### Philoshophy of Aphex Audio Processing

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Werrbach Guides Aphex Designs By Tom McGinley Of RW Special Report 02.01.02

### Tom McGinley of RW Online

This is one of a series of occasional articles about the people behind today's audio processors.

It has been said that audio processing is personal. You may not know the name of the person who designed your CD player or console, but you may well know who invented your onair processor.

If you use a product from Aphex Systems there's a good chance it was designed by Donn Werrbach.



Donn Werrbach Aphex Chief Engineer

The company has been around since 1975 and grew from a single product: the Aural Exciter, invented by Curt Knoppel.

In the 1970s, an album credit from Linda Ronstadt and a Wings tour credit gave the company a higher profile, and it moved from Massachusetts to California. Now in Sun Valley, its product line has expanded to include processors used by recording studios, broadcasters and other professionals. In 1984 the owner, Marvin Caesar, convinced Werrbach to move from Hawaii to California to take over the dutiesof chief engineer. Every Aphex product since 1985 has been designed by Werrbach, now the company's vice president of engineering.Werrbach spoke about his career and the line of Aphex products with Radio World

Technical Consultant Tom McGinley.

*RW:* Aphex is well-known for audio processing products that are used both in the studio and in the air chain. Tell us a little about the design philosophy behind early products like the Compellor and Dominator.

Werrbach: The Compellor and Dominator have proven to be our most successful products. I think that's because they address the two most critical and fundamental areas of dynamic range control: average level and peak level. Traditional comp/limiters have been used to address these problems, but they are relatively primitive and impart an audible change. but what if I don't want that and just want the sound to be the same as before? It has always been my curse to have to keep reinventing the wheel. I can't help myself and I just can't stop experimenting. So that's become my design philosophy. I want everything I create to add something to the art; to take it to a new level; to be innovative. My approach to creating products is to imagine some kind of tool that is needed but not available or to make a process sound better through some kind of clever algorithm that I have to discover.

**RW**: The Compellor has become perhaps the world standard for a stand-alone smart AGC unit, found in almost every radio station

and production studio. With 20/20 hindsight, why do you think it became so popular?

Werrbach: I did not expect or even dream that the Compellor would go so far. Naturally, I hoped it would be successful, but I didn't really have an idea what that meant. I was totally flattered even to have a company like Aphex take an interest and then work with me to bring it to the market. It was my first commercial product and to see it become so successful has been my greatest thrill. It sells basically on its reputation alone. We are shipping as many as ever, 18 years after its introduction. Other companies have tried to bring out a competing processor, but they have not succeeded in matching the sonic performance of a Compellor. One reason is that our patented processing techniques are very hard to duplicate.

**RW**: From the beginning, Aphex has favored analog audio processing designs over digital processing techniques. How has that philosophy evolved and influenced the new generation of Aphex products?

Werrbach: We still know that, at the purely sonic level, analog is better than digital. That is a God-given fact, and nothing will ever change it because digital is a quantized and sampled numeric approximation of reality. However, digital audio is a growing and demanding market that is displacing, to some extent, the analog market. We still find a strong market for our analog equipment because of two things. First, there is a demand for high-quality processing that is not being supplied by digital processors because of technical limitations. Second, there is always an analog front and back end. Digital is just an intermediate step where sound is stored, mixed and edited. The field of digital audio production is a very important target for most audio equipment companies, and we do have our battle plans in the works. We have brought out our Aural Exciter and Big Bottom as plug-ins for a first entry. However, we have learned that hardware-based digital audio products are much more important for the industry. We are expending a great deal of research expense to develop digital signal processors of that type. Our biggest advantage in the industry is that we have so many advanced and patented audio processing techniques in analog that we can bring into digital. Our greatest problem is that digital signal processing hardware is still so primitive. Capturing the sonic quality of our analog products will require very high sampling rates and intense DSP algorithms that present hardware can't really handle at a low cost. Nevertheless, our philosophy is to maximize the digital audio performance over putting tons of so-so effects into a single unit. We expect to beginreleasing high-quality, all-digital products within the next 14 months.

### *RW:* Your most ambitious product is the 2020 Broadcast Audio processor.

Werrbach: The model 2020 took a long time to create and bring to fruition. It comprises more than 13 patented audio processing technologies, more than any other audio product I have ever heard of. It was designed to go into FM radio stations and serve as the final audio processor before transmission. It combines circuits to level out the program, add multiband compression to improve program consistency, limit peaks for maximum total modulation, and deal with transmission problems caused by pre-emphasis. It also contains a digital I/O interface and a stereo multiplex generator. Fortunately, I designed the 2020 to be modular so certain processing sections can be supplied as options. That means they can be omitted for non-FM broadcast applications like mastering studios and such. This opened up a number of possibilities to use it outside of FM stations, and we have sold many to non-FM customers. It makes a fantastic mastering tool, and it is also useful for general recording and live sound. Because it is digitally controlled, it can be run from a PC and has preset storage for instant recall of designed settings. The biggest thing about the 2020 is that all of the processing is in analog. There is no loss of quality due to aliasing and other typical DSP problems of other products. The sound produced is very clean and natural. We feel our best bet is to model our patented, successful and unique analog processing algorithms. We are discovering that some of them are very hard to duplicate accurately in digital. RW: The original 2020 has been replaced by the 2020 MkII. We understand this is a substantially improved design and not merely an updated version. Describe the differences. Werrbach: The MkII is certainly an improvement, not that the original wasn't great too. What I did was to reinvent the "back

end" of the processor and let certain improvements ripple backwards. In the summer of 2000, I was in Germany visiting the WDR federally run broadcasting company. I was impressed by the fact that German audio engineers have a certain kind of sound they like. It is reflected in everything. They love big diaphragm condenser mics, and they love their Genelec speakers. Voices are surrealistic, and very close sounding like they are spoken next to your ear. The highs are sharp and strong while bass is somewhat restrained compared to American tastes. I felt that I wanted to make the 2020 more capable of matching that sound for the German broadcast market. I also felt that if I could do that, I could make it sound a little sweeter for everyone else, too. The result is probably the cleanest multiplex spectrum of any FM processor and no appreciable overshoot. I also took advantage of the opportunity to upgrade the stereo generator module with dual outputs and other added features. We reconfigured the leveler module so it can be split into dual independent processing channels. That allows the MkII to now act as two independent mono processors for users who had asked for it, such as TV networks and Webcasters.

*RW: Is there an upgrade path for current 2020 users?* Werrbach: Yes, we are providing an upgrade path for Model 2020 owners who want to turn them into MkII's. All the information about that is on our Web site(<u>www.aphex.com</u>). For a very nominal cost, you get all the audio processing features of the MkII but you don't get the updated stereo generator or the new front-panel aesthetics.

**RW**: Is there something unique about the 2020 Mk II preemphasis filter? Is this one of the keys to the performance the unit achieves?

Werrbach: Yes, of course. One of my patented inventions is the distributed pre-emphasis filter. This allows me to divide the preemphasis curve into two sequential stages where the preemphasis can be added more gradually. In the 2020 it is divided among the multiband compressor and pre-emphasis limiter sections. This helps keep the sound well-balanced, even when we call for heavy processing.

RW: Who was involved in the development of the 2020 Mk II?

Werrbach: There are three people I would like to thank: Gary Liden, Kim Steffensen and Richard Faith. These comprised Aphex's entire engineering staff at that time, and I taxed them all. Without

entire engineering staff at that time, and I taxed them all. Without them I would still have proto boards wired together all over my workbench.

**RW**: What are the next important product introductions that we should expect to see from the company?

Werrbach: I have launched the Thermionics line, which I intend to keep driving. We released the Model 1100 Thermionic Mic Preamp more than a year ago and it is getting unbelievable raves for its sound. There are a number of products in the works, one of which is a comprehensive voice processor/mic preamp. This will comprise numerous processing stages and some newly developed technology for de-essing and spatial enhancement. There will be multiband compression, and downward expansion, equalization, etc., and it will contain a super quality digital audio output. Of course, it will be based on my Reflected Plate Amplifier tube patent. I also am pre-designing a very high-quality direct box, a studio quality power amplifier, and other things that I don't want to jinx by talking more about just yet. Outside of Thermionics, we are releasing our new Model 204 Aural Exciter with Optical Big Bottom. There will be more 200 series products to come after that. Besides all that, we are working intensely on a new line of digital audio products that we expect to begin releasing some time next year.

*RW:* Is there such a thing as a "Donn Sound" that sets Aphex products apart from those of other audio processing products? Werrbach: I suppose I'd have to say the answer is yes, just out of practicality. I always design while listening. As to what my "Donn Sound" comprises, it's hard to verbalize. To try and describe what I listen for, I love deep unrestricted and easy flowing bass. I hate it when bass sounds like it is high-passed, boxy, or pinched back. I spend a great deal of time studying bass and learning ways to process it more musically. I love present and forthright vocals. I hate it when a vocal sinks back into the mix when other instruments are layered on, unless it is an artistic effect. I love definition. I love to be able to distinguish all the various instruments in a mix. I like to be involved in the listening experience. Anything that clouds or masks definition and devolves the imaging makes me unhappy. I don't like harsh digital distortion. It hugely aggravates me and I hear it all the time these days. Once you become sensitive to detecting digital grunge, you are cursed forever. I spend a lot of time looking for better compression and limiting algorithms, and of course that is purely judgmental but it lets me play god just a little. *RW: Some of your products like the Tubessence mic preamplifier* 

*RW:* Some of your products like the Tubessence mic preamplifier use vacuum tubes. How do you describe the sonic differences and advantages of employing such vintage technology in an age dominated by digital techniques? Are the differences really significant or just nuance?

Werrbach: With digital audio recording and production, a whole new dimension of creative freedom is available. However, with all the great utility of digital production, engineers and producers have accepted a profound amount of audio degradation. The total digital mix seems to somehow go bad. It gets flat, dry and edgy. For some kinds of music this is good, and art tends to fit the tools and instruments used by the artist, so a lot of the modern music forms are coming out unintentionally featuring these digital artifacts. However, this is seen as a problem by many artists and producers. They wish they could get the beautiful, layered and dimensional mixes that can be made with analog. By passing tracks or a whole mix through a piece of analog tube electronics, some of the fine detail can sometimes be recreated and the sound improved. The question is, "Why tube, and why analog?" Tube circuits are inherently analog, and they are not numerically linear like digital. Tube circuits comprise numerous nonlinear properties following mathematical laws that are foreign even to solid-state circuitry. That's another way of saying they generate unique distortion and compression effects that can't be duplicated digitally. There is no true digital model of a tube circuit. To get the real tone and responsiveness, you still need the real tube amp. We have been told by our customers, many of them the crem de la crem of professional recording, that our thermionic mic preamps just have a big, beautiful sound they have almost never been able to capture before. I know that is a psycho-acoustic effect of the tube's characteristics from the many hours of listening experiments in my lab. We can actually measure the specific distortion curve, but there are no methods yet devised to accurately measure any of the subtle temporal or dynamic effects. Some of the tube "magic" still remains empirical. That is one reason we can't package this effect into a digital signal processor. RW: What about "digital grunge"? You have built your products on the belief that the best analog audio processor can still be adjusted to sound "better" than any digital unit in terms of warmth and lack of unfriendly distortion by-products at the same loudness levels.

#### Explain why this is.

Werrbach: Digital grunge is real enough. It can be reduced in digital signal processors by exhaustive algorithm development. However, that may heavily burden the DSP power that is economically available. Therefore, you find the grunge gets into everything eventually. What constitutes digital grunge is the numerical rounding and truncation that is often re-entrant or recirculatory in the DSP code, and aliasing products generated by any nonlinear function like gating, clipping, compression or limiting. Digital workstations are based upon DSP engines running DSP code that can have all these adversities in varying amounts depending upon the skills of the algorithm designer and codewriter and the extents of processing. Just straight mixing on some workstations causes audible grunge. Grunge can creep in at CD mastering even off an analog master because of the A/D conversion and the DSP that is used for coding the CD format. This kind of distortion is distinctly unnatural. No object in nature creates anything like digital grunge. Analog distortion is comparatively benign because harmonic and intermodulation distortion can be found in nature. That is one reason a good analog audio processor can sound better than a digital unit. Another reason is that advanced analog processing algorithms are far easier to develop through experimentation. To develop digital processing algorithms, first you have to abstractly conceive of what you want to try. Then you have to write extensive code to implement it to whatever approximation you are allowed by available processing power. Then you have to compile the code, load it into a target processor and finally run some audio through it to listen to the result. Many DSP algorithm designers just test

their code on an offline simulator and never actually listen to it in real time. Those who do run real-time testing can never hope to test as many ideas as the analog designer within a reasonable time window. That is why, to this time, digital processors contain nothing but primitive algorithms approximately comparable to the analog art of 50 years ago. It is fairly obvious that the most reasonable path to developing better digital processing is to model advanced analog processors. Until that happens, and the problems of digital grunge are truly eliminated, analog processors will always sound better.

*RW:* What is your opinion of the ongoing loudness wars being waged by stations on both the AM and FM bands? Will the evolution of digital broadcasting and the Internet change the general sensibilities of most programmers that being loud will always be important?

Werrbach: Digital broadcasting will not end the loudness wars. Some of us thought, just for a fleeting delirious moment, that it would. However, the dynamics of commercial broadcasting are proving to be just the same as analog FM and AM. That goes for Webcasting as well. Programmers seek every tool at their disposal to beat their competition and loudness is one of the tools. A possible exception could be direct satellite or cable radio where all the channels are exclusive and originated by the same company. Then there is no direct competition between channels. In that case, audio processing is usually omitted altogether and that causes problems. There needs to be at least moderate processing to hold up program consistency and peak control over the medium.

### **RW**: What will the coming of Ibiquity Digital broadcasting mean for broadcast audio processing? What is Aphex doing to get ready for the implementation of this new medium?

Werrbach: As far as Aphex is concerned, we're ready now. Our 2020 MkII is modular and can be configured without pre-emphasis or a stereo generator. We havehigh-resolution digital audio I/O already available. The main difference for iDAB, or IBOC as it is also called, is that it is not pre-emphasized or limited to 15 kHz bandwidth. That is going to improve the sound of the medium immensely if the technology for iDAB can ever reach all the milestones and become practical enough to actually be implemented widely.

RW: On-air processing is a subjective arena, and it's a business that seems to be more and more defined by the marketing of high-profile personalities like Bob Orban and Frank Foti. Where do see yourself and Aphex fitting into this competitive landscape? Werrbach: Well, I don't see myself getting into a hissing war with either gentleman, although the competition is warming up. As most can remember, Foti came out, some would say recklessly, with a negative campaign against Orban's 8200 processor. He ran some ads about the 8200's digital grunge. Naturally, Orban's company struck back, and that is when we saw Bob himself being put out on display in their ads. They merely downplayed the grunge issue and pitted Bob Orban's professional credibility against that of Frank Foti as they cast Frank Foti as a junk scientist and Bob Orban as the master of audio design. It has been a sad battle ever since. It appears that Frank may have felt the sting because he has turned away from the direct credibility confrontation as far as I can see and concentrated on proving himself and his products. I think we will see the high-profile personalities drop more into the background and the product marketing become more hardware oriented. I believe that both Orban and Foti view Aphex as insignificant competition. They are keenly focused on each other. Meanwhile, we have made deep inroads and have taken some hallowed ground away from both. We continue harping on our better sound quality and let everybody compare boxes to make up their own minds. Our analog sweetness and clarity, as well as the more advanced analog processing algorithms, wins a lot of races, especially with the new MkII release. We are certainly in it for the long run and intend to continue pressing into that market. RW: Assess the quality of audio compression or bit-rate reduction algorithms used in digital audio today, and how much improvement we should expect in the future? Werrbach: I always recommend using uncompressed digital media whenever possible to anyone that will listen. Anybody with good ears hates to hear bit compressed digital audio. That MP3 quality is so widely accepted as good sound is shocking. However,

we live in the digital age where audio quality is second in

importance to distribution. The narrowness of Internet bandwidth and ISDN audio links dictates extreme bit compression, and the show must go on. After three decades of digital audio consumption, people are trained not to expect anything more. The fact that "CD quality" is now the buzzword for "perfect sound" is really disappointing to me. CD quality is mid-fi, not hi-fi. That was not the promise of digital audio back in its infancy. We were promised future developments would take us further towards perfect audio. Instead, what we got was a bunch of hideous sounding compression algorithms. Yes, we now have 24/96 digital technology, but where can you find it in use? Practically nowhere. The entertainment industry and consumer product manufacturers aren't bringing it to the masses. Instead we get Minidiscs and cute little MP3 players and crappy sound. Because there is such a demand to pack digital audio into tighter bandwidths, there will continue to be more compression algorithms developed, and I hope they will get better. Future technology may allow less lossy compression through wavelets or fractals or some other mathematical transformation as computing speeds soar. These methods are now only practical in non-real-time recovery at present CPU speeds. However, when we get 100 GHz CPUs that fit into an earphone, maybe it can happen.

RW: What percentage of the company's business is in traditional radio broadcasting? What are your biggest growth areas? Werrbach: Aphex does about 40 to 50 percent of our business with broadcast customers, both radio and tv, but mostly radio. We have designed our products to be flexible and useful in broadcast and non-broadcast environments alike. Our biggest growth area is on-air processing at this point, but we are projecting additional growth areas for the future. Webcast processing is growing. We are getting on a faster track to generating more new products with the larger and stronger engineering staff that is now onboard. We expect to open up many new roads as we introduce more new products. The Thermionics line that started with the Model 1100 has made a big hit with the high-quality oriented artists and producers. We see a definite demand for more of this family in a world where studio equipment is getting lower in quality to meet the low price demands of home studios. Another growth area is going to be in digital audio processors. Yes, I said digital. I cannot discount the advantages of digital in manufacturing and sales. Digital audio products require so much less labor to build and test that it is quite sobering. We are

constantly barraged with "When will we see a digital Dominator?" and the like from audio industry professionals. To that end, we are developing a digital audio platform that will take us there. We are aiming at the highest digital audio quality, and that will elevate our

line above the others.

interview Of Marvin Caesar's APHEX's CEO Salon de la Musique, Paris, septembre 23rd 1994

*Could you tell us when the story of APHEX began*? We started in 1975, April 1st. In America we have a holy day called "April's Fool", where everybody is playing jokes on everyone, and this joke has lasted almost twenty years! We started only with the Aural Exciter, and at the beginning we only rented it for 30 \$ a minute: soon the top artists around the world rented the Aural Exciter for their albums, also P.A's for example. In 1980, we started selling the Aural Exciter, then we came out the low-cost version..

#### What was the name of the first version?

It was actually a model 402, and that's what is used on albums of Linda Rondstadt, James Taylor, Jackson Browne, Fleetwood Mac.... It's interesting to know that the 402 was a tube unit, like our latest product now. It became more and more popular, we came out with the 602, a solid-state version, and then in 1981 we made the Aphex II, which was for sale, and then in 1983, we started with the type B, and it sold on a much bigger market, wider market. And we also introduced the Compeller, the Dominator, the Expressor, and we made a left turn into the MIDImarket. I never wanna see a 5-pin connector again! So we stayed very much focused on the analogue signal processing market.

What was your contribution to the MIDI market? We made the Tube Factory, the Studio Clock, the Impulse, which was a trigger to MIDI, for drums. They were the finest products, but each product required so much explanation that by the time you finished explaining to a musician, you had no time left to make any profit... And that's a problem with all equipments: if you look at the line of equipment, every piece has an invention, we have patents and patents and patents: we don't make anything that's typical, that's usual: every piece on our entire line has a story. But at least we can explain much more easily about signal processing than MIDI to an idiot. Now that's what we started calling us: idiots: but don't call me! Our chief engineer is coming from the broadcast side, so his mentality is " 100 % modulation", and stop. So almost everything we do we have a higher vision "maximum modulation, not giant peaks", and that's very important in digital world, because every 6 dB down is one bit. So, for example, a typical DAT player: the instruction says "Record O VU @ -18 dB". So usually the typical maximum is 13 bit, the low level signals 8 bit, and it's just for example: so many people now use the Dominator, which is a three-band peak limiter, to get the maximum level without flashing. (Clipping!). Perfect square waves under threshold and the threshold is at maximum, and when it hits the maximum point, it sounds fine. So it's a really terrific product. The retail price of the Dominator is 9000F, much too expensive for the typical home recordist, so we developed a line of lower cost products, easy to use, easy to understand, and so clear that one reviewer in England criticised the gain reduction meter saying "it's not accurate, because it says 18 dB, but it doesn't sound like 18 dB of gain reduction". So he's so used to listening to shitty products that to think of 18 dB even more than 6 dB and not have a sound, and here's 18 dB: it's impossible! So we took our technology and made it into a smaller, less expensive package, easy to use. The first product in the line was the 104, which is the Aural Exciter and the Big Bottom. The circuit that we sell in it is better than the first circuit we rented a 30 \$ a minute.

### We made a review of the 104 and the 105, and were surprised by the limited number of knobs. Is that a deliberate choice?

Yes, it's a big challenge that I've made. The first thought of many home recordists look at is "How many knobs?». They say "It has more knobs, so it's better!". Challenge to the people is " Get a sound with your compressor, the best you can do with any compressor, other than an Aphex. You got your sound? Now let's go to Easy Rider". In two seconds, "Aow, which one is that?" and it's the Easy Rider swimming. But the mentality is: "I have to have more knobs". But the others can work and work and work, maybe they get close to the sound of the Easy Rider, with few knobs. So that was a little bit of the philosophy of the Easy Rider, but of course of the Aural Exciter and the Big Bottom too. One of the important features of the Big Bottom was that it increases bass without increasing peaks, because always when you try to increase the bass, EQ or sub harmonic synthesisers, the peak goes crazy. So you have more clipping, the speakers blow with all this bottom, so here's the Big Bottom circuit, very inexpensive, and it's making the bass more strong, without increasing peak. It's very nice, especially for smaller speakers, vocal D.J, small format tapes, or digital: it's working great. When we had the 105, which is a perfect gate, I challenged other professionals... listen to the quality. I noticed you had written VCA on your list of questions, and that's a very important part of the philosophy. The company philosophy is "a signal processor must be able to do nothing before it does something". That means that it should sound like a straight wire from input to output, without any effect, absolutely be transparent. That's the #1 goal, and we achieved that, and one of the goals that we achieved is through the VCA's. Very low noise, very low distortion. Now, of course, the point of the VCA is to move! And one of the problems with other VCA's is that they have a DC offset. So when you move very quickly, DC is coming out, at the output. Our VCA's : nothing, micro volts.

I think you sell those VCA's to other companies... Not at all: why should I sell my advantages to other companies? That would only look stupid! Those components are made on our design, on our special specifications. The electronic design around the VCA's has always been the same. The difference between the professional products and the low-cost products is the complexity of the input and the output stages: not just balanced, but servo balanced. Many of our professional products, if you look at the inside, have more circuitry for input and output than in the competitors' whole box. A VCA is moving, and one of the fastest moving VCA is a noise gate. Very often, if you ask a noise gate to go for a 100 dB attenuation in a few microseconds, you'll hear it: crrrr... Our VCA has no problem about that, no control offset. Also in a limiter, if the VCA is moving, and then starts to put DC on the output, detectors looking at the DC are working too hard, so it creates some distortion. That's another reason why our VCA is so wonderful for noise gates and limiters. That's one point: now, look at the Easy Rider: it is something wonderful, but if you look at the output, there's no big overshoot. The people who want a very open sounding compressor make a slow attack time, but the slow attack creates a big overshoot, you have to make the level lower and lower to protect from big overshoots. With the Easy Rider, you don't need it, but many people at the home recording level do not understand that: so you need to educate them a little bit. The advantage of Easy Rider is not only that it sounds good, but it's also protecting peaks, its slow attack but then it adds a faster attack. In other words, on audio sound, first sound is slower, so it feels like an overshoot, but it's no electronically overshoot.

### Do you use transformers?

No transformer, a transformer is a filter, even the better ones. Our frequency response is almost from DC to maybe 150 kHz. People say "You're crazy, why do you need to go to 150 kHz? " The reason is: transients. When you look at digital, 20 Hz to 20 kHz, one of the problems is transient response. It has slew rate limitation, and that's why digital has not that air, that feeling of space you find in analog machines. We don't have to go into an analog versus digital discussion, but that's just one part of our philosophies. We test capacitors for example, and listen very carefully to different styles of capacitors, and we use what sounds good.

# So you don't plan to develop products in the digital domain?

People asked us for it, but we say "When digital starts to sound!", but right now it's no point to make a digital reverb or delay: Yamaha, Lexicon, Alesis... there are too many companies, and again our idea is to do everything we do as unique. We don't go into the market to copy somebody, to do something after... I'd do another job! It's not interesting. So we have the 104, the 105, and the 106, and now the Tubessence. We came in and said "O.K, we need a mike preamp". We looked around and wondered what we could do. Our first thought was to have a four-channel mike/ instrument preamp, using the SSM part, which is a standard mike preamp chip. We listened to it and we said, "What's so special? Why do we need it?" : so instead we said "O.K, let's make something special for the home market", and we developed a special tube circuit, which uses a low-voltage tube : this circuit is also patent-protected, because one of the problems we have is to come out with products that have patents. The 105 for example has logic assistance, new gear, patent-protected: so Mr Behringer doesn't copy it! The 106 : patent protection. On the 107, there's a patent on the special tube circuit, so it's a combination of??? Max Spencers on front end and tube amplification: one tube running low voltage for both channels. It's a great invention. Because it's running low-voltage, it has a long life, no heat: it's perfect for the home market. And what we did while we were developing the tube circuit was to bring the whole circuit into different studios to make comparisons. And each time people listened to our mike pre, or Tube Tech or Avalon or Neve, all the top devices, they listened to all of them and people said, "It's not fair, the Aphex is louder!" And we look again, and we make a sine wave in the studio and wind up perfectly the sine wave, and then try to switch again: "The Aphex is louder!» as we have a much wider bandwidth, no transformers, and also a lot more presence, it feels more powerful. So the impression is it's louder, same level: very important again for the mentality of P.A or broadcast: to have more sound at the same electronic point. We were talking and talking, and people said, "it's louder!» so what we had to do was to make another invention, to design a product just to test our

own products. It's a switch box: mike in, mike pre out, to mike pre B, from, front (?), line out. The reason to put it in this box is you cannot put a microphone into two mike pre's at the same time, because of impedance loading: so you have to switch, but you can't switch too fast, especially with phantom powers, so we have a delay on these relays, it's totally passive, it's only relays. Then the point is: "How do we make it absolutely perfect unity gain?» there is a test signal, the same to both preamps, comes back, one preamp out of phase, so if you make the gain on one of the preamps to be 1/10 of a dB, it's 40 dB down. Now we're on unity gain, now we test, and every time when it's so close, everybody was satisfied and said "It's perfect", I compared it in Munich to a pre-amp designed by Rupert Neve himself, we tried it on an acoustic guitar, with a Neumann U 47, the guys playing in the studio switch the Aphex : you hear the box, and the fingers on the strings. Neve : smaller box, the details were gone, still guitar, but as if it was not the same instrument. The price for one channel of the Neve : 3500 DM. Price of the Aphex : 1200 DM. So what you give up when you buy a 107 is the fancy knobs, the fancy displays, it has an outboard power supply, a small chassis, but if you're thinking of how it sounds, if you're dreaming to get a good sound from your expensive microphones, how do you do it ? It's not possible. Really the market we have, even now we compared it to the most expensive preamps in the world, but what we're telling people is "O.K, try it against the preamp you have in your console, and then you'll be believing this is fantastic.", an then you go to compare the mike preamp with the Aphex, you'll really hear the difference, and also if you want to go direct on preamp, to DAT or to ADAT or to tape, then you can do it. And not take the odd quality of the audio down through the console.

#### The beginning

When we started, we had half a room, and a table. I knew some people who worked in studios, but what really started the business going was the Linda Rondstadt "Hasten Down the Wind " (1976) album, the sleeve notes said "Mixed with the Aphex Aural Exciter", and people heard that album and found so much presence, they called and that's how we started. We replaced the tube circuit with a solid state one, because working with tubes is so difficult... It was much easier so. Today, we're going back, it's really a terrific thing to be able to go back because now really the style is tubes. People are making mistakes saying "tubes are warm", tubes are really open and fast, there's no slew rate limitating, there's detail. "Warm" to me, to my ears, is a round sound. A transistor or a solid-state circuit takes a square wave and makes a triangle wave, because of slew rate limitating. And a square wave is like music: if you're able to follow a square wave, you are able to follow a transient. Also the overload characteristic: the solid-state devices mostly have hard clip, they make the edges a little rounder, much better sound.

### Will there be a new Aural Exciter built with tubes like the first one?

Maybe, maybe. For now, we're going to use this circuit in other products;

# You sell preamps, limiters, and exciters... Do you plan to develop for example a mixing desk?

No, it's too big a job to do mixing consoles. What we may do in the future is maybe make individual strips, so that somebody can have compression, gates and EQ in one strip with the preamp. It depends what the market asks us for.

All these devices would make a nice mastering console... No comment...

# Can you tell us about Mr Behringer, who copied your products without licence?

The German Federal Court found him guilty in 1992, he was copying exactly the Type B Aural Exciter, Type D, and then Type F. He copied so exactly those products, same face blade, used the same arguments in his brochures, and so then we started pursuits in 1987. And he put on so many arguments to the Court that it took until 1992 to find him finally guilty. In the meantime, he kept on using and using our technology. Then the next product he copied was the 612, a noise gate, and he copied everything so exactly, but from an earlier version, that he even copied the mistakes we had made! But he was hard to argue we didn't have a patent on the 612, but we went to Court because he had copied our manual, page for page, illustration for illustration. So we could show the Court exactly what he did, and were able to bother him for the copyright. He's an unbelievable thief, and then he says that he developed all this on his own, so people thinks he's a good engineer, but all he is a copyist. Each product is a copy.

#### Did he copy products from other manufacturers ? Among others dbx, Bristow, Rockon, Mackie. He comes out with a console exactly like the Eight-Bus. So he's a very dangerous person. And it's not allowed in America to form a cooperation to go in trial against a manufacturer. It's a problem because I play with rules above the table, he plays with rules under the table: he has no morality, he laughs, he makes a mockery of business ethics, and it makes me crazy because I could go home and I could sleep, the problem is what he's doing is confusing the market by telling them "Oh, that product is perfect, it works great", but when you analyse the product it's a bad copy. But he's that kind to make great advertising: that's easy for him, because he has no engineering expense. So that's why each one of the products we do now must have patents.

# Have you projects of what will come out after the Tubessence in a few months?

No, nothing I can talk out because rolling existing products out of the marketplace makes people angry. What we do make when we come out with an improvement is that we give it to the market too. For example, the Compellor has been around since 1984. We made a new invention for the Compellor two months ago, and we made an update kit available to all the owners at low cost, so people are not angry, they can install it themselves, it's very simple, no need to go to the retailer.

*How many Aural Exciters did you sell over the world?* Last year, we have produced a hundred thousand Aural Exciters, not including those, which are licensed to other manufacturers. Yamaha uses it in the digital domain for SPX 900, 990, 1000, SY 99, the digital mixer. It's a great thrill for me to see on a Yamaha

product: "licensed by Aphex" The other application, which is very interesting for the Aural Exciter, is for assistant listening. There's a law in America now, if you have many people in a P.A system and if some people, say, are hard of hearing, you must give them some way to hear emergencies and so on. And a company uses an Aphex system and they use the Aural Exciter for the people who have hearing loss, because the Aural Exciter works very well if your transmission is bandwidth-limited, or if the people who are hearing have hearing loss. It increases intelligibility, so it's a great application. Also for low-cost industrial amplifiers.

### How many people work for Aphex?

We are fourty people, we manufacture in our own factory, we don't manufacture in China. So if we come with a change, we can react very quickly. For example, at first we made a low-pass filter 60 Hz, 6 dB/oct. And the feedback was "No, that's not enough!", so we made it 80 Hz, 12 dB/oct. We made some tricks: instead of being critically damped, we made a ramp and then flat, we under damped, so you have more the feeling of bass, even though it's cut. We trust our ears... We listened at capacitors too, for our mike preamps. Almost all manufacturers use tantalum capacitors in their preamps. They work perfectly as capacitors, but they sound terrible. So we use very expensive special plastic capacitors, which work as well but sound beautiful. So we spend money for the components, not for so much promotion: we prefer a good quality sound and people like that too.

### About the two attacks-compressors

It has to be dependant on the waveform. It doesn't have a short rise time, you don't wanna to go to another attack time, you want it to be slow. Have a sharp attack that's you wanna do an application. So we have an intelligent circuit, not just automatic, slow/fast, but depending on waveform. Behringer uses the term "interactive" : bullshit ! Ask the Behringer distributor "What does it mean, interactive? Where is the circuit?"

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Our design philosophy was to have the same product applicable to many applications. For example, the Dominator is used in recording, in mastering, in broadcast, in cable TV and radio, in P.A too for system protection across the stereo bus and one of the most impressive applications is an in-ear monitor. The limiter that is used all over the world as a standard for ear-monitors is the Dominator. So the top artists, Gloria Estefan, Phil Collins, Madonna, Barbra Streisand... they are listening to their own voice, and artists are the most critical of course of their own voice, so all of them are listening to their own voices through Dominators, that's how clean it is.

That way, we can keep the price very low, even on our professional products: for example Dominator has 8 limiters on 1 U. What do you think about the price ? It may look expensive for 1 U, but what's inside works perfectly.

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