Specialized Testing versus Generalized Knowledge

They say a specialist is a person who knows more and more about less and less, and the ultimate specialist knows everything about nothing. I've always been proud of being a generalist, but taken to the extreme that would suggest you know less and less about more and more, with the ultimate generalist knowing nothing about everything. Obviously, neither extreme is useful at all, and what I strive for is a happy medium, knowing as much as possible about as many subjects as possible, and always learning more.

I have always been interested in all things scientific and technical. In high school, I wondered what field I could pick that used as many of my interests as possible. I thought Biomedical Engineering might be a good bet, so I took a novel academic path. My two bachelor's degrees are in Biology and Electrical Engineering Technology. The Biology department offered an option in Health Physics (nuclear safety), which I took. I was lured into doing some undergraduate research in chemical kinetics, specifically computer calculations of particle trajectories in time-of-flight mass spectrometers, and shock wave formation in rarified gas shock tubes. I was also exposed to a variety of chemical instruments, as well as high vacuum technology. The chemistry department offered a pioneering minicomputer interfacing course, which launched my career-long involvement with computers for data acquisition and control. My EET program required one specialty track, but I took three of the four being offered: analog design, digital design, and RF design. Engineering Technology also required courses in manufacturing processes and materials science that served me well later, and which Electrical Engineers usually don't have in their curricula.

In my freshman year, my English professor decided I could write, and tried to entice me to switch majors to English. I declined, figuring a technical education would pay better and give me something more interesting to write about. I've done pretty well as a writer, and my first job out of college was as a technical writer.

My second job was in air pollution analyzer design at Meloy Labs. This crossed disciplines … I was doing chemistry as much as I was electronics, including working up a catalyst system for converting hydrogen sulfide to sulfur dioxide. The sensors bridged into physics, as I worked with such technologies as photomultiplier tubes, narrow-bandpass optical filters, and flame ionization detectors.

If I have a specialty, it is rigging up tests. My career at Artech Corp was essentially that. While we did perform many standardized tests, much of the time we configured specialized tests, either derived from standard tests but modified for a particular application, or invented to simulate some product-specific condition.

Some of these were fairly sophisticated. I set up one test which monitored 126 thermocouples to record the temperatures at seven locations each on 18 electrical receptacles. We used this to perform a market survey of all the NEMA 5-15R duplex electrical receptacles on the market at the time. The test involved novel real-time analysis of the temperature trends, plus computer control of the test configuration.

One of our customers wanted sections of armor plate tested with a new method they had dreamed up. Modifying an existing technique, they wanted slotted and notched plates to be mounted on a massive test die, and exposed to "air-column" blasts of a range of intensities. The blasts were rigged by placing measured explosive charges on cardboard boxes of standard dimensions on top of the plates, producing a repeatable "air column" blast. The slots allowed the plates to bend along one axis, and the notch in the center of the plate acted as a crack starter location. I applied strain gages to the plates and used a high-speed data recorder to record the response of the plate to the blasts.

Other tests could be quite simple, such as pressurizing a SUV fuel tank until it burst, or stretching a length of sport-jumping bungee cord until it broke. But while simple, these tests obviously carried an element of danger and needed some careful thought to anticipate and minimize the risks. The KISS principle (Keep It Simple, Stupid) is always necessary to design tests which are economical and cost-effective, but economy also means not getting anyone hurt. Again, there are usually simple and cost-effective ways to avoid hazards, but only if you understand the test well enough to anticipate the danger.

Generalized testing is a highly interdisciplinary field. In my years at Artech, I needed my electronics background to design, build, and modify instrumentation and control circuits, knowledge of a number of sensor technologies, knowledge of physics and mechanics, a firm understanding of strengths of materials and structures, chemistry, biology, and hydraulics, good knowledge of building trades including plumbing and electrical power, and even a bit of consumer psychology. I also generally had to design and build the specialized test apparatus myself. This required a variety of construction skills including carpentry, metalworking, electrical power, and mechanics. In addition, I maintained and repaired most of the equipment, including a high-performance servohydraulic testing machine.

Artech was a small company, usually no more than 25 employees, and we rarely were in a situation of generous funding. Our market niche was cost-effective testing. I ran the physical testing department. We also had a chemistry department, a metallurgy department, a machine shop, a footwear testing lab, and a non-destructive test department. We were constantly working together and learned each other's disciplines, rather than the usual practice at large corporations of pigeon-holing people into narrow specialties.

When I left Artech, I picked up Energy-Matter Conversion Corporation as a client, then later as a full-time employer. At the time, the company consisted of four people: Dr. R. W. Bussard, his wife, a receptionist-bookkeeper, and me. I ran the lab, designing, building, instrumenting, and running plasma physics experiments, with the end goal being nuclear fusion. My electronics background, dating from the 1960s, included vacuum tubes, and the machines Dr. Bussard had designed worked on many of the same principles. My time-of-flight mass

spectrometer experience gave me both an understanding of the physics of ions in the machines and familiarity with high vacuum technology. My Health Physics background meant I was familiar with nuclear physics and with various radiation detectors. I found myself working with high currents provided by banks of large storage batteries, which I was already doing with my own solar experiments at my weekend cabin. I picked up experience with strong magnetic fields, among other new fields.

My work at Athena Controls was focused on Unmanned Air Vehicle control systems. Again, no single discipline was going to get the job done. I've always been an aviation enthusiast. My knowledge in this field supported my electronics and instrumentation background to make me ideally suited to develop the system for calibrating the mix of sensors in these units. I did development and production troubleshooting. I knew all aspects of these units, which involved sensors, precision instrument amplifiers, analog to digital converters, GPS receivers, and embedded microprocessors. I rigged up tests performed using automobiles and aircraft. I worked with outside labs on a variety of qualification tests including EMI/EMC, temperature, humidity, altitude, shock, vibration, and corrosion tests. My last few years there I designed and built hardware-in-loop simulators, complex systems which simulate whole aircraft control systems with as much real flight hardware as possible, especially servos and other mechanical actuators. The sensor technologies and their corresponding calibration methods gave me a firm foundation in the following:

MEMS accelerometers	Ideal Aerosmith 2-axis turntable
MEMS rate sensors	Ideal Aerosmith 2-axis turntable
Magnetoresistive bridges	MEDA 3-axis Helmholtz coils
Airspeed and altitude	Druck air data calibrators
Temperature performance	Thermotron temperature chambers

This gives you some idea of what I mean by naming my consulting service "Assorted Technical Expertise." It is the best description I could come up with for what I do. I am comfortable in crossing disciplines. I'm an expert in a number of fields and knowledgeable in a number of others. I love learning new technologies, and what I don't know, I'll learn. I'm used to being a one-man shop, designing, building, troubleshooting, operating, and fully understanding a test from start to finish.

I am probably not the best choice if you need to qualify a product with an array of standardized tests. There are labs that do this routinely, and they have millions of dollars worth of specialized equipment with which to do these exacting tests. I've worked with MetLabs, Alion, E-Labs and others. But expert and qualified as these labs are, they are sometimes not the best choice if you have an unusual requirement or if you failed one of their tests. Their prices usually don't include troubleshooting or advice on working around the problems, and their schedules are frequently too busy to open up time for extra work. While I don't have their millions of dollars of specialized equipment, I can often rig a very close approximation to any given test requirement. I can take the time to find the problem and I can help you design a fix and test it out. Because of my broad background, I can also frequently spot problems it would take a team of specialists to identify.