

# Stan's Safari Part 4

(First published in HiFi Critic in 2008)

**We left things in the last issue with a big question mark** over the true worth of many of the circuit design claims of the amplifier manufacturers. Today amplifier design should be easier than it has ever been because there is a huge reservoir of past designs to build upon and now most circuit design is done using computer simulations so it is quick and easy to tinker away to your heart's content whilst observing the improvements offered by minor re-designs. Life is so much easier than in the days of yore when every component change involved a soldering iron and measurements could be slow and tedious. But are the results worthwhile?

Call me an old fogey if you will but my own observations of some of the younger engineers brought up on computer simulations is that when after days of circuit manipulation the distortion at 20kHz is halved there is great joy and a sense of achievement. But is any listener ever going to hear any difference? That is the question that is all too often left hanging in the air never to be resolved. So if I am making a contention that often a lot of these circuit improvements don't make a great deal of difference in the real world then what is it that does influence the sound; for most readers of this journal will contend that many amplifiers do indeed sound different? Well, so far as this issue is concerned, we will focus on two areas; components and construction. Actually I have 45 years experience of the effect of the first although mostly without being aware of what I was doing. How so?

From time to time in my career I've experienced some startling insights and in consequence been able to be quite creative in some of my designs. But I've also been amazingly thick at times and completely missed innovations that were staring me in the face. The earliest of these must have been in the early 1960s when, as a student-apprentice, I was working at Smiths Aerospace in Cheltenham. I quickly became known to senior management as the lad who could build good audio amplifiers and to help me fulfil my increasing order

book (all unpaid but all representing favours done in the positive column of life) I was given free access to the redundant stores; a stockpile of unwanted, but high quality components mostly paid for by the taxpayer via the Ministry of Defence.

My prototypes had used 10% tolerance carbon resistors and whatever other components I could find in the various junk boxes but now I was able to build “production” units with 0.1% tolerance (yes that is 0.1%) metal oxide resistors; Painton potentiometers; a selection of very high quality capacitors and, get this, some newly developed pure silver wire with PTFE insulation; yes nothing was too expensive for the MOD. One slight limitation was that I was restricted to whatever I could find so there was some puzzlement over my use of, for example, 102.1 kohm resistors instead of the more common 100kohm and 0.2276mFD capacitors; but it all added to the mystique of being a future hi-fi guru. These were true audiophile amplifiers full of the best military spec components the MOD could afford to throw away and they seemed to work extremely well. In fact compared to my prototypes the sound was “brighter” and “louder”, my pre-hifi vocabulary being limited to the more obvious aspects of the sound. What was more the difference between the crap component versions and the new versions was so obvious to everyone that a couple of early adopters demanded that I exchange their inferior amplifiers. Now sitting where we are today the implications should have been obviously; they were staring me in face; screaming loudly. But did I see them? No, and the chance of audio Super-Stardom passed me by.

I then came across a hoard of beautiful C-core transformers and some examples of the then new toroidal transformer. The only problem was that they were designed for the 400Hz supplies used on aircraft and plugged into the 50Hz mains they did nothing more than fry the fuses. A friendly old-timer suggested a borrowed one of the lab’s power-supply units which was little more than a 400 Hz oscillator and a powerful valve amplifier. I was very surprised to find that with my new mains supply my amplifiers sounded still “louder” (I desperately needed some more descriptive terms at that stage but years were to pass before they came to me) and had less background hum

and noise. And what's more the toroids sounded even better than the C-cores. So again the experimental facts stared me in the face; clean power supplies improved the sound and better regulated power supplies also affected the sound. But did I make the right connections? Well partly and I've specified toroidal transformers in my designs from that day to this.

The subject of components next reared its head when I was at Lecson and I found that choice of power supply reservoir capacitors from different manufacturers markedly changed the sound and so in a bout of enthusiasm I then replaced the tantalum capacitors in the signal paths and again got consistent changes to the sound. I discussed this with Chris Rogers, one of the few magazine reviewers of the age who was open to daft ideas and he reported back similar results with his GEC based valve amplifier design. At about the same time I had dinner with Bob Stuart and he, not unreasonably, asked why the capacitors should change the sound and I had to admit that I hadn't a clue why; they just did. By this stage the penny had finally dropped and component selection became a part of my design programme although it was some years before I understood what was going on in "ohms law" terms.

This experience proved commercially invaluable during the many years I designed for Rotel. From the first RA-820/RA-840 models to the BX4 variants the circuit design remained the same (apart from the early exit of the tone controls) with the changes being limited to the internal construction and the choice of components used. I could hear a difference and so could all the magazine reviewers and the customers. Awards came fast and furious and the factory basked in the comfort of having substantial forward orders. But eventually I could do no more within the extremely tight manufacturing budget and changed to a better power amplifier circuit after which the whole sequence started again; indeed a variant of that circuit still appears to be in use today.

But what about the effects of the internal construction methods? Well once again my occasional relapse into Homer Simpson mode stood me in great stead. During 1987 John Atkinson wrote in *Stereophile* magazine:

“It was something said to me by Cambridge Audio's Stan Curtis which triggered this line of thought. We had been talking about the difficulties of a designer realizing his original engineering thought as a mass-produced "consumer durable." Stan had found that the ubiquitous step of laying out a pre- or power amplifier's circuit on a printed circuit board introduced a sometimes surprisingly large degradation in sound quality, even though the circuit was identical to that of the hard-wired "bird's-nest" prototype. The increased complexity of the pcb traces, coupled with the perhaps less-than-optimum dielectric properties of the pcb material itself, and perhaps even the reduction of the circuit's physical realization from three to two dimensions, conspire to rob it of some of its sonic transparency.”

I first began to notice this effect way back in the early 1970s when at the first iteration of Cambridge Audio it was the accepted practice to form all the wires into a loom where they would all be laced tightly together and where all bends would be at neat 90 degree angles. It all looked very nice and gave the Production Manager something to focus on but it played havoc with my designs. My “rat’s nest” design would look a mess but work superbly yet when productionised into a paragon of neatness some strange couplings would occur through the wires causing an audible softening of the sound and even worse some instabilities such as the random triggering of the protection relay circuits.

Eliminating such problems was tedious in the extreme because the circuit boards were drawn by hand and prototype boards could take a week or two to appear and pretty soon the design process could be extended by a couple of months. So it came to pass that sometimes some problems never did get resolved and got swept under the carpet. In fact I could say that the delightfully smooth sound of the Cambridge Audio P50 was more accident of construction than electronic design. Once again I was dimly aware of the

problems but had failed to grasp their significance. Rewinding rapidly to the Smith's Aerospace amplifiers I should mention that they were built onto boards of some expensive cream coloured laminate into which turret lugs were mounted and linked together by short lengths of the PTFE covered wires. But then in my day job I was introduced to the new technique of printed circuit boards which I designed and drew up using India Black ink. Naturally it wasn't long before I'd designed boards for my pre and power amps. and soon a team of young apprentices were hard at work in the chemistry laboratory etching boards. However when I assembled the amplifiers there was general disappointment and agreement that they sounded, well how can I put it; less "loud" than the hard-wired versions. I was confused; how could the new technology sound worse than the old technology? Remember these were the days of Harold Wilson's "White heat of Technology".

I suspect I blamed impurities in the copper tracks or some such unknown but I had another go with a different track layout, so maybe I was on the right track. This time the circuit oscillated so for a time I gave up printed circuits as a bad job. Moving back to the present day it is the case that circuit board design for what I might term high-speed audio electronics still remains something of an art and I can confidently say that if you want an amplifier to under-perform just get the board designed by a CAD guy who normally works on digital circuitry.

My own knowledge has come a long way since those days and I've developed some sure-fire ways of constructing amplifiers some of which haven't yet seen the light of day in commercial products. But the circuit board is still considered by many to be the only viable form of construction despite the big question marks that surround it. A couple of issues back I mentioned how hard-wired valve amplifiers invariably sound better than the circuit board versions when auditioned on a like for like basis. On the other hand circuit boards have given us consistency in performance and economy of manufacture so they aren't automatically a bad thing. I'm sure we will be returning to these topics at greater length but what my meanderings come down to is that designing a circuit schematic is but two-tenths of the job. The

real work comes in turning that virtual road-map into a fully functioning highway.

I'll conclude by suggesting that it would be fun to give half a dozen designers the same amplifier schematic and send them away to build a prototype. I'd wager they'd mostly sound different to one another. You could say that they all would suffer from imperfections and distortions but in different ways. Now that should give us all pause for thought.

**Stan Curtis**

**c. 2008**