Quality Factors in Knif Pro Audio Equipment

I'm lucky to be in mastering equipment business, one of the last resorts of real understanding in quality. How ever, I do feel that there is never too much info about those things that affect longevity and sound quality among other factors. With this essay I wish to shed bright light on my own thinking and what you should be aware of when comparing gear and trying to understand pricing of (my) products. I will cover some technologies or building practices that **surpass** mine in some ways to give an idea what kind of compromises even expensive gear sometimes includes. It is also useful to think what factors and techniques do not justify their price.

I like to keep things as objective as possible, but heck, when writing about my gear that is kind of difficult, so excuse me. Also excuse my English, I don't care to give this essay to someone to correct as long as it is readable.

I will cover mostly those things that have some relevance to Knif Soma, since it is my most recent and perhaps most complex design.

Case

Lets face it, it is not common to find equipment that fails in the rack because of badly built case. But there are some factors worth to study a bit. Gear will eventually be shipped from place to place and connectors will be pulled and pushed etc.
Case can flex. If there are more than two or three components sharing same the substructure in the equipment any flex will try to move them in respect to each other. If they share the same circuit board and are attached to the case the situation is bad. Any strain will be transferred to the most vulnerable part, namely solder points. My policy is simple: I do not do it. The maximum amount of components attached to the same sub-PCB and case is two. Second problem with big substructures is the difficulty in repairs and modifications. There is no limit to my irritation when someone brings me brand X device with one broken switch that requires the dis-assembly of the whole front panel in order to be replaced.
All switches and connector must be screwed to case. A connector or switch relying on soldering to PCB is a weak spot. One kick and you possibly ruin a whole circuit board. It is cheap though.
What about case material? I use aluminum cases with milled parts from thick plates because of many things.
One is heat conduction. I can safely use any part of the case as heat sink for regulators etc, since the heat will be effectively dissipated to the whole case.
The other is electrical conductivity. Thick aluminum is pretty perfect for a back plate. There is no need to hard wire every earth potential to one spot only. I can assume that substantial area of the back plate is at the same potential and attach different grounds to it locally and have effectively perfect star grounding. For example safety ground is firmly attached to the proximity of power inlet and signal input and output grounds close to their connectors.
Third is the fact that aluminum is not ferromagnetic. One could err to think that it

is nice to have steel case in order to shield components from external magnetic fields, but thin steel sheet is not very effective as a shield but still effective in transferring fields inside the equipment. Therefore I think that steel is a definitive no-no in quality equipment.
Soma has sides and front panel “frame” milled from 10mm thick aluminum and threaded for all necessary screws. With 4mm thick bottom and back plate the structure is extremely stiff, even without lid on.

Magnetic shielding

I often get requests for separate power transformer. It certainly isn't a bad idea, but so far I have decided to solve possible problems with magnetic interference with quality components and proper shielding. Why? Of course to cut cost, yes, and because it is safer, but also because it is possible and most importantly because it makes my gear less prone to pick up stray fields from other gear. It is surprising that most mastering quality EQs which use coils do not have proper shielding for them. Therefore they buzz. Soma has proper mu metal shielding for the coils.

Let me tell an example of bad designs which illustrates the two sides of magnetic interference. I would very much like to mention the very famous brands involved, but must contain myself. In a local studio here in Helsinki there was a problem with an EQ buzzing a lot. Too much for even pop music. We started to isolate the problem. The source for the magnetic field was from ca 5 rack units above, a certain tube compressor with inferior mains transformer. And that was picked up by EQ coils, which *did* have shielding, but unfortunately not from proper mu metal. Since the source was so bad and receiving end so sensitive there was no way of using the gear in the same rack. Not very professional.

Power transformer must be of toroidal type and have magnetic shielding. In Soma it has two layers, one composed of silicon iron and another from mu metal.

Signal switching

The best way to switch signals is with relays. There are again three reasons. Relays can be placed anywhere and thus signal path is foreshortened. Good relays are hermetically shielded, normal switches are not. Relays last very long. Typical life for a front panel switch is 50 000 operations and those sub-miniature relays I use in Soma last 100 000 000 operations according to the manufacturer. That is right, a hundred million operations. On first reading this doesn't make any sense, but remember that these are used in telecommunication equipment that switch constantly and one million operations is easily reached in a year. Also, 100 million operations estimated life means that they very probably don't break before one million, and we can forget the risk that even one of the ca 140 relays in Soma's EQ circuits breaks. That is a relief since those relays are not available everywhere and desoldering them is very difficult and it would be difficult for an average tech to find the broken one.

For many adjustments like gain trims we have to use either potentiometers or rotary switches. Since no respected mastering device uses potentiometers we are left with the other option. 23-position high quality rotary switches are expensive. There is no way around it. The equation gets still more expensive since every rotary switch must then be equipped with resistor ladders, either directly to solder

lugs (a royal pain) or small, *single, local* PCBs (as in Soma) which is still a lot of work. All respected mastering equalizers therefore have eight, ten or even twelve 23-position, expensive gain switches and (sometimes) a bit less expensive frequency switches.

If you are reading this you probably know the difference between stepped potentiometer and rotary switch, but if you don't do find out and never mix them because there are some equipment which use stepped potentiometers and pretend that it is almost the same thing. Of course it isn't.

Signal connection and connectors

It is very simple. Never use connectors in the audio path if you don't have to. Obviously you sometimes have to use them, but inside equipment their amount should be minimized since they can fail. There are some good gold plated connectors, yes, but you can never beat a solder joint. In Soma and in Knif gear in general the only connectors inside are tube sockets. They are pretty impossible to avoid of course. Luckily (and perhaps this is the only time one can say so) tubes have limited life span, and therefore the connections will be “rubbed” every now and then.

Modern high end manufacturers have not been able to resist the temptation to use a lot of connectors. Almost equally disturbing is the use of million pieces of cheap ribbon cables. You can think what ever you want about sound quality differences between short pieces of cables or wires, but there is no way around the fact that ribbon cables either require a connector (bad) or a solder joint. When the day comes that you should desolder a ribbon cable you will regret that they exist. It probably doesn't make any sense to be too delicate then, just clip them into pieces and desolder one thread at a time. OK then. I use them too. Shame. But *not for audio* and *never for big part sets.* In Soma there are straight, short, high quality ribbon cables for every bands frequency selector switch, all of them without connectors. Furthermore it is highly unlikely that they ever have to be desoldered, since the rotary switch is easy to desolder from the small sub-PCB.

For all power and signal wiring I use only teflon insulated silver plated copper wire. Sounds very exotic and waste of money, but actually it is not very expensive and has substantial benefits. Teflon is the best “sounding” dielectric and mechanically strong. The best part is that it does not melt or deform when soldering and thus any mods or repairs can be done multiple times and everything still remains neat and safe. I never use wires directly soldered from both ends to circuit boards, and quite rarely even from one end. Instead I use turrets soldered to PCBs, which serve as soldering points for wires. In this way when soldering or desoldering there is not risk of damage to PCB or wire and everything remains easily reassembled.

When it comes to XLR connectors there is only one right brand and it is Neutrik. When it comes to precision and quality, certain countries seem to excel and one has for centuries been above other, Switzerland. I use their gold plated connectors but the regular sort is fine too if you ask me. The difference is mostly cosmetic but if you remember to use gold plated plugs too you are free from corrosion for ever.

If only on side is gold plated it has no use.

Audio transformers

Tube equipment usually requires some audio transformers, in pro audio mostly both input and output and sometimes, like in Knif Vari Mu II also interstage. Since I design gear to be sonically neutral and care for good specs too one of the most important factors is transformers. Good transformers are made by a handful of companies only, and transformers suitable for Soma by Lundahl only. Making small signal, low impedance transformers is easy. Making high impedance transformers suitable for MS coding is hard, and making high impedance single ended tube output transformers suitable for MS decoding is very hard. Choosing suitable transformers is hard and finding the right connections and impedances and terminations to make them work both in non-coding and coding mode is very hard even when the starting point is Lundahl quality. Furthermore, to keep the component costs of Soma increasing it became evident after scientifically valid AB-evaluation that only amorphous core material is suitable for output transformers when the ultimate low level information recovery is needed. No need to hate normal iron though, it sounds fine, but because of hysteresis it imposes kind of gray veil over delicate information. I have also been able to repeatedly measure less memory effects in amorphous cores, effects that lack nice and solid explanation at the moment but are in agreement with AB tests and null tests. Once again you get what you pay for. Amorphous output transformers from Lundahl cost a lot because it is not a mass product and the cores are made to order in the USA.

Circuit boards

Thicker is better, especially in tube equipment which needs to be sturdy. There is a limit often determined by those modern components with the shortest legs, but so far there has been no problem in Knif equipment to use 2.4mm laminate. I find this to be the minimum for high end equipment. It is very scary to put a tube in socket on a regular 1,5mm thick board flexing like crazy. PCB failure in any equipment is a major pain and should never ever happen. Thick laminate helps to keep capacitance between top and bottom layer low. This is important in high impedance tube circuits.
Copper on PCB in Knif products is 70u thick which is twice the normal. This is good for heat transfer from hot components like power resistors and tubes. It also helps to wire tube heaters in restricted space and keeps ground potentials low.
But then, the best PCB is no PCB. Point to point wiring and turret boards are superior in most respects. They are easy to modify and repair and have superior electrical performance in many ways, but unfortunately have to be reserved for fairly simple gear that does not use modern components. Building Soma without circuit boards would be next to impossible. How ever there are many ways to utilize PCBs. The worst and very often seen is the way to fill everything on one big thin PCB and hope that nothing ever falls apart or no one ever wants modifications to be done.

Passive components

I don't think the sound quality between polyester and polypropylene capacitors is worlds apart, but why go cheap here? I'm totally amazed that most high end equalizers use polyester filter caps. They might cover some hard sounding artifacts, but they do sound veiled and boring too. Polypropylene caps are not the biggest investment at this level anyway, so why save those 20 dollars?

Also power supply filter caps, specifically the last ones in the filtering and regulating "chain" must be polypropylene if possible. They are in the signal path as much as any other capacitor at least in any single ended amplifier. Do not get fooled to think that power supply is somehow separated from the signal, because it isn't – current draw from power supply caps varies according to the signal and if the caps are not ideal, their behavior will affect the signal. From all passive components electrolytic capacitor is worst in objective terms and also the easiest to "hear". There are audio grade types around, but they are still miles behind film caps. Fortunately tube circuits can use polypropylene capacitors in power supplies quite easily. Knif Soma has dual power supply for the make up gain amplifiers, so both channels have their own regulators and last filter caps, which are from Mundorf, Germany.

Integrated circuits

To continue the casual style let me tell you about one comment I read today on a certain forum. A person tried to explain others that paying big money for premium quality gear makes sense "because it will last least 10 years" Now, please, even the crappiest stuff can last 10 years, we are not talking about televisions or computers here. High end audio gear is designed to last 20 years minimum, and I like to think much further. That's why you have read my comments about possible repairs and modifications so many times. Components do age, we replace those aged or broken components, if (and this is the big if) they are available. I'm not claiming that I could somehow know some part's availability after 30 years, no, but I can say that if you have gear with programmable IC or Eprom, you will never find the same components again and these components do break. If the manufacturer still exists you can perhaps have them program a new chip for you, but if the original code is lost, it is lost and somewhat tedious to find out. Possible, yes, cheap, not.
In Soma I have to use digital circuits to make the real Q -agenda possible. It was a hard choice whether or not to use something programmable. It would have allowed some more tricks, but then I decided to find out what can be done with decent amount of the most basic CMOS logic. If any IC is going to be available in some form in distant future then I think it will be these logic ICs, if not new, then at least as surplus components. No need to worry. I have used IC sockets to make eventual replacement possible without soldering, and in any case it is likely that CMOS logic is more robust than programmable stuff anyway.

Thanks for reading. In this partially flaming "essay" I've covered many of the things I find important in quality design at the moment, namely in

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