

Chapter 1

Our Gang: The Electronics Kids

You usually start books like this by talking about your parents: who they were, or what they did for a living before you were born or while you were growing up. But the thing is, I never did know for sure what my dad did for a living. As early as I can remember, my brother, sister, and I all had to grow up with this secret. And as secrets go, oh man, this one was huge. We weren't even allowed to talk about his work or ask questions about it in the house. The conversation was strictly off-limits.

I did know Dad was an engineer, and I knew he worked in the missile program at Lockheed. That much he said, but that was pretty much it. Looking back, I figure that because this was in the late 1950s and early 1960s at the height of the Cold War, when the space program was so hot and top secret and all, probably that's why he couldn't tell me anything more about it. What he worked on, what he did every day at work, he'd say absolutely nothing about. Even up to the day he died, he didn't give so much as a hint.

I remember how in 1960, when I was ten, I finally understood why he'd never be able to. He said it was because he was a man of his word. Once, when he was explaining why you should never lie under oath in court, that's what he said: "I'm a man of my word."

Now, on my own, I managed to put together little bits and pieces. I remember seeing NASA-type pictures of rockets, and stuff related to the Polaris missile being shot from submarines or something, but he was just so closemouthed about it, the door slammed there.

I tell you this because I'm trying to point out that my dad believed in honesty. Extreme honesty. Extreme ethics, really. That's the biggest thing he taught me. He used to tell me it was worse to lie about doing something bad under oath than it was to actually do something bad, even like murdering someone. That really sunk in. I never lie, even to this day. Not even a little. Unless you count playing pranks on people, which I don't. That's comedy. Entertainment doesn't count. A joke is different from a lie, even if the difference is kind of subtle.

The other thing my dad taught me was a lot about electronics. Boy, do I owe a lot to him for this. He first started telling me things and explaining things about electronics when I was really, really young—before I was even four years old. This is before he had that top secret job at Lockheed, when he worked at Electronic Data Systems in the Los Angeles area. One of my first memories is his taking me to his workplace on a weekend and showing me a few electronic parts, putting them on a table with me so I got to play with them and look at them. I can still picture him standing there working on some kind of equipment. I don't know if he was soldering or what, but I do remember him hooking something up to something else that looked like a little TV set. I now know it was an oscilloscope. And he told me he was trying to get something done, trying to get the picture on the screen with a line (it was a waveform) stable-looking so he could show his boss that his design worked.

And I remember sitting there and being so little, and thinking: Wow, what a great, great world he's living in. I mean, that's all I

thought: Wow. For people who know how to do this stuff—how to take these little parts and make them work together to do something—well, these people must be the smartest people in the world. That was really what went through my head, way back then.

Now, I was, of course, too young at that point to decide that I wanted to be an engineer. That came a few years later. I hadn't even been exposed to science fiction or books about inventors yet, but just then, at that moment, I could see right before my eyes that whatever my dad was doing, whatever it was, it was important and good.

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A couple of years later—I was six, maybe seven—I remember Dad demonstrating another piece of equipment for a bunch of people at his company. A big group of people was there. These weren't just people he worked with, but also our whole family and other families, too. I think it was just a drilling machine he was demonstrating.

And my dad, even though I was just this little kid, told me I would be the one to get to throw the switch to turn it on. He said I had to do it at the exact right time.

I remember worrying about how I would know when the right time was and thinking: Now? Now? When should I do this? Now? My dad was busy talking and joking with the families of the guys who worked there, who were going to watch me do it. Then suddenly it felt like the right time. I can't explain why, but I just felt inside it was the right time. So I went ahead and threw the switch.

I heard a lot of laughter, and I didn't know why. Suddenly I realized I had thrown the switch too early. Now that I look back on this, I see this might be the beginning of my shyness, you know, getting butterflies in your stomach because you're afraid of failure when you have to talk or something.

Or maybe that was my first prank, but it was definitely unintentional!

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But there were also lessons from my dad, serious lessons that got me an incredibly early start in engineering. These lessons would always start because I'd ask a question. And I had a lot of questions.

Because my dad was an engineer, there were all kinds of interesting things lying around my house. And when you're in a house and there are resistors lying around everywhere, you ask, "What's that? What's a resistor?" And my dad would always give me an answer, a really good answer even a seven-year-old could understand. He was just an extremely good teacher and communicator.

He never started out by trying to explain from the top down what a resistor is. He started from the beginning, going all the way back to atoms and electrons, neutrons, and protons. He explained what they were and how everything was made from those. I remember we actually spent weeks and weeks talking about different types of atoms and then I learned how electrons can actually flow through things—like wires. Then, finally, he explained to me how the resistors work—not by calculations, because who can do calculations when you're a second grader, but by real commonsense pictures and explanations. You see, he gave me classical electronics training from the beginning. For engineers, there's a point in life when you understand things like how a resistor works. Usually it comes much later for people than it did for me. By the fourth grade, I really did understand things like that.

And my dad was always around to help me understand still more things. Like light. How does a lightbulb work? I wanted to know. Not many people my age knew—probably most people who are grown up still don't. But he explained it to me: first how

lights are made, then how electrons went through wires, and how those were what made a lightbulb glow. And I wanted to know how, how did it glow? So he went back to the beginning, explaining to me how Thomas Edison invented lightbulbs and what he had to figure out to do it. He realized that basically you had to create a vacuum—it had to be a vacuum because if there were oxygen in it, the wire would just burn up when it got hot. So this vacuum (remember, a vacuum has no air in it) is in this little bulb, and the point was to get heat—by moving a lot of electrons through a wire—into it.

And the more electrons that go through the wire—that is, the higher the current—the brighter the lightbulb will glow. Cool! I was eight or even younger when I understood this, and knowing it made me feel different from everyone else, different from all the kids I knew. I started to feel as if I knew secrets no one else knew.

I have to point out here that at no time did my dad make a big deal about my progress in electronics. He taught me stuff, sure, but he always acted as if it was just normal for me. By the sixth grade, I was really advanced in math and science, everyone knew it, and I'd been tested for IQ and they told us it was 200-plus. But my dad never acted like this was something he should push me along with. He pulled out a blackboard from time to time, a tiny little blackboard we had in our house on Edmonton Avenue, and when I asked, he would answer anything and make diagrams for it. I remember how he showed me what happened if you put a plus voltage into a transistor and got a minus voltage out the other end of the transistor. There must have been an inverter, a type of logic gate. And he even physically taught me how to make an AND gate and an OR gate out of parts he got—parts called diodes and resistors. And he showed me how they needed a transistor in between to amplify the signal and connect the output of one gate to the input of the other.

To this very moment, that is the way every single digital device on the planet works at its most basic level.

He took the time—a lot of time—to show me those few little things. They were little things to him, even though Fairchild and Texas Instruments had just developed the transistor only a decade earlier.

It's amazing, really, to think that my dad taught me about transistors back when almost no one saw anything but vacuum tubes. So he was at the top of the state of the art, probably because his secret job put him in touch with such advanced technology. So I ended up being at the state of the art, too.

The way my dad taught me, though, was not to rote-memorize how parts are connected to form a gate, but to learn where the electrons flowed to make the gate do its job. To truly internalize and understand what is going on, not just read stuff off some blueprint or out of some book.

Those lessons he taught me still drive my intelligence and my methods for all the computer designs I do today.

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But even with all of this—all the lessons and explanations a kid could understand—I want to tell you about the single most important lesson he taught me. Because this is what I have always hung on to, more than even the honesty thing. He drilled into me what it means to be an engineer. What I am talking about is what it means to be an engineer's engineer. A serious engineer. I so clearly remember him telling me that engineering was the highest level of importance you could reach in the world, that someone who could make electrical devices that do something good for people takes society to a new level. He told me that as an engineer, you can change your world and change the way of life for lots and lots of people.

To this day, I still believe engineers are among the key people in the world. And I believe that I will be one forever, and I have

dedicated my whole life to engineering. I realize that when engineers create something there is often an argument that the creation could be used for bad or good. Like the atomic bomb. My dad had the opinion that change is what moves the world forward and that's the path we're on and basically all change is good. That any device people want is good and should be made and not get stopped by governments or anyone else. And I came to that same view when I was very young, ten or maybe younger. Inside my head—and this is what has really stayed with me—I came to the view that basically, yes, technology is good and not bad.

People argue about this all the time, but I have no doubts about it at all. I believe technology moves us forward. Always.

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Now, you've got to realize that, electronics-wise, 1950s Northern California was another world compared to what things are like now. For example, where I was growing up, everybody who owned TVs and radios literally had to replace the bad vacuum tubes inside them themselves. Grocery stores had these giant tube testers that everyone in the family—kids, parents, everyone—knew how to use. I mean, we knew that when the TV went bad you opened it up and then took all the tubes to the grocery store, where you'd insert them in that machine. There was a meter on it that would tell you if the tube was good, weak, or bad. You could buy replacements for the bad tubes right there in the grocery store and take them home to reinsert in your TV.

In case you're too young to remember, this was a clunky solution, but it worked pretty well. The only bad part was the human effort this required—taking out the tubes, testing each of them, putting them back in. So much work! I used to look at those tubes, trying to take apart what they were made of. They were just little filaments—they ran hot and could burn out like a light-bulb. It was as simple as that. I remember wondering what it would take to build a tube that wouldn't burn out, or a TV that

didn't need tubes to work at all. How much easier they would be for people.

That's how I was, how I've always been—and still am, it seems. I've always had this technical side and then this human side. For instance, I remember telling my dad when I was ten that when I grew up, I wanted to be an engineer like him, but I also remember saying I wanted to be a fifth-grade teacher, like Miss Skrak at my school. Combining the human and the technical turned out to be the main thing for me later on. I mean, even when it came down to something like building a computer, I remember watching all those geeks who just wanted to do the technical side, to just put some chips together so the design worked.

But I wanted to put chips together like an artist, better than anyone else could and in a way that would be the absolute most usable by humans. That was my goal when I built the first computer, the one that later became the Apple I. It was the first computer to use a keyboard so you could type onto it, and the first to use a screen you could look at. The idea of usable technology was something that was kind of born in my head as a kid, when I had this fantasy that I could someday build machines people could use. And it happened!

Anyway, anyone you meet who knows me will tell you that that is exactly me—an engineer, but an engineer who worries about people a lot.

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According to my birth certificate, my full name is Stephan Gary Wozniak, born in 1950 to my dad, Francis Jacob Wozniak (everyone called him Jerry), and to my mom, Margaret Louise Wozniak. My mother said she meant to name me Stephen with an *e*, but the birth certificate was wrong. So Stephen with an *e* is what I go by now.

My dad was from Michigan; Mom was from Washington State. My dad and his brother, who later became a Catholic priest, were raised in a strict and pious Catholic household. But by the time

my parents had me—I'm the oldest of three—my dad had rebelled against that: the Catholicism, I mean. So I never got any exposure to religion. Church, mass, communion. What is that? Seriously, I couldn't tell you.

But from the earliest age, I had a lot of conversations with my parents about social policies and how things work. As for religion, if I asked, my dad would say, no, no, he was scientific. Science was the religion. We had discussions about science and truth and honesty, the first discussions of many that formed my values. And what he told me was, he just wanted things to be testable. He thought that to see if something is true, the most important thing is to run experiments, to see what the truth is, and then you call it real. You don't just read something in a book or hear someone saying something and just believe it, not ever.

I eventually came to conclude that, yes, I believed the same thing. And at a super young age, I knew I would do something scientific when I grew up, too.

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I forgot to mention before that my dad was kind of famous, in his own way. He was a really successful football player at Caltech. People used to tell me all the time that they used to go to the games just to see Jerry Wozniak play. And my mom, she was great to me and my younger brother and sister. She'd be home when we came home from school, and she was always really pleasant and funny and interesting and gave us stuff to eat that was special to us. And was she ever funny! I think it was from her—definitely not my dad—that I got this sense of humor of mine. The pranks I like to play, and the jokes. I have been playing pranks on people for years and years. And my mom, well, I guess you could thank her for that. She just has this wonderful sense of humor.

When I was in the sixth grade in 1962, my mother was big into Republican politics. She was a huge supporter of Richard Nixon, who was running for governor of California, and there was some

event in San Jose where Nixon was speaking and she said, “Oh, Steve, why don’t you come along?” And she had a plan, a joke I would do. She wanted me to meet him and tell him, opening up a piece of paper, that I represented the Ham Radio Operators of Serra School, and that our group unanimously supported Richard Nixon’s election for governor. The joke was, I was the only sixth-grade ham radio operator in the school, probably in the whole state. But I did it. I walked up to Nixon and presented the paper, which we literally wrote with a crayon just before leaving home.

I said, “I have something for you.” Nixon was really gracious, I thought. He seemed kind, and he smiled at me. He signed one of my schoolbooks I had with me, and even gave me the pen he signed it with. About twenty flashbulbs went off, and I ended up on the front page of the *San Jose Mercury News* for this. Me! The only ham radio operator at Serra School and probably the youngest one in the whole state, representing a club made up of nobody but me, presenting a fake certificate like it was the real thing. And everyone believed it. Wow!

So it was funny and everything, but something bugged me, and I’m going to tell you that it still bugs me to this day. Why did nobody get the joke? Doesn’t anybody check facts? The newspaper cutline said something like, “Sixth grader Steve Wozniak represents a school group that’s for Nixon.” They didn’t get that there was no school group, that it was all a joke my mom made up. It made me think that you could tell a newspaperperson or a politician anything, and they would just believe you. That shocked me—this was a joke they took for a fact without even thinking twice about it. I learned then that you can tell people things—crazy jokes and stories—and people will usually believe them.

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We spent most of my early years in Southern California, where my dad worked as an engineer at various companies before the secret job at Lockheed.

But where I really grew up was Sunnyvale, right in the heart of what everyone now calls Silicon Valley. Back then, it was called Santa Clara Valley. I moved there when I was seven. It was all just really agricultural. It was totally different from the way it is now. There were fruit orchards everywhere. Our street, Edmonton Avenue, was just a short one-block street bordered by fruit orchards on three of four sides. So pretty much anywhere you drove on your bike you'd end up in an apricot, cherry, or plum orchard. And I especially remember the apricots. Every house on my block had a bunch of apricot trees in their yard—our house had seven of them—and in the fall the apricots would get all soft and kind of splatter wherever they landed. You can imagine what great projectile weapons they made.

When I think of that street, looking back, I think it was the most beautiful place you could imagine growing up. It wasn't as crowded back then, and boy, was it easy to get around. It was as moderate of temperature as anywhere else you could find. In fact, right around the time I moved there—this was 1958—I remember my mother showing me national articles declaring it to be the best climate in America. And as I said, since the whole place had barely been developed, there were huge orchards every which way you went.

Edmonton Avenue was actually a small Eichler subdivision—Eichler homes of that period were kind of famous for being architecturally interesting homes in middle price ranges. They stand out as special homes to this day. And the families in them were a lot like mine—middle class, with dads commuting to work at the new electronics and engineering companies starting up, and moms at home. Because of that, and the fact that a bunch of my friends could pretty easily get electronics parts and all kinds of wires from our dads' garages or company warehouses, I thought of us as the Electronics Kids. We grew up playing with radios and walkie-talkies and weird-looking antennas on our roofs. We played baseball and ran around, too. A lot.

I remember when I was in the fifth grade I was really athletic. I was always being told I was the best runner, the top athlete in school, the best baseball player, and I was really popular because of all that. But electronics was really my life, and I loved devising all kinds of projects with the Electronics Kids.

In fourth grade for Christmas, I got the most amazing gift from my parents. It was an electronics hobby kit, and it had all these great switches and wires and lights. I learned so much playing with that stuff. And it was because of that kit that I was able to do the neatest things with the Electronics Kids. I was the key kid in designing a house-to-house intercom connecting about six of our houses.

The first thing to do was to get the equipment we needed. The main thing was wire. But where were a bunch of kids supposed to get yards and yards of wire? And how we got it—it was just unbelievable. One of the guys in my group, Bill Werner, literally walked up to a phone guy and asked him if he could have some telephone wire. He'd seen long spools of it in the guy's truck, so he just asked him for one of them. I don't know why, but the telephone guy just gave it to him, saying, "Here's a cord, kid."

What Bill got was a spool of wire about a foot in diameter. It was a lot, a whole lot, of wire. It was two-wire cable, solid copper wire inside of plastic insulation in the colors white and brown, twisted every inch or so to keep the two wires together and to minimize electrical noise from being picked up. Think of it as a plus wire and a minus wire. If some electrical interference is strong, it gets picked up equally by the plus and minus wires due to their being twisted. The point is that there is never a single wire that is always slightly closer to the interference signal. The plus and minus wires serve to cancel out the interference. You get as much minus as plus. That's how telephone cords work, as I found out from this. It is also where the term "twisted-pair" comes from.

And so then I figured out what to do with all this cord, designing on paper really careful lines with my different-colored pens. And I figured out where the switches would be, and how we would connect carbon microphones (that's how microphones were back then) and buzzers and lights so we kids wouldn't be waking our parents up with loud noises that would let them know what was up. We had to make sure we could do this in absolute secrecy, and that we kids could turn the buzzers off at night so we could wake ourselves up just by the light.

Once we finished the design, the bunch of us rode our bikes down to Sunnyvale Electronics, the local store and hangout for kids like us. We bought all this neat stuff, the microphones and the buzzers and the switches, you name it.

The next thing we did was connect the wire between all the houses. There were these wooden fences that separated all the houses on our short little street, and we just went along the fence in broad daylight, stringing this wire along and stapling it in. You know, it's possible that putting staples into wire would short it out. We were so lucky that didn't happen. And we stapled that wire all the way up the block—from one of my friends' houses to mine, and then I set up my switch box, drilled some holes in it, mounted some switches, and you know what? It worked! So then we had a house-to-house secret intercom system so we could talk to each other in the middle of the night.

We were about eleven or twelve then, so I'm not trying to convince you this was a professional modern engineering system, but it really worked. It was just a tremendous success for me.

In the beginning, we used it to call each other, I guess it was just so cool to be able to talk to each other. We'd call each other up and say things like, "Hey, this is cool! Can you hear me?" Or, "Hey, press your call button, let's see if it works." Or, "Try my buzzer out, give me a call." That was about the first week or two, and after that we started using it as a way to sneak out at night.

It didn't ring in this case, it had to quietly buzz, and it had to work on lights. So Bill Werner or one of the other guys would signal me, or I would signal one of them, and we had a code that would mean different things. I can't tell you how many nights I woke up to that buzzer or a light thinking: Oh boy, we're going out tonight!

We were a group of kids who loved climbing out our windows and sneaking out at night. Maybe it was just to talk, or go out and ride bikes, or sometimes it was to toilet-paper people's houses. Usually girls' houses. Ha. We'd go out in the middle of the night and say things to each other like, "Does anyone know anyone who has a house we should toilet-paper tonight?" To tell you the truth, I never had any idea who we should toilet-paper—I never thought like that—but the other guys usually had someone in mind.

And then we would go to the all-night store and try to buy, like, twenty-five rolls of toilet paper. I remember the clerk saying, "Hey, why do I get the feeling that this isn't to be used for its intended purpose?" I laughed and told him that we all had diarrhea. And he sold it to us.