Rarely Asked Questions

Strange stories from the call logs of Analog Devices

Make do!

Q. What is the most important characteristic of a successful analog engineer?

A. Ingenuity. I was recently given a subscription to "Make" magazine, which is devoted to gadget construction projects of surprising sophistication using, mainly, cheap everyday materials. Every engineer should read it.[1]

The words engine and engineer come from the Latin *ingenium*, which means *cleverness*. The best engineers use unexpected resources to accomplish their projects faster, better, and at lower cost.[2] Recently, I saw a small boy with a net failing to catch some little fish for a school project. With two plastic soda bottles and some adhesive tape, we made a trap in ten minutes which caught more than two dozen fish in the next hour.

A handful of simple CMOS logic, along with some basic op amp and instrumentation amplifier circuitry, can often perform precision analog functions very efficiently. Analog ASICs, FPGAs, or microcontrollers could probably do the job, but their development, which takes much longer and is expensive, may not be justified where the project is urgent and the quantities involved are small.

This is particularly true with test circuitry. I regularly rant about the necessity of verifying software simulations by checking that the behavior of hardware prototypes is congruent with the simulation results, but the common objection is that it is often hard to test them with simple test gear. Yet most of the time hardware checks are for functionality, not precision, and it is usually possible to make quite complicated signal sources from a hand-ful of parts if their levels and timings need not be too accurate.

It is easy to make buffers, amplifiers, inverters, summing circuits, and sine oscillators with an op amp or two; and 4000-series CMOS is particularly valuable for logic functions in this sort of application because it will work with supplies from 3 V to 18 V, it is much less noisy than most logic (because it is not very fast), its Schmitt input devices can be used in oscillators and delay circuitry, and it is available in dual inline packages, simplifying construction and modification of test circuitry.

When interviewing applications engineers, I always ask the candidates what electronic engineering they have done for themselves recently. I usually hear of small projects, often improving some piece of equipment by increasing functionality using the techniques we have just described.[3]

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[1] www.makezine.com
[2] *An engineer can do for a nickel what any fool can do for a dollar. (Henry Ford)*
[3] *When told that work is work and spare time is not for engineering I am concerned that the candidate's world view is not really that of a successful engineer.*

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