VOICES

Dave Fullagar, analog-IC designer and entrepreneur

Dave Fullagar made his mark at Fairchild Semiconductor in the 1960s. He designed the ubiquitous µA741 op amp, perhaps the most successful op amp ever. *EDN* recently had the chance to interview Fullagar. A portion of that interview follows. To read more, go to www.edn.com/071122pulse1.

Were you an electronics genius as a boy? Were you building crystal radios and winding your own slot-car motors?

A I've met very few geniuses in my life, and I'm certainly not one of them! But yes, I was building crystal sets at about age 9. Until I was 12 years old, we lived on the moors in the north of England in a house with no electricity, so a crystal set was my only option. In 1954, I read an article entitled "How to build a radio in a flashlight." It used something called a transistor—a Mullard OC71. I went down to the local radio store to buy one. "Never 'eard of a transistor, boy. Don't know naught about that," said the proprietor in a broad Yorkshire accent. I finally did acquire some OC71s, and I still have them. They are glass-encapsulated junction-alloy devices. To make a phototransistor, you just scrape the black paint off the glass.

The µA741, the first internally compensated op amp, is one of the landmark parts in analog history. How did you come to design this part?

A My assigned task when I joined Fairchild R&D in 1966 was to design the successor to the µA709. The target specification I was given by marketing was of the "let's-improve-all-the-key-specs-by-50%" variety. However, the biggest problems with the 709 were its idiosyncrasies, not its specifications: It was tricky to stabilize, there was no short-circuit protection, and it would latch up and self-destruct in nanoseconds. National Semiconductor's LM101, which [the late Robert] Widlar designed, addressed many of the user-friendliness issues but still required external compensation and had a kludgy front-end bias scheme. Widlar must have come to the same conclusion, because he later redesigned it as the LM101A with a much-improved front end.

I proposed the internally compensated µA741 in mid-1967 to Garth Wilson and Marv Rudin, who ran the Linear R&D Group. Next thing I knew, I was sitting in Gordon Moore's office. He asked me if I'd mind moving to Mountain View [CA] because that would expedite the introduction of the part, which occurred in May 1968.

What parts did you work on at Intersil? Were there any accomplishments you are particularly proud of?

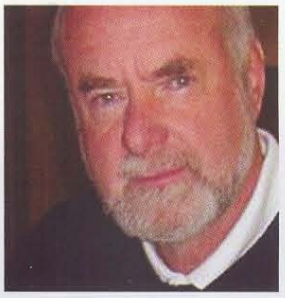
A It's interesting that, as a circuit designer, you get tagged by your best-known design. ... I'm known by the 741 op amp. ... For me, the Intersil years were the most creative. I developed the first IC logarithmic and antilogarithmic amps and the first monolithic FET-input op amp, the ICL 8007, which dominated the market until the bipolar FETs came along.

I also got to spend a month in Japan designing the first electronic-shutter IC for a single-lens-reflex camera for Canon. This circuit took the logarithm of three inputs—film speed, aperture, and light intensity—summed the result, stored it while the mirror went up, and then took the antilogarithm to generate the shutter speed. It used about 20 transistors in total and was probably my most elegant design. Nowadays, this is done with about half a million transistors in a microcontroller—how prosaic.

Both you and Linear Technology's Bob Dobkin showed me logarithmic-amplifier circuits. What is it about that circuit that you like?

A Interesting—I didn't know that Dobkin also used that circuit. I've been using it since I designed a logarithmic amp for Intersil in 1970. I like it as an interview topic because it isn't something you find in a textbook. The first—relatively simple—challenge is doing the dc analysis. The more interesting part is figuring out the impact on ac stability of having an active element in the feedback and what it takes to achieve unconditional stability.

Maxim copied a lot of Intersil parts as a second source at the beginning. The famous ICL7660 charge pump and the 7106 and 7107 DVM (digital-voltmeter) chips were a few of the parts. Did they keep you going while you designed Maxim parts?



A Absolutely. The original business plan called for the speedy introduction of 14 second-source parts to generate quick cash flow, followed by proprietary parts. Generating positive cash flow in a start-up is key: If you have to go back to the venture capitalists for an unscheduled round of financing, you get taken to the cleaners.

Considering your accomplishments at Maxim, of what do you feel most proud?

A I feel proudest of the design team I recruited. They were—and still are—some of the finest people in the industry, having designed an incredible number of innovative products, as well as serving in senior-management positions.

Any chance that you'll get bored in retirement and design a few parts for some lucky company?

A That's very flattering, but, after being retired for almost nine years and in management for 20 years before that, no one would want my designs today! But if anyone would like me to put together an electronics package for their sailboat, with a voyage to Tahiti included—well, that might be different.**–by Paul Rako**