albums, **Rediscovering Lost Scores, volume one**, several tracks for **Clockwork Orange**, unavailable until now, can be heard in Hi-D sound. During the "Quintessential Archeomusicology" portion of assembling these two volumes several older tapes were discovered to contain **CO** tracks which had been mislabeled, and were overlooked when we put together our definitive soundtrack collection of music for the film. We were pleased to discover three tracks which had not been heard since 1971 and they are included here, available for the first time. READ MORE.

Tron - Was available for the first time on CD on a 2002 Disney release (additional information above). An LP of the music score was released with the film in 1982 (LP on CBS 37782, and cassettes). That sold out in the mid 80's. A deluxe letterboxed LaserDisk of **Tron** came out in 1996, Disney 6141 CS, which contained some of the deleted music restored in a Supplemental Section. (I made special mixes for them as a favor.) This edition formed the basis for the new 2002 DVD of the film, which includes those restored music tracks as well. While preparing the new bonus mixes I discovered there was a major problem with the master tapes -- they had become unplayable! A few tracks were transferred after hours of struggle, the rest would not play at all, or even rewind! The urathane-based binder had absorbed atmospheric moisture and turned into glue -- phooey!

After searching for the most authoritative recommendations (thank you, Eddie Ciletti!), we reported on these pages some good news, on **Go Bake a Tape**, or Tron Lives! After slowly baking each tape in a carefully adjusted and timed dehydrator, the masters temporarily returned to good playable condition, I made Hi-D transfers right away, and they sound wonderful. There things sat for the better part of three frustrating years (encouraging many poor quality pirate editions to "fill the demand") until Disney's 2002 decision to release a new CD of the score at along with the DVD edition of the film. Read more of the story HERE.

Good news about the score to TRON: With the 2005 release of our newest two albums, **Rediscovering Lost Scores, volume two**, several tracks for **TRON**, unavailable until now, can be heard in Hi-D sound. As the notes explain, some of these final master tracks were dropped late in the production of the film for extra-musical reasons. And others were test tracks which developed into the final versions heard on the soundtrack. While the Disney CD seems to have become unavailable for the moment (we're looking into it), this new album contains several favorite themes and moods from the film in arrangements which have been unavailable before now. READ MORE.

"Lost" Record Hunters, please note:

Any album titles not mentioned above **were not made by me**, and I have **no connection with them** at all! (Note: a few tracks of mine, from the above albums, were included on a handful of CBS compilations in the 70's & 80's, as mentioned just above.) When **SOB** first came out there was the expected flurry of "Me-2" albums, and some had titles that attempted to suggest they were sequels to mine, "Switched-On This or That," puns on "Bach" and "Moog." I couldn't keep track of them all, and the others that have followed since then. Most I've heard were unfortunately rather poor, including more recent Me-2-ers, granting that I'm particularly fussy about making music via electronic media. A handful, for example by Dick Hyman and Gil Trythall, were fresh and decent. (The late, great SF author,Ted Sturgeon, was so right: "99% of EVERYTHING is crud!"! Haven't you noticed? ;-)

So as for your questions of where you might find: "Moozart's Moogsical Cow" (sorry), or: "Switched-At-Birth Salieri" (wotta concept) the short answer is: "Say again??!" Occasionally one of you will mention an album whose title is vaguely familiar to me. More often not. Since I'm a rather poor detective myself, I confess to having few good ideas how to track down an album title that perhaps had a limited run years ago, and has never been reissued in any form. If you know the company that released it originally, you might try writing them or their successor. Have you tried one of the more powerful, ubiquitous Web Search Engines like Google? Put a "+" sign before each critical term, and put quotes around multiword search terms, like: [+Moog +record +"The Ill-Tempered Sympathizer" +"P.D.Q. Bach"]. And since you know now it's not my recording, add a "minus" term: [-Carlos], so you won't be led back here. You may turn up some clues...

A decent library may have old issues of record guides that would help you track down that title, company and number that haunts you. I know how it is, and have yet to find every movie, recording, book or magazine article that I think back on fondly years later. As for some past treasures that I HAVE managed to find (brace yourself), the worst case is that the memory is often much better than the

reality. **Ooff!** But sometimes you do find a lost "gem" or two. Good hunting to you!

--Wendy Carlos

(Top of the Page)

Back to the Wendy Carlos Home Page

Wendy Carlos Discography
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Wendy CARLOS

Welcome to the Living Page

(First show me what's new!)

Official Wendy Carlos Online Information Source

Wendy Carlos is one of the most important composers living today. While primarily connected to the fields of electronic music, sound design, and alternate tunings, her compositions transcend these genres. It is certain that her music will be included among the major milestones of 20th century music.

***Note:** Due to major changes in the music business, we unexpectedly lost our ESD distrubution, leaving us stranded with few good options. On top of two other critical business issues not yet fully resolved, time for updating this website became severely limited. We expect to have news on a new set of releases of Wendy's albums, plus a return to regular additions on the site as soon as possible. Thank you for your many concerned inquiries and patience, good friends.*

BTW: **Trash your Cache** and/or hit **Reload**, to be sure you're getting the latest page versions.

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