Jay McKnight at Ampex

by Alex Kostelnik

Alex Kostelnik's interview with Jay McKnight for Tape Op¹ was mainly about Jay's current work at MRL. Here is the rest of that interview, that's mainly about Jay's work at Ampex from 1952 to 1972.

Magnetic Reference Laboratory (MRL) founder Jay McKnight has had a long and fascinating journey in Audio Engineering. Jay has a picture of himself as a kid (maybe 6 years old) pulling a little wagon with an Edison Phonograph on it. In Junior High, Jay played the violin in the school orchestra, but was also a projectionist. A major influence on him was Glendale High School in California. There Jay worked with a factory-installed Langevin PA system as a student. The school had a Brush "Sound Mirror" tape recorder, and they also had a disk recording lathe on which Jay and fellow classmates would record the school radio programs. There the scales tipped away from being a musician and towards Electrical Engineering.

Jay attended Stanford University from 1948, where he earned a "Double E" degree in 1953. While a student at Stanford, Jay worked for the student radio station, KSU (later KZSU). He also attended concerts by the Stanford Symphony. An unusual man was always there recording them. He was Harold Lindsey from Ampex. They often ran into each other and talked about recording, and eventually Harold asked Jay to come work for him at Ampex. (AMPEX is said to be from "Alexander M. Poniatoff EXcellence".) There he worked on the Model 350 electronics and the Cinemascope theater system electronics.

In 1953, Jay "volunteered" for the army (on threat of being drafted), and ended up working for the Armed Forces Radio Service in New York City. While in New York, Jay also moonlighted at the legendary Gotham Recording Company, and with Rein Narma on the design of Les Paul's console for his new 8-track Ampex recorder.

After his army service, he came right back to California and Ampex, in Redwood City where he performed pioneering research. Jay has been involved on so many levels in analog's formative years that I could never fit everything he told me into this article.

Development of The Ampex 350

Alex: What are some things you did at Ampex in the fifties? Did you work on the Model 300?

Jay: No, the Model 300 was designed in 1948. But I did work on the design of the Model 350, which used an improved Model 400 electronics. There were several pedestrian problems – we eliminated the VR-150 voltage regulator tube, which had been used in the Models 200, 300, and 400, but

which was no longer necessary. We re-did the output stage, changing the 6C5 triode tube to the higher-power 6F6 pentode.

The most important thing I remember that we re-did was way the repro pre-amp equalization was done. About that time; a customer had come in to discuss a problem with my boss, Frank Lennert. This customer did recordings of birdcalls on his Model 400, and he had a problem with low-frequency thumps. It was distortion on the birdcalls. The birdcall makes two simultaneous high-level, high-frequency tones. And we poked around a little and found what it was: On the 400, the pre-amp had a limited current output, and the equalization was done by shunting its output with a rather low-impedance RC network. The two high frequencies of the birdcalls would overload the pre-amp, and you got what they used to call "CCIF intermodulation".

Alex: So it sounds like low-frequency thumping...

Jay: Yes. Because the pre-amplifier gain at low frequencies is 40 dB higher than at the 3 kHz range, if you have low-frequency distortion product that's 40 dB down it comes out at 0 level. Plenty loud, makes these nasty thumps.

Alex: And that's due to the EQ pre-emphasis. Or is that due to gain structure necessities?

Jay: Well, it's due to the fact that there is an integrator circuit directly after the first playback amp, which is where the EQ structure is if you will, and this causes the low-frequency intermodulation distortion product to be amplified a lot.

Alex: But at a particular emphasis because of the EQ curve, isn't that correct?

Jay: Perhaps you're thinking of the high-frequency preemphasis in recording. It isn't that problem. It's a problem of how the repro equalization is done. The repro equalization is a 6 dB an octave slope that levels out about 3 kHz. So the gain at 50 Hz is about 30 or 40 dB higher than it is at the high frequencies. And the amplifier is just a low-power pentode loaded by a capacitor, so it's feeding into a low impedance at high frequencies. And the amplifier overloads with high-level high frequencies, and the intermodulation makes a thump.

In response to this intermodulation problem, we worked out a feedback equalizer which was first used in the Ampex 350,

¹ Alex Kostelnik "Behind the Gear: Jay McKnight of Magnetic Reference Laboratory", Tape Op Nr 52, p 26, (2006 Mar/Apr).

then used in subsequent machines. This replaced the passive integrator circuit of the Model 400

Alex: And these were all octal tubes at this time?

Jay: Yes.

Professional Recorders in the 1940s and 1950s

Alex: On another subject: Is it a small world at this point? Like if you work at Ampex, it is like literally a few hundred people nationwide who even know about this stuff at this point in the 1950s. It's not like now...

Jay: Yeah, sure, there were a few companies. In the mid-tolate 1940s, the Brush "Sound Mirror" was presented as a professional recorder, but it was clearly not, so it went nowhere. Brush lost their opportunity at that point. There was the Magnacord. It was pretty good but not really fully professional. I mean, it was used, I guess, semiprofessionally. We had one at the junior college, and I think at Stanford. They were around. But they were not really heavy-duty professional things. And Ampex came out with the Model 200, which was very expensive, I think they said \$4000.

Alex: But it was a brick outhouse.

Jay: Yeah. It was really professional equipment. So Ampex at that time was sort of *the* pro recorder. And Ranger had made a machine that didn't quite make it for the test.

The Les Paul Console

Alex: Did you do some work for Les Paul in the early eight-track years?

Jay: I remember having been out to Les' place with Rein Narma around 1955, when I was still in the army. Rein and I and a couple of others designed and built the console that Les Paul had for his 8-track Ampex machine.

Alex: This is something that Les commissioned Ampex to make? Or is this something that you were doing as an independent consultant for him?

Jay: I think Rein Narma had been doing audio design stuff for Les for some time. He was doing Rudy Van Gelder's stuff and Gotham Audio stuff and Les Paul stuff. I knew Rein because I was the guy that did the disk recordings at night at Gotham Recording.

Alex: Was this during the formative stages of his home studio where he used modified broadcast consoles?

Jay: No, the console that we designed and built for Les was a unique console for him. Custom built from scratch.

Alex: What did he need that required a custom console?

Jay: Well, I suspect it had to have eight tape recorder inputs, which was not a stock thing in 1956. And it had tone controls. I don't remember what else.

Erasing Heads

Alex: When you came back to Ampex after the army, you did some work on tape heads. Tell me about that. They are such an important part of the recording process...

Jay: I did a research paper on tape erasure for Ampex in 1959. It was later published in the AES Journal – "Erasure of Magnetic Tape", Journal of the Audio Engineering Society, Vol. 11 No. 3, July 1963. Nobody had ever published much

on that subject. There had been a lot of patents, but not really much looking into erasure on tape.

Alex: Did you have any breakthroughs there?

Jay: Well, we found out exactly why a double-gap erase head is necessary. It had been used since the very earliest Ampex machines... well, I'm not sure about the first Ampex 200s, which were introduced in 1948. I'm sure the Ampex 300, introduced 1949, had a double-gap erase head. I can't recall exactly where the double-gap idea originated.

Alex: Do you remember that discussion on the Ampex list ² where people said "Oh, yeah, my 351 won't completely erase 456 tape" and someone would say "You need a double-gap erase head"?

Jay: Well, all of the Ampexes after 1949 had double-gap erasing heads. So I think what was happening was that the tape was not tracking over both gaps in the erase head. If you get the wrap angle (the rotation of the head) wrong, you can end up with the tape contacting one gap, but not the other. Someone may have remounted the erase head incorrectly, and when that happens, you can end up with too little wrap on the erasing head. If you go over only one gap, you won't get a complete erasure.

Alex: Ah, I was mistaken. I thought double gap erase heads came out only with the introduction of high-output tape formulations in the 70s. In other words, after the 351.

Jay: No, they go back much farther than that, at least as far back as the Ampex Model 300. And I did some measurements and researched what happens and why you need to have a double-gap head. If you have only a single gap in the erase head, you find out that as you increase the erasing current the remaining signal goes down on a steep slope, and then it levels out... it turns out that it's actually a re-recording problem. The funny thing is, that paper, which is one of my earlier papers, is the one thing that is frequently cited in the digital recording business. In the texts there, they cite back to that paper – the only erasure paper around.

Alex: Interesting. I always thought it was just that magnetic particles on the tape oxide were so ornery you had to slap them around twice to get them to let go.

Jay: Well, no. What seems to happen is that the recorded field on the incoming side of the erasing head produces a little bit of field clear over on the other side of the gap. So the signal is fully erased in mid-gap, but then it gets re-recorded at the outgoing side. The double-gap erase head cures this problem.

I eventually did a lot of research and engineering for Ampex, and they encouraged me to publish papers on this work. My published papers (mostly from my years at Ampex) are listed on the MRL website at http://home.flash.net/~mrltapes/jmbibsub.pdf.

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The Ampex List is a fantastic resource for anyone interested in recordingespecially analog technology. Log on to http://www.recordist.com/ampex and go from there. It is unique in that the tone is almost always courteous and gentlemanly. The wealth of talent on this listsery is breathtaking.