Erhard and I, on the other hand, were to work on the next generation full-blown TIMS, to be code named TIMS-II, which would bring the benefit of the new microprocessor technology to the original TIMS concept. Erhard had been working on the general design plan, which is known as the 'system level design,' for some time before I got there and had the technical plan for developing this product generally laid out already. Erhard took the greater part of my first real working day after I'd settled into my new apartment to explain to me what a TIMS was and what TIMS-II was going to be. He was planning to incorporate most of the designs already going into Mini-TIMS. This is known in engineering as 'leverage.' But a full-blown TIMS had to do more things than the Mini-TIMS could do. In particular, there were measurement functions TIMS-II had to have that the Mini-TIMS did not have, and the old TIMS designs for these functions had to be brought up to date and changed to take advantage of microprocessor technology. That was where I came in. I was to start designing the new electronics for these functions. And Erhard knew which one he wanted first. "You'll be designing Hits and Dropouts," he told me.

"Great! What's a 'Hits and Dropouts'?" I asked. I'd never heard of such a thing.

Erhard answered my question by handing me a several hundred page manual entitled *Theory of Operation of the HP 4940.* Along with it he handed me a telephone company pamphlet entitled *Bell Publication 41009*. "It's all in there," he said with a grin.

This is what I meant when I said my education had prepared me very well for the theory side of my work. One of my senior year courses had explained a little about 'transmission impairments,' but there were others, such as Hits and Dropouts, it hadn't mentioned at all. In point of fact, over 99% of the EE world doesn't know what 'Hits and Dropouts' are. The fact I didn't know wasn't a reflection on my education. It was a reflection of the fact that every high technology corporation has engineering problems very specific to their business that other high tech companies neither know nor have to care about. An engineering education prepares you in the fundamentals that are used regardless of whether you are designing a TIMS or a toaster. And it also prepares you to be able to *teach yourself* what you need to learn in order to work in whatever specialized problem areas your company has to deal with. If it didn't do these two things, it wouldn't be an 'education'; it would be 'training.' In 1975 the managements of America's high technology corporations knew that and knew the difference between education and training. Today I'm not so sure they do.

Anyway, I lugged that four inch thick stack of documents over to my desk and set to work learning what 'Hits and Dropouts' was. Within about a week I thought I had a pretty good handle on what it was and had managed to sketch out the general technical plan for the electronics that would be needed to measure it. (This kind of technical plan is called the 'block diagram level' of the design). Erhard looked my work over and pronounced it a good start. He also pointed out a few practical things I still needed to figure out in order to get my developing design to fit in and work with the rest of the instrument.

The nice woman in Personnel on my first day had told me ties weren't required at HP, but she hadn't said anything about them being forbidden so I was wearing a tie at work each day. No one else did, but I like to wear a tie. To me it's a constant personal symbol that I'm not working in the bakery anymore. You might say it's my own private little badge of triumph. Yes, I know a lot of men complain that ties are uncomfortable, that they're 'choke collars' and so on, but that actually isn't true. Buy a shirt with a neck size that'll go around your neck without needing a winch, guys. It's your shirt, not your tie, that's choking you. Anyway, about the third morning of real work I was sitting at my desk deep in thought about Hits and Dropouts and scribbling some things in my lab notebook. My desk sat along the corridor of the lab and it, along with the short wooden bookcase sitting on it, formed part of the 'wall' that defined the corridor. Suddenly I heard a stern sounding Voice From Above:

"WHO gave YOU the day off?" it demanded.

Startled, I looked up and there was Bob Allen, the Lab Manager, standing in the corridor, peering

down at me with a scowl from over the top of my bookcase. My face must have been a study in bewilderment because he suddenly broke out in a big, toothy grin. "Everybody knows you can't think with a tie on," he added. Then he strolled off down the corridor, still grinning.

He left in his wake a fairly unsettled twenty-one-year-old. I didn't know if he was just kidding me or not. I knew I didn't know him well enough yet to be able to tell. I did come to find out later that Bob liked to tease people; he was a bit like Grandpa Teters in that regard. So it's possible he was just teasing me. On the other hand, no one else wore a tie, these people didn't know *me* yet either, and Bob might have been letting me know in a jocular way that I was violating some kind of unwritten HP folkway. Clearly, judging from a couple of the guys in the lab, HP didn't mind its engineers coming to work looking like they'd just finished weeding their gardens. But maybe they *did* mind it if somebody wore a tie. Maybe some of them would think I was trying to show them up or something. It was keenly in my mind that I was in that six month probationary period, so I decided discretion was the better part of valor and I should quit wearing a tie to work. At least for six months anyway. In the grand scheme of things it was an awfully minor matter. Still, though, I was pretty irritated about it. Apparently it was okay for somebody to exhibit his freedom of expression by wearing blue jeans that let his kneecaps show, but it was *not* okay for me to show *my* freedom of expression by wearing my little badge of accomplishment. Fair? No. But I'd known life is often unfair since I was ten years old. My ties stayed home in the closet after that. For the time being. □

I'd been working on my assignment for about two weeks when Del called a group meeting. The ten members (including Del) of the TIMS group gathered in the division's conference room just after lunch. There Del told us the U.S. Navy was interested in our Mini-TIMS except for two things. They wanted it to be able to measure a transmission impairment called 'phase jitter' (which *was* one of the transmission impairments that had been covered in my senior course) and they wanted it to supply output signals they could use to drive an old-style analog X-Y plotter to make a permanent hardcopy record of the testing. Phase jitter was one of the measurements TIMS made that Mini-TIMS did not. The other feature, which came to be known as 'analog outputs,' was something even TIMS did not do.

Del did not explain that adding the U.S. Navy to the list of Delcon's customers would be a very good thing for our small division. I didn't think that needed any explaining; it was obvious. So when he told us he had decided to put TIMS II on hold and reassign Erhard and me to the task of designing a second version of Mini-TIMS that would have these features I wasn't surprised. Apparently I was wrong, though, about how self-evident the benefit of bringing in the Navy as a customer was. Some of the older guys were pretty upset about the decision and voiced their disagreements right there in the meeting. This surprised me for a couple of reasons. The first was just because they didn't see the self-evidence of the benefit like I did. The second was because the guys who spoke up really weren't personally affected by the decision. They weren't the ones having their assignments switched. Only Erhard, me, and one other guy, a young engineer named Dave Novotny, who was a couple years older than me, were directly affected, and Erhard and Dave weren't among the guys objecting to Del's decision.

But Del listened calmly to the guys' objections and quietly responded to them one by one. By the end of the meeting the guys in the section might not have agreed with his decision but at least they accepted it. I was impressed for two reasons. First, the guys who had spoken out against the decision *had* spoken out against it. The fellows I'd worked with at the phone company never openly argued with the boss in public like that. They rarely agreed with the boss' decisions, but instead of saying so they'd just grouse about it in private at coffee break. Second, Del seemed to take it as a matter of course that some people *were* going to disagree with his decision and that it was his job to convince them to support it whether they agreed or not. He could have just said 'the decision is made, that's all there is to it.' After all, he was our boss and nobody was going to quit over this. But that's not what he did. I later learned that what I was witnessing that day is called 'consensus building' in manager terminology. It's the difference between being a leader and being a ruler. Del was our boss, yes, but he was also our *leader*. After the meeting was over, I never heard one single bit of grousing over the decision from anybody. We were all signed up that

bringing out a second version of Mini-TIMS was now an objective for our group.

Del made Erhard the project leader for this new project. Erhard, in turn, assigned the phase jitter measurement design to me and the analog outputs design to Dave. I'm pretty sure Erhard wanted to get this project over with quickly so we could get back to TIMS II, and his assignments were in line with this. Analog outputs would be a completely brand new TIMS feature that had never been done before. It had to be an invention from the ground floor up. Phase jitter, on the other hand, had been done before in the original TIMS. It was basically a leverage assignment, copy-and-modify-to-fit-into Mini-TIMS. Dave had close to two years of experience already while I was a raw, wet-behind-the-ears rookie with the ink still drying on his diploma. Dave was a proven performer while I had yet to prove I could actually do anything. Erhard was making the smartest use of his people.

Dave wasn't actually completely done with his assignments on Mini-TIMS yet, but his designs were far enough along that he felt comfortable taking on added design responsibility. At least he looked comfortable with it as far as I could tell. One of the Mini-TIMS' new features had come straight out of the microprocessor revolution. It was a printed circuit board plus microcomputer software (called 'firmware' because the computer programs were stored permanently in special chips called 'read-only memories' or ROMs) that allowed a Mini-TIMS to be controlled by a computer. This, in turn, allowed customers to automate their testing processes. The basic idea for this hadn't originated in Delcon Division; I'm not sure if it had been thought up first at HP Labs, the company's 'pure research' lab, or if it had been thought up at one of the company's other product divisions, or perhaps at Corporate Engineering, a part of the company whose work had an across-the-company scope. But whichever was the case, this feature was being designed into most of the company's new instrument projects that year. It was officially known as the Hewlett Packard Interface Bus or HPIB. HPIB *did* require invention on Dave's part because HPIB was really a standard for designs rather than the design itself. A few years later there would be standard integrated circuit chips for implementing the HPIB function, but these did not yet exist at that time. HPIB was also eventually made a standard by the Institute of Electrical & Electronics Engineers (the IEEE, which is the main professional society for electrical engineering) and would become known as Standard IEEE-488. But this, too, hadn't happened yet. HPIB was still too new an invention. HP's products that came out the same year Mini-TIMS did were among the first products in the world to offer HPIB.

Dave's other responsibility was a measurement called 'noise with tone.' Noise with tone had been one of the measurements built into TIMS and included in the Mini-TIMS. It had been Dave's first assignment on Mini-TIMS after he'd joined the company and, except for technical details, that assignment had been pretty much like the first assignment they'd given me. He had mastered it already and his design was pretty much done except for cleaning up occasional problems uncovered during testing of the Mini-TIMS prototypes. Dick occasionally teased Dave a little, in a good-natured way, by calling him 'Dave Noise-with-Tony' instead of 'Dave Novotny.' It was a way of acknowledging Dave's first big design success.

As for phase jitter, that had been done once already for TIMS. Paul Winninghof, one of the older guys, had been the inventor. Erhard's instructions to me were pretty straightforward: Copy what Paul had done in TIMS and modify it as needed to work in a Mini-TIMS. If I had any technical questions as I went, I was to consult with Paul. It wasn't what you'd call a glamorous assignment, but it wasn't all that much different from what I'd planned to do with Hits and Dropouts anyway. At least I already knew what 'phase jitter' was from my college course and had a better idea of how measuring it was probably done as I went into my new assignment. I still more than half thought of myself as just a college student masquerading as a real engineer and, frankly, almost everything about my new job was still pretty intimidating. I was almost desperately anxious to prove to these guys, and to myself, that I had the talents and abilities to be a good design engineer. Just because I had a job here didn't mean I'd made the team yet. Not in my mind anyway. In the pros most rookie athletes get cut; I didn't see any reason that couldn't happen to rookie engineers. So if my team needed a nose tackle, hey! I'll do it! Put me in, Coach.

Del had a suggestion of his own that Erhard was only too happy to agree with. New product design

goes in stages. It's often called 'the product life cycle.' It begins with the conception of a product, goes through a definition stage, then an initial design called a breadboard prototype, the purpose of which is to prove the basic concept of the product. This is then followed a more advanced design, called a lab prototype, that actually works in all particulars and meets the product's specifications, followed by another prototype, called the production prototype, that proves the product can be mass produced. The breadboard prototype is usually a hand-wired collection of electronic assemblies called breadboards. The later prototypes do away, mostly, with hand-wiring and use what are known as printed circuit boards. These are glass-epoxy boards with the wiring already built in using lines of copper called PC traces. Printed circuit boards are called 'PC boards' or 'PCBs' or 'PCAs.' (The 'A' stands for 'assembly').

This whole design process might sound needlessly rigid and inflexible, and managers lacking product design experience often think it is, but in fact it is the most efficient way to get from an idea to a money-making product. At every stage in the process there arise particular classes of problems that have to be solved and the product life cycle process is designed to deal with the peculiar natures of these problems and *when* they have to be solved. Managers who are ignorant of the nature of the design and invention process are often known to try to speed things up by trying to shortcut this process. What always happens is that the problems still crop up, still have to be solved, and the 'wing it' approach these managers try always ends up taking longer and costing more to get from idea to shipping product. Despite what the Harvard Business School might think, it simply isn't true that a manager doesn't need to know the specific details of the business he's managing. That is one of the many great and stupid management myths that were to become popular in the 1980s. In my more than thirty years of professional engineering and engineering management, I've seen smart people try to shortcut this process many times and they have failed in the attempt to shorten up the cycle every single time. Sometimes their failure takes their whole organization down with them. Neither divisions nor companies are immortal. Ask Clinton Engines.

Naturally, I knew nothing at this time about the product life cycle. But there was one big difference between the Mini-TIMS and the new project being launched. Only mine and Dave's parts of it were new. All the rest was the same as Mini-TIMS itself and only our new designs needed bread-boarding. Mini-TIMS was just then at the edge of the production prototype phase and we could use these prototypes as the foundation of *our* breadboard phase. And that was Del's suggestion. (Even if Del hadn't suggested it first, Erhard *would* have; it was plain old common sense, which engineers are supposed to have a lot of). The way Del told *me* about it was to tell me, with a kind of evil little grin, that the next thing I'd be doing was building one of the Mini-TIMS production prototypes, turning it on, and testing it. Once I had it working as a Mini-TIMS then I could go ahead and have my way with it in bread-boarding the phase jitter design. The prototype I built would become the first breadboard HP 4943. (Our project never did get a code name of its own; I'd suggested 'Mili-TIMS' since the whole thing started with the Navy, but Del vetoed that idea; we just ended up calling it 'the ′43').

Bright and early the next morning my pal Al Howard came by with a mechanical carcass, a big box of parts, and a stack of pasteboard binders containing the theory of operation, schematic, and turn-on and test procedure for each and every PCB in Mini-TIMS. He dumped them with obvious enjoyment on my workbench, gave me an ear-to-ear grin, and left with a cheerful, "Have fun." I stared ruefully at that big pile then sighed and turned on my soldering iron. I wasn't too happy about this particular task. It seemed to me it was the sort of thing a technician should have been doing. But there weren't any technicians in our R&D lab and Mini-TIMS didn't 'belong' to production yet.

As it turned out – and I'm sure Del and Erhard both knew this perfectly well right from the start – putting that prototype together was a valuable learning experience for me. I knew next to nothing about the details of the Mini-TIMS design when I switched on my soldering iron, but I sure as heck knew a lot about it by the time that prototype came to life. In the process I also learned a lot about practical circuit designs. I knew the basics, yes, but my colleagues knew a lot more than the basics. I got ideas for how to do things out of each and every PCB I tested and turned on. As a crash course in the *practical* art and craft of electronics design, that assignment couldn't be beat.

It also helped me get to know all the other guys in our group much, much better. These PCBs were their designs and boy-oh-boy did I ever have questions as I was turning on and testing the prototype boards. The guys were as tolerant of me pestering them with my questions as if I were their kid brother or, in Paul's case, a favorite nephew. When I came to the magical heart of Mini-TIMS, the microcomputer PCB, Dick took me under his wing and taught me a lot about both the hardware and the firmware. He was in charge of all the firmware going into the project and had designed almost all of it single handed.

It took me longer than it would have taken a technician, but finally I had that prototype running. It was time to start doing my phase jitter design and converting that HP 4942 into the first HP 4943. I now had a much clearer idea of how I could take advantage of that nifty little computer built into the product and I kept this constantly in mind as I studied and understood Paul's design from the original TIMS.

Erhard gave me a couple of days to learn about Paul's design then asked me to give him a plan for how I was going to go about doing it for the ′43. A plan? Okay. Good idea. I'll do that. Then he asked me to include a time schedule for the different specific tasks I was going to do. My face fell when he said that. "I've never done this before," I confessed. "I don't know how long any of this'll take."

This was the first time since my arrival I'd had to admit I didn't know how to do something. Believe me, I was pretty scared about having to 'fess up to it. But good old Erhard, bless him, appreciated my honesty and I'm pretty sure he sensed how nervous I was. We sat down at his desk right then and there and he explained the general sorts of things I'd probably need to do – not in specifics, of course; in general – and about how long each one of them would typically take to accomplish. Some of the things he explained were things I wouldn't have even thought about. By the time he finished, my confidence was back and I had something new under my arm: an understanding of what was expected of my job performance as far as roughly how long it should take me to do different things. All by itself that went a long way towards relieving my anxieties about how I'd know if I was proving myself and how I could evaluate *myself* in terms of whether or not I was doing a good job. It was like getting a peek at the answer sheet before a test. By the time I went back to my desk, I was feeling *much* better about my job.

Erhard had told me to copy Paul's design as much as possible, and that's what I did initially. Of course I went through the numbers and did the math for myself. I had to do that or I wouldn't have known what I was doing. Also, there were a few things that could and should be improved simply because there were newer, cheaper, better parts available in 1975 than existed when Paul did his original design. I could change the design to use these better parts without any real problem. Next, there were a few things that *had* to be done differently just because a Mini-TIMS wasn't a TIMS. My design had to accomplish the same function, but it had to accomplish it a little differently because some pieces of the old design just didn't exist in the Mini-TIMS. It gave me the chance to do a little innovating of my own, which made the job just tremendously more fun for me. I was able to come up with a few snazzy little circuit designs I felt pretty proud of. Most of this came straight out of the fact that Mini-TIMS had a microcomputer in it and TIMS did not. The 'missing pieces' were missing because the microcomputer did that job in firmware and the hardware had been eliminated.

But there were two things about the old design that, strictly speaking, didn't *have* to be changed but which I thought *ought* to be changed. The first was this strange little circuit Paul had included in the original design. I figured out what it did and how it worked, but what I couldn't understand was *why* it was needed. The more I looked at it, the less sense it made to me why it was there at all. I decided to ask Paul about it. If I was missing something, he'd tell me what it was. If he was okay with eliminating this circuit I'd be able to tell Erhard that Paul had okayed my taking it out. Either way, I'd still be following my instructions to copy the TIMS design.

So I went to the quad next door where Paul sat. A 'quad' was a little four-man office area, kind of the forerunner to today's ubiquitous office cubicles except it held four people instead of one. Paul was at his desk. He was bent over and really concentrating on something. Paul was bald like Uncle Wayne and had a little ring of graying hair that looked for all the world like a monk's haircut from the middle ages. His left

hand was on top of the bald spot on his head and his nose was about three inches above a tablet of engineering paper that held some scribbled equations he was focused on. He was a man deep in thought.

I walked up to his desk, dragging a chair behind me, and sat down. "Excuse me, Paul," I said, "but do you have a minute for a question?" He slowly turned his head and looked at me. He didn't straighten up and his hand never moved from his bald spot. He looked at me with unblinking eyes. I took that to mean he had a minute for me so I launched into my question. "You know that phase jitter circuit where you . . ." My question was pretty technical and it took me about five minutes to ask it. All the while Paul never moved or blinked. Finally I finished and waited to hear his answer. A few seconds went by in silence. Then half a minute. Then all of a sudden Paul blinked and sat upright. "I'm sorry," he said, "I wasn't listening. What did you say?"

Now *that's* concentration. It struck me funny and I chuckled a little bit before repeating my question. This time Paul was listening and he explained to me why he had put that circuit into the design. I thanked him and went back to my desk. There I thought about his answer. The reason he'd given me was pretty mathematical so I won't try to explain it here. But the more I thought about it, the more convinced I became that there was a flaw. Paul's reasoning was sound, but it was based on an assumption I didn't think was true. I worked out the math in more detail and when I was done I was convinced Paul's circuit was solving a problem that didn't really exist. It could be removed entirely and not change anything except for reducing the cost of the PCB.

Now I found myself in a kind of dilemma. The circuit I wanted to get rid of was relatively expensive and complicated and I was sure eliminating it was the right decision. On the other hand, I'd been told to copy that design; time was of the essence in doing this project. Also, there was still a possibility I'd made a mistake and Paul was right all along. Paul had received his *Master's* degree in EE the year I had started kindergarten; I might be arrogant sometimes, but I wasn't so arrogant that I didn't respect the *decades* of actual design experience Paul had that I didn't. I decided to design my breadboard to include a little jumper wire arrangement whereby I could switch Paul's circuit in and out of the design. That way I could actually *test* both alternatives and, if I was right, I could show Paul and Erhard I was right. If I was wrong, no harm done. I'd just wire Paul's circuit in permanently and learn from the experience.

The other thing I thought ought to be changed was a little bigger matter because it involved more than just the phase jitter measurement PCB. I wanted to change something in the way the TIMS *system* was arranged. Here I felt like I was going way beyond my charter. I was responsible for the phase jitter PCB, not for how the ′43 *as a whole* was to be designed. This issue had to do with the order in which electrical signals were being processed within the product. A raw rookie wanted to tell the very people who had invented TIMS that there was a better way to do it. There was a Yiddish word I knew, *chutzpah,* and I sure felt like it took a lot of it to even propose doing what I wanted to do. But I had done the math and then double checked it and then double checked it again and I was certain I was right. My way would be a little better in terms of measurement accuracy and it would also be a little cheaper to build. But, again, what if I'd made a mistake? I decided to do my jumper wire trick with this change, too. That way I'd *know* and, if I was wrong, again no harm done. If I was right, I could *prove* I was right by the only way that really matters in engineering: by showing them in the prototype itself that my design worked *better.*

There was one more thing that went beyond my charter that I wanted to do very badly. I didn't want to do just the phase jitter PCB hardware design; I wanted to do its *firmware* design too. I had just started my senior year at ISU when the invention of the first *true* microprocessors had been announced to the world at large with great fanfare. I had known immediately that the consequences of this technology would be nothing short of revolutionary. The chance to work with microprocessors had been one of the big factors in my decision to take HP's job offer. Erhard might have been billing me as the 'crack new analog guy' but his crack new analog guy very badly wanted to get his hands on the microcomputer part of the project. There was a revolution going on in the electronics world and I wanted to be in the thick of it.

Erhard had only assigned me to do the hardware. In those early days of the microprocessor, most

people took the firmware for granted, if they thought about it at all. Dick had been doing most of the firmware for Mini-TIMS; the small fraction he hadn't been doing Dave had done. I think Erhard might have just been planning to have Dick whip out the phase jitter firmware in an afternoon or two. He might even have been thinking maybe he'd do it himself. I know Erhard had a real hankering to get his hands on this technology too. Every bit as big a hankering as I had.

I asked Dick if he thought there'd be any problem with me doing the firmware for my design. I didn't need to sell Dick on the idea, as it turned out. Firmware design simply *wasn't* the easy stroll in the park a lot of people thought it was in those days. It took every bit as much design effort as hardware did. More, in fact, because as soon as people found out they could do one new thing with this microcomputer innovation they immediately wanted to do *more* new things with it. Specifications for what the firmware was supposed to do were in such a constant state of change that designing it was like trying to shoot ducks from the back of a rodeo bull. Over Friday night beers after work Dick often complained that people didn't properly appreciate firmware or how much work it was to do. He was a guy who wasn't about to turn down any help graciously offered.

Next I had to sell Erhard on the idea. This took a bit more talking. He wasn't too enthusiastic about the idea at first. Fortunately, I had taken another special problems class my last quarter in school on the basics of microprocessor hardware and firmware. My professor for that class was a former Silicon Valley guy who had friends at Motorola. They had given him some very early prototype microprocessors and, as luck had it, they were M6800 microprocessors, the very same kind we were using. I could point to that as credentials for being able to do the job. On top of that, Dick endorsed the idea on the grounds he didn't know when he could get to it but it wouldn't be for awhile. In truth, the phase jitter firmware was pretty simple stuff compared to all that Dick was doing. If Dick's work were compared to a term project, my work would be nothing more than a homework assignment. Erhard could see how eager I was to take on this job so he did what a good boss always does: He gave me all the rope I was asking for. The task was mine to do. I was confident in taking this on because I knew *I* wouldn't have to shoot ducks from the back of a bull. The phase jitter hardware designer was a *very* close friend of mine: Me.

Mind you, I wasn't doing this to try to impress people. I wanted to do it so badly because I wanted the experience. I knew microprocessors were going to change everything in our world. I also figured that if electronic brains ever did become a reality the odds were very, very high that microprocessors would play a central role in them. So I wasn't doing this to impress anybody. I was doing it for *me*.

Give or take a few days it took me almost exactly the amount of time to get the breadboard prototype running as Erhard had told me it would. First I tested and debugged my design using the TIMS circuit configuration just as I'd been told to do. Once I got this working, I tested the two 'extra' changes I wanted to make. As I had thought, that one circuit of Paul's proved to be unnecessary. As soon as I'd verified that I went straight to Paul to tell him. I first explained my math to him to show why I'd thought we didn't need it. Then I showed him the breadboard. I was a little nervous about how he might react, but I needn't have been. He was professional about it all the way. "That's good!" he told me. "That's a real improvement." I beamed from ear to ear.

Next I tried out the other change. It, too, worked just like my calculations had predicted. I went and got Erhard. First I explained what I'd done and the reasoning behind it. Then I showed it to him in the breadboard. We looked at the key signal on an instrument called an 'oscilloscope' and he could see for himself the improvement my change had made. The cost savings he'd noticed right away when I was explaining what I'd done. He gave me a very pleased smile and a pat on the back. "That's good," he said. "Do it your way." Kites don't fly as high as I was soaring that day.

I was sitting at my desk the next morning when to my surprise Erhard brought Brian Moore, the Division Manager, into our quad to see the ′43 breadboard. He had me give Brian a demo of the phase jitter measurement. Brian seemed pleased and Erhard looked about two inches taller than he usually did. Then Brian, who rarely came into the lab and didn't see the prototypes very often, impulsively reached

forward and switched the measurement selector switch on the front panel. He wanted to see one of the other Mini-TIMS measurements at work.

Uh-oh, I thought. One thing I hadn't bothered to mention to Erhard was that there was a problem with that switch. When I'd put the prototype together I'd left a loose connection somewhere and almost every time anybody turned that switch it lost contact. The unit would make a funny sounding noise – ding, ding! *ding! DING!* – and the front panel display would go out. I'd intended to get around to fixing it eventually but since I pretty much always left that switch set to 'phase jitter' it hadn't been a high priority to me to do the fix. I had found out that if the connection did let go a light tap to the chassis with my ball peen hammer always 'fixed' it.

Sure enough, the second Brian turned that switch the unit made its funny noise and the front panel lights went out. "What is it doing?" Erhard cried out, his German accent a little heavier than usual.

"It's just a loose connection," I said casually, like nothing was wrong. "Don't worry."

"Can you fix it?" Erhard asked anxiously.

I shrugged. "Sure." I picked up my hammer and gave the unit a light tap. It quit making noises and the front panel came back on. Erhard's face turned all red and Brian gave him a half amused, half bemused look and left without a word to go back to his cubicle.

Erhard told me to fix the loose connection. □

Most of the time that's spent in developing a new product is spent testing it, finding out what doesn't work quite right, and fixing the problems. The process is called 'debugging' because the problems are referred to as 'bugs.' Usually a project had one breadboard unit, then a few lab prototype units, and finally a larger number of production prototype units. Debugging is on-going throughout the design process. Bill Hewlett and Dave Packard, the founders of the company, called it the 'test-fix-test' process. If not for Erhard's guidance, I would have badly underestimated how much work goes into debugging. But thanks to the heads-up he'd given me, I figured I'd have my hands full right into autumn. Therefore when I applied for admission to Stanford I'd asked for, and been accepted for, a winter quarter start. It turned out I did indeed have my hands full right through autumn and Stanford's fall quarter.

The breadboard had been built using electronics parts the lab kept in stock. But as we advanced into the lab prototype stage I needed to order some parts for it we didn't keep in the lab stock. This resulted in my meeting Lee Brooks.

Every manufacturing operation has at least one person known as 'the buyer.' The buyer does what the title implies: she buys things. Delcon had one buyer, an overworked woman named Lee Brooks. Lee was middle aged when I met her, but I bet she was an absolute knockout as a young woman. Because she was the one and only buyer for the whole division, and because most people tend to forget that parts don't just magically materialize on the doorstep the next morning, it was common for lab engineers to put off telling Lee they needed parts. This tended to put almost all the lab's dealings with Lee on an emergency footing and, quite naturally, Lee didn't harbor many warm feelings toward R&D lab people.

Lee and Rich especially didn't get along, even when Rich did remember to order his parts on time. You see, Rich had what you might call a Don Rickles sense of humor. Not too surprisingly, a lot of people found him irritating instead of funny and Lee was one of them. He had referred to her, more than once and in her presence, by the nickname 'Babbling Brooks.' When I first got to Delcon he called me 'Oil Wells' for awhile until I told him my dad's name was Earle. 'Oil' and 'Earle' sounded close enough that I guess he decided that nickname wasn't funny. Which, of course, it wasn't.

I winced the first time I heard him call Lee 'Babbling Brooks,' and I winced again when I saw the look she gave him. Lee always had about a two foot stack of purchase orders sitting in her inbox and whenever one of Rich's purchase orders came to her desk it went straight to the bottom of that stack and tended to stay there awhile. He pretty much never got his parts when he needed them.

When the time finally arrived for me to order parts for the prototypes I dutifully started filling out the purchase order, asking Erhard to decode the parts of it I didn't understand. There was one line on the form for stipulating by when the parts would be needed. I asked Erhard what I should put in that blank. I didn't want to say something too close to when I'd actually need them, but I'd lugged enough hundred pound flour sacks and fifty pound boxes of shortening off the delivery truck to know supplies didn't materialize on the doorstep overnight.

"Put ASAP there," Erhard said. I asked him what that meant. "As Soon As Possible," he replied.

That was one bit of advice I decided not to follow. If everybody in the lab was using that for a due date, I thought it was probably more than a little likely ASAP would really mean 'as soon as Lee felt like getting around to it.' I decided to leave that space blank and go see Lee instead. I hadn't actually been introduced to her yet, so this would be our first actual conversation.

When I walked up to Lee's desk, which was just off the factory floor production area, she gave me that special look she reserved for lab engineers. The one that says, "What the heck does *this* bozo want?" I politely said hi and introduced myself. She politely replied, "What do you want?"

"Well," I said, "I'm new here and I was wondering if you could give me some advice about how I should fill out this purchase order." Lee blinked twice then suspiciously asked me what I wanted to know.

I pointed to the 'due date' line and said, "I'm not sure what's the usual amount of time I should use for this date," I said.

"Six weeks," she snapped.

I thought about that for a couple of seconds and then slowly said, "Ooo-kay. I *guess* I can make that work." I filled in a date six weeks hence. Lee looked a little astonished. Then I asked her if she could check the rest of the form and tell me if I'd made any mistakes. She looked it over and pointed out a couple of things that should have been different. I changed them to what she said. Lee looked even more astonished. She held out her hand and I gave her my purchase order. She put it on top of her stack.

Three days later I got my parts. I went out to her desk again and thanked her. "That really helped me out, Lee," I said. "I really appreciate what you did for me." She claimed she hadn't done anything.

For as long as I was at Delcon, I always got my parts in three days, four max. □

Lee wasn't the only direct source for parts that weren't in the lab stock. Another and more often used source was production itself. There was an area just off from where they assembled the printed circuit boards where row after row of shelves were set up. They looked for all the world like library book shelves, and this was where production parts were kept. When we took parts from production we were supposed to fill out a little form documenting what parts we had taken, how many, and which project they should be charged to. Filling one of these out took about five seconds. However, it was fairly common for lab engineers to ignore this 'bureaucracy' and not bother with this form.

It was Bob Allen's custom to hold an offsite lab retreat at a hotel in Palo Alto every three years, and it so happened there was one of these my first summer at HP. The purpose of these retreats was to review how we did things in the lab and to modify the way we conducted our day to day R&D business to improve the process. In addition, there were also gripe sessions where there was no rank in the room and anybody could gripe about anything they wanted. Bob and his managers took these retreats very seriously and most of the suggestions and ideas that came up were soon implemented back at Building 30. That summer the Production Manager had a gripe. Not too surprisingly, it was about the way lab engineers would take parts from production without filling out those slips. He made a plea to us to stop doing that.

Personally, I thought it wasn't unreasonable for him to ask us, very nicely, to quit stealing parts from production and I didn't think what he was asking was too much trouble. However, not every one of my colleagues saw it this way. Several of us were walking down El Camino Real afterwards on the way to

lunch and I happened to be walking next to Johann Heinzl. Johann was from Austria and spoke with a thick German accent. After Paul and Erhard, he was probably the oldest guy in our group and a brilliantly talented circuit designer. There is an important technique used in electrical engineering called 'feedback' and Johann was such a master at using it that I called him the King of Feedback. It seemed to me like there was nothing he couldn't get a circuit to do using this method. I learned a tremendous amount about it from him, including my first exposure to what are called 'adaptive' circuits – circuits that in a sense modify themselves and 'learn' how to improve their own performance. This is done with feedback of a special kind known as 'performance feedback.' I was later to learn the underlying theory for this technique from one of my favorite Stanford professors, Dr. Bernie Widrow, but I learned my first lessons about it from Johann.

There isn't much doubt that Johann had the heart of a rebel or maybe an anarchist. He was one of the guys whose normal working attire suited working in a garden equally well. He had long, unkempt hair that rarely met up with a comb and was the only guy in the lab to sport a full mountain man's beard. With his thick accent, general unconcern for his personal appearance, and brilliant abilities as an engineer he conjured up images in my mind of Einstein. Anyway, as we were walking down the street he suddenly turned to me and, out of the blue, said in that thick accent, "Wells, I'm luckier than you."

I was a little surprised by this remark and asked him what he meant. "When I join the company," he said, "we get to design two, three boards a year. Now *if you're lucky* you get to design *one* board a year and spend the rest of your time doing *paperwork!"* Johann didn't like to fill out forms.

Bill Hewlett and Dave Packard both seemed to have a soft spot for our division. Delcon division had been Delcon Corporation until Bill and Dave bought it in 1968. Every once in awhile one or the other of them would come down from Palo Alto unannounced and just drop in to see what was going on at the company's tiniest division. When I joined HP the company had just had our first billion-dollar year. Dave was chairman of the board and Bill was president and CEO. Dave tended to come in rather unobtrusively and just wander around the place talking to whoever he met. He did this late one afternoon and wandered out into the production area.

One of the women who worked in the production stockroom area was kind of short and couldn't reach the top shelf of the parts bins. That particular day she needed something from up there but somebody had run off with the little library-style wooden steps she used to reach the top shelf. Dave, who in many ways resembled Abraham Lincoln without the beard, was a very tall man, an ex-football player, and he just happened to walk into the stock area as she was looking for the missing steps.

She saw Dave but, being fairly new herself, she didn't know who he was. She pointed a finger at him and said, "You! You're a tall fella. Reach up there and get that box for me, would you?" Dave did and then had a pleasant little chat with her before resuming his wanderings. Her supervisor came rushing over to her and, a little out of breath, exclaimed, "Do you know who that was!?"

"No," she replied cheerfully, "but he sure was a nice fella!"

When Bill dropped in for a visit his entrances tended to be a little more visible. About the best way I can describe Bill Hewlett is to say imagine what Dennis the Menace would be like when he grew up. There was a pathetic terrorist organization operating in the Bay Area when I first moved out there called the Red Army Brigade or something like that. They were a stupid and inept hangover from the sixties. My first summer there they had tried to bomb the HP Labs facility at Deer Creek. There were all these chemical tanks sitting outside the building which stored various chemicals – some of them rather toxic – that were used to fabricate integrated circuits. The bombers blew up the only tank on the grounds that was filled with water. They also tried one time to kidnap Bill Hewlett's son right in front of his, the son's, house. Since they seemed to have a special animosity for HP, the company accordingly tightened up its security procedures. One of these reinforced security procedures required the receptionist in the front lobby to inspect everybody's name badge or employee ID card before granting admission to the building.

There was a new receptionist working our front lobby one day when Bill dropped in. He'd parked his car in the visitor parking lot out front, came in, and proceeded to charge straight through the lobby to the door leading inside. Our young receptionist cried out, "Sir! I need to see your identification!"

Bill never even broke stride, "I'm Bill Hewlett," he said and charged on inside. She grabbed the phone and immediately called our captain of security, whose desk was just down the first hallway and had a clear line of sight to the door. "Some guy just walked in here like he owned the place!" she cried.

The captain had a perfectly clear view of who was charging down the hallway. "He does," he replied. When Bill heard about this he went back out to see the receptionist, praised her for her work, and asked her if she'd consider coming up to company headquarters in Palo Alto and working *his* reception desk there. □

I started attending Stanford in January of 1976. I belonged to what was known as the Honors Co-op Program, which was a professional master's degree program Stanford set up to serve the thousands of working engineers in the San Francisco Bay area. Students in this program attended school part time and, as I mentioned before, HP gave me paid time off during the day to attend classes and reimbursed half the costs of my graduate education. Stanford's fee for Honors Co-op students at that time was one hundred ten dollars per course credit. My first quarter at Stanford coincided with when I became eligible for HP's employee stock purchase benefit as well as for the company's profit sharing program. Consequently, after payroll deductions money was pretty tight my first quarter and I took only one three-credit class. Later I paid for school by selling my quarterly HP stock purchases and handing the proceeds over to Stanford. The stock market at that time wasn't going anywhere in particular so there wasn't much to be gained immediately by hanging on to my HP stock. The stock market malaise would continue, drifting up and down within a trading range, until 1983.

Stanford required me to submit a study plan of the courses I was going to take. Before putting this plan together I wanted to touch bases with Bob Allen to get an idea of just how far the company was willing to go with this paid time off benefit. After all, our lab projects were in full swing and I figured there had to be some kind of limit to HP's tolerance of my absence from work. I asked Bob what I should plan on for a quarterly course load at Stanford.

"Take two courses a quarter, hurry up and get your degree, and become useful," Bob said.

If we'd had this conversation at the start of fall quarter I probably wouldn't have known Bob was kidding about the 'become useful' part. In fact, I probably would have been worried to death that I wasn't cutting it in the lab. However, in November I'd received a nice ten percent raise so I just grinned at Bob when he made that wisecrack. I continued getting ten percent raises at six month intervals for the next couple of years, and that was all the proof I needed that I had made the cut and my bosses were happy with my work.

My advisor at Stanford was John Linvill, who was then chair of the electrical engineering department. John was a kindly, white-haired gentlemen who was internationally recognized for work he had done in the 1950s on mathematical modeling of that then-new wonder device, the transistor. The term 'modeling' is used to mean the development of a mathematical theory for describing how something works or behaves, and for a time the Linvill model of the transistor was very important as scientists and engineers came to understand this device and to develop the circuit theory needed to properly use it. From John and a couple other professors there I learned a great deal about how to develop models for integrated circuits and devices. In my own research work later on I was able to expand upon what I learned from John to the extent that today I call myself a 'model maker' – which means I develop theory describing how any sort of thing works. A great deal of my current work in computational neuroscience – the mathematical theory of the brain and spinal cord – is the direct descendent of the science I learned from John back in '76.

The physics and technology of semiconductor devices – the silicon devices from which the great majority of all electronics is made – was one of my special areas of interest at Stanford. There were two

reasons for this interest. The first had to do with HP. The microprocessor revolution and the integrated circuit technology revolution driving it was having a clear impact across the high technology spectrum. It was clear to me in '76 that we were then seeing only the beginning of this. In fact, I made a prediction to Del and some of the other folks I worked with that within about seven years we'd be developing our own custom microchips in almost all HP's products. Most people were skeptical about this prediction, but as it later turned out this prediction ended up being pretty accurate and started happening at just about the time I'd predicted it would. Another part of this prediction was that the key electronic technology would eventually end up being neither purely 'digital' (computer-like circuits) nor entirely 'analog.' It would instead be a combination of both on the same integrated circuit microchip. This, too, ended up being the case and is today known as 'mixed-signal very large scale integration' ('mixed-signal VLSI'). In '76 the prevailing assumption was that 'digital' was the 'wave of the future' and 'analog' would be going the way of the dodo. That never happened. I don't think it ever will.

The other reason for this interest was, of course, my private off-duty interest in electronic brains. One of the courses I took early on at Stanford was a course named Biological Signal Processing. I hadn't taken a biology course since junior high and I knew I needed to know more about the central nervous system (brain and spinal cord). This course was a terrific way for someone with my background to enter into the world of brain science. After all, if a person really wants to work on creating an electronic brain, it pretty much is a given one has to know how biological brains are put together and how they work. The course required a term project in which the student had to model some biological system. I chose the eye of the nudibranch mollusk and was able to put together a nice mathematical model as well as a preliminary electronic circuit design for imitating how this eye worked. Of course, in 1976 the technology for doing a practical implementation of this electronic eye wasn't there yet, nor was the biological knowledge of it fully complete. (The latter is more complete today, but still not entirely complete).

From studying biological signal processing theory it was clearly self-evident that if electronic brains ever became real, they would involve enormous amounts of integrated circuitry. Hence the other reason for my interest. It turned out that Stanford had a terrific bookstore stocked with well-written books on a wide spectrum of subjects I regarded as being probably important in the quest for electronic brains. It soon got to the point where I couldn't visit the Stanford Bookstore without walking out with an armful of books, most of which I bought as part of my private research into electronic and biological brains. HP, of course, didn't reimburse me for these and there was no reason they should. It was my private interest being served by these purchases and I always budgeted part of my take home pay for book purchases.

The second area where I concentrated my graduate studies at 'the Farm' (as Stanford is affectionately known by its alumni) was in digital signal processing and the mathematical theory of digital systems. Again there were two reasons for this. One was, of course, the microprocessor revolution itself. To an EE a 'signal' is any physical quantity that can be said to carry information. Voltage and current are two examples of this but so are electromagnetic field intensities, fluid pressure, temperature, mechanical vibrations, chemical transport phenomena (such as is found in the connections between nerve cells in the brain) and an endless host of other real world phenomena. Signal processing theory deals with the mathematical representation of these quantities and with the changes and transformations produced in the 'flow of information' carried in the signal by the physical entities. These act on, and in turn are acted upon by, physical signals. In fact, a great deal of what electrical engineers do can be accurately said to be signal processing. Electronic circuits are the main means by which this signal processing is carried out.

Before the microprocessor most electronic signal processing was carried out by 'analog' circuits. But with the coming of the microprocessor it was now starting to become practical to augment and in some cases replace these analog circuits using microprocessors and firmware. I was already doing some of this in my phase jitter design. The theory of digital signal processing had already been around for a relatively long time but it had been a kind of theoretical backwater in which only a few dedicated specialists worked. Now with the existence of microprocessors, digital signal processing suddenly became something the EE world at large was paying attention to. Beginning around 1976 it had, almost overnight,

become the hot topic. Since digital signal processing is carried out using what are known as digital signal processors, and since digital signal processors are one brand of digital computer-like systems, studying digital signal processing and the mathematical theory of digital systems went hand in glove.

The second reason for my interest in this area was the exact same reason as for my interest in semi-conductor physics and technology: electronic brains. One of the most startling things I had learned in my biological signal processing course was that a great deal of (although not all of) the signal processing that goes on in real brains is nothing else than a form of digital signal processing. Once again I found that the things I wanted to learn about in order to do my job better were also the exact same things I needed to learn about for my private research. Indeed, I was surprised to learn that the original concepts that had led to the invention of the digital computer itself – which is largely credited to an amazing mathematician named John von Neumann – came straight out of brain studies by physiologists. These studies had given rise to a science known as 'neural network theory' and it turned out that the very first digital computers were designed to be 'neural networks.' *That* was the reason they had been called 'electronic brains' when I was a boy. So it turned out that Walter Cronkite hadn't lied to me after all; it was just that the computer people had been exaggerating and romanticizing what they were doing.

In my studies of this topic I was fortunate to have two remarkable professors. The first was Bernie Widrow. Bernie is today recognized as one of the early pioneers of neural network theory. He is an absolutely great teacher as well as a world-recognized authority in his field. From him I learned digital signal processing theory and had my introduction to neural network theory. When I later did become a college professor, I modeled my own teaching and lecture style after Bernie's example.

My other great professor was Ed McCluskey. Ed was also already a world-recognized expert. In his case, he was known for his work in the theory of logic circuits. From him I learned the mathematical theory of digital systems and received a formal education in computer theory in general. As it happened, Ed was never too thrilled to be spending his time in a classroom teaching these basics to us thick-skulled graduate students. But he was pretty accessible outside of class and I had many fascinating conversations with him during my time at Stanford. I think I learned a lot more valuable things from him outside of class than inside the lecture room. Ed was an inspirer of *ideas*.

When coupled with my R&D work back at Delcon, my Stanford years were just a terrific time of personal growth for me as a scientist. Looking back, it is amazing how well the two experiences meshed together to create a whole that was undeniably more than the sum of its parts. On the whole I very much enjoyed my Stanford experience and graduated with my master's degree on January 4th, 1979. □

1976 was another presidential election year. President Ford was running for reelection and being challenged by the former governor of California, Ronald Reagan. The Democratic candidate was the former governor of Georgia, 'Jimmy' Carter. I wasn't entirely happy with President Ford but I wasn't entirely unhappy with him either. The Democrats, who by then were dominated by the liberal wing of the party I always detested so much, had swept the 1974 congressional elections and I thought President Ford was a counterbalance to many of the things the liberals were wanting to do in the way of ruling us. When South Vietnam had fallen to North Vietnam in 1975, he had not tried to get us re-engaged in that immoral war. I generally approved of his foreign relations policies and the progress that seemed to be going on there toward ending the Cold War. I thought that in a number of ways President Ford was closer to being a Kennedy Democrat than any of the liberal Democrats were, although both were a far cry from actually *being* a Kennedy Democrat. On the other hand, I still wasn't too happy about the Nixon pardon, and I wasn't in favor of giving up the Panama Canal. But what disappointed me about President Ford the most was his lack of leadership in getting the economy put back together after the disaster of the Nixon years. The poster child example of this had been his pathetic 'whip inflation now' program with its pathetic WIN buttons. It was nothing more than a publicity stunt and even as a slogan it fell way short of *ask what you can do for your country.* I thought President Ford on the whole was a good man but not much of a leader.

Both Governor Carter and Governor Reagan had published little paperback books during the election campaign and I read both of them. Governor Carter's book, *Why Not The Best?*, impressed me a great deal. Unfortunately, this impression was entirely negative. Most of it was autobiographical, which was okay but not all that central to what he would do if he became President. The smaller part of the book that talked about what he wanted to – he never even said *would* – do as President was almost all Mom-and-Apple-Pie pabulum. *'All our citizens must know that they will be treated fairly,'* he wrote. No, all our citizens *must be* treated fairly. I'm pretty sure knowing we'd be treated fairly would automatically follow if in fact we *were* treated fairly. Most of the book had this passive tone to it. It was a recipe for ineffective leadership and maybe even no leadership at all. The liberals were going to own this man.

Governor Carter had written, *'I am a farmer. . . Also, I can claim with credentials to be an engineer, a planner, a nuclear physicist, a businessman, and a professional naval officer.'* Aside from the fact that made it sound like he didn't do any one of these occupations very well, what came through to me all the way through his book was that he was really a preacher. With the single exception of Dr. Martin Luther King, Jr., I've never seen a preacher end up being anything other than a disaster as a leader. I'd sooner vote for Mickey Mouse than for a preacher. They both live in the same world. It's down in L.A.

It didn't bother me in the least that Governor Carter was a Baptist. I'd know a fair number of Baptists, including some Southern Baptists, and they were all good kids. They didn't take their particular religion any more or any less seriously than the Lutherans, Methodists, Presbyterians, Episcopalians, Catholics, Mormons, Reorganized Latter Day Saints, Moslems, Jews, and others I knew, and they were content to let the rest of us go to hell in our own way. But a preacher is usually an ideologue and not many of them are tolerant of the views of anyone who hasn't been 'saved' according to their particular dogma. Of all the various Protestant cults I liked the Baptist cult the least. It seemed to me their brand of 'Christian' dogma spent the most time of any of them in the Old Testament, the least time in the New Testament, and of the whole Protestant lot they knew the least about God and tended the most to think of God as a fearsome and vindictive Mesopotamian despot. I don't know why Joshua ordered the murder of all the little children of Jericho, if that ever really happened, but I am certain of one thing: If he did, God didn't tell him to do it. So it did bother me Governor Carter was a Baptist *preacher*. I thought he was probably a good and decent man at heart, but I didn't trust him an inch to lead our country.

Governor Reagan's book, which was actually written by a guy named Charles Hobbs, was entitled *Ronald Reagan's Call To Action.* That, at least, didn't sound like he planned to be a passive President. It really came out too late to affect the '76 election, but it did profoundly affect *me*. I had always associated Governor Reagan with the Goldwater campaign of 1964 and with that lunatic wing of the Republican party known as the conservatives. These were the people who had caused the 'under God' clause to be inserted into the Pledge of Allegiance. These were the people who were always in the biggest hurry – even more so than the liberals – to change that pesky document called the Constitution whenever liberty and justice got in the way of their ruling the rest of us. These were the people who longed to return to the nineteenth century, pre-Teddy Roosevelt days of the robber barons when a handful of super-rich men practically owned all the rest of us as serfs. These were the people whose bible was Adam Smith's *The Wealth of Nations,* and who picked and chose from that great book the same way most Protestant cults pick and choose whatever suits them from the Old and New Testaments. Conservatives are always quick to hold up the parts of Smith's book that tout the rights of business owners while at the same time ignoring something else Smith had written about, namely that labor unions were the only way most working people had to counter the economic and political power of the wealthy few *and that it was necessary for the good of a nation that the power of the few be checked.* For all the conservatives' slogans about 'free enterprise' and their mantra that free-market capitalism was always absolutely good – which the history of the nineteenth century had proven wasn't true – the fact was and is that the right wing agenda they work towards inevitably leads to tyranny and the destruction of the social contract that holds America together. I didn't detest the conservatives *more* than the liberals, but I did and do detest them as much.

So by and large I hadn't planned on paying much attention to Ronald Reagan. Del, however, told me I really should at least take a look at him. He said he was a different kind of conservative. And since I did respect Del's opinions, I bought a copy of Governor Reagan's book and started reading.

There were things in there I didn't much like, but to my surprise there were many things in there I did agree with. More to the point, he came clean on many more specifics about not only what but *how* he was going to try to change things. I didn't see very much at all in the way of brainless conservative-for-the-sake-of-being-conservative dogma. I didn't see much in the way of let-the-free-market-take-care-of-itself-and-it-will-take-care-of-you nonsense. He opposed pretty much everything the liberals were doing, but the way I saw it he was against *how* they were doing it rather than the end goals themselves. For example, he said, *'Welfare reform must start from the assumption that everyone can contribute something productive to this society. Then the goal becomes to make as many people as possible independent of the need for welfare.'* Well, if that can be done it's called 'fighting poverty' and that *is* what is meant in the Constitution when it says one task of our government is to promote the general welfare. Del had been right; Governor Reagan *was* a different kind of conservative. I even had the at-first-ridiculous thought that maybe he wasn't really a 'conservative' at all. Compared to the liberals he was, of course. But compared to the arch-conservative kooks in the Republican party, he didn't seem to be. And there was no trace of Nixon – the conservatives' conservative – at all in what he was saying that I could find.

I had thought of the Republican party as being a party dividing itself into two wings. One, of course, was the wing who would rule us as robber baron despots; the other was the office-seeking wing that day by day became more like the detestable liberals. Now I was developing a feeling deep in my gut that maybe there *was* an alternative to our rulers of the left and right. Maybe here was a *leader,* the first one I'd seen since President Kennedy. If he could push the wing nuts out of power in the Republican party and pull the real Democrats – not the liberals but the kind of Democrat I was – away from the Democratic party, there was, I thought, real hope for restoring the America I knew before the disasters of the Vietnam era sixties and the fascist years of Nixon. There might be a chance to develop a Great Society that *did* work. Maybe the effort would fail; there aren't any guarantees in the world. But it was surely a duty to *try*. I did something I never thought I'd do; I joined the Republican party so I could do what I could to support Governor Reagan the next time. I had become a Reagan Republican. The year was 1976.

Everyone, of course, knows what happened that year. President Ford became the nominee of the Republican party and Governor Carter became the nominee of the Democratic party. It would be another year when not-the-best men were the only candidates. President Ford ran against Governor Carter and Governor Carter ran against Nixon. I voted for who I thought was the best of the not-the-best men, President Ford. Governor Carter took the South, except for Virginia, a swath of states running northeast from Kentucky to New York and Massachusetts, and the liberal-leaning Midwest states of Minnesota and Wisconsin. The rest of the Midwest, the entire West, and most of New England went to President Ford. Governor Carter won fifty percent of the popular vote, vs. forty-eight percent for President Ford, and two hundred ninety-seven electoral votes vs. two hundred forty. If a mere twenty-five thousand votes in Wisconsin and in Ohio had gone the other way, President Ford would have won. It was that close. The Carter years had begun. □

From mid-1975 through 1976 technology to support the microprocessor revolution was developing rapidly. At the time I had arrived at HP this technology was, to say the least, primitive. To make a micro-computer based system work requires a lot of very detailed debugging of the firmware and the interactions between the microcomputer and the rest of the system. Semiconductor manufacturers such as Motorola supplied some basic development tools of course, but by themselves these really weren't sufficient for dealing with all the different technical problems we faced and had to be augmented by other test and measurement instruments and computer peripherals. For example, when Mini-TIMS first started the nearest thing we had to a computer monitor was an old-style teletype. Besides being slow and noisy, these proved to be unable to take the constant pounding that our debug printouts required. Along one whole wall of one of our quads were the broken carcasses of teletypes that had simply worn out under the

strain. Test instruments were even more inadequate. We were trying to bring the future into being using the test and measurement technology of by-gone days.

Other divisions of HP stepped up to fix this problem. New computer terminals, which replaced the old teletypes altogether within a few short years, were developed by HP's Data Terminals Division in Cupertino. This was a development that didn't really respond to the microprocessor revolution; it was a general need throughout the computer industry and a number of computer companies responded to it all within a short time. Test equipment was a more serious issue and HP's division that made logic analyzers, instruments used to debug computer circuit designs, stepped up here. Engineers from this division began visiting our lab, and others within HP, to find out what we needed to do the job. We were only too happy to let them know. By the latter half of 1976 a new breed of test instruments was rolling out, designed according to the things we'd told the engineers from the logic analyzer division, and as a result HP became the leading company in this particular arena. The Mini-TIMS projects benefited from being among the earliest recipients of this new technology. We had these tools on our workbenches before the ink on HP's marketing brochures was dry. These new logic analyzer projects had a tremendous impact on the high technology world at large and they helped shape the course of high technology for the whole world for many years to come.

A number of different outside companies, semiconductor companies who wanted to get into the business of selling microprocessor chips, also began paying us visits. During 1976 it sometimes seemed as if a new brand of microprocessor was being introduced by somebody almost every week. Most of these did not survive the intense competition of the years that followed, but for awhile it was pretty much snowing new microprocessors. The companies coming to talk to us were already looking ahead to their next generation microprocessor designs and they came to see us to find out what features and capabilities these would really need. They also wanted to find out what they were doing right and what they were doing wrong in terms of the support products – things like the computer programs we used to develop the firmware for microprocessor-based products. Again, we were only too happy to tell them. Again, the new tools that eventually came out of this helped shape our world.

Furthermore, we ourselves were learning better design techniques for microcomputers. As the first Mini-TIMS, the HP 4942, was going into production, market research by our marketing department had uncovered a need for yet a third version of Mini-TIMS. This new project was a lot like the ′43 except that instead of the phase jitter measurement it would have a different TIMS measurement called 'non-linear distortion' or NLD. We called this one the HP 4944. Del made Johann the project leader for it and Paul did the measurement design. Al Howard made the necessary design changes to the mechanical portion.

With three such very similar products, it should have been easy to leverage our firmware designs and rapidly finish off the firmware parts of each product. In fact, though, our first generation firmware design was proving too unwieldy to do this. The technical reasons for this were obvious. Better design techniques for *firmware* were badly needed, and Dick and I developed these. Later, with HP's permission, I would be teaching these methods at an IEEE-sponsored night class held at San Jose State University and from there they seeped out into Silicon Valley to a number of companies. Again the work helped influence the future, although not nearly to the extent the other two things did.

The years from 1975 into early 1977 were the years when the promise of the microprocessor revolution became the fact of the microprocessor revolution. And, yes, things were never the same again after this. I had the extraordinary luck to be a foot soldier in just the right place at just the right time to be in the thick of this exciting and adventurous event and to play a part in shaping this new world. To this day, and correctly I think, I can look back on those few crucial years and know that I had helped make a difference that echoed far beyond my little corner of the world. I had been able, in my own small way, to pay the first installment toward keeping my Promise. □

As 1976 was coming to an end our project was finishing the production prototype phase and getting ready to be released to manufacturing. For me this meant many of my day to day tasks involved making

sure the documentation for my designs was complete, production test procedures were in place, and that generally production wouldn't have any design related problems building the product. Product development engineers do not build the products; production does that. In a real sense you could say that the sum total of my work was all aimed at producing this documentation. No lab engineer really likes this phase of a project all that much, but the fact is that it is for the sake of this phase that everything else is done.

In those days hand assembly techniques were used for relatively low manufacturing volume products like those Delcon produced. Automated assembly machines existed at the time, but they were expensive and the capital investment required really only made sense for high-volume products. To support the work of the production people who would assemble my printed circuit board, one of the things I had to do was build an 'example' board for them with all the pieces snugly soldered into place. Now it so happens that production people do a lot more soldering than an engineer does and as a result they become pretty top craftsmen at it. I built my example board – my very first design that would actually sell for money – and carried it proudly out to the production supervisor. She thanked me, flipped it over, and looked at the back side where all my soldering joints were.

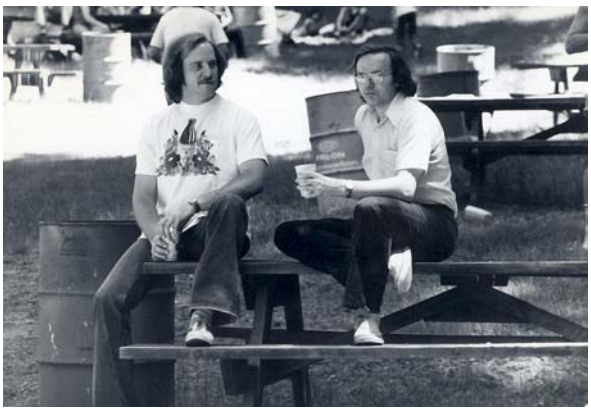
And laughed. Out loud. In front of everybody.

My face turned red. Naturally my feelings were a little bit hurt. But, like I said, every woman on that production line could solder better than I could.

For the turn-on and test procedures for my board I basically just wrote down precisely all the steps I had used all along while developing the design. I also specified all the test instruments that were to be used and the measurement settings for each instrument. The document ran to several pages in length. My next task was to train the production technician in the specific procedure.

The technician assigned to my board was a young guy, possibly a year or so younger than me. But he had been on the job longer than I had (technicians graduate with a two-year associate degree) and was generally regarded as the best technician in the division. He listened patiently as I walked him through the procedure step by step. We finally came to one fairly complicated part that took five or six steps to accomplish. He dutifully followed my procedure, then looked over at me and said, "Why don't you just do this?" He flipped a couple of dials on the measuring instrument and zip, zam, zot accomplished the very same thing in one step.

I tried very hard to keep my mouth from dropping open. Not entirely successfully I should add. Then I grinned at him a little sheepishly. "You know," I said, "that way's a lot better. Why don't we do it that way instead?" I changed the procedure to his way of doing it. He, in turn, went around telling all the rest of production that I was the best engineer in the lab. It's amazing how often it happens that listening to smart people makes me look smarter. □



HP company picnic at Little Basin (1977). The guy on the left is one of Delcon's technicians, the guy on the right is me (age 23). The photographer took me by surprise in this picture.

The little celebration the division had on the day I first arrived was the only one I ever saw at Delcon. On the other hand, every summer every HP division had a company picnic. In the Bay Area, where the company had a lot of small to medium sized divisions, it was usual for several divisions to hold their picnics on the same day in a beautiful wooded

area up in the nearby mountains called Little Basin.

When I first moved to the Bay Area I didn't even know there *were* nearby mountains. Most days you couldn't see them through the haze the Bay Area smog produced. But they were there. I'm not sure how much area Little Basin covers, but it seemed like a lot. Because Delcon was the tiniest of HP's divisions that meant most of the people at the company picnic were from other divisions and I didn't know them. It was a little hard to hunt down people I did know in the crowd that gathered there and I still had my old sense of discomfort among crowds of strangers. Nonetheless, I wouldn't miss the picnic for anything. It was one of the finest old traditions of the company and had first started in HP's very early days when the whole company was smaller than Delcon Division was in 1977. The company picnic was one of the many elements of the common culture of HP that was known as 'the HP Way.' So even though the picnic meant rubbing elbows with a lot of strangers, I always thoroughly enjoyed them.

Pranks and practical jokes were another part of the HP way of life in Del's group. Bob Weisickle was another young engineer in our group. Bobby was a year older than me and, until I arrived, had been the youngest engineer in the lab. He and I tended to be the main instigators of practical jokes although we were by no means the only pranksters in Building 30.

One of Bobby's favorite vehicles for pranks was paper tape holes. Every computer, including a micro-computer, uses what is called a 'machine language.' This basically consists of packets of ones and zeroes, known as 'bytes,' that instruct the machine what to do step-by-step. Each different kind of computer has its own machine language. However, it is difficult and error prone to try to write firmware directly in machine language. Instead a symbolic language, called an assembly language, is used by programmers to write the firmware. This assembly language must then be translated into the machine language. In those days we would write our microprocessor firmware using a minicomputer, an HP Series 1000, which would do this translating into the machine language for the M6800 microprocessor. The minicomputer would output the series of machine language bytes by punching a series of holes in a paper tape. The paper tape was about three quarters of an inch wide and when it was rolled up on a reel would usually be about five or six inches in diameter. The tape would then be read into the microprocessor development system using a paper tape reader. The residual paper left over after all the holes were punched were collected in a little bucket-like receptacle. These residues were the 'paper tape holes.'

Each paper tape hole was a tiny, circular bit of paper and we always had thousands and thousands of them laying around in the paper tape hole bucket. Bobby would collect these and use them to set various kinds of booby traps. One morning when I came in to work, he had rigged up an air powered gizmo to spray paper tape holes and hidden it in my center desk drawer. When I sat down and opened my desk drawer *whoosh!* out came this mushroom shaped cloud of paper tape holes and I almost jumped out of my skin. I had paper tape holes all over my desk, all over my work area, in my hair, in my mouth, in my shirt pocket, and some even got inside my shirt. It took me almost half an hour to clean up the mess.

Naturally, I would always retaliate with some prank of my own. A lot of creativity would go into the pranks we pulled on each other, although Bob Allen did draw the line on how far we could go. For example, he wouldn't let us have water fights with the portable fire extinguishers. Well, not more than once anyway.

Age was no protection against being the victim of a practical joke. Anyone was a potential victim. Anyone but Bob Allen, that is; nobody ever did quite have the guts to pull one on him, although I secretly thought he might have enjoyed it. Bob had the soul of a prankster. Paul, who was the oldest guy in the lab, wasn't granted this immunity. There was a sex hotline in Palo Alto and anyone who called it was treated to a sexy-sounding woman's voice making all kinds of interesting suggestions. Paul was a pretty religious guy, very much a married man, and had no vices that I knew of. The combination was too good to pass up. One morning when Paul was away from his desk Bobby and I left him a phone message note telling him to call this hotline number. When he came back to his desk everybody in the group except Erhard, who didn't know about it, was covertly watching Paul to see his reaction when he heard that hot

dish on the other end of the phone.

Paul found the note, picked up the phone, and dialed the number. Unfortunately, he got a busy signal so he just hung up and went back to his work. It was a big letdown and all the rest of us went back to work too. Later that afternoon Paul got back around to that phone message and dialed it again. This time nobody was watching but all of a sudden the peace and quiet of the lab was interrupted by Paul's high pitched voice, "Erhard, you S.O.B.!" Everybody knew what had happened immediately and the whole group erupted with laughter. Everybody except Erhard, that is, who didn't have a clue what had happened. The fact that Paul blamed Erhard for the phone message made it all twice as funny.

That was the first and only time I ever heard Paul cuss. Another time I was at work extra early in the morning. We had an important project checkpoint coming up and everybody was making a maximum effort to meet the deadline. My phone rang and I picked it up. It was Paul. He was out in the lobby and had forgotten his employee name badge and his employee identity card. The security guard on duty therefore wouldn't let him come in the building. Could I come out and identify him so he could come in to work?

When I stuck my head out the door into the lobby Paul was seated on one of the visitor's couches. "Oh, good!" he said when he saw me and he scurried up to the lobby desk to sign in and put on one of the temporary ID badges. I said to the security guard, "What's going on?" He nodded toward Paul. "This guy says he works with you," he replied.

"I've never seen him before," I said. "Don't let him in!"

Paul's mouth dropped wide open and for a delicious second he couldn't say anything. Then he yelled at me, "You . . . you . . . *you dirty guy!"* I laughed and told the guard it was okay, Paul did work here.

One of the ways you knew where you were in the lab's barnyard hierarchy was by the kind of electronic calculator you had. Bob Allen didn't believe in spending his lab budget capriciously and so when somebody got one of the newest HP calculators he passed his old one down to the next senior guy, who passed *his* down to the next guy, and so on. When I started I was given an HP-35, the original and cheapest model. Don Dresch was one of the more senior guys in the calculator chain. He was an avuncular man in his mid-thirties and worked as one of the project leaders. We nicknamed him "Dr. Don" after a local radio personality by that name. One day Don became the proud recipient of HP's newest and most powerful model of electronic calculator. He kept it locked in a security cradle on his desk and the day it first came he couldn't resist showing it off to us younger guys. Hmm . . .

In those days printed circuit boards were designed by laying out the patterns of copper traces on these big transparent sheets of plastic using a sticky red tape. This was called 'PC layout' and was done by skilled people known as PC layout artists. The PC layout tape was exactly the same color as the red calculator displays, which in those days were made using red light emitting diodes (LEDs). That evening after Don went home I drifted over to the PC layout department and sliced off a piece of that red tape. Then I went to Don's desk and carefully stuck it down over the display of his new calculator. Each evening that whole week I added one more layer of tape to Don's calculator. Friday morning we found him hunched down over his calculator trying to read the display. His nose was practically on top of it. "Gee," he said to us, "these LEDs are sure dim!" □

I would spend part of my vacation time each year going back to Iowa to see the family at Christmas. Christmas was always a big event in my family and I didn't want to miss it. I would fly from San Francisco via either Denver or Chicago and then take a connection to Moline, IL, where somebody would meet me. I found a surprise waiting for me Christmas of '75. Dad had turned the bakery over to Melody and her husband, Kenny, and moved back to Maquoketa. Sherri had built a second house on her ten acres in Reynerville, which isn't a town but rather is what that particular section just outside the Maquoketa city limits was called. Mom and Dad were living in that house. It surprised me a little that Dad had retired so soon – he was only sixty-two at the time – but then, as I have said, bakery work was hard work and I

guess by then it was just too physically demanding for Dad to do anymore. It didn't surprise me they had moved back to Maquoketa. Mom considered Maquoketa home and hadn't liked living in Bellevue.

Christmas, as always, was wonderful except for the fact that Kenny made something of a pest of himself trying to get chummy with me. I was polite to him, of course. For better or worse, he was family. But I didn't particularly want to be buddies with him. Kenny must have sensed this because he said to Mom privately, "I don't think Rick likes me." Mom tried to reassure him by telling him, "Rick doesn't warm up to people very quickly." True, but Kenny was right, too. There was just something about him I didn't like very much. The following year, around Easter time, he ran off on Melody and I never saw him again. It had turned out he was every bit the bum I had always thought he was. Dad sold the bakery after this happened and that was the end of our bakery business. Melody went on to attend a nearby college, within commuting distance from Maquoketa, and eventually became a CPA. The world lost an artist.

I would never spend all my vacation time in Iowa. I always saved some for other enjoyments. In the winter of '76 Glen gave me a call. A bunch of our brothers were planning a ski trip to Snowbird, Utah, and did I want to join them? Did I? You bet! The one problem was that the ski trip would overlap my first exam in John Linvill's course. I spoke to him about this and he readily agreed I could sit the exam as soon as I got back.

I'd never skied before; there aren't any mountains in Iowa. But several of us were in that boat so we took ski lessons the first day on one of the little bunny slopes at Snowbird. Tom Korpela, who was then a senior and Lorne's roommate, proved himself a natural athlete and picked it up right away. I, on the other hand, had a lot of difficulty with the ski maneuver known as 'the snowplow.' You see, my feet naturally turn slightly outward and the closest I could come to doing a snowplow was to put the skis straight ahead. This works pretty good for high speed ski runs but not so good for doing the snowplow. I took an extra day of private instruction from a beautiful ski instructor who tried everything she could think of to teach me how to do it. For some reason, though, I turned out to be a *very* slow learner. Finally she gave up and taught me how to control my speed by doing tight little turns, which I could do.

When I finally did hit the real slopes I had an absolute blast. I was a long way from being the most skilled skier to ever tear down the side of a mountain. I had the turning radius of the battleship Missouri and on my first day of real skiing my brothers tagged me with a ski nickname: Avalanche. But it was great fun and it was great to be with my brothers again, so I hated to see our ski trip come to an end.

When I got back to Mountain View my phone rang. It was John Linvill. He asked me politely how my trip had gone and I told him it was great. "No injuries?" he asked. "No broken bones?" Nope, I told him. I was flattered that he asked. "Then you can take the exam tomorrow?" he asked. Oh. Yep, can do. □

When the ′43 went into production I had expected to be assigned to work on TIMS II again but plans had changed. Instead 1977 saw me and a bright, younger, newly hired engineer named Willy Sagun, who had just graduated from Cal Poly San Luis Obispo, assigned to a "blue sky" project Del wanted to try. A blue sky project is a project that is regarded as high-risk because when it starts no one knows if it can even be done. Bob Allen liked to hold about ten percent of his R&D budget in reserve to try blue sky projects. If one succeeds it usually more than pays for the nine previous ones that failed. As R&D assignments go, being entrusted with a blue sky project is a pretty big compliment to an engineer's ability. For me it was a double compliment because I was also being asked to be 'big brother' to Willy, just as Erhard had big-brothered me when I had first arrived. For the first stages of the project we didn't even have a project leader we reported to. Del handled things like performance evaluations and salary administration that had to be done for us. For a lab engineer it was a dream assignment.

One disadvantage of the test equipment we manufactured was that in order to use it the telephone line had to be taken out of service while it was being tested. In the mid-1970s more and more high speed data communication between one computer and another was taking place and this had led to a classic 'who is at fault?' argument between modem owners and the telephone company. 'Modem' stands for 'modulator-

demodulator' and is the name given to the part of your computer that communicates over the phone line. When a problem develops with having too many data errors happen during transmission, modem owners would generally claim the phone line was bad, while the telephone company generally claimed it was the user's modem that was at fault. Our new blue sky project was aimed at providing a way to resolve these kinds of disputes.

The basic idea was to invent a TIMS-like instrument that could test the phone line *without* taking it out of service. This is called 'non-intrusive testing.' The main technical problem was that a TIMS used test signals it generated and fed into the line, which would be 'intrusive' testing. We were to look for a way to build a TIMS that didn't generate any test signals. This had never been done before. Del's idea was to see if we could somehow use the modem's signals and the information they carried within them in place of the suite of TIMS test signals. He let Willy and me choose the code name for this project and we decided to call it 'Watch Dog.'

For the first little while I worked on Watch Dog by myself while Willy was given a starter assignment to help him over the initial new job jitters and so he could learn a little bit about what a TIMS was. After about a month of research work, I had figured out there was a pretty fair chance that Watch Dog could be built using the power of digital signal processing methods. The biggest technical issue was that the micro-processor chips available at that time weren't powerful enough computers to handle all the calculations that would be required. However, the nature of these calculations was such that they could be broken into simpler pieces that individually *could* be handled by individual microprocessor chips. What that meant was that Watch Dog would have to be a special kind of computer that used many microprocessors all at the same time. This kind of computer is called a 'multiprocessor' computer and up to that time these kinds of computers had only been built on an enormous scale and were known as 'supercomputers.' But it looked like Watch Dog might be possible using this approach and it wouldn't cost remotely as much as any of the big supercomputers did. I estimated we could do it – if in fact it *could* be done, which wasn't at all a given yet – for about the same cost as a TIMS. This approach also meant that the crucial part of the design would involve the algorithms – the computer programs – that would actually carry out the digital signal processing. The hardware would be relatively simple compared to these and the specific details of the multiprocessor design would be dictated by the nature of these algorithms. Later this kind of approach to design would come to be called 'hardware-software co-design,' but that term hadn't been invented yet. Willy and I would be developing a design method for doing this along with the Watch Dog itself.

Once I'd convinced myself this approach was worth a try, I presented it to Del and Bob Allen for their review. They likewise decided it looked like it might be do-able and gave the go-ahead to move on into the breadboard phase. It was at this point when Willy came on board full time. We started working on algorithm development and on what is known as 'simulator software' to use as an initial vehicle for testing and debugging these algorithms. Once we had the basic algorithms developed part of the lab proto phase would involve modifying these algorithms to use simplified computer arithmetic approximations, called 'fixed point arithmetic with scaling,' because the microprocessors of the day weren't really powerful enough to do what is known as 'floating point' arithmetic, the most commonly used form of arithmetic in bigger computers. Our breadboard phase algorithms would be 'proof of concept' designs and the real designs would follow during the lab prototype phase.

The digital signal processing mathematics we were using had all kinds of exotic and impressive-sounding names such as 'homomorphic deconvolution' and 'complex cepstrum domains.' We weren't shy about throwing these mysterious sounding monikers around either. At that time very few engineers had even heard of them and the terminology lent an air of wizardry to what we were doing. Basically, we were showing off. I was, anyway. Willy took this all pretty seriously, as rookie engineers always do. We talked such a good game that Bob Allen decided to feature the Watch Dog project during division review.

Division review was a once-a-year happening when HP's top managers and members of the Board of Directors came around to an operating division to find out what was going on. Division reviews happened

at different times at different divisions, but every single division of the company always got its chance to shine once a year. Bob told me I'd be making the lab's presentation for Watch Dog.

Well, I put together my dog and pony show for the review and on the appointed day the big dogs came down from Palo Alto. Bill Hewlett led the procession, and I noted he wore a short-sleeved white shirt *and* a tie. Mine were still hanging in the closet at home. Bill sat right up front, about three feet away from where I stood. Next to him was John Young, who had just been designated as HP's president and would also become CEO when Bill retired in another year. Sitting among the Board of Directors was Luis Alvarez, the 1968 Nobel Prize winner in physics. At age twenty-three I was about to make a presentation to this group of corporate and scientific Olympians. Was I nervous? *Oh, yeah!*

Well, I launched into my talk, fancy buzzwords and all. I was kind of half-hoping that our intimidating terminology would hold down the questions I might get asked. I should have known better. These guys didn't get where they were by *pretending* they understood things. I'd gone about five minutes when John Young interrupted me with the first technical question. "Rick, can you explain . . .?"

Before I could say a word, Bill turned to him and said, "Well, John, the way that works is . . ." I was a little taken aback by Bill Hewlett fielding the question I'd been asked, and I was *very* impressed that he not only answered it but *he answered it correctly*. I'd thought this stuff was so ink-still-wet new that nobody would really follow all the details. Bill turned back to me, leaned forward, and with a small wave of his hand said, "Go on."

The next question came about two minutes later. It was from Luis Alvarez. "Rick, what does . . .?" Bill turned around in his seat and said, "Well, Luis, what that does is . . ." He got that one right, too. He turned back to me, gave me that little wave of the hand, and said, "Go on."

That's the way the whole presentation went. I'd talk, somebody would ask a question, Bill Hewlett would answer it with the right answer, and then say to me, "Go on." When the presentation was over the managers and Board members all complimented me on it, and Bill said to Bob Allen, "I'm glad to see your lab's staying on top of new technology." Bob was beaming from ear to ear and standing about two inches taller than he usually did. The whole thing was a great success. □

Bob Brown, my fellow Iowa Stater, had come to work in the cable fault locator group in our lab, which was the same group Rich Page and Don Dresch worked in. A cable fault is a problem such as an open circuit or crossed wires (called a 'split') in a telephone cable. The products that group built were instruments for locating where the problem has occurred. Bob had worked on the HP 4910G Split-Open Locator, which was also released to production about the same time my project was. Between the time I arrived in the summer of '75 and early 1977 the division introduced seven new projects to production, which is pretty high R&D productivity considering the small size of our lab. In fact I never saw this level of productivity in new product development matched again by any other organization I've known in the thirty years that have passed since then. But at the time I didn't know I was witnessing something extraordinary.

Bob didn't stay in the lab after he finished his work on the HP 4910G. He was ambitious, wanted to rise in management, and he saw a career opportunity to do so by transferring into our marketing department. From there he rubbed elbows much more with Brian Moore and the division's other functional managers than I did and so I got to hear more inside gossip about some of the things that went on outside the lab. One of these tales I found the most interesting involved a problem with the 4910G that was discovered shortly after it was announced and released to production.

It turned out that a bug had been missed in the ´10G's firmware and, as a result, a measurement inaccuracy had been introduced. The details are fairly technical but the basic problem was that there were some conditions that are known to occur in the field under which the instrument could be off by as much as five feet or so in telling the customer where the cable fault is. That might not sound like very much over the course of a mile or so of telephone cable, but to the guy with the shovel who goes out to fix the

cable it is a big error. Brian Moore called a meeting of his top managers, the functional managers of R&D (Bob Allen), marketing, production, and, if I recall correctly, one or two of the regional sales managers to discuss the problem.

On a purely technical level the problem wasn't hard to fix. It was, after all, just a bug. It would cost the division about five thousand dollars in new tooling for the Read Only Memory, but on the industrial scale of things this is a minute expense. The real issue was that we would have to recall all units that had been shipped in order to fix them, replace all the inventory of old ROMs that contained the bug, and delay on-going production and shipping of the product. Also, of course, it would embarrass HP in the eyes of Delcon's biggest customer, Ma Bell. The meeting was called to talk about these problems.

Somewhat early in the discussion someone – I don't remember if it was the marketing manager or one of the regional sales managers – asked, "What happens if we don't do anything?" What happens, in other words, if we kept the problem a secret and just went on selling a defective product. There was a hushed silence for a second or two around the table and then someone asked, "Is that ethical?"

Before Brian could say anything, Bob Allen replied, "Well, that depends on your view of what ethical is. When Bill (Hewlett) and Dave (Packard) come down here and ask Brian why he did that, if Brian can explain it to them and feel good about his explanation, then it's ethical."

Brian immediately said, "We're not going to do that."

We ended up fixing the problem, doing the recall, and all the other things. As it turned out, the problem ended up not seriously affecting sales of the product and the phone company even thought highly of HP for owning up to the problem right away and fixing it. □

As 1977 drew near its end Willy and I were happily buried in our work on Watch Dog. Del had given us a free hand to pursue the applied research work we were doing and, more and more, things seemed to be coming together nicely and the product looked more and more feasible with each passing week. Rich had moved into the TIMS section and he, Dick, and Erhard – among others – were working on TIMS II. Then something pretty awful happened: Del was promoted to functional manager of marketing and was replaced by one of our other group leaders, a man in his late thirties named John.

Of course, this wasn't an awful thing for Del. His new job was just one step below division manager now. But for me it turned out to be an awful thing because John was as different a manager as could be. To be specific, he was what is these days known as a 'micro-manager.' Overnight I lost one of the best managers I'd ever work for and, in his place, got one of the worst.

A micro-manager is called that because he insists on knowing about and approving every single little thing his subordinates do. An excellent manager like Del knows he can tell whether things are going well or badly by watching the visible signs of progress in his group and from periodic but relatively infrequent status reports. He trusts his people to do their jobs and knows that if some big problem does crop up they will tell him about it. A micro-manager is just the opposite. John immediately demanded that I tell him every little thing Willy and I were doing and questioned every technical decision I was making. The latter might not have been all that bad, considering how young I still was, if John himself had been technically up to date and capable of understanding the technology we were working with. But he wasn't. Most engineers will put up with a small amount of being micro-managed if they respect the technical abilities of their supervisor. If the boss really knows his stuff technically, a good engineer isn't afraid to learn from his usually greater experience, the way I learned from Erhard. It didn't take very many weeks for me to not respect John's technical abilities at all. However, that didn't stop him from second guessing me at every turn and I found myself having to spend hours each week trying to educate him about technical things of which he was wholly ignorant and didn't really care to learn about anyway.

Under Del we were working at a gallop. We made mistakes, of course, but we also soon discovered them and fixed them. And we could *try* things, see if they panned out, and if not we'd then know why

they hadn't panned out and would learn ever more detailed knowledge about the nature of the problem we were working to solve. Under John this fast, free-wheeling, and *efficient* way of doing our job came to a screeching halt. You see, a micro-manager doesn't really *trust* his people to do the right thing. He's always looking for them to make a bad mistake and he wants to prevent mistakes from ever happening. Now, it is true enough that most managers can fall temporarily into micro-manager mode during emergencies or during periods of great stress. The very best ones, like Del, never seem to succumb to this, but most of the rest of us mortals do from time to time.

With John, though, micro-managing was the normal way of doing business and not a once-in-awhile thing. Micro-managers tend to be 'thing oriented' and rarely 'people oriented.' Among other things that means they seldom appreciate their people's strengths, although they're pretty reliable about appreciating their people's weaknesses, both real and imagined. A micro-manager will take a thoroughbred racehorse and hitch him to a plow. And that is exactly what John did to us.

The consequence for me was that Watch Dog soon ceased to be the fun and all-absorbing 24-7 center of my universe it had been and increasingly became a daily exercise in frustration. Anyone who knows me could easily predict how I would react to this. I increasingly came to regard *John* as the greatest single obstacle to the success of the project and our relationship became increasingly one of mutual hostility. *I* was hostile anyway, and more than ready to interpret almost anything John said or did as a sign he felt the same way about me. Eventually John dealt with this by placing a project leader over us, a guy who likewise knew nothing about the technology we were using. This shielded me from having near-daily confrontations with John, but since he then proceeded to micro-manage our new project leader, and he in turn was forced to micro-manage us in order to be able to respond to his own micro-managed condition, things actually went from bad to worse. I came to loath the two of them.

I have always believed life is too short to spend it working for a stupid boss, and by early 1978 that was exactly the situation I felt myself to be in. In many places if a situation like this develops the employee is just stuck. A person has to have a job and an income, and many people find themselves with no recourse but to trudge on. However, in Silicon Valley a good engineer almost never faced that kind of trap. There were hundreds of other places he could always go to work for the same or even better money. I had no desire whatsoever to leave HP, but HP had a lot of divisions in the Bay Area. I started looking around for 'other opportunities' and soon found one.

Over in Cupertino there was an interesting project going on that was being managed by a guy who had previously been a group leader at Delcon. I already knew him from my original interview trip. His name is Jim Hood. I had liked him when we'd met previously and the guys in the lab who had known him very well all spoke highly of his abilities as a manager and as a person. He had left Delcon for personal reasons unrelated to work. And he had an opening. I gave him a call.

Jim remembered me and seemed delighted at the prospect of having me come to work for him. I would have to submit to another technical interview – that was a normal part of the process even when a person is merely transferring between organizations in HP – but I wasn't worried about that. The job involved bringing the microprocessor revolution to bear on the electronics that control computer peripherals – mass storage devices such as disk drives and tape drives in this case – and I knew that at that time there weren't all that many people who had the kind of actual experience in this work that I had. Jim knew that too. We arranged for me to come down to Cupertino and interview for the opening.

The rules at HP said that when you do something like this you must inform your own managers and let them know what's going on. The rule is there mainly to make sure that such a transfer doesn't do severe damage to the business operation a person would be leaving, but it is in any case the ethical thing to do. But since I neither liked nor trusted either my new project leader or John, the person I told was Bob Allen. Bob wasn't happy about it, but he was a good and decent man and he put no obstacles in my way. I went to the Cupertino interview with his full permission and knowledge if not with his heartfelt blessing. The only thing I didn't tell him was the very personal nature of my motivation. I disliked John a great deal,

but I wasn't going to attack his character by telling Bob what I thought of him. My dislike for him was *personal*. If he and I had both been ten-year-olds we probably would have settled it by duking it out on the playground but that's not how you do things in the adult world. A professional divorce would settle things just as definitively and nobody would lose any teeth.

On the appointed day I drove down to Cupertino for the interview. Jim's guys put me through the usual technical grilling common throughout HP in those days, but I had a big two and a half years of experience and a couple years of graduate school behind me this time so it wasn't really all that bad. Not too surprisingly, everybody in Jim's team was older – most of them a lot older – than me, but they were all pretty good guys and I liked them. I especially liked Jim. His management style wasn't the same as Del's, but he was personable, easy to talk to, and definitely *not* a micro-manager. John was a ruler I had to knuckle under to; Jim was a leader I would follow, and that makes all the difference in the world. It does to me, anyway.

The job was pretty interesting, too, although not nearly the technical challenge Watch Dog was. In a computer system there is what is known as a 'memory hierarchy,' a progression of different technologies for storing data in such a way as to optimize the performance of the computer. At one end are the very fast, very expensive semiconductor memories called 'registers.' Often next comes a small amount of slightly slower, slightly less expensive type of memory called a cache. Next come larger, slower, even less expensive memories. These are technically known as the 'main memory' but most people these days know them by the acronym RAM. After that comes the high capacity, slow, very cheap electromechanical memories known as disk drives. Computer engineers also refer to these as 'mass storage' generally speaking and as the 'backing store' more specifically. Next and finally, particularly in those days, came the extremely high capacity, extremely cheap, and extremely slow memories known as the 'backup store' or tape drive. Disk drives and tape drives, taken together as a class, are the 'mass storage devices.'

Most tape drives are said to constitute 'off line storage' because you have to go get the tape manually and put it in the tape drive whenever you want to store or retrieve something. Jim's project was different. It would be an 'on-line' tape drive that could fetch and install a library of tapes automatically, thereby constituting what was being called 'a true fourth level in the memory hierarchy.' The idea had been invented by IBM and commercialized in a million-dollar tape library system known as the IBM 3850 System. What we were doing was a much lower cost, scaled down version of this suitable for use in minicomputer systems (rather than the giant mainframe computer systems IBM built at that time). The project was code named 'Jumbo' and it needed a mass storage controller.

The mass storage controllers of 1978 were much more primitive, and much more costly, than they are today. Today's mass storage controllers usually include their own RAM memory devices to act as a cache memory, control more of the 'nuts and bolts' operation of the disk or tape drive (thereby freeing the computer's software from having to do this), and incorporate very sophisticated circuitry for detecting and correcting data errors from the disk or tape, thereby greatly improving the protection afforded to your stored data. None of these things existed in the controllers of '78 except for some relatively primitive error detecting and a limited amount of error correcting capability. My job would be to design a new generation of mass storage controller and, by working with other engineers in HP's disk drive division, help define a new common architecture for mass storage controllers that would be used throughout the company's computer product line. HP had entered the minicomputer business in 1966, the same year I had become interested in electronic brains, and our computer business now amounted to about half the company's total revenues, somewhere in the neighborhood of a billion dollars a year in 1978. We were an up-and-coming upstart in the minicomputer world, and I would once again be in the thick of the action. The thing that would make this all possible was, once again, the microprocessor revolution.

The other guys on Jim's team had all given me a 'thumbs up' following my technical interviews and Jim offered me the job on the spot. I accepted immediately and we shook hands on it. My transfer wouldn't be official until Bob Allen okayed it from Delcon's end, but for all practical purposes it was a

done deal.

When I got back to Building 30 I went immediately to Bob and told him what had happened. I was happy and excited about my new job, but at the same time I was sad to be leaving Delcon. I would miss the people there – with two exceptions – very much. Bob took the news calmly and then, unexpectedly, made me a counteroffer. If I would stay at Delcon I would be promoted to project leader of Watch Dog.

I was surprised, stunned, and very, very flattered he made such an offer to me. I had only been with the company for two and a half years and becoming a project leader in that short a time wasn't very common. Nothing Bob could have said or done could have moved me more deeply than that because it proved more than anything else could how highly he thought of me. Nonetheless, and with real regret, it was an offer I had to turn down. The prospect of still having to work for John wasn't really the issue because I'm pretty sure if I'd made that a negotiating point I'd have been out from under John in the blink of an eye. But there were other factors that were issues in my having to turn down Bob's offer.

First, getting a fast promotion had never once entered my mind. If I accepted Bob's offer it would have felt too much like I'd blackmailed him into giving it to me. I hadn't, of course, but it would have *felt* like I had, and Bob would never have been able to be sure that wasn't what I had in mind all along. Such a thing is not uncommon in big business. Today the euphemism they use for this is 'hardball negotiating.' These people, and Bob not the least of all, had been very, very good to me, had welcomed me into their midst with nothing but kindness and patience, and they were my friends. I just *couldn't* let personal gain bring along even the appearance that I thought so little of them and distrusted them so much I would be willing to stoop to blackmail to advance my own career. Some of them – Dick and Rich and Willy in particular – would know I hadn't done this, of course. But could Erhard or Paul or Johann or Dave or Don or Del or Bob or any of the others ever really know that? Of course they couldn't. I valued and cherished their friendship and respect too much to risk losing or tarnishing it.

Second, there was Jim. We had made a deal. We had shaken hands on it. I had made him a promise that I would join his team and I wasn't about to break that promise and back out on it for the sake of a promotion. In my eyes nothing would have been more dishonorable. I wouldn't make myself into another Collins Radio. And maybe Jim might have questioned if my whole purpose had really been nothing other than to bludgeon a better job offer out of Bob. It was a matter of ethics. Other people might have felt differently and made a different decision and if so I would not prejudge them. But for *me* there was no other decision possible than the one I made. It was a matter of what the philosopher Kant had called a categorical imperative. Kant wrote, *the love of honor is the highest duty of humanity to oneself, so little capable of abridgment that it has to go further than love of life.* That was the way I felt. □

My new group did not belong to any of HP's divisions. Although we were housed with the Data Systems Division of HP – the division that made the company's line of HP 21XX minicomputers – we officially were part of what was known as Computer Systems Group Corporate Engineering and Jim's immediate boss was a guy named Marco Negretti, who was the engineering manager for CSG and the unofficial dotted-line boss of all the R&D lab managers on the computer side of the company. Marco liked to keep one or more little R&D labs on the side where possible innovations in computer systems that didn't fit neatly within an operating division's charter could be tried out. If one looked good, it would later be transferred to one of the operating divisions for further development to become a new product. I think it is likely, although I don't really know for sure, that doing Jumbo was originally Marco's idea.

By the time I had joined the team the decision had already been reached that if Jumbo's breadboard design proved the concept of a 'miniature IBM 3850,' the project would be transferred to the company's disk drive division in Boise, Idaho. This division was relatively new – it had come about because HP was starting to diversify its operations out of California, where the business climate had become less friendly in the judgment of Bill and Dave – and although it had been officially in existence for a bit over a year it was, for all practical purposes, still a start-up division. It had been an explicit part of the understanding in Jim's job offer to me that I would at least *consider* transferring with the project to Boise when it went.

The company had no intention of forcing anyone to move to Idaho if they didn't want to or couldn't, but the agreement was that the team working on Jumbo would keep an open mind about going with the project when it was transferred.

I was perfectly willing to be open-minded about this for two reasons. One of them had to do with being able to own my own house one day. As bad as inflation was running – during President Carter's first year in office inflation ran a little over 7.5% as measured by the spending value of a dollar, and it would explode to over 11% between 1978 and 1979 – the price of houses in the Bay Area was shooting skyward at an even more ludicrous rate. Rich, for example, had paid sixty thousand dollars for a one-bedroom condominium, which was three times what our house on Judson street had cost us. To find a house he could afford, Bob Brown and his family had to go all the way to San Jose, which gave him a three hour commute *in each direction* on that great parking lot known as the Bayshore Freeway during rush hour. Even very modest houses out in the far boonies cost well over four times my total before-tax income, which in those days meant no bank would make me a housing loan. And the upward spiral in housing prices showed every sign of accelerating to still more ludicrous levels. Simply put, I was priced totally out of the Bay Area housing market.

Apartment rentals were also climbing steeply. In 1976 I paid $240 per month on my apartment; in 1977 it climbed to $280/month, and in 1978 it climbed again to $310/month before falling back later that year to $285/month after Proposition 13, the one percent initiative on property taxes, passed. It wasn't just my apartment complex that saw this either; every apartment complex in Mountain View was doing exactly the same thing. It was becoming very clear that landlord companies could keep raising the rent as much as they wanted to and there was absolutely nothing someone like me could do about it except move. But move where? As I said, rents were all doing the same all over. My income had climbed faster than this, but I didn't kid myself that I was going to continue to see ten percent raises every six months forever. As more and more people found themselves locked out of the housing market, like I was, I could only see the rent situation getting worse and worse. That's just basic freshman economics.

My other reason was that I was finding the social life in the Bay Area to be far different than I had assumed it would be. Californians just weren't Iowans, by which I mean they didn't seem to be a very sociable bunch of people. I mentioned before that Mountain View was basically a city of apartment dwellers. One reason I had chosen to live at the Cypress Point apartment complex was the presence of a large, nice common room and a very nice swimming pool. The presupposition I had made was that these were the natural gathering points for the single people who comprised the main body of tenets at Cypress Point. I would be able to meet my neighbors, especially those of the opposite sex, in a natural setting that would be comfortable to one and all. After all, we would all be 'home' in a manner of speaking. From there it would be easy to make friends and maybe even meet a nice girl with whom there might develop something more than friendship.

As I said, this proved to be nothing but a supposition. Most days and times the common room and the swimming pool were utterly deserted except for the staff that ran the complex. Cypress Point was a dwelling without a community. The situation wasn't confined to just Cypress Point either; if it had been I'd have moved someplace else where there *was* a community atmosphere. Even stranger, as I listened to my coworkers who were already married with families, it seemed to me that when the weekend came mom and dad took off in one direction and the kids took off in another. Every house I saw in the Bay Area came with a very big fence around it, far too tall to even look over the top of, as if the individual houses were isolated fortresses. It looked to me very much like even the communities weren't communities in the Bay Area. This social climate was something totally outside my previous experience and, when all is said and done, I thought it was very impoverished.

I belonged to both a weight lifting spa and a racquetball club. I joined the spa because pushing a pencil around isn't too strenuous and I wanted to keep in shape. My coach there was an inspiring guy named Clancy Ross, who was the 1946 Mr. America and the 1953 Mr. World. These days a spa like this is likely

to have about equal numbers of both sexes, but it wasn't that way yet in the 1970s. The members were all male, although there was one guy I thought probably wasn't 'straight.' Likewise, the racquetball club turned out to also have an almost all male membership. Thus, while there was some pretty good locker room camaraderie at both places, there was something pretty important missing.

That left the singles bars scene. Here the stilted conversations were even more plastic than in Iowa. Everyone was posturing and pretending to be someone they weren't. It was prime turf for a lounge lizard. Too bad I wasn't one. So, while I loved the many cultural features of the San Francisco area, the more or less ready access to major league sports, and the many very fine restaurants, I was finding it impossible to think of the Bay Area as 'home.' Outside of work I had no roots here and it didn't look like I was going to be able to plant any roots any time soon. Things were probably different for people who were born there, went to school there, and grew up there. But I was finding myself a stranger in a strange land. □

The Cupertino site where my new group worked was at that time one of the largest in HP. The complex of buildings there housed three of HP's computer group divisions. Data Systems Division designed and built the company's line of minicomputers aimed at customers with technical applications such as in engineering and factory automation. General Systems Division designed and manufactured the company's HP 3000 line of business minicomputer systems. Data Terminals Division manufactured the company's line of computer terminals. HP's vice president in charge of the Computer Systems Group had his office on that site as well. It was the center of HP's computer universe at the time, although the next few years would see our desktop calculator division in Colorado enter the computer market proper as the desktop calculators turned into desktop computers. Later still HP would introduce a not very successful line of personal computers made at a division in Oregon. Interestingly, the Cupertino site had been the workplace of a young engineer named Steve Wozniak, who left the company after HP turned down his proposal to do something called a 'home computer.' Wozniak teamed up with another young guy named Steven Jobs and started his own company, Apple Computer. This wasn't the only time HP's computer side suffered from lack of market vision, but it was probably our most famous bad call.

Going from HP's tiniest division to its largest site was something of a culture shock for me, but at least my ties could come back out of the closet now. In that sprawling site nobody particularly noticed them. I figured that if Bill Hewlett got to wear a tie then I could too. The Jumbo team was located in Building 42 Upper, just about dead center in the middle of the Cupertino site. I was again the youngest person in my group. The oldest guy in our group was a physicist-turned-engineer named Bill Girdner. Bill was a real old-timer; he had been the first college graduate hired by HP in the early years of the company. When he interviewed with Bill and Dave, he had been so excited about the company that he forgot to ask what his salary would be before he accepted the job. Jumbo was his last project before retirement. In actual fact, he had more time served with the company than either Bill Hewlett or Dave Packard because, as he put it, "both those fellows had time off." Bill Hewlett had served in the army during World War II and Dave Packard had served a stint as deputy secretary of defense in Washington, D.C. from 1969 to 1971. Bill and Dave both came down for his retirement party near the end of 1978 and, when Hewlett commented that Bill had been with the company a long time, Girdner laughingly reminded both of them he'd worked here for more years than either of them. Bill actually lived in Monterey and kept an apartment in Palo Alto where he stayed during the work week. He was a very cool, unassuming guy and you'd never guess he was a millionaire many times over by the time I met him. His responsibility on Jumbo was the design of the helical scan magnetic tape heads used in Jumbo.

The three next oldest guys were Jerry Ainsworth, Bob Colpitts, and Earl Stutz. Bob and Jerry worked on the analog electronics for Jumbo and Earl was our chief software guy who worked with the systems software people in DSD and GSD in defining how HP's computer systems would use Jumbo. Jerry's job was designing the electronics that actually wrote data to and read it back from the Jumbo tapes. He was a tall, lanky guy with a dry sense of humor that really cracked me up. I ended up learning some valuable things about high frequency circuit design from him.

Bob Colpitts was kind of the opposite from Jerry. He didn't smile much and was kind of gruff, but he, too, was a pretty good guy. His job was doing the electronics that controlled the actual movement and positioning of the tape. Toward the end of 1978 he was stricken with viral encephalitis, which is a disease that attacks brain cells. Nobody, including him, knew it at first. The best guess of how he contracted the disease was from a mosquito bite out in the woods somewhere. The first symptoms came when he started forgetting how his own circuit designs worked or what they did. He went downhill pretty fast, eventually even forgetting who his wife was, which was what led to his disease being diagnosed. It was eerie to watch, and when we found out one morning that Bob was in the hospital we were a pretty nervous work group. Viral encephalitis can be very contagious and we had been working in very close quarters with him. But luckily nobody else caught it. The disease is usually fatal, but Bob did survive it. Sadly, though, it wiped out his memory of all his engineering training along with I don't know what else. HP found him a job working on one of the company's production lines after he recovered.

Earl was kind of a rabble rouser at heart, and he soon discovered that I made a pretty good rabble to rouse. Whenever there was something he didn't like about the project or the way management managed or whatever, he'd get *me* all fired up about it and when Jim came in to work he'd sic me on Jim. I'd kind of blindside Jim over his first cup of coffee about whatever it was Earl had stirred me up about. If Jim hadn't been such a good guy I'd have probably gotten myself into pretty serious trouble. As for Earl, he was the picture of calm statesmanship whenever Jim would come talk to him about whatever it was. Then I'd get pretty ticked off at Earl for setting me up like that. You'd think after a time or two I'd have learned my lesson, but I was twenty four, full of fire and vinegar, and had a lot of hot buttons. Earl really knew how to find and push them. With friends like him, who needs enemies?

There were two guys who were just a few years older than me. Bob Frohwerk, like me, had come over from the instrument side of the company and was working on the error correcting code system that would go into the Jumbo controller. He was a quiet guy, a graduate of Cal Tech, and we became pretty good friends. Bob and I ended up being the only ones who went with the project to Boise when it was transferred there. Billy Moon was the mechanical engineer who designed the complex tape transport mechanism for automatically mounting and dismounting the tapes. He had previously worked on the company's line of disk drives before that operation had been turned into a division and moved to Boise. That meant he'd already turned down moving from California once, and he wasn't too happy about this project being sent there also. But he did an incredible design job and by late 1978 the breadboard tape transport system was working perfectly. It was practically a lab prototype.

I had jumped on my assignment with both feet and was making pretty good progress. At that time there was quite a controversy going on over whether or not a microprocessor would be capable of being used in a mass storage controller. The argument against it was that it was too slow to handle the high speed data transfers to and from a disk drive or other mass storage device. It turned out that the data path was the only thing a microprocessor was too slow to handle, though, and I proposed a controller architecture where the data path itself was handled by a special circuit, called a direct memory access or DMA circuit, while the microprocessor handled everything else. That approach ended up being adopted by the operating divisions. Another question that was up in the air at that time was whether or not to put a local random access memory (RAM) cache into our mass storage controllers. At that time RAM technology was barely out of its infancy and RAM storage was still fairly expensive. RAM chips fast enough to do the job came with only 1024 bits (128 bytes) of storage. Nonetheless, I was able to show people that this would be cost effective and provide a number of performance benefits, and so that, too, ended up being adopted by the company. Neither of these things represented any great flash of brilliance on my part; the decisions were obvious once someone had done the calculations. It just turned out that I was the one who ran the numbers first and showed them to various project managers within the company.

The most controversy, as it turned out, involved the decision over which microprocessor to use in a mass storage controller, and here I wasn't successful at selling my proposal. At that time there were a great many commercially available microprocessor chips being sold by a number of different companies.

By this time managers within HP had come to recognize that firmware development was the costliest and most time-consuming aspect of microprocessor/microcomputer product development and, as a result, there was a strong push to standardize the mass storage controller design across the different product lines. This meant choosing *one* of the available microprocessor models. The question was: Which one?

Whichever one it was, it would have to be powerful enough to handle the company's most high-performance products. Different microprocessors had different performance capacities, so I undertook a performance study to find out which ones were viable candidates and how their relative performances stacked up. It turned out that the fastest one was an internal HP microprocessor called the MC5, followed next by Motorola's M6800, then one from the Zilog Corporation called the Z80, and finally one produced by the Intel Corporation. My study also showed that the Z80 would end up being a performance bottleneck for our high end mass storage devices, and so from a technical standpoint only the MC5 and the M6800 were really viable for a 'common controller architecture.'

Complicating the issue was the fact that the MC5 was based on a brand new semiconductor technology known as 'silicon-on-sapphire' technology. At the time this wasn't a proven technology. HP was trying to develop it internally and it was having a whole host of problems. One consequence of this was that MC5 chips cost divisions fifty dollars apiece at that time, compared to five dollars for the M6800, and even at that price the company was losing money on each MC5 it 'sold' to the divisions. To me it seemed clear there was really only one choice, and that was the M6800. That was what I proposed we use.

Well, it turned out no one else saw it that way. Jim sent me up to Boise to present the results of my study to the Disc Memory Division staff. I made my presentation to a room full of young engineers and only slightly older project managers. One of the things I emphasized was the issue of performance bottleneck my study had turned up. After I finished my presentation and made my recommendation, one of the young engineers – a fellow named Greg Spohn who would one day come to be the best boss I ever had – remarked that he had already written his firmware for a Z80 machine. I did warn folks up there that this machine would not be capable of meeting the performance specifications for their high-end product, a disk drive codenamed 'the Big Fixed Disk' or BFD, but the DMD lab decided to ignore this and went with the Z80 as their standard. It turned out later that BFD *did* end up having the controller be the performance bottleneck and they had to mount a 'performance improvement project' after it was introduced to fix the problem I had warned them about. It really was a dumb decision on their part.

Jumbo ended up not using my recommendation either. Paul Ely, who was the vice president in charge of HP's computer business, heard about my decision to go with the M6800 and invited me down to his office to talk about it. He listened while I outlined all the technical reasons why this was the right choice. Then he patiently explained to me that it was more important for HP as a whole to develop the silicon-on-sapphire integrated circuit technology and that to do this it was necessary for business reasons that everyone use the MC5. It turned out DMD was able to defy this edict, thanks to a very nasty reliability problem that was later discovered. But Jumbo worked for Marco, Marco worked directly for Paul, and so while Paul complimented me on my technical analysis, the answer was going to be the MC5. Period. It turned out later that HP never did manage to make the silicon-on-sapphire technology viable, so this too ended up being a bad decision. I was finding the whole situation frustrating. Jim had hired me because of my experience in doing microcomputer designs, but nobody was giving this experience any weight in the decision making process. Technical issues were taking a back seat to microprocessor politics and there was nothing I could do about it. □

As 1978 drew near its end DMD had me fly up to Boise for a job interview and to give me a look at the city. I appreciated the look at Boise because I had to make a decision over whether or not I wanted to move there. I was less happy about the interview part because, in effect, I was being interviewed to see if I could keep the job I already had. I felt a bit insulted by that and went into that interview process with a chip on my shoulder. However, after all was said and done I guess I did okay in spite of my more or less

rebellious attitude because DMD did offer me my position, on Jumbo, in their R&D lab. The job would start in early January, 1979, just after my graduation from Stanford.

The new Idahoan. Me at age 25 when I moved to Boise (1979).

I found Boise to be a very attractive place to live. It struck me as being kind of like a miniature version of Des Moines. At the time its population was just a bit over one hundred thousand, big enough to provide the benefits of a metropolitan area but small enough to not be as impersonal a place as the Bay Area was. The housing market there just then was a buyer's market because the raging inflation going on under President Carter had pushed interest rates into double digits but, at the same time, Idaho had a usury law on the books that capped the rates banks could charge at ten percent. The net result was there were a lot of new houses that had been built that the builders were having trouble selling. I was able to get financing and make a deal on a nice little brand new three bedroom house on a quarter-acre lot in a new subdivision on the west side of town. So it was that the day after New Years in 1979 the movers came to my apartment, loaded all my stuff on the truck, and I left California to become an Idahoan.

I arrived in Boise on the afternoon of January 3rd. Because the closing on my new house wasn't for another nine days yet, I first stayed at the Quality Inn, which called itself a 'motor hotel' – basically it was a pretty fancy motel, much nicer than a Motel 6 but less grand than a full-fledged hotel. HP was paying the costs of my lodgings there until I could move into my house; this was a relocation benefit from the company. Bob Frohwerk and his wife arrived in Boise at the same time. We had in fact 'convoyed' from California to Boise together. Bob and I were the only two from our Cupertino group to transfer with the project. Jim had been intending to come as well, but in the end he felt he couldn't leave California. He had been divorced a few years earlier and there were certain legal complications attached to the terms of the divorce, mostly having to do with his kids if I remember correctly, that stopped him from leaving the state. Bob and I would be getting a new boss as a result.

The company gave us both a grace period before we actually had to report in to work. This was intended to let us take care of the details that come with moving to a new city. Since my house closing was still several days away and there wasn't much I could do until then, I decided to report in to work the next day just to let folks know I'd arrived and to get situated in my new workplace at least. I figured that when the closing finally got here I'd take whatever time off I needed to take care of things then. My new lab manager, John Stedman, readily agreed to that. There weren't any time clocks anywhere in HP; no one ever had to 'punch in' to go to work, and the whole system was pretty laid back. I also got to meet my new boss, a section manager named Rich Smith. Rich was a white-haired, friendly guy, easy to like, and my first impressions of him were pretty favorable.

Another person I touched base with was a woman in Personnel named Addie Jensen. Addie had been a huge help during my house hunting trip. Before coming to work for HP Addie had been a realtor and she knew much, much more about the ins and outs of buying a house than I did. In fact, she had given my realtor a regular third degree grilling after I'd settled on my choice of houses, asking him pointed questions such as 'was the house on the city water supply' and dozens of other pretty important things it never occurred to me to even think about. She took such good care of me that I called her Aunt Addie.

Now she helped orient me to my new surroundings and gave me a lot of good tips on the practical mechanics of getting settled in Boise. These included things like where the best deals on various things were to be found in town, a map of the city, and a bunch of other small but important tidbits of information. Addie was a one-woman Welcome Wagon and she made it easy to get settled in. I always liked Aunt Addie a lot, although after her retirement a few years later I didn't see much of her again.

My personal finances were pretty tight all during that first year in Boise. The monthly mortgage payment on my house was four hundred sixty-one dollars a month, which was one hundred seventy-six dollars a month more than my apartment rent had been. But at least this payment was fixed – I had a thirty year mortgage and this was before variable interest rates had been thought up by the bankers – and there would be no more uncertainty from year to year on what my monthly 'rent' would be. In addition, I had another couple of smaller monthly loan payments to make stemming from other miscellaneous house-related expenses such as putting in a yard, installing a water conditioner to take care of Boise's famously hard water, and a few new appliances, such as a refrigerator and a clothes washer and dryer, I hadn't needed as an apartment dweller. I was also making car loan payments to the HP Credit Union. In 1977 my old Buick had finally pretty much had it and I had purchased my first new car, a 1977 Buick Skyhawk. The car had cost seven thousand dollars – a huge sum – and I'd taken out a six thousand dollar loan from the CU to buy it. I also still owed the Maquoketa State Bank three thousand dollars from my student loans, but fortunately I didn't have to begin repaying that until January of 1980 since I had just graduated from Stanford – officially on January 4th, 1979 – and there was a year's grace period on student loans.

So, all told, I was in debt to the tune of about fifty thousand dollars with a monthly take-home pay, after taxes, withholdings, and other payroll deductions, of about eight hundred sixty dollars a month. My total monthly expenses actually exceeded this amount but between selling my HP stock purchases, which came every three months, the twice-a-year profit sharing checks I received, and income tax refunds I did manage to just barely keep my nose above water without having to go even deeper into debt. Basically, every three months my checking account would dip into the red at the end of the month and a couple of days later I'd get money from selling stock and/or profit sharing, and that would give me the cushion I needed to get through the next three months. Occasionally some unexpected expense would crop up and I'd have to dip into my savings at the CU to cover it. I hated to do that. Financially I wasn't getting ahead any but at least I wasn't getting behind either. In 1979 I was living right at my disposable income.

I was even able to scrape up a little money – one or two hundred dollars here and there – to help support Governor Reagan's presidential campaign. Even before moving to Idaho I had become extremely dissatisfied with President Carter's inability to bring inflation under control and I generally regarded the things he had tried as ineffective and not really dealing with the root problem, which was a too-loose money supply. The government was paying for things by printing new money. On top of that, and as I had feared in 1976, the liberals in Congress had indeed succeeded in blocking the relatively few things President Carter had proposed that I did like. Domestic policy wise, they owned him and were ruling us. I had applauded President Carter's Executive Order declaring total amnesty for Vietnam-era war resisters, which he had issued on the first day he took office, and I had been deeply impressed by his accomplishment of the Camp David Accords, in September of 1978, which finally brought about peace between Egypt and Israel. But these were about the only things he had accomplished that I agreed with. I strongly disagreed with the Panama Canal Treaty in September of 1977. The SALT-II Treaty with the Soviet Union hadn't happened yet, wouldn't happen until the end of 1979, and even then would never be ratified because of the Soviet invasion of Afghanistan.

The economy during President Carter's term in office had continued to be flat at best – it was referred to as 'stagflation' – and that wasn't good either. On the other hand, I was succeeding in making a little extra money in the stock market by trading stocks. While still at Delcon I had set up a small account at Dean Witter and when I moved to Boise I had transferred this account to their Boise office. One of those little relocation chores I did have upon arriving was to meet my new local broker – or 'account executive' as stock brokers like to be called – a guy just a little older than myself named Scott Krueger. Scott and I hit it off very well at our first meeting and he's been my broker now for almost thirty years and through three different brokerages. My account wasn't too big in 1979 – just a few thousand dollars – but the drifting economy was producing fairly predictable up-and-down patterns in stock prices. I learned how to chart them to spot low points – where I could buy in – and high points – where I could sell out. I'd win some, lose some, but overall I was managing to inch ahead. Because I had so little money available to

invest, in those days I mostly traded stock options, which are very volatile but do have a limited amount of downside risk on the one side and the potential for very large returns when you do it right – or least did have in those days before stock index futures and programmed trading. I had learned about stock option trading from an HP Corporate attorney I had met in the summer of '77 at a company training course I had been sent to in Monterey. Paul was originally from New York City and he practically lived for option trading. He was a good teacher.

Today I wouldn't recommend this kind of stock market trading, but in the stock market environment of the President Carter years, and for someone with my limited resources at the time, it was a good way to grow my money little by little. But there's also a certain element of 'gambling' involved in the stock market and I had a pretty hard rule that my stock account had to take care of itself. I wouldn't, for example, pull money out of somewhere else and put it into my account with Dean Witter. The sole exception to this was that I did deposit my HP stock in that account. But since I also used proceeds from selling that stock to cover my living expenses, even this was a limited amount of infusion. I also made it a hard rule that I would never engage in heavily leveraged investments – such as futures trading – nor would I sell stocks 'short' – which has a limited upside and practically no limit to the downside risk. As much as it is possible to be a 'conservative trader' in the option market, I was conservative. I was going after increments, not a big killing. As they say on Wall Street: Bulls make money, bears make money, but pigs never make any money. And this saying is true. □

Disc Memory Division – DMD, as it was called – turned out to be one of the strangest places in many ways I've ever worked. It's main, and really only, business was the design and manufacturing of disk drives, most of which went into HP computer systems. Despite the fact that the industry spelled 'disk' with a 'k,' the division spelled its name 'Disc' with a 'c.' This was one of its more minor oddities. It was well known within the company that HP's computer side had a bit different culture from the rest of the company, although the HP Way was still a part of it. But DMD's culture, especially for the first few years I was there, was even more different. In many ways it was more like a colony of HP than part of the HP mainstream.

In the first place, it was a pretty new division. It had been started a little over a year and a half or so before I got there – I no longer remember the exact startup date for the division – and was experiencing the kind of phenomenal growth rate one doesn't often see except at a successful startup company. We were growing at a rate of about thirty percent per year when I first got there, which is a rate of growth that turns out to be extremely difficult to manage. Almost everyone there – from Dick Hackborn, the division manager, right down to the R&D engineers on the bench and the production operators on the lines – were new at their jobs. And it was a *young* division in terms of the ages of the people working there, too. Although there were a few experienced lab engineers still working as engineers, such as Bob and myself, the great majority of the R&D lab was made up of kids fresh out of college plus a few more who had been out two years or less. I'm not sure how big the R&D lab was when I got there, but it was at least four times larger than Delcon's had been and probably swelled pretty close to at least a couple hundred engineers within my first two or three years there. That's a lot of young people.

One of the signs of this demographic was the parties. For about my first two years in Boise someone would throw a party practically every Friday and Saturday night. DMD was always a pretty stressful place to work – in part because most of us were still so young and therefore inclined to be a bit nervous about our jobs, as I had been when I arrived at Delcon – and the R&D lab had something pretty close to the same 'work hard, play hard' ethic my fraternity had had in college. A big fraction of the lab were people who were already married when they arrived – and the young wives took full part in the parties – but another large fraction was still made up of single people. Although the lab was again numerically dominated by men, there were a few women in the engineering ranks here, which I immediately marked down as a tremendous improvement in the work environment, both professionally and socially. If you're wondering: Yes, a woman makes just as good an engineer as a man, and we had some really good ones.

Another sign was the 'over-thirty/under-thirty' football game. For the first couple of years we had a Saturday touch football game held at a nearby junior high school field where one side was made up of guys age thirty and above and the other was made up of guys under thirty. The over-thirty guys were pretty much all managers while the under-thirty team was pretty much all non-managers, so it wasn't too unusual to find yourself lining up against your boss (although not in my case; Rich was pretty far past age thirty and didn't participate) or even *his* boss or even his boss' boss. Although the game was touch football and nobody wore pads, that didn't really moderate the hitting that went on, and I'd come out of that game with black and blue bruises all over my body. They'd heal up just in time for the next game. After a few more years had gone by, I'd gotten to the point where those bruises wouldn't be healed up in time for the next game, and that was my clue that my football days were finally over once and for all. (I had played intramural flag football when I was in college and once in a great while we'd put some games together in the park when I'd worked at Delcon).

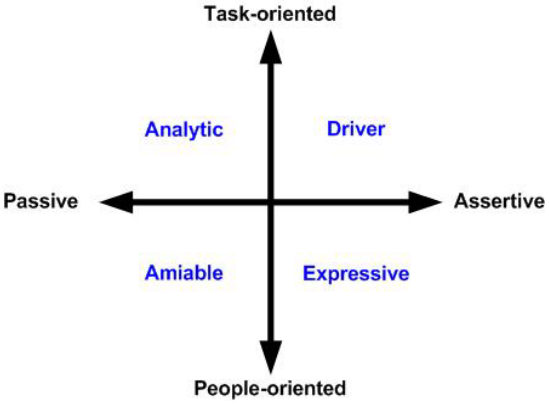
Dick Hackborn, the division manager, always held Friday 'coffee talks' that lasted about a half hour or so and at which he and the other higher-level managers shared information with all the division's employees. Work would stop during coffee talk and people would cram into wherever it was being held to hear about what was going on. For my first couple of years at DMD, if anyone had turned thirty during that week they would hold a kind of mock ceremony where that person would be awarded 'Ye Olde Stick of Thirty,' which was invariably a walking cane to help the 'elderly' person hobble about the workplace.

For many years DMD also held frequent Friday 'beer busts' every time we had anything to celebrate or even whenever the division management team thought it had been too long since the last celebration. There were actually three beer busts held any time we had one, one for each of the three shifts of workers, and the division manager or one of the functional managers – lab manager, manufacturing manager, admin manager, marketing manager – would show up for each one of them. Beer busts involved plenty of kegs of beer, wine coolers for those that preferred them to beer, and grilled hamburgers and hotdogs. Especially for the first few years, these tended to get to be pretty wild parties in their own right, and when the company's beer finally ran out, there were usually two or three dozen of us or more who would move the party to downtown Boise and continue it into the wee hours of Saturday morning with dancing and whatever else came into our heads. There was no rank during a beer bust. One time a bunch of us threw the general manager into the man-made lake that had been built on the HP campus. Another time the manufacturing manager and I got into a kind of slam-dancing contest in a downtown Boise nightclub where the party had been moved; every time we and our dance partners came within arm's reach as we were dancing, *yahoo!* he and I would throw elbows at each other. Hard. Just for fun. I'm pretty sure he had as many black and blue bruises to show for it that weekend as I did, but it was a blast.

For those Fridays where no beer bust or big private party was planned, many of the lab section managers would throw parties at their houses after work. By comparison with some of the other section managers, Rich's parties tended to be pretty tame, but some of the other managers threw parties that could have come straight out of Hollywood. Most of DMD's managers had moved to Boise from the Bay Area and had made so much money when they sold their houses down there that their Boise houses tended to be palaces, complete with pools and hot tubs. No movie star ever had more fun than we did.

So, especially for the first two and a half years I lived in Boise, DMD was more like a way of life than a place of employment. About the best way I can describe the period from 1979 to mid-1981 is: We weren't a company; we were a tribe. I've never seen any other place I could remotely begin to compare to it. For me that first year at DMD would have been paradise on earth if the Jumbo project had been going well. Unfortunately, it did not go well at all. □

I want to make something clear right up front. No nicer man than Rich Smith ever drew a breath. To this day I consider him a friend and there aren't too many things I wouldn't do for him if it were within my power to do so. But one of the things I wouldn't do is work for him again. When it came to the job of new product development, Rich and I turned out to have irreconcilable differences.



Dimensions of interpersonal styles

At root the underlying reason for the difficulties Rich and I had with each other was a pronounced difference in our two styles of interpersonal relationships in the work-place and our joint failure to recognize that each of us was creating problems for the other as a result of this difference. Just a couple of years later the company began holding a management training course, called 'Managing Interpersonal Relations,' that talked about this, but in 1979 I knew nothing about personality theory and I doubt if Rich knew any more about it than I did. But the main idea is that how other people perceive you in their interactions with you, and how you behave so as to leave them with this perception, can be modeled using two dimensions of behavior. The model is illustrated in the figure shown above. Today psychology has made some refinements to this model – the more recent version is called a 'circumplex model' – but the basic factors are the degree to which one's behavior is assertive vs. passive and task-oriented vs. people oriented. These two factors are used to define four interpersonal relation types called Drivers, Analytics, Amiables, and Expressives. For example, the stereotypical 'used car salesman' personality type is a person who is highly assertive (think of high-pressure sales pitches) and highly people-oriented. This type is called an 'Expressive.' Diagonal personality types on this graph are called 'poison relationships' because the two styles are opposites of one another and so two people with such opposite styles have the most difficulty understanding where each other is coming from. HP introduced their training course to teach managers and project leaders how to recognize other peoples' interpersonal styles and to adapt their own style to the person with whom they were dealing.

There is no 'good-bad' that attaches to any of the four styles. Nor is a person's style in the workplace necessarily the same as it is in other settings. In my early years at DMD a lot of my new friends made remarks from time to time that I was two different people, Rick-at-work and Rick-off-duty, and they were right. I've mentioned before the tendency for my family on Dad's side, and me as well, to take things pretty seriously, especially when it comes to work and getting the job done. This is the 'task-oriented' side of the vertical axis on the graph. One of the results of the relationship between Dad and myself going all the way back to the time when he sent me out to sell lawn mowers is that I grew up developing a lot of independence and drive in going after what I wanted. This is the 'assertive' side of the other axis. Put them together and they come up 'Driver' on the interpersonal style graph so far as my workplace behavior goes. It was, of course, a different thing when it came to our after-work parties where the 'task' was just to have fun with my friends.

Rich, on the other hand, was an 'Amiable.' Amiables tend to regard preserving their relationship with other people to be of paramount importance and they tend to give hints rather than come right out and say what they're thinking. A 'Driver' or an 'Analytic,' on the other hand, tends to say what he thinks pretty bluntly and expects other people to do the same. One of my favorite Erhard stories happened one day when he and I were talking about his project plan for the HP 4943. There were a number of minor points in his plan I thought could be improved and I was cheerfully, if rather assertively, nitpicking him on these points. Finally even Erhard's near-inexhaustible patience wore a bit thin and he said to me, "Look, Rick, when you're in charge we'll screw it up your way. Until then we screw it up my way." When he said that I broke out in a big, delighted grin and said, "Fair enough, Chief." We did things his way and as it turned out his plan worked just fine. With Rich, on the other hand, I very rarely could figure out what he was trying to get at and usually didn't understand what he was saying at all. To me it almost always seemed like we were having two entirely different conversations. On the flip side, I'm pretty sure he must have found my blunt, outspoken way of talking awfully upsetting. I thought of it as candor; I'm sure he must have thought of it as something else.

We had a 'new' guy in our group, an ex-IBMer named Ted who was several years older than me and working with me on the Jumbo controller design. Ted was every inch the same 'Driver' personality style I was. There were a thousand details regarding various technical decisions about the controller design, and Ted and I loved to argue about them. One of us would throw out an idea, the other would disagree with it, and we'd go back and forth until we ironed out our differences and came up with an idea that was better than the ones either one of us had started with. Our arguments tended to get pretty loud and noisy and were sometimes laced with remarks like, "Look, blockhead, don't you see *this* would cause *that* problem?" Ted and I were having great fun, but I can see how it might have seemed to other people overhearing us that Ted and I were deadly enemies. Rich, who was scandalized by the way we talked to each other, was certain of it. Remember, an 'Amiable' wants to preserve people relationships above all else. A 'Driver' wants to get results and get the job done. And doesn't particularly like to be told what to do. Amiables hint; Drivers tell. I don't know if Rich ever talked to Ted about how we behaved with each other, but he regularly chewed my hind end out about it and he flatly refused to believe me when I'd tell him Ted and I got along great. Afterwards I'd ask Ted if he felt like we were getting along okay, and he'd just give me an incredulous look and say, "Sure. Don't *you* think so?" So then I'd get ticked off at Rich for chewing me out over nothing. I don't think it ever occurred to Rich how much he was getting on my nerves; I know it never occurred to me how much I was getting on his.

Still, none of this might have mattered – or at least might not have built up into a big problem between Rich and myself – if the Jumbo project itself had been making progress. But it wasn't. As I saw it the only progress we were making was backwards. In Cupertino the team had come up with a working breadboard prototype. At DMD, with all the new people coming on to the project, it was to be expected there would be a steep learning curve as everybody was figuring out what a Jumbo was and so it was to be expected that the transition from breadboard to lab prototype would be slower than usual. Unfortunately, some time prior to the project's transfer to Boise the local DMD management had decided to change one of the project's most basic technical specifications, namely how much data was to be stored on Jumbo's tape cartridges. Our design, which matched what IBM had done with the IBM 3850 system, stored fifty megabytes (fifty million bytes) of data on one tape cartridge. The basic Jumbo transport held sixteen of these cartridges, giving it a storage capacity of eight hundred megabytes. DMD's largest disk drive at that time stored one hundred twenty-five megabytes, and the largest of the new disk drives under development right then stored four hundred megabytes. Our Jumbo system also had an additional library storage element – we called it 'the can' – that held three hundred and eighty tape cartridges, each capable of being mounted on a Jumbo tape transport automatically using a bit of clever robotics. That took our tape library system up to an online backup capacity of nineteen *billion* bytes – far more than the total storage needs of any HP computer system either then or for the next decade.

However, somebody at DMD – who exactly I don't know – argued that this storage capacity wasn't enough. One basic Jumbo wouldn't have enough capacity to back up 'the Giant Fixed Disk' or GFD. The GFD was a disk drive in the early 'where do we go from here?' planning stages and was planned to hold one billion bytes of data. It turned out later that DMD never did start the GFD project and, in fact, nearly a decade more would go by before we produced such a high-capacity disk drive. GFD was science fiction. But, nevertheless, it was decided a Jumbo would have to store one hundred megabytes on each cartridge – twice its designed capacity – to be a 'viable' product. For a great many technical reasons, this decision meant that practically everything else about Jumbo's design had to undergo very major and very, very technically difficult changes.

I don't know if the DMD folks who decided on this change ever discussed it with Jim Hood or not. I know they never discussed it with the Cupertino design team. We would have argued strongly against it if anyone had discussed it with us because it made the project impractical with the state of the art technology we had available in 1979. But, instead, we were just told of the decision very shortly before the transfer to Boise happened. I never knew if Rich's amiable nature just made him go along with this decision or if he just never realized how impractical the challenges it caused were. What I did know was

that in Cupertino we'd built a working breadboard. In Boise we had nothing and were having to start all over again practically from scratch and with a design team in which no member had ever designed anything remotely like what we were now being called upon to develop. With our young engineering team the original Jumbo specifications would have been hard enough to develop; with the new ones it turned out to be impossible to do at that time. DMD's decision was a terrible blunder.

As a month, and then two, and then six went by with no visible signs of progress being made I became more and more frustrated. Not the least of my frustration came to center on Rich because, with his amiable and no-pressure style of running the section, it looked to me like nobody else cared about our total lack of progress. I began wondering if DMD even cared whether this product ever came out or not. That bothered me a lot because I believed in the importance of this project; I wouldn't have joined Jim's team in the first place if I hadn't been convinced of the product's merits. I'm sure this impression of mine was over-exaggerated; no engineer and no manager ever really doesn't care whether or not what he or she is doing is successful. But since I couldn't see Rich doing anything to push us out of the rut and get the project back on track, I think the erosion of my morale was understandable. □

In an R&D lab as big as ours that has multiple projects going on, there is never any shortage of critical problems in need of people to solve them. As Jumbo continued to languish there was another project, a disk drive product called the HP 7910, that was up to its eyeballs in all kinds of technical problems. Disk drives were DMD's bread and butter, and when a project like this one needs help R&D management always looks around to see if they have people working on less important things who can be pulled off and employed to work on more important things. Nothing is less important in a lab than a project that is making no visible progress, and our section was a natural place to look for people to lend a hand. So when the call came for Jumbo to provide somebody to help out on one of these problems, Rich had just the guy for them – his favorite troublemaker, me. It was the first decision he had made in months that I went along with wholeheartedly. I was sick to death of Jumbo by then, could clearly see the project was doomed to be canceled, and I jumped at the chance to do something useful again.

The particular job I was reassigned to was an assembly line tool used by production called a 'servo writer.' Disk drives record special information on the disks that the disk drive control system uses to align its mechanics in order to be able to organize, store, and retrieve your data. This information is called 'servo code' and it plays a functional role not altogether different from the grooves on an old-style phonograph record. But disks do not come with this code already in them; it must be put there and that is what a servo writer does. In many ways a servo writer is kind of like a very specialized robot and you can't build a modern disk drive – or even a vintage 1979 disk drive – without one.

Production had a servo writer but it had been designed while the 7910 project had still been in California – prior to DMD being set up – and the original designer had stayed behind in California. (I met him a number of years later; he was a pretty good guy and the servo writer had been taken away from him and sent to Boise before he'd had a chance to really finish it). Production was having a lot of problems, both with the existing servo writer itself and with other production problems they had come to blame on the servo writer – many of which were not actually problems with that tool. In a nutshell, production was demanding a new servo writer tool.

I was teamed up with a relatively new twenty-three year old engineer, who was just a year out of college, named Vern Knowles. I had known him slightly during Jumbo, but the servo writer project was the first chance I had to actually get to know him. It turned out that Vern and I, over the next couple of years, became very close friends. He is smart, technically top-notch as an engineer, an exceptionally good craftsman, exceptionally dedicated, and he tops it off by being one of the finest, most honest, most honorable men it has ever been my privilege to know. I didn't know it when we first started working together, but Vern would become one of the very few of those closest friends I call my brother in everything but blood. He is the brother I mentioned earlier in these memoirs.

Vern and I split the workload between us. I designed the microcomputer and the firmware for the new

servo writer – a capability the old one didn't have – and Vern designed everything else. We made a great team and in less than a week I went from feeling frustrated and angry about Jumbo to having a great deal of fun working with him on our new assignment. Vern had been working on this problem before I was assigned to it and already had a pretty thorough technical idea of how it should be designed. I was immediately impressed with his abilities. This didn't keep me from teasing him a little bit from time to time. Vern takes his job pretty seriously too, but I found there was a lot of good humor and laughter in him always ready at the surface. Plus, of course, there is a bit of Grandpa Teters in me. And, as it turns out, Vern could give back just as good as he got from me. We were playing golf together one evening at the Eagle Hills golf course when two huge, separate swarms of mosquitoes decided we were just the thing to have for supper. As we were headed back to the clubhouse, Vern suddenly cut in front of me on the run and deposited his whole buzzing swarm on me. He ran back to the clubhouse laughing and unmolested by mosquitoes with me and my now gigantic swarm in hot pursuit right behind him.

It was just the sort of thing I wished I'd thought of first.

Officially Rich was still my boss but in fact he pretty much ignored what we were doing. Except for one thing. I'd known while I was still in Cupertino that DMD was going to throw out HP's MC5 micro-processor first thing, so I'd prepared on the side an alternate microcomputer design using the M6800. The DMD lab had also already decided to go with the Z80 part, as I mentioned earlier, but I had still hoped that since Jumbo wasn't a disk drive I might be able to get them to go along with how I wanted to do the controller. This turned out to be naive, as I found when John Stedman, the lab manager, called me to his office for a little chat one afternoon.

I'd gotten to know John a bit while I was still in Cupertino. Because all our equipment was going to end up going to Boise, Marco had decreed that all capital equipment costs be cleared through John. One of the big ticket capital items was an HP minicomputer system to support the controller firmware development. I'd gotten permission from Jim to order one and, in due course, the purchase order came to John for his approval. The cost of this equipment was around forty thousand dollars.

Now, one thing I didn't know was that John had figured out he could buy HP computers for a lot less money by ordering their parts and simply putting them together ourselves. He'd instituted doing this up in Boise already, but I didn't know about it. One day when he was down in Cupertino for a visit, he sat down with me to talk about my purchase order. He wanted me to buy my computer using this same trick. I understood what he was suggesting – John made suggestions rather than gave orders; a smart person soon learned to listen to his suggestions, too, because there was a lot of good thinking that went into them – but I wasn't eager to follow this suggestion. It meant a lot more work for me at a time when I was already pretty busy. But I wasn't having any luck talking him out of it. All the while I was sitting there wondering to myself, 'Why is he insisting on this?'

Suddenly it hit me. "John," I said, "this is *Marco's* money." John's eyebrows went up a tiny fraction and he suddenly broke out in a grin. "Oh!" he said and he immediately signed my purchase order. In that single instant I knew John and I were going to get along great. He had the same pragmatic attitude about things as I did.

So the day John asked to see me in his office to talk about 'the microprocessor issue' I wasn't worried. He listened patiently while I went through the same technical arguments that hadn't worked with Paul Ely. After I was done talking, he patiently went through all the management, cost, and development time business issues in favor of using only one common microprocessor design throughout *all* of DMD's products. What it came down to in the end was an unknown: Was it really, really true the Z80 *couldn't* be made to work in Jumbo? That's the kind of question you can't really answer with 100% certainty before you build one so what it boiled down to was a question of making decisions in the absence of complete and certain information you'd like to have in making the decision. In the economics of management it's called 'decision making with risk' and it's what people in John's position get paid to do. I really appreciated the fact that he'd taken the time to *talk* with me about it instead of just telling me how it was

going to be (the way Paul Ely had). I also understood the fact that at the end of the day it was John, not me, who would be the guy held accountable for the overall success of running his lab. I thought I was right on a technical level, but I didn't know for a stone cold fact I was right and one thing was for sure: If we didn't try to make the 'common controller' strategy work we would fail to achieve the larger objectives John had for the lab. Under HP's system of management by objectives, this was one of those cases where my job was to help meet the bigger objectives. I agreed I'd get with the program and that was that. I felt like John and I reached the decision *together*. I had no hard feelings and I think John respected me for being a team player instead of a prima donna.

But the servo writer was a different story altogether. It didn't have anything to do with on-going or future new product developments. It was a one-of-a-kind production tool and the objective was to get it working and out on the production line as fast as possible. And I had a finished hardware design already in my pocket and ready to go. All it needed was firmware. I decided to go with it for the servo writer.

Rich had a conniption when he heard about it and called me into his office for another hind end chewing. What was the matter with me? Why was I insubordinately flouting the lab strategy? I was going to climb down from my big ego and comply with the Z80 common controller decision.

I came pretty close to losing my temper – which if I had really would have been insubordination, something that in any company gets you fired pretty fast. I doubt if I was able to hide how I felt about this meeting. "Look, Rich," I replied, "I don't see why you care about this. It's just a five dollar part and there's only going to be one of these *ever* built. It's just a production tool. I've got a design ready to go and all the tools needed to do it. If we do it your way the design starts all over again and we need to buy new tools we don't have right now to do the job. Do you want me to get this job done as fast as possible or do you want me to screw around with it for an extra month or two more than it ought to take when we're ready to go *right now.* Tell me which you want and I'll do it."

I was almost certainly more confrontational about this than I needed to be or usually would have been, but that had more to do with all the previous frustrations than about this one disagreement. Rich and I had been building up to this for quite awhile now. I know Rich didn't like my tone, but he was too good an engineer not to be able to see I was right about this and that it really *didn't* have anything to do with the lab strategy. Plus, troublemaker though I might be in his eyes, I was still one of his people and I think he sensed how close I was getting emotionally to telling DMD and HP where to shove it. So he put his own feelings in his pocket and told me to go ahead with what I was doing. He didn't forget about the incident, but he did leave me alone to do my job after that. And at that point in our relationship, that was about the best either of us could hope for.

And so Vern and I happily went ahead and designed a new servo writer for production. Toward the end production asked for some auto-diagnostic features to be added to it so a third guy, a software writer named Phil, joined us to do that part of it. We did the job in a pretty short amount of time compared to how long this kind of work usually takes and got it installed and running down in production in the autumn of 1979. We finished the job just a short time before the Iranians stormed the American Embassy in Tehran and seized fifty-two Americans as hostages. □

When I first arrived in Boise there were two divisions located on the large HP site: DMD and the Boise Division, which manufactured the company's line of computer printers. The two divisions were housed in two large two-floor buildings, Building 81 (Boise Division) and Building 82 (DMD). DMD was growing so fast that we were literally crammed knee to knee on the upper floor of Building 82. As soon as the winter weather cleared work began on the construction of a third large building, Building 83. DMD would expand into that building as soon as it was ready to occupy. The division's incredible growth rate fueled plans to rapidly expand the company's line of disk drive offerings and there were a number of high-demand new products just waiting for development teams to come work on them. As a consequence, while Vern and I were finishing up the servo writer the inevitable finally happened. The Jumbo project was cancelled and our section was broken up to provide engineers to work on these new products.

Vern and I ended up being assigned to two different projects. He would be going to work on HP's first five-and-a-quarter-inch disk drive, while I would be going to our first eight-inch disk drive project. Both these projects 'belonged' to the same section manager, an interesting and ambitious guy named Ken Jochim. My new project manager was a energetic HP veteran in his thirties named Chet Haibel, who reported to Ken. My friend Bob Frohwerk was assigned to a related project, a more traditional tape cartridge product that would 'plug in' to a box that integrated a disk drive with this tape drive to produce what was known at the time as an 'integrated storage solution.' Only one other guy from Jumbo ended up on the same project as me, a good, solid engineer named Craig Walker who was fairly new to HP but had a lot of design experience from working at the Naval Weapons Lab in China Lake. Craig had been one of the designers of the Sidewinder missile.

Rich ended up moving over to the Boise Division since he no longer had a section to manage inside DMD. He and I never worked together on any projects after that, but we'd bump into each other in the hallways from time to time. Once our 'poison' boss-subordinate relationship ended, I was able to remember Rich's warm and very human qualities without the stress of the project getting in the way. I had liked him a lot when I first moved to Boise and once we no longer had any reason to clash over things I could like him again. I wasn't unaware that half the problems we'd had with each other were my doing. But really none of them had been personal. We just didn't see eye to eye on how to do projects and that's not something to hold a grudge about. Over time we repaired our friendship and forgot about the past.

Chet and I were pretty opposite in a lot of ways but our differences complemented each other. His personality style was 'Expressive,' which is a style I've always found very easy to work with because I never needed a secret decoder ring to figure out what was being said to me. Chet would give it to me straight and I could be equally forthright in talking to him. His mind was an boiling geyser of new ideas, a lot of which weren't too practical but a fair number of which were nothing short of brilliant. Chet was a much more fertile idea man than I ever was. The problem was that he wasn't so strong on dealing with the myriad details that have to be worked out to bring an idea to life. But that was always *my* strength. I could take one of Chet's ideas and plow through all the nits and grits that had to be solved to make it work. The two of us put together made an incredible team and I loved working for him.

He started visiting the old Jumbo section to meet and get to know me practically the minute he found out I'd be on his project – maybe even a little bit before he was supposed to. I was a little wary of him at first and, given what had been going on between Rich and me, he was a little bit wary of me. But he never seemed to look at me as a potential problem; he looked at me as a challenge for his leadership to overcome. And he did that in a fairly unorthodox way by challenging me to sporting contests after work.

Like me, Chet is very competitive. One of his favorite recreation activities when he'd lived in California was hang gliding. I'm not exactly unadventurous, but that was too much adventure even for me. I'd been a bit wary of heights ever since that day Lyle and I had tried to climb down that bluff outside Maquoketa. Fortunately for me, his first challenge was the exact opposite of extreme sports: bowling. I'd mentioned to Chet that I'd done some bowling in college. I failed to mention that I'd competed in intra-mural bowling and I was probably the best bowler in the frat house. Dad had taught me how to bowl and when I'd had that paper route that went out past the bowling alleys in Maquoketa I'd often stop off at the Hi Ho on the way home and bowl a few games. So as soon as I mentioned that I was a bowler he challenged me to a match. Chet wasn't a bad bowler either. But he wasn't a '200' bowler and at that time I was. I rolled three '200' games in a row, each game scoring higher than the one before. If I remember correctly, my last game was something like a 260, which turns out to be the best game I ever rolled. Chet hates to lose, but he took it like the good sport he is and I started liking him.

A new racquetball court had recently opened in Boise and Chet asked me if I'd ever played. I admitted that I had, which I think surprised him a little. I'd started putting on a little more weight, probably from the stress I'd been feeling over Jumbo and from the problems Rich and I had been having with each other. Quite frankly, I didn't look like a racquetball player. But then a lot of people over the years had been

surprised to find out I had some athletic ability; I was a kind of 'stealth athlete.' I also somehow forgot to mention to Chet that I'd played racquetball on my noon hours practically every day for the last two years I was at Delcon. I'd often played Del, who was a terrific athlete and a considerably better racquetball player than I was. I'd become a better player from playing against him just for the sheer purpose of lessening the degree of embarrassment attending the shellacking I'd regularly receive at Del's hands. When it came to racquetball, Chet wasn't Del and I'd beat him fairly regularly. Again, he hated to lose but he was a terrific sportsman and before too long he'd won my respect and I think I won his. I really think that if you want to learn something about another man's character there's no better way to do it than through athletics. I was just glad he never challenged me to hang gliding. By the time our project was rolling, Chet was my pal as well as my boss.

One thing Chet did just as our project started really earned my gratitude. One of the standard procedures at HP at that time said that when a person got a new boss his old boss had the option of writing up a performance evaluation. HP's performance evaluation had a number of different evaluation categories and each one was scored as either unsatisfactory, needs improvement, good, very good, and excellent. (This scoring system was changed later, but this was the one they had in 1979). Rich chose to write up an evaluation on me. It was time for the chickens to come home to roost.

Up until that time I'd always received extremely good evaluations from my supervisors. This was something Chet would have known because he'd have seen it in my personnel file. Not too surprisingly, Rich's evaluation of me was a lot worse. He filled it out and then gave it to Chet because the rules said I had a right to see it and to set down any disagreements I might have with it. Given the chance, I'd have had a lot of disagreements with that one. But I never had the chance to respond to it. Chet showed it to me but before I had time to get mad he said, "You know, this just isn't right. This isn't you." He tore it up, wrote his own evaluation of me, turned it in, and saved me from having a big blot on my record. The kind of blot that would have ended up costing me a lot of money. From that second on, there was no way I was ever going to let Chet down. He could have told me to run through a brick wall and I would have. □

I met so many new friends during '79 and '80 that trying to name them all in these memoirs would be impossible. It would be a list to outdo the recitals of the generations in Genesis. But in any vote for the most colorful person I met during those years, first place would have to go to my friend Chic Slutz. Chic is a warm, big-hearted Texan who came to work as a production engineer working on the HP 7910, which was the disk drive product for which Vern and I were doing the servo writer. If you've never had the pleasure and experience of knowing a native of the Lone Star State, all I can say is you're missing something worth having. Chic is a living, breathing example of all the best – and some of the more exotic – qualities that I've come to expect of a Texan: honesty, integrity, loyalty to his friends, a love of life, trustworthiness, a taste for adventure, and a willingness to take life as it comes and bend it to his ways. Plus, of course, the rather unique dialect of a true Texan. It took me a little while to catch on to some of his words and phrases: 'fahr' for 'fire'; 'you did that like a frog walks' for something done clumsily or ineptly; 'turkey lips' for something that doesn't really fit or isn't quite right; and many, many other examples.

I liked Chic the first time I met him, which doesn't happen a lot with me. He, Vern, and I became chums almost right away and, if I remember correctly, within about a month of the time when I first met him we put together a weekly poker game that ran once a week like clockwork through almost all of the 1980s. The game is still going on today, although as we've all gotten older the frequency has dropped to once a month. When Chic bought his first house he spent an enormous part of his summer nights and weekends putting in a sprinkler system for the yard. Chic likes to work with his hands and I've lost track of the number of clever gadgets I've seen him think up over the years.

One Friday during the great sprinkler installation, I was sitting at my desk when Chic seemed to materialize out of thin air right beside me. "Whatcha'll doin' tomorrow?" he asked with a big, bright smile on his face. I don't remember what I'd been planning to do, but whatever it was I told him.

"Wrong!" he said with an even bigger grin. Vern and I ended up spending that Saturday helping him finish installing his sprinkler system. Once it was in, Chic began holding an Annual Texas Barbeque in his back yard each summer for the next several years. Chic's barbeques weren't ordinary barbeques, either. They featured endless amounts of mouth-watering food, cooked up Texas style, and oceans of drinks. They were always one of the most popular events of the year. I don't know how many dozens of people would attend these, but there have been conventions of Idaho State Democrats that weren't as well attended. I wouldn't have missed one of them for anything.

Chic quite literally married the girl next door. Patricia is a marvelous woman who lived in the house next door to Chick and worked for the Boise Cascade Company. I doubt if there's anything about trees and other plants she doesn't know. One day before Chic and Patricia got married, Chic materialized beside me again and told me I was helping plant trees in Patricia's back yard that Saturday. Vern was again involved and we spent an enjoyable day lugging trees around and helping set them up under Patricia's expert directions. She appreciated the help and not too long afterward, when I finally got around to having some landscaping done in my own yard, Patricia did the landscape design for me and helped me with the details of working with the nursery and picking out trees and bushes. And she did a fantastic job. Me? I know nothing about this sort of thing. I can usually tell the difference between trees and bushes, but that's about the extent of my knowledge of botany. Today Chic, Patricia, and their kids live on a small ranch several miles outside Boise. It's a little piece of Texas transplanted to the Inland Northwest.

My friend Candy Charity. This picture was taken at a company picnic in the early 1980s.

Another friend I met in 1979 was Candy Charity. Like me, Candy is an Iowa State alum and, in fact, we were contemporaries there although we did not meet until she was hired and moved to Boise after getting her engineering degree. It didn't take too long for us to become friends, although I'm almost always a little slow to cozy up to new people and this was the case with our friendship. Candy is pretty close to my own age and one of the first things I noticed about her was that she is a very intelligent person – which is only to be expected from an Iowa State engineering graduate. But as I got to know her better I found out she was also very level headed, a lot of fun to be with, and has a marvelous sense of adventure I liked very much. She also has a lot of courage and in those early years, as one of only a handful of women engineers working at HP, she wasn't afraid at all to stand her ground against the men. She has fine leadership qualities and a free-spiritedness I greatly admired. I number more than a few women among my friends, but as I got to know Candy better and better I slowly came to discover, to my amazement, that she was different somehow. It took me kind of a long time, too long as it turned out, to figure out how I felt about her because I'd never been in love before. I'm not very smart about that sort of thing. But eventually I realized what it was I was feeling and that she was the first woman I'd ever met who I wanted to marry. Unfortunately for me, I'm not very good at the courting game and by the time I'd actually sorted out my own feelings it was too late. Another good friend of mine, Keith Whitaker, also fell in love with Candy and before I had a chance to show her how I felt they got engaged. I don't really agree with the old bromide 'it's better to have loved and lost than never to have loved at all,' and I felt pretty bad about it for myself. But Keith and Candy were and are my very good friends and if it was fate for Candy to marry someone else, I'm glad it was Keith. I've always wished them the very best of happiness.

I've only fallen in love one other time and that was several years later. I don't really like to talk about this so all I'm going to say here is that one didn't work out either. But she was and still is my friend. □

When the revolution in Iran toppled the Shah and his government in the first few months of 1979 I

didn't have any particularly strong feelings about it. I didn't particularly like the Shah. I thought the few things he was doing to bring Iran into the modern age were fine, but on the other hand he was a dictator and a despot who ruled his country by force and terror. Although he had been an ally of our country, I didn't see any particular reason why competent diplomacy shouldn't succeed in keeping Iran as an ally without having to put up the tyrant. I was concerned about the radical fundamentalists, led by Ayatollah Khomeini, and became even more uneasy after Khomeini's fanatics emerged as the dominant force in Iran and set up the theocracy that actually rules the country. Still, for the next six months it didn't seem to me that what was going on in Iran was any of our business. Liberty means you should live *and* let live.

Then in late October President Carter allowed the deposed Shah to enter the United States to receive medical treatment for cancer. Probably like most people, I figured the Iranians wouldn't like that too much, but I didn't have any appreciation for how much they'd dislike it. On November 4th, 1979, a mob of revolutionary militants stormed our embassy in Iran and the hostage crisis began. During the first week or so the situation appeared to be just a bunch of crazies, but then Khomeini gave them his backing and, just like that, it was no longer just crazies but the Iranian government itself that was holding our people. My reaction was pretty much the same as everyone else's: I was outraged. On November 14th President Carter froze Iranian assets in the U.S. I guess the idea was to force Khomeini's government to bargain for the release of the hostages and to obey the unanimous U.N. resolution calling for the immediate release of our people. But the religious extremists in Iran weren't having any of that. They wanted the Shah, they wanted the Shah's wealth returned to Iran, they wanted a U.S. apology for ever supporting the Shah, and they wanted a U.S. promise to keep our noses out of Iran's internal affairs.

Although I had thought President Carter's decision to let the Shah into the U.S. was a case of preacher impulses overcoming good judgment, I didn't blame him for causing the crisis. Who in America would have guessed at that time just how little regard Khomeini's fundamentalist thugs were going to have for the customs and rules by which civilized nations coexist? I did think President Carter was inept at dealing with the crisis during most of the course of the next four hundred and forty-four days, and never more so than the pathetic and badly bungled rescue attempt he tried in April of 1980. Too little force applied too long after it should have been was how I looked at it. The bungled attempt looked especially amateurish contrasted with Israel's commando raid rescue of its hostages in Uganda. I looked at what Iran had done as an act of war against our country, and if Congress had seen it the same way, it would have been a war I wouldn't have had any moral dilemma about so long as we waged it to *win* it and didn't screw around with it like President Johnson had done in Vietnam.

In December of '79 the Russians invaded Afghanistan to restore their puppet government. There was a lot of talk at the time about this could be the start of a Russian move against Pakistan and India or a move to invade the Middle East to capture the oil fields, but I didn't think either scenario was the least bit likely. The Russians would risk all-out nuclear war to take over Pakistan? The very idea was ridiculous. The only thing more ridiculous was President Carter responding to it by declaring the U.S. would boycott the 1980 Olympic Games in Moscow. The Olympics, I felt then and I feel now, are something special, outside of politics altogether, and ought never to be abused, especially for a cheap publicity stunt. Maybe the administration thought they looked tough; I thought they looked stupid. What was Afghanistan to us? I continued to back Governor Reagan's presidential campaign. □

My new project was given the code name 'Peso' – supposedly because one Mexican peso exchanged for about eight cents at that time and the HP 7908, our product's official designation, would be DMD's first eight inch diameter disk drive. As it happened, the team had wanted a different code name, so when we got pegged with the Peso name, everybody just called our project 'the '08.' There were two other major projects already in progress when we started, a fourteen inch 'Winchester technology' disk drive family called the HP 7911/12 family and an old-technology fourteen inch disk drive, namely the BFD. By the time the '08 project started the BFD was no longer a 'fixed' disk drive, the decision having been made to use a removable disk pack. The BFD acronym had stood for 'big fixed disk' and so was no longer really accurate, but no one changed it. Although the '08 had started well behind the others we were

hoping to short cut the development cycle and leap frog the other two into production by using a disk mechanism purchased from another company. That way we would only have to develop the electronics and not the entire thing.

Vern's new project, a five and a quarter inch disk drive code named 'Nickel,' was a start-from-scratch project that wasn't planned for introduction until a couple of years after the '08, '11/12, and the BFD hit the marketplace. In addition to these direct projects there was also a special group, called the Controller Group, responsible for developing the common controller hardware and firmware for all three products. It was run by a pair of young project managers, Steve Lieske and Roger Buckthal, who managed the hardware and firmware teams, respectively. They reported directly to Ken but had a dotted-line report to the section manager for the BFD, a guy named Bob Passmore. DMD was trying out its first experience with what in manager-speak is called 'matrix management.' This overall organizational arrangement took me out of the microcontroller game once and for all, and I wasn't sorry about that in the least. I was tired of microprocessor politics and by this time I had all the experience with them I needed for my purposes.

All these projects except BFD were in Ken's section. I had found Jumbo stressful because of its total lack of progress. The '08, '11/12, and BFD projects were just plain stressful with sauerkraut on top. The work in Ken's section would have been extra-stressful just because of the fact that everybody was new to their jobs, except for a few 'old timers' like me, and the majority of the section was so newly graduated that the ink wasn't dry on their diplomas yet. The patient mentors who had brought me along at Delcon didn't exist at DMD. I mentioned earlier that high growth rates like DMD was going through are very, very tough to manage. The absence of experienced mentors is one big reason why. Then, as if the natural conditions weren't conducive enough to high stress, Ken notched it up even higher by posting signs all over the lab when we moved to the new building, Building 83, that read '$8 a second.' That was what it was supposed to be costing the company every second our projects weren't in production. You can probably begin to see why we partied so hard every weekend in 1980. This kind of work environment wasn't found anywhere else in HP. It was unique to DMD.

A lot of the young folks in our section were leery of Ken. His interpersonal style, like mine, was a 'Driver' style although in comparison with me his management of interpersonal relations was statesman-like. As it is with pretty much all Drivers, it was always fairly clear that results were what counted with Ken. Being a Driver myself, I understood his style, knew the rules he played by, and as a result I was always comfortable with Ken. He always seemed to me to be like kind of big Cheshire Tiger. 'Work hard, play hard' was definitely his philosophy and he would throw these Friday-after-work section parties at his house up in the Boise foothills. He had a pool and a hot tub and there was always plenty of beer, pretty close to no rules, and no rank at his parties. The first time I went to one of these I made the mistake of going straight there from work and showed up still wearing my tie and sport jacket. The second I stepped into Ken's back yard my coworkers pounced on me and threw me, tie, jacket, and all, straight into Ken's swimming pool. Although I normally go swimming in considerably less formal attire, it was all in fun and I didn't mind the dunking. Work hard, play hard. I didn't wear my tie or jacket to any more of Ken's parties, though. One time one of the guys arrived at Ken's bare-chested and wearing goat leggings.

Unlike Rich, Ken knew how to handle me. Our conversations were always plain-spoken and not too infrequently even pretty blunt. But the fact that they were always about getting results took the edge off. If he criticized me, he always did it in that context and in private so I never took it personally, the way I did with a lot of things Rich had said to me. It turned out that Ken had had his eye on me since before I ever moved to Boise. Chet told me one time when we were relaxing at the end of the work day that he'd been concerned about having me assigned to his project but Ken had told him I was a good guy and the only problem was Rich didn't know how to manage me. All he'd need to do was point and unleash me.

Ken had recognized how competitive I was, and not long after I joined his section he challenged me to a racquetball match. It was sort of the adult version of what the boys on the playground did back when I was a kid, or what Duane and I had once done in the men's locker room at the Hi Ho. Ken wasn't a bad

racquetball player either, and he was every bit as competitive as me. We played a hard-fought match but I was younger and able to edge him out and win it, whereupon he stripped off his sweat-soaked Tee shirt and gave it to me as a trophy. I still have it. Between Ken and Chet I was working for *leaders* again and in that stress-filled setting that made all the difference to me.

The ’08 was the smallest of the project teams in Ken’s section. Roughly speaking, a disk drive consists of the following subsystems: Head-disk assembly, also called the HDA but more often just called ‘the mechanism’; servo system, which sees to the control of the proper positioning of the drive’s magnetic recording heads relative to the stored data; read-write system, which actually writes data to the disks and reads it back; disk controller, which I described earlier; and power supply, which converts the power coming out of the wall socket into the voltages needed by everything else in the disk drive. Our disk controller design was being done by the Controller Group so the ’08 team didn’t have to do that part of the design. The mechanism we were buying as a component so the only other mechanical design needed was the outside packaging for the product. A newly arrived young mechanical engineer named Terrill Hurst took care of that. Chet had two experienced engineers on his staff, Craig Walker and myself. Craig was given the servo system and Chet handed me the power supply. The read-write was given to a new graduate named Larry Copp; later another new graduate, Lisa Hecht, came aboard to also work on the read-write. The thinking here was that read-write would be the easiest part of the electronics design, a misconception. Disk drive technology at that time was required to meet a performance spec of fewer than one error per ten billion bits transferred. This is called the ‘raw error rate spec,’ and it turns out that *everything* has to be done almost perfectly in a read-write design to meet this spec. In reality, read-write is probably the most difficult part of the design and not really the sort of assignment to be given to a rookie working under ultra-stressful conditions. But, newcomers that we all were to the world of disk drive design, nobody realized that when the project started.

Although the ’08 power supply design presented its share of technical challenges it was in pretty much every way a straight-up electrical engineering assignment and of all the things people were doing in Ken’s section it was probably the easiest assignment around. Between the disk drive mechanism, the tape drive mechanism Bob Frohwerk was working on, and all the various electronics going into the ’08, the numbers added up to a three hundred watt power supply design. I originally suggested we use one of the still-relatively-new-on-the-scene ‘switching’ power supply design approaches, but when the project started in 1979 ‘switchers’ still had a bad reputation for being quirky and too noisy for use in a disk drive because of the tight error rate requirements and its vulnerability to electrical noise. Consequently, lab management had banned the use of ‘switchers’ so the ’08 power supply was a classical ‘linear’ design. My job got even easier when we hired a bright young electrical engineering intern to come work with us. His name is Rick Hilton and he was a 4.00 student who had just finished his junior year at the University of Idaho, which is three hundred miles north of Boise in the little town of Moscow, Idaho.

I had been serving as a technical interviewer for HP since 1976, and my previous experiences with ‘straight-A’ 4.00 interviewees had left me with a generally unfavorable impression of them. They seemed to be ‘test taking experts’ who didn’t really have the basics nailed down. I had come to prefer students with grade point averages somewhere in the 3.30 to 3.90 range. The kids who had to struggle a little more usually seemed to learn more too. But young Rick was the exception. He had learned his lessons well, was very smart, a hard worker, and a marvelously pleasant young man. I’d given him a glowing thumbs up after interviewing him and when he was hired as an intern Chet assigned me to be his mentor and put him to work on the ’08 power supply. I tried to pattern myself as a mentor after Erhard; this was the second time I’d found myself in that role. Rick caught on very quickly and in what seemed like no time at all I was actually having to remind myself a lot that he still had a year of schooling to go. The more he demonstrated his skills and talents, the more responsibility I let him take on until the power supply was more his work than mine. I have very rarely met a more talented young man.

One of the principal technical issues in designing linear power supplies in our wattage range is electrical efficiency. Power supplies dissipate power too, and in fact linear supplies usually dissipate more

power inside the supply itself than they deliver to the rest of the system. One important factor in this is that the '110 volts' that comes out of your wall can really be as low as 105 volts and as high as 130 volts. The supply has to be designed to work at the lowest voltage in this range, and this means its efficiency at the highest voltage in this range is *very* poor. We needed to do something about that problem. Chet and I brainstormed about it and he came up with the idea of putting what we called a 'preregulator' circuit, built using a very old trick called a magnetic amplifier, into the design. The idea was that this preregulator would compensate for the wide range of voltages coming out of the wall so that the rest of the design could be done as if we had a nice, reliable single wall socket voltage to deal with. Chet had the basic idea, I worked out the design details, and Rick built it and got it working. Eventually the three of us were awarded a U.S. patent for this invention.

With young Rick able to handle so much of the power supply work, Chet decided I didn't have enough to do and so, with Ken's concurrence, he made me project leader for the '08. Probably as good a way as any to explain the difference between being a DMD project leader, my new assignment, and being a project manager, Chet's job, is to say the difference is like that between a noncommissioned officer and a commissioned officer in the army. Project managers are ultimately held responsible for the success or failure of their projects. They take care of salary administration and performance evaluation, participate in the business planning activities of the lab, and have to attend endless meetings for most of every day. Chet's chair at his desk was empty most of the day while he was away doing 'manager things.' But a high technology product development also has countless technical and interdepartmental coordination issues involving a lot of nitty-gritty engineering details. We had to coordinate with the Controller Group, make sure our design would meet the needs of HP's service organization (part of the marketing department), would satisfy the things production required to build the product, and dozens of other things. The work of all the individual lab engineers on the project had to be coordinated to meet the tight scheduling demands of the project, and there were a lot of tiny design details – such as cables, interconnections between the different printed circuit boards, and numberless other small, uninteresting, but vital things that had to be done. Responsibility for all of this now fell to me. I became the one engineer on the project whose screw-ups could kill the whole thing. Anybody else could mess things up for awhile, but if that happened it could always be fixed. Up until now my job had been routine and reasonably free of stress. Now the responsibilities I had came complete with all the '$8 a second' pressures our section labored under plus the normal challenges that always come with being the direct supervisor of a team of people.

I'm sorry to say that as a first-time supervisor I had a lot to learn and I made plenty of leadership mistakes during the '08. I was twenty-six, hadn't had this kind of responsibility before nor experienced the kind of frenzy that characterized DMD's R&D lab, and at this stage had no 'people training' in such things as how to handle interpersonal relations between myself and the people I was supervising. I hadn't learned how to be a leader yet; it would take me several more years before I learned enough about the art of leading a group of people to do a reasonably good job of it. I'd been made a supervisor, but I hadn't yet made myself into a good leader. I doubt if *I* would have put up with working for me as I was then.

Still, though, the team did manage to pull off what I have to say was a spectacular job of product development given how inexperienced we all were with high technology disk drive design and how inexperienced my friends' new boss was. It wasn't a neat and tidy process. In fact, it probably would have made anyone who likes things to go with orderly neatness according to a well defined process sick. But we responded to challenges and setbacks nimbly and flexibly as they came up and we did in fact come from behind to pull ahead of the other two projects and enter production ahead of them, just like the strategy said we were expected to do. As soon as it became clear the '08 *was* pulling ahead schedule-wise of the others, two hardware guys from the Controller Group, Ron Takasugi and Greg Esplin, were moved into our lab area to finish off the controller printed circuit boards for the '08. They were an important part of the project's success and made a lot of key contributions that got us down into the factory first. In doing this they were moved from under the supervision of Steve Lieske, who had excellent people skills, to being under a guy who didn't have those skills yet, namely me. I know that had to hurt, which is

something I have to apologize for to them, but the fact is we couldn't have pulled it off without them.

There were a countless number of tough engineering problems that had to be solved to bring out the '08, and everybody on the team certainly had their full share of them. In a lot of ways everyone's job was a kind of Sisyphean task in the sense that if anybody *did* get on top of everything they were responsible for doing, there was always some other problem somewhere else that needed solving and guess who that one would end up going to. I took to calling this 'the doctrine of equal pain.' Everyone on the team at one time or another – and usually more than once – stepped up to take on these challenges and that is why we succeeded. Since then I've worked with teams that were as dedicated, but never one that was more dedicated. The men and women of the '08 project embodied what the word *company* really means. If you look this word up, you'll find it goes all the way back to the Latin word *companis,* which literally translates 'with bread.' We all depended on each other for 'our bread,' and that is the essence of what Rousseau called the social contract.

I can't close the story of the '08 without mentioning a couple more people. One is Marla Schneider, who joined the team not long before we took the product down to the factory. Marla was an electrical engineer, from Minnesota if I remember correctly, and she took over the power supply after young Rick went back to school to finish his degree. I was helping out with the read-write debugging at the time. As I mentioned earlier, we had badly underestimated the technical challenges associated with it. It wasn't just the '08 that was discovering this; the 7911/12 project had run into the same kinds of problems we were having. Only the BFD wasn't having major problems with read-write and this was because they had two older, experienced engineers working on it. One of them was a brilliant circuit designer named Bob Batey, who is the single best circuit designer I've ever met. The '08 read-write didn't have any one single killer problem with its design, just a lot of little ones mostly centering around noise issues. They were the kinds of issues where experience counts the most. Chet understood about these sort of things so when I suggested to him I should step in to clean these up he agreed right away, even though it meant he'd have to shoulder some of the project leader responsibilities I wouldn't have time to tend to while working on this. I also wouldn't have time to deal with the last few details of the '08 power supply as we got it ready for production prototype, and that's how Marla came to join the '08 team.

The core of what was new about the '08 supply was the preregulator circuit, and the core of this circuit centered on two devices called 'transductors.' The transductor, which is also known as a 'saturable reactor,' is actually a very old device. It was used in radio amplifiers at least as far back as 1916 before the invention of the vacuum tube made it largely obsolete. It looks like a regular transformer in every way but it's not a transformer and the design rules are different. HP at that time did all the company's transformer design in Palo Alto at a place called the Manufacturing Division. Normal transformer design can be reduced to a set of formulas and at Manufacturing Division this design was done by technicians using a computer program.

But, like I said, transductors aren't transformers no matter how much alike they look. The guys down in Palo Alto didn't have a canned computer program to design them and the designs they did send back to us were completely unsuitable. Transductors hadn't been used – except perhaps in a very few places here and there – since the 1950s and the design technique for them had long been forgotten. Marla jumped in and rediscovered on her own how to design them. She did an outstanding job and her design worked perfectly. I don't think Chet really understood what it took to get this particular job done and, unfortunately, he and Marla didn't get along very well. Marla was a competitor – she was an athlete who competed in gymnastics in college – and just as un-inclined as I am to sit back passively and be told to do things. You might say she was a feminist at a time when most men neither knew nor understood feminists nor understood that the old female gender stereotypes had gone the way of the dodo. If Marla had been a man Chet would have understood her, but she wasn't and you could say he was 'gender baffled.' I tried to act as moderator between them, but as a diplomat I'm afraid I made a better parking valet. Still, when all is said and done, Marla was an excellent engineer and, I'm sorry to say, she didn't get the credit she deserved. I wasn't able to prevent this and to this day I count it as one of my failures as a project leader.

The other person I need to mention was a guy named Jerry, who was the manager in charge of production engineering for the products in Ken's section. DMD's production engineering staff was woefully undermanned, which was mostly because of a certain ivory tower hubris coming out of the R&D lab. A lot of lab people actually went around saying our products would practically build themselves and so production engineering wasn't really necessary. Well, this is just total bunkum. There's a million practical reasons for why things go wrong in a factory and production engineers are the folks who fix these problems and keep products shipping out the back door. If you want your manufacturing business to fail, all you have to do is underestimate how important your production engineering staff is. And that's what DMD had done.

When the '08 finally went downstairs to the factory in 1981 most of our R&D team went downstairs with it to function as a 'transition team' during the handoff from lab to factory. As transition team leader I wasn't in charge of what went on engineering-wise in the factory. Jerry was responsible for that. With the inadequate staffing he had been given plus the enormous pressure he felt coming down from up above to get shipments ramped up to the level where the plan said they needed to be, he was one stressed out guy. It turned him into a micromanager, which immediately brought back unpleasant memories for me. To add to Jerry's stress levels, he wasn't actually my boss. I worked for the lab, he couldn't really *order* me to do anything, and he reminded me so much of John at Delcon Division that he and I ended up getting along about as well as India and Pakistan.

For my part, I was shocked and horrified by the chaos that reigned throughout our factory line as they tried to deal with the many, many problems that always crop up during a new product introduction. At one point, production had parts from twenty-four different production-run work orders strewn around all over the place trying to build *one* production run. Production was deep in fire-fighting mode and as a result wasn't managing to fix *any* of the problems keeping them from being successful. But, just as Jerry couldn't order me to do anything, I couldn't tell production to change what they were doing either. The situation got worse and worse by the day.

Finally things got so bad that Jerry called a joint meeting of the production engineering and transition team staffs. There he announced that until shipments reached the target level my lab engineers and I were going to work as production line technicians to help the line make their shipments. I'd have been okay with that if that would have really fixed things, but it wasn't going to. The problems we were having weren't random accidents or the result of a divine curse. Every one of them had a root cause and the only way to get production ramped up *and keep it there* was to find these root causes and fix *them*.

"Jerry," I said after he finished telling us his plan, "that's the stupidest idea I've ever heard." At that time I was kind of notorious for making undiplomatic remarks like this and Jerry took it just exactly as you'd probably think he would. He lost his temper. A short spat of shouting went back and forth between us as everyone else in the room cringed and tried to turn invisible. Finally Jerry shouted at me, *"If you think YOU can do better, why don't YOU take charge of this?"*

I was hoping he'd say that. *"Okay,"* I snarled right back at him, *"I will."* From that point on I had a free hand on our line. I'm pretty sure Jerry was expecting – and maybe even hoping – I'd fall flat on my face, but it had been pretty obvious to me for some time by then what had to be done to get things back under control and make real progress. I set up a Failure Analysis Lab, staffed by two very good production technicians, and we began managing our way through the problem solving process. I took the 'meet shipments at all costs' pressure off the production line manager and we started working closely together to come up with real solutions to the problems we were having. My transition team did what we were supposed to do: *engineer* the solutions to these problems and get these solutions out to the line. It took two months but by the end of that time we were ramped up and the line could operate without us any more. The HP 7908 was finally in production. □

The years 1979 through 1981 weren't any easier for the folks working on the other lab projects than they were for those of us who had been on the '08. By the end of '81 quite a few of us were showing

some signs of combat fatigue. The number of private weekend parties had dropped off pretty sharply by then, those who were married had started to have kids and settle into a more usual home life routine, and the main socializing – not counting beer busts or Ken's section parties – had started to become more centered around smaller activities and recreational sports.


HP co-ed softball league

Slow pitch softball is very popular in Boise. There is a city league with various divisions and we also had a co-ed 'HP League' that played its games on HP's large, park-like campus. Softball was one of Steve Lieske's passions, along with mountain climbing, and when he formed an HP League team in 1980 both Vern and I joined it. Vern played shortstop and I usually played first base, sometimes played catcher, and once in awhile pitched. More than anything else, it was softball where I came to know Steve and his wife Chris, Keith Whitaker, and more of the folks in the Controller Group, especially Bob Pentecost – who was a software engineer – and his wife Vicki, who was an accountant in DMD's finance department. A softball doesn't came at you anywhere near as fast as a baseball does so even I was able to get some hits. I loved playing softball and participated in the HP League for the next seven years until my over-thirty knees started giving me too much trouble to be able to play well enough to have fun. One year our team even managed to win the league championship.

Soccer is also pretty big in Boise. It's not a game I've ever liked, but Vern was and is a huge soccer fan. HP also had a soccer league and, although I never took part in it, Vern did and every once in a great while I'd stroll out to watch some of his games. He played goalie, which seemed to me the most sensible position to play if one was going to play soccer at all until Vern broke his leg during one of the soccer games. I should probably say he had his leg broken because what happened was he got kicked in the leg while breaking up a run at his goal. I wasn't at that particular game, but I heard about it pretty soon afterwards and went down to visit him in the hospital. His leg was wrapped up in a huge cast and he was hooked up to a morphine IV with a little button he could push whenever the pain got to be too much. Hospitals under the best of circumstances don't tend to care about the dignity of their inmates. He'd been brought in straight from the field all sweaty from the game and nobody at the hospital had thought that maybe it would be a good idea to help him get cleaned up after setting his leg. Consequently, when I got there he smelled a lot like a barnyard goat. After he finally got to go home he was on crutches for quite awhile and had to wrap that big cast in a plastic bag when he took a shower. I never heard him complain, but I bet that cast had to itch like the dickens after awhile. We held the poker game at his place while he was hobbled up on crutches.

I'd have hung up soccer for good after that if it'd been me, but Vern loves the game and kept playing. After breaking his leg he outfitted himself with shin guards and various other forms of plastic armor to prevent another repetition of the accident. It turned out that a few years later he broke his other leg anyway in a similar soccer field collision, despite being armored up. That one convinced him it was time to retire from soccer. It convinced me football was far safer than soccer.

Chic, Vern and I started playing golf fairly regularly on the weekends with different guys making up

the other slot in our foursome. Boise has a lot of nice golf courses; the three we played most often were Shadow Valley, Eagle Hills, and Indian Lake. Until the '08 project ended, Vern, Craig Walker, Larry Copp, and I also sometimes took off a little early from work to get in nine holes at Eagle Hills. We were out there one afternoon when Idaho Governor John Evans and his party happened to be just in front of us. Being ever the good politician, the Governor insisted we go ahead of his group and that led to what we came to call 'the Governor's Curse.' Every time Governor Evans was in sight of us, none of us could hit the ball worth a darn. There were muffed shots going all over the place. Every time he was out of sight we'd get off our shots and play well. It wasn't that we were nervous about the Governor; that wasn't it at all. But every time somebody muffed a shot I'd turn around and look behind us and, sure enough, there was Governor Evans. After that round we joked that he'd lost our votes for ruining our golf game. But this was just a joke; I liked Governor Evans and always supported him. He was a moderate and an important counterbalance to the tribe of Bible-beating, ultra-right-wing troglodytes known as the Idaho Republican Party. My support for Governor and then President Reagan in no way extended to the Idaho Republicans who dominated the state legislature.

Not surprisingly, politics tended to dominate our lunch time conversations during 1980. President Carter's reinstitution of registration for the draft gave the handful of us who were old enough to have gone through the draft lotteries during the Vietnam era a chance to tease young Rick Hilton, who was one of the young men now required to register. Even though the draft itself didn't come back, and never looked like there was any chance it would, we'd 'congratulate' Rick on his new status as 'cannon fodder' for his country. Rick somehow failed to see any humor in this at all; he wasn't any happier about the possibility of being drafted than I had been back in '71.

Most, but by no means all, of my friends and colleagues wanted Governor Reagan to win the 1980 election. Those who did not tended to be against Governor Reagan rather than for President Carter. They saw him, like most of the country did, as being a right-wing conservative and, in fact, his campaign speeches that year *did* tilt more to the right than they had in 1976. This was something I found quietly disturbing, but I was still convinced he wasn't really as right-wing as people thought he was. There was no doubt that the guys running the national Republican Party were tilted strongly in this direction, but I was hoping *President* Reagan would be able to moderate that influence and keep things more to the center. Vern, on the other hand, very much opposed both Reagan and Carter. He threw his support to the liberal independent candidate, John Anderson. When November 4th finally arrived, Governor Reagan received just under forty-four million votes – slightly above 50% of the popular vote – and took all but six states and the District of Columbia in the electoral college. The Republicans also managed to pick up a majority in the Senate, the first time that had happened in many years, and the Democrats retained control of the House of Representatives. The stumbling, bumbling Carter Years were over at last. □

VII. The Reagan Years

The Reagan Years were almost over before they began. Like the rest of the country, I was appalled on March 30th, 1981, by John Hinckley, Jr.'s attempted assassination of President Reagan and hugely relieved when the President recovered from it. Once again a fruit loop with a gun had almost changed the course of American history. I had been working in Cupertino when a Bible-beating fruit loop, Dan White, had gunned down San Francisco's Mayor Mosconi and city supervisor Harvey Milk inside City Hall. There had been two back to back attempts to assassinate President Ford in California in 1975, one by one of Charles Manson's deluded followers and another by a nut case named Sara Jane Moore. Also while I'd been living in California, there had been a massacre at the Golden Dragon restaurant in San Francisco's Chinatown by a Chinatown street gang. I've often wondered why the he-man gun nuts of the NRA, who oppose every measure of common sense gun control, never seem to mention the fact that Wyatt Earp – who I assume would have to be one of their heroes – didn't allow guns to be worn in Dodge City or in Tombstone. Maybe the NRA just isn't a supporter of law and order.

Whatever else anyone can say about President Reagan's first term, it certainly wasn't dull. There were

many things he accomplished in that term I was very happy about and many things that disappointed me. On the day he took office the inflation rate was 11.8% and unemployment was at 7%. The prime rate had peaked at a staggering 21.5% in December of 1980, the highest in U.S. history. The U.S. economy was a train wreck in progress. On Wall Street the gloom in the bond market had gotten so deep there was actually talk to the effect that the bond market was dead, that it would never recover. AAA corporate bonds issued by some of America's strongest companies were trading for fifty-five to sixty-five cents on the dollar with yields of 15% and even higher.

The way I saw it, if these companies went down and defaulted on their bonds, everybody else was going to go with them and it wouldn't much matter where you put your money. If they didn't, it meant they were giving away free money on Wall Street. I started buying up these AAA bonds, as many as I could scrape up the cash to get. It was the only time I violated my own rule about not injecting new money into my stock market account. The interest I'd be making was tremendously more than my savings at the CU were earning. I didn't worry about the bond market going even lower because I don't trade bonds. When I get my fingers wrapped around one, by golly it's a prisoner. If the bond market had continued downward, I'd have just bought some more. But, as it turned out, this period was the low point for bonds and I've never seen anything remotely like it since. Our economy was in bad shape, but I ended up making a lot of money on these bonds.

President Reagan's economic moves succeeded in finally pulling the economy out of the toilet and the new monetary policy by the Fed did succeed in finally beating the inflation spiral even though we had to go through two years of recession to get there, with unemployment peaking at 9.7% in 1982. The recession hit Maquoketa pretty hard, and when I went back there to visit I was shocked by how many empty stores there were along Main Street. Businesses I'd known since I was a little boy were gone. President Reagan's popularity in Maquoketa never fully recovered from that. Maquoketa hadn't gone through a recession; they went through a full blown depression in those years.

I think we probably had to have the recession to finally break inflation but I've never been too sure how big a role President Reagan's enormous increases in defense spending contributed to eventually ending the recession and putting the economy back on a growth path. I was fairly skeptical of the notion of 'trickle down economics.' I thought it was more likely the rich guys who benefited the most from this policy would just put the money in their pockets, and I think that is what largely happened. The defense spending along with the tax cuts – which took the top income tax bracket down from 70% to 35% over the next seven years – led to a huge increase in the national debt, which I didn't like one bit. I thought the tax cuts and the tighter monetary policy were good moves, even though I think there's something basically wrong with the idea that my bracket ended up at 35% while billionaires only forked over 28%. But I was not too happy with the defense build up. Some say it was their attempt to match this that eventually led to the collapse of communism and the Soviet Union, but I'm not so sure that wouldn't have happened anyway. Communism is a bankrupt system all on its own, probably the worst idea any economist (Karl Marx in this case) ever had. The only thing that remotely compares to it as a formula for disaster is the program the liberals set up in this country, which they modeled along the lines of Britain's policies (which likewise ravaged the economy of Great Britain).

HP was not a direct beneficiary of the defense buildup; HP isn't a defense contractor. But we were probably an indirect beneficiary of it because HP continued to grow at a healthy clip and DMD really kept growing. Ken and Chet must have thought highly of my work because my own income started rising very rapidly after the '08 as well. They might have been giving me more credit than I deserved, but I wasn't about to argue with them over that or turn down the money. No, sir. From 1982 on my income exceeded the living expenses I needed for a life style I was comfortable with and the excess went into savings and investments. The only person or entity I've ever completely trusted to look after me in my old age is me, and I had no intention of ever being one of those senior citizens of whom stories were told – urban legends? Maybe not – about their having to eat cat food. HP in those days did take very good care of their retirees, but I had a lot of years to go before retirement and things can change in the course of a few

decades. Bill and Dave didn't run HP anymore.

I was disappointed that there were a lot of changes President Reagan had proposed in his book back in '76 that his administration never put into effect. How much of this might have been due to Congress vs. how much of this just wasn't part of the conservative Republican agenda I don't know. I certainly believed then, and I still believe now, that rescuing America's economy was the single most important thing that had to be done and President Reagan's first term did accomplish that. But my hopes that we would see a better, workable, *practical* Great Society never did come to pass during his presidency nor is there any sign of it today. Either President Reagan really wasn't the moderate I thought he was or else he wasn't able to dislodge the conservative fringe and deliver on the moderate 'big tent' Republican Party he promised when he ran against President Ford in 1976. Either way the outcome is just the same.

I'm not sorry for being a Reagan Republican. I'm just sorry the Reagan revolution *I* joined never came to be and didn't live past his first term. It is true that government can be the problem, either by having too much *or* too little of it. But government is *never* the problem when it properly takes care of the only six things the American experiment assigns to it: to form a more perfect union; to establish justice; to ensure domestic tranquility; to provide for the common defense; to promote the general welfare; and to secure the blessings of liberty for *all* of us. They are all equally vital and government has to do *all six* well. That is why conservatives and liberals *both* give us bad government. They have forgotten, if indeed they ever knew, what government is for. It isn't the Praetorian Guard for the rich nor is it the Salvation Army. Americans do not have to accept as our only choices being either serf or ward of the State. □

Late in the summer of 1981 John Stedman stopped me in the hallway one afternoon and asked me if I'd like to teach a class for the EE Department at the University of Idaho up in Moscow. Ever since HP had come to Boise the company had been providing philanthropic support to the U of I, mostly in the form of equipment donations. But this year he was thinking about doing a little extra something. If somebody volunteered, the company was going to 'loan' him to the university for a semester. The idea greatly appealed to me so I volunteered to be the 'loaned professor.' John passed the word along and the next thing I knew the EE Department gave me an appointment as 'Affiliate Professor of Electrical Engineering.'

There is a university of sorts in Boise itself. It is named Boise State University (BSU) and not all that many years earlier it had been Boise Junior College. BSU had no engineering program at all and is pretty much a fourth rate university. HP in those days gave BSU almost no support at all. The University of Idaho, on the other hand, is Idaho's land grant university and had been established in 1889 by the 15th territorial legislature. It became a 'state' university when Idaho was admitted to the union in 1890.

When I first moved to Boise I had assumed the U of I was just some little cow college tucked away up in the Palouse region of Idaho's panhandle. I was, after all, a Stanford alum and how could Idaho of all places have a quality university? That turned out to be a fairly colossal bit of conceit. HP employees in Boise could work on their master's degrees via remote education either from Stanford or from the U of I. Both schools provided video taped classes that could be watched on site or an HP employee could take a year off at 75% pay and go live at either university to attend classes. Both Vern and Rick Hilton ended up electing to relocate to Stanford for a year to get their M.S. degrees. Most of our engineers on the Boise site elected the video taped 'outreach' classes instead. One of the things the HP Boise site did to support continuing education for its engineers was to provide local tutors who knew the subject matter and could answer questions for our people. I had by then been serving as one of these tutors for some time, both for Stanford classes and for U of I classes, and had discovered – to my surprise – that the U of I did in fact deliver a high quality graduate education in engineering. The only real difference I could spot was that Stanford was loaded to the gills with big name, world famous professors and the U of I was not. But a difference in the quality of education? No. I couldn't see one. On top of that, we hired a lot of graduates from the U of I – and not just for the Boise site either. I knew a lot of them and without exception they were excellent engineers. So when John asked me if I'd volunteer, I knew I would be working with

people I could respect in a place I wasn't ashamed to be associated with.

The only thing was I didn't want to live full time in Moscow for a whole semester. Moscow is three hundred miles north of Boise up in the lower part of the Idaho panhandle and it's a five and a half to six hour drive. I didn't want to sacrifice my social life for this and, besides, I had my extracurricular research I wanted to get back to. The big push to get the '08 out had interrupted my brain work from plain old exhaustion. No problem, John said. I ended up commuting by air three times a week using Cascade Airlines, a local puddle hopper that flew between Boise and the Moscow-Pullman Airport. I'd fly up Monday, Wednesday, and Friday morning, meet with students in the morning and early afternoon, teach my class in mid-afternoon, talk to the students some more, and fly back to Boise that evening. HP paid for the whole thing. It was a splendid example of HP's commitment to the seventh corporate objective: Citizenship.

The arrangement also let me pitch in and help a little bit on the 7911/12 project, which was going through its production ramp during this time. I was partnering with Jan Skurzynski, one of our bright and talented women in the R&D lab, a triathlon competitor, and a pretty amazing person in general. Project leader wasn't a permanent rank; we only had project leaders when there were projects to lead. If HP had had a dual career ladder at that time – manager or technical contributor – project leader would have belonged to the technical contributor ladder. I was assisting Jan by doing some analytical work on error rate testing.

I loved being back in the academic setting. The students were great kids and the faculty members were warm, friendly, and very dedicated teachers. If there was one thing to criticize about the EE Department at that time, it was that they were, I felt, too light on research. At that time the U of I wasn't a Carnegie Research Intensive University, although it would become one later. This doesn't mean they neglected research entirely. They had a strong Systems group there and one of the more interesting research projects going on at the time was aimed at solving the problem of detecting and correcting instrument failures in nuclear power plants. This work was to prevent the kind of failure that had caused the near disaster at Three Mile Island in 1979. They also had some interesting work going on there in artificial intelligence, which naturally attracted my interest.

My office in the EE Department was right next door to a young new professor named John Purviance. Johnny's area, like mine, was in systems theory and, on top of that, he was pretty curious about what R&D at a company like HP was like. We became fast friends and I got to know him and his wife pretty well that semester.

The fall '81 semester ended just before Christmas and I took some vacation time over Christmas and New Years '82 before heading back to saddle up full time at DMD again. There must have been something about being back in the academic world that got to me though. On Monday morning of January 4th, I was just about to shave before going to work when the switch broke on my electric shaver. Muttering about the poor product quality of electric shavers, I got out my shaving cream and regular razor. I'd just finished lathering up my face and had just lifted the razor to my chin when the sight in my mirror made me stop. Why was I doing this? I started wondering. I stood there for about a minute looking at myself in the mirror and couldn't come up with a good reason. Then I washed off the shaving cream, dressed and went to work. I've never shaved since that day; just a monthly beard trim at the barbershop when I get my hair cut. By Wednesday of that week people passing me in the hallways would stop me and ask, "Are you growing a beard?" I told Vern about that and he just laughed.

Toward the beginning of spring in '82 I was asked to do some research work having to do with read-write design for the brand new metallic thin film disks we were planning to use in our next batch of products. A lot of people, including IBM, had been working on thin film disk technology for quite awhile by then, but it was HP's research team that was first to solve the set of technical problems that had been preventing this from becoming a viable commercial technology. We were building an entire factory to produce thin film disks for our own products. The R&D for this belonged to our Technology Section,

which was under the third of our R&D lab's section managers. As I got deeper and deeper into this work, it dawned on me that this was the kind of research work people got Ph.D. degrees for doing. It was also the kind of work that dovetailed nicely with the Systems expertise at the U of I. The problem was that while HP supported its engineers in obtaining their masters degree, there was no comparable program by which a person could get his doctorate.

I went and talked with John Stedman about this and he immediately agreed my going after a doctorate was something he would support. There were a few conditions that would have to be met, but they weren't particularly restrictive. Next I called Johnny up in Moscow and asked him what he thought of the idea and if he'd be interested in being my major professor. He was delighted with the idea and also agreed right away. My program would be a bit out of the ordinary; all the major research equipment I needed to carry out this work was at HP down in Boise. But if I'd agree to spend another semester *full time* on the Moscow campus at some point and make regular trips up there the rest of the time to talk to people, I could do the bulk of my work down in Boise and the university would go along with it. We were, in effect, pioneering a way to offer doctoral level graduate study throughout the state of Idaho. I went back and told the other John what Johnny had worked out up there and he agreed to it without hesitation. The way John saw it, we were pilot running a new educational opportunity for HP's engineers. So it was that by summer of '82 I was admitted to the doctoral program at the U of I and in the fall I became a student again. John saw to it that my work assignment at HP was identical to my doctoral research. There were important problems DMD needed to have solved that my research work would solve – assuming that I succeeded – and so my doctoral studies and my job became one and the same thing. It was the sweetest deal on earth and it did lead to a new educational benefit open to my fellow engineers if any chose to take advantage of it. That was corporate objective number five: Employees. □

On Mt. Regan in the Sawtooth Wilderness Area (1984)

By the summer of 1982 I had lived in Idaho for three and a half years but had not experienced the splendor of Idaho's scenic backcountry. I had just been too busy all during that time and, to tell the truth, I only half believed the stories I'd heard of it. That summer Steve and Chris Lieske saw to it that changed when they invited Vern and me to come along on a backpacking trip to Alice Lake in the Sawtooth Wilderness Area near the tiny town of Stanley.

Stanley sits about an hour from Sun Valley. I'd heard of it already even though I'd never been there. In the winter the TV news would report the coldest spot in the nation and its temperature. Then they'd say what the temperature in Stanley was. Stanley was always colder than the official coldest spot in the nation, which was not something that made me want to pay it a visit. But one hot summer weekend the four of us piled into two vehicles and off we went. It was an unforgettable trip. When I got home from it I recorded my impressions in a letter to Mom and Dad. The letter read in part:

> I spent the weekend backpacking in the Sawtooth Mountains over near Stanley with some friends. What an experience that was! I have never been in country as beautiful as the places I walked through this weekend. We camped out on the shore of Alice Lake in the Sawtooth Wilderness Area. Alice is six miles deep in the back country and you climb 1600 feet in elevation from the transfer camp at the base of the mountains to reach it. You would have loved it. No motorized vehicles are allowed in the wilderness area and you are alone with nature and a handful of other hikers.
>
> The first two and a half miles of the trip go through a heavily forested area that is truly primeval. There are thousands of trees of all kinds including pine, aspens at higher levels, and

some trees like Iowa has. Some odd looking yellow flowers grew wild along the trail and their heavy scent permeated everything. The path is narrow and skirts Pettit Lake before following a mountain stream into the woods. About two miles into the woods we came upon a roaring rapids fed by a small waterfall. The trail was about 100 feet above the stream bed and the water was white capped where it broke over the rocks. We could hear the rushing water for a quarter of a mile before we came to the spot.

The woods were as dense and wild as the forests in a fairy tale and I half expected us to stumble on a band of elves smoking their pipes on a log in a clearing or else to come upon a rock nymph combing her hair on one of the rocky cliffs that overlooked the trail.

After we broke out of the lower woods the trail rose very quickly along a narrow path up the side of the mountain. Here the trail became very rocky with thousands of loose stones forming the foundation of the path. The rocks here were white granite for the most part and were so polished by the wind and rain that they were perfectly smooth. The smallest rocks on the trail were the size of flat baseballs. The trail circled up the mountains and we walked along the edge of a cliff for over a mile. The mountains rose above us like a great white wall for a thousand feet. Great black birds nested near the mountain top and clear blue water poured from crevices in the cliff wall. I've never worked as hard as I did climbing up that mountain trail with a twenty-five pound pack on my back.

At the top of the mountain trail we could stand beside a clear blue and white rapids and water-fall and look back down into the valley below. Pine trees made a green carpet on the mountain sides and covered the valley. White clouds wisped among the taller peaks, and the mountains below were purple majestics in the tapestry of the earth. A small lake far below us appeared to have green veins where the underwater plant growth was very thick.

At the top of the mountain trail I felt that I had reached my maximum walking range. However, Alice Lake was still another mile back into the woods so after a short rest we pushed on into the forest. Up here the plant growth was not as thick as below but was still dense. The trees were all pine trees at this level and the bushes thinned out. The bushes on the trail below bore red berries but these bushes up here bore no fruit.

Alice Lake was calm, blue, majestic, and large. The wind made intricate ripple patterns on its surface. It was bounded on all sides by pine trees or by the steep walls of high mountain peaks. These peaks were nearly barren of trees and still bore snow in places. Directly across the lake from our camp was a forbidding peak called El Capitan Mountain. This cliff rose at a sixty degree angle from the lake and its last four hundred feet to the peak went straight up. Loose rocks were strewn about for one hundred feet up from its base. The lake-ward side of El Capitan has never been climbed, although its back side has.

This weekend in the mountains was fantastic and gave me an appreciation for the conservationists that I never had before. James Watt can do any darn thing he wants with the desert, but he'd better leave my mountains alone. I wish you could have been here with me. At every step along the trail I saw and felt the majesty of nature and the grandeur of God. I intend to go backpacking again over the Labor Day weekend.

God has another special place and it's called Idaho. And the most special part of this special place is the land they call the Sawtooth Mountain Wilderness.

The Alice Lake hike lit a passion in me and for the next several years every summer from July through early September I'd get back into the mountains for the weekend as often as I could. Sometimes Steve and I and another friend or two would go. More often I'd go with Vern, either with or without the company of other friends. He loved those mountains as much as I did.

The Sawtooths aren't the only beautiful and special place, of course, but they are my favorite. Unlike places like the Seven Devils, the hike into the Sawtooth Wilderness is pretty much uphill all the way, which means the hike out is downhill. That was something I appreciated a lot, especially on very long hikes further in than Alice.

Alpine Lake in the Sawtooth Mountains.

The wilderness areas are peppered with countless small, pristine lakes nestled in the arms of surrounding mountains. Trees often ring the lakes like a green necklace. Because there are no motorized vehicles allowed in these areas, you come across occasional small groups of other hikers and, once in awhile, a pack train of horses carrying the camping gear for some larger party. But most of the time you're all alone with only your companions by your side. Utter quiet lies over everything here in nature's cathedral.

A hidden Sawtooth meadow along the trail.

Everything is awash in colors. Not just green and brown, but purple and red and pink and yellow and blue and pure, pure white. If I hadn't seen the glory of these places for myself, I never would have believed anyone who told what was to be seen out there. On an unfamiliar trail you never can predict what you'll see next. You can be walking through a thick wood and suddenly a spectacular meadow will open out before you, as if you had just walked through a doorway into a completely different land.

Vern, Karen, and Liz in the Seven Devils.

Although there are many places where day hikes – in and out on the same day – are possible, the most beautiful places are usually far enough back into the wilderness that it is better to camp overnight. If we did any fishing on a trip or just wanted hot food we'd build a campfire. I had a concoction of fish and rice I particularly liked to make. However, that had to be done very carefully because of the danger of forest fires. A lot of the time we'd run a cold camp, especially when the fire danger was high.

On the trailhead with Scotty Carter (age 7). This picture was taken by Scotty's mom, Mary.

The Idaho backcountry is dotted with countless hot springs. Especially after a strenuous hike in, these are absolutely wonderful for relaxing and letting the cares of the world take care of themselves. Quite a few of them are *very* hot and I always eased into them kind of gradual like. If it was an overnight trip we'd always set up camp before enjoying nature's hot tub because after soaking in one ambition levels were kind of low.

Mount Heyburn. Upper left: The mountain seen from a distance. Upper right: The bench lake that lies at the base of the summit climb. Lower left: When the sun falls on the mountain at just the right angle it glows as if Heyburn were a mountain of gold. Lower right: View looking down from Heyburn's saddle.

Whenever I went hiking with Steve it was a good bet that mountain climbing was going to figure into things sooner or later on the trip. I'm not a climber but I was perfectly happy to go along as high as I could get by scrambling. But when the ropes, pitons, and other serious climbing gear came out I'd find a nice comfortable place to sit and turn spectator.

One of my favorite trips with Steve was to Mount Heyburn. Heyburn is about ten thousand feet high. It's not the tallest mountain in Idaho; that distinction goes to Borah Peak with its elevation of twelve thousand six hundred and sixty-two feet. But Heyburn's still an impressive little mountain. Craig Raese, another friend who was also a climber, came along and he and Steve aimed to reach Heyburn's summit. We had hiked about two miles from the trailhead when all at once the trail came to a dead end. Steve turned around with a grin and said to me, "Did I tell you about the off-trail part?" No. Steve usually had a little surprise or two like this up his sleeve. We labored on through the woods for a few more miles passing a series of bench lakes as we slowly gained altitude. The fifth bench lake, six and a half miles in and a bit over two thousand feet up from the trailhead, was at the base where some serious scrambling up the mountain side began. But that was for the next day. We pitched camp, relaxed, and watched a couple of guys who were skiing down one of the big snow fields that decorated Heyburn even during high summer. There was no ski lift there of course. They'd ski down, managing to turn and stop before they plunged into the lake, then take off their skis and climb back up to the top again. Definitely they were a pair of serious skiers.

We began Steve's and Craig's assault on the summit the next morning. They wanted to approach from the back side of Heyburn, which meant we had to first skirt the lake until we came to a saddle in the mountain that provided a pass to the other side. The ground around the lake was pretty steep and covered

with thousands and thousands of small, loose rocks. Every step we took caused these rocks to begin trickling downward and pretty much right away we had a bunch of tiny little rock slides splashing into the water of the lake. We were about halfway around when I noticed my steps were now causing even more little rocks to start avalanching down from up above as the ones below them started falling. One of these little rivers of rock snaked up the mountain side straight into a three foot granite boulder up above. It started coming down, too, and the little rock slide made a perfect railroad track for it to follow. Right at me.

There really wasn't any way to move quickly or run to try to get out of its way. I was standing on a slope covered with marbles and I knew if I tried to move too quickly I'd find myself riding a rockslide right down into the lake. But you can bet that boulder had my undivided attention. I went into a slight crouch and waited for it. Just as it got to me I did a Fosbury as high as I could over it and to one side. It went by beneath me and I landed on my bottom and took a short sleigh ride toward the lake. Fortunately, enough rocks had cleared out when the boulder came down that I skidded to a stop after only about four or five feet. Whew! Then I got back up and resumed following Steve and Craig.

They reached the start of the snow field and waited for me to catch up. The footing was actually better on the snow and we made our way up and over the saddle to the back side. From there Heyburn got progressively steeper and what little vegetation there was started quickly thinning out. Pretty soon I had to use my hands as well as my feet to get up the mountain. All during this clouds began rolling in around us and we actually climbed through the clouds until we could look down at them from above. A bit more scrambling and we reached the point where the cliff face went practically straight up. Steve and Craig began getting their climbing tools out. I found a nice comfortable rock and had a seat.

It took the two of them quite awhile to get up that cliff face. Watching them creeping up that wall, I decided I definitely had the best seat in the house. What they were doing didn't look fun at all to me. They were maybe a hundred to a hundred and fifty feet from the summit when I noticed the clouds down below were being joined by their big brothers, and these new ones were coming in at and above our altitude. It looked like in just a little while we were going to get a real close up look at a rain storm.

I guess Steve and Craig had the same thought. They couldn't have seen the ones sneaking around the corner that I was looking at, but they could sure see the even higher ones coming over the top of the mountain. From where I was sitting I could see that common sense was prevailing up there because they were getting out their repelling harnesses. It was time for a nice, fast exit from Heyburn. Steve came down first and made it look easy. Then Craig started down. About halfway down the cliff face his gear jammed and there he was, stuck like bug against the rock wall. He hung there for quite awhile trying to get unjammed. There was absolutely nothing Steve or I could do to help. I don't know what he finally did to shake loose, but it looked to me like he came down the low tech way. It was a tense moment.

The assault on Heyburn. Left: looking back down at the clouds below and some new ones coming in. Right: Steve (center) and Craig (directly above him on the ledge) repelling back down.

He did get down safely though, without using the Wells technique, and we started hustling back down the mountain. We managed to get down and back to our campsite before the rain started coming down. Rather than hunch down inside our tents and listen to the rain coming down, we voted 3-0 to pack up and get our buns out of there. Mount Heyburn won that day.

Whitewater rafting. In front, left to right, are Vern and Brian Breckinridge. Behind them are Chris and Steve. I'm the guy in the green hat.

Another great outdoor activity I was introduced to by Chris and Steve was whitewater rafting. Chris especially loves water sports and she sort of took on the role of sports director for our rafting outings. Idaho is crisscrossed by countless small streams of various whitewater classes. I discovered I didn't care much for class 3 rapids and below; they don't pack the punch, thrill-wise, of the class 4 and 5 streams. With some streams there are stretches where we would have to put ashore and carry the raft around impassable barriers such as waterfalls. It turns out rafts don't deal with waterfalls well.

The first time I went rafting, which was the outing shown in the picture above, we were gathered along the banks of the river suited up in our life jackets and waiting for our river guide to turn up. He walked up to our group from behind me without me hearing him. The first sign I had of him was a hard, friendly thump on back. "Alright!" he greeted me happily. "We've got some *beef!"* Apparently he thought I had all the qualifications necessary to make a good rower.

Rafting isn't too hard to do unless you're the guy manning the tiller. In calm stretches you just basically kick back and enjoy the float. When you come to whitewater you really only have to do two things: paddle hard and stay in the raft. The tiller is the skill position in navigating the rapids. Everybody else just supplies muscle power. The rafts come with a rope that runs all the way around the outside. This is the safety rope and it's there for you to grab if you get bucked out. You grab that rope, stay with the raft, and then your friends can pull you back in, if they're so inclined.

That happened to me once. Before setting out our guide and tiller man had remarked with pride that he'd never 'lost' a rafter – by which he meant none of his charges had ever been bucked out of the raft. Of course, he was a young man and he didn't know the whitewater god was listening. Part way down the river I guess we didn't supply enough muscle power because, despite the guide's best efforts, we got caught up in some pretty bumpy water. The raft gave a heave and the next thing I knew I was airborne. I came down in the water right beside the raft and grabbed that safety rope with my left hand, keeping my paddle firmly clutched in my right. I leaned back in the water and stretched my legs out in front of me to put my feet downstream, the idea being that it's better to hit underwater rocks with your feet than with your head. The guide had been looking the other way when I went overboard – he was busy trying to navigate us through all the rocks – and didn't see me go flying out. He also didn't notice there was a missing person when he did look back since my head was hidden out of sight beside the raft. Nobody else said anything about it either, so I got to enjoy that stretch of whitewater from the water. Actually that was quite a lot of fun. I don't recommend it because there *is* always the danger of hitting rocks and it wouldn't be too hard to break a leg or worse. But I didn't hit any. When we finally cleared the whitewater and floated into a calmer stretch Rick Hilton, who had been sitting next to me, turned and asked the guide in a calm voice, "Should we pull him in?" That was the first he knew that I was in the water. He got such a shocked look on his face that I laughed out loud. *"Yes, pull him in!"* he said urgently and my pals hauled me out of the water. Once back in the raft I accused Rick of pushing me overboard, which he protested with an injured denial. He hadn't pushed me, of course; but Rick sometimes takes things so seriously I

couldn't resist teasing him. Besides, what kind of question is, "Should we pull him in?"?

Sometimes there are holes in the water. Yes, really. I'm not making this up. There are places where the water is so turbulent that whirlpools form, and while most of them are small there are some that get to be pretty gigantic. We went into one of these one time while rafting Hell's Canyon. Normally you try to avoid this, but on this particular outing I guess the guide miscalculated or something and in we went. The entire raft fell into the hole on the upstream side and I remember being amazed at the sight of swirling water all around us rising a few feet above our heads. We shot straight across the bottom of the hole and up the other side like Moby Dick breaching. As we came out the other side Chris, who had ducked down inside the raft when we went into the hole, sat straight up and cried out, *"We made it!"* Just at that very second a wave broke over the front of the raft. She had put the hood of her jacket up to keep dry and the hood made a perfect funnel for the water as the wave hit her right in the face. I laughed until the tears started rolling down my cheeks. □

Christmas in Iowa. Upper left: at Bill's house in Cedar Rapids, 1976; Dad, me, sister in law Maryann, and nephew Nick. Upper right: at Sherri's house in rural Onslow, 1979; me, Dad, Gary's mother Bonnie. Lower left: at Melody's house in rural Delmar, 1986; Sherri, Melody, me, Dad, Mom, Bill. Lower right: at Melody's house for Christmas dinner.

I mentioned before that Christmas was always a special time in my family. For many years I always flew back to Iowa over Christmas to visit my family. It was over the course of these visits that I finally came to make peace with Dad. One of the things I finally accepted was that all the things that had caused us problems when I was a boy really did only come from Dad trying as best he knew how to prepare me

for the time when I would be a man and have to make my own way in the world. I finally did come to realize that my dad had always loved me even during those years when I thought he did not. I still think he never really knew his son very well when I was growing up, but I came to forgive him for that. Now that I was on my own and was successful in my career, he quit worrying about my future and that let us come to get reacquainted – or maybe acquainted – with each other. I can't put my finger on exactly when it was that I finally gave Dad his son back, but it was sometime during President Reagan's first term. I wish it could have been much sooner.

Christmas Eve at the family settlement in Reynerville at the outskirts of Maquoketa.

A lot of things changed in Iowa over the years. Sherri got remarried in 1977. My new brother-in-law was a widowed farmer named Ronnie Reid who had a nine hundred acre farm in rural Onslow. Ronnie had three sons of his own – Mark, Dwight, and Curt – and so I now had three new nephews to get to know. After Sherri and her two boys moved out to the farm, Mom and Dad moved into her old house above the downstairs tax office. Also in 1977, after the separation, Melody had a son and she named him Aaron. The first night I met my infant nephew, I had just come in the door of Mom and Dad's house and Melody presented him to me. As I held him in my arms for the first time, little Aaron drooled all over my suit jacket. In May of 1986 Melody also remarried. I made a special trip to come back for the wedding. Sherri, who thought I didn't know how to dance, thought she'd get me out on the dance floor and embarrass me. She had a surprise coming. I had learned how to dance while I was still in junior high and had gotten a lot of practice in since then. I twirled her around on that dance floor and enjoyed every astonished squawk she made when I'd spin her around. My newest brother-in-law, Dan Witt, is a *very* big man, full of laughter, who has a very tender heart. He formally adopted Aaron as his own son. I hadn't liked Kenny, but I loved my two new brothers-in-law.

Bill was also back in Iowa for good. He had left IBM before I moved to Boise to become a vice president with a small Cedar Rapids company called Norand. It was a change that surprised the entire family, and no one more than me. Bill was with them only for a short time and then he left them to start up his own business in CR.

Glen and me at my folks' house in Maquoketa

Glen had graduated and first lived in the little eastern Iowa town of Monticello. Later he took a job as a civil engineer for the city of Davenport. With Glen living right there in eastern Iowa only a short drive from Maquoketa, I'd see him every time I came back for a visit, too. My brother Al Welch had become a pharmacist and had a Snow White's up in Wisconsin, again not all that far away from Maquoketa. If Lyle had also still lived around there somewhere that would have made things perfect, but he and his whole family had moved sometime after I had left for college and I was never able to find out where. It's been more than thirty years – soon it will be forty – since the last time I got to see him, but he's still my brother, they are still my extended family, and I think of them often. Brotherhood forged in the crucible of living is for a lifetime.

Aunt Hazel at her house during one of my Christmas visits in the early 1980s.

No visit was complete without seeing Aunt Hazel and Uncle Wayne. Mom, Dad, Wayne, and Hazel used to play bid euchre fairly regularly, the men against the women. When I came back I'd take Dad's place in the game. Dad and Uncle Wayne used to cheat, mostly because if they didn't Mom and Aunt Hazel would regularly clean their clocks. The two of them over the years had worked out an elaborate set of signals they would use – which Mom and Hazel came to know just as well as they did. Naturally Dad and Wayne loudly denied that they had signals whenever Mom or Hazel would accuse them of cheating, but Dad did confess to me one time that they really did signal to each other. I didn't know the system they used and so when it was Wayne and me vs. Mom and Hazel at least the game was honest. As it happened, I was a lot bolder card player than Dad or Wayne and we held our own pretty good against the women because I'd get the bid more often than Dad did when he played. We'd play cards late into the night until Dad couldn't stay awake any longer and insisted it was time to go home. If it had been up to me, we'd have played until the sun came up. Most people have only one set of parents; I had two.

Mom (left) and Aunt Sylvie (right) in the early 1980s.

I also loved seeing Aunt Sylvie when I came back. Sometime after I left Iowa she had become a lay deacon in her church, the Reorganized Church of Jesus Christ of Latter Day Saints. When the LDS church had split in two in the nineteenth century, after the murder of Joseph Smith, the Brigham Young group that moved to Utah had claimed the name 'Mormon Church" and they're the ones who are known as the LDS church. The RLDS stayed in the Midwest and they are not the Mormons. I suspect Martin Luther and his Lutherans got along with the Catholics about a thousand times more amicably than the RLDS and LDS churches get along. When I first moved to Boise, Addie Jensen happened to ask me what church I belonged to. Rather than get into a long theological discussion I just said I had been "brought up" in "the Reorganized Church of Jesus Christ of Latter Day Saints, which is *not* the Mormons." Addie cheerfully responded, "Oh, we have that here. They call them 'Jack' Mormons." Addie didn't know 'Jack Mormon' is what the LDS call people who have fallen away from the LDS church. My Mormon friends always got a big laugh out of that story.

Sylvie was Mom's older sister and when I was little I learned a lot about God from her, although maybe not in a way she would have entirely approved of. Even when I was little I never bought into the RLDS dogma and I never agreed to be baptized because I think when you accept baptism you're promising to go along with the doctrine, which was not a promise I could have kept. But dogma isn't what Aunt Sylvie taught me. You see, Sylvie taught me through the example of her life. Aunt Hazel was my second mom but Aunt Sylvie was my first aunt. Latter day or not, I think my Aunt Sylvie *was* a saint.

Christmas dinners were usually held at either Sherri's house or at Melody's. I love both my sisters, but I preferred the dinners at Melody's simply because Melody had turned out to be a fabulous cook. If Mom was still alive I couldn't say this, but Melody is a better cook than Mom. That is just another amazing talent my little sister has that no one had ever suspected. Nobody in the family knows when, where, or

how Melody learned how to cook. I know Mom didn't teach her.

One Christmas at Melody's somebody got out one of those games where one person draws a card with a question on it and another is supposed to answer it. I don't remember the name of that particular game, but it was something like 'Ethics' or 'Morals' or something. It's a game designed to cause trouble. One question I remember being asked was, 'You have just found out your sister's husband is having an affair. Do you tell her?' There we all were sitting around the table. I looked at Sherri and Melody. They were both leaning forward, ready to pounce on me whatever my answer was. I looked at Ronnie and Dan. They were both sitting there, pictures of innocence, examining the ceiling with sort of an 'Oh, this has nothing to do with *me*' look on their faces. I looked at Mom. She was giving me Mom's Warning Look: *you better be careful what you say, Buster.* Maryann, my sister-in-law, was leaning back with a big grin on her face, waiting for the fireworks to start.

"Which sister?" I asked.

Sherri gave a squawk. *"What do you mean, 'which sister'?"* she demanded. Sherri, Melody, and Maryann got into a noisy discussion about my obvious lack of ethics and whether or not 'situational' ethics was ethics, and so on. Mom gave me an approving smile and a nod. Ronnie and Dan both relaxed. In all the uproar they all forgot that I hadn't actually answered the question, and when after a minute or two I drew the next card and asked the next question I got away with it. That question was a question I wasn't about to answer for the sake of some silly game. No, sir. □

A lot of changes took place at DMD in the first years of President Reagan's administration. Division manager Dick Hackborn was promoted to a vice president while the '08 was still in the lab prototype stage. It was at this time when HP's disk drive and printer divisions were placed in their own business unit, which meant Dick replaced Paul Ely at the top of our part of HP. Dick was replaced as division manager by manufacturing manager Doug Spreng, the same guy I'd traded elbows with on the dance floor after a beer bust one time. A lot of the guys in the lab didn't like Doug very much, but I got along with him quite well. Like me, he had a 'Driver' interpersonal relations style and neither of us needed a decoder ring for us to understand each other. While I was working on fixing our read-write bugs in the '08 he'd drop by each morning to see if I was done yet. Usually I'd have my face buried in an oscilloscope hood when he'd drop by and my clue he was there would come when I'd smell the smoke of the long, skinny cigars he smoked. I'd get a whiff of the odor and just say, "No, not yet, Doug." I wouldn't even have to take my face out of the scope hood. He'd say something like, "Keep at it," and leave until the next morning.

The BFD finally made it into manufacturing, where it became known as the HP 7933. It came out well behind schedule and only after enormous cost overruns in its development. For a time it had a certain notoriety within the company for representing one of the biggest R&D cost overruns in the history of the company, a distinction that ended the management career of its section manager at HP. He was recruited away from HP by Digital Equipment Corporation, who thought they were conducting a successful raid on DMD's management personnel. Not long after it was introduced, we started getting complaints about its performance being too slow and a follow-up 'performance improvement project' had to be mounted. The prediction I'd made back in 1978 had come true.

We also had our own local version of Paul Ely's failed 'silicon on sapphire technology' venture. In our case the new technology was called 'the magnetoresistive head,' or 'MR head' for short. The magnetic head in a disk drive is the transducer that writes data onto the disks and reads it back. It is a key technology component that determines how many bits per square inch of disk surface can be reliably stored and retrieved. The idea of using MR technology had been proposed by researchers at IBM as far back as the very early 1970s but no one had yet been able to produce a viable one suitable for commercial use in disk drives. DMD had had a very large section, known as 'the technology section,' working on this when I first moved to Boise.

One of the potential benefits of MR head technology was supposed to be the ability to write thinner tracks of data on the disk. The ’08, for example, recorded data at a density of three hundred tracks per inch. Nickel, Vern’s project, was supposed to be able to record at one thousand tracks per inch. A big part of the sales pitch put out by the section manager for the MR head team was that only MR head technology could meet the requirements of our planned next generation of disk drives. At his urging, John had taken a big gamble and ordered the MR head to be incorporated into the Nickel design.

The reason this was a big gamble is that brand new technology is very, very hard to make work and the probability of a new technology failing is very high. In Bob Allen’s words, brand new technologies are ‘blue sky’ technologies. DMD’s MR head was, unfortunately, one of those technologies that eventually did not succeed. Its incorporation into the Nickel project created huge technical problems for that design team, and a lot of them, though by no means all, fell squarely on Vern.

John had decided to place me and my research project snugly inside our next top-of-the-line disk drive project, which was code named ‘Eagle’ and would later be known as the HP 7937. My new boss was Greg Spohn, who had started out, like me, as a design engineer and had been made a project leader on the HP 7911/12 project at about the same time I became one for the ’08. Greg had always had his sights set on a career in management and after the ‘11/12 came out he was promoted to project manager for Eagle’s electronics team. Although he and I were pretty good pals, he was a little nervous about this new workplace relationship that my being placed under him produced. Would it be a problem for me to work for him? He carefully raised this concern with me at our first meeting after I was assigned to the Eagle section. “Greg,” I said cheerfully, “I’d *never* question your god-like powers.” Somehow that answer failed to reassure him, but it turned out we never had any serious problems with each other in all the years I ended up working for him. All in all he was my boss for eight years – longer than I ever worked for any other single person – and he was the best boss I ever had, bar none.

I had no direct design responsibilities on Eagle, although I did act as a kind of technical consultant on questions involving magnetic heads, disks, and the read-write process. At the time these areas were at the center of some of the division’s most expensive production problems in disk drives. One of my coworkers dubbed me ‘the theoretical malingerer’ and for awhile that nickname stuck. One of the earliest things my research established was that our MR head was *not* the crucial technology for meeting our need to pack more data into a disk drive. It turned out that our thin film disk was the key for this. Nickel, like Eagle, would have been able to meet its goals without using the high risk and unproven MR head.

Saying so, however, was kind of a delicate matter. We had some upper level managers who had pretty much bet their careers on the MR head and DMD had poured millions of dollars into its development. Speaking against it was treated more or less like popes and bishops treated heresy in the Middle Ages. The Eagle management team had been watching all the problems the MR head had been producing for the Nickel design team and somehow or other were able to avoid having Eagle be ordered to also use the MR head. I suspect that outside the technology section a nasty case of reality had begun creeping in among DMD’s other managers. Eagle would be the big breadwinner product when it came out, and it was seen as a project that could not be allowed to fail under any circumstances. But, in the face of years of claims that the MR head was mission critical, it had to be an uncomfortable decision to not use it in Eagle. Here there was one tiny bit of comfort I was able to provide. I built a breadboard, known as a ‘spin stand’ because it consisted of a spinning disk and magnetic head, with which I proceeded to demonstrate that recording data at Nickel and Eagle densities without the MR head did work and worked just fine. In the business this is known as a ‘feasibility demonstration.’ I even used some of the electronics Rick Hilton had designed for Nickel when I built this spin stand.

When the Nickel team found out Eagle wasn’t going to use the MR head they immediately began lobbying for its removal from their project. Vern even had a private meeting with John to try to get the MR head decision changed. Unfortunately, he got the same ‘we have to do this for important business reasons and you just have to make it work’ answer from John that I’d gotten a few years before on the

microprocessor issue. Vern's a pretty quiet guy, but there for awhile he was furious with John about this. In fact, I've never seen him madder about anything than he was about this. Problems with the MR head continued to plague Nickel like a degenerative disease and eventually the project was cancelled at the end of its production prototype stage, which is probably the most expensive point in the product life cycle for a project to fail. The back-breaking straw came about when somebody – I don't remember who – demonstrated that among its many problems the MR head suffered from an extreme sensitivity to static electricity. Gruesome pictures of dead MR heads, taken under a microscope, revealed the terrific damage being done to the head by very minute amounts of static discharge. Doug Spreng, who was well acquainted with what was and was not practical in controlling static electricity in a factory, took one look at this evidence and immediately cancelled both the MR head and the Nickel project. In the process this also ended up damaging the management career prospects at DMD of the technology section's section manager. Doug's decision was a good, if long overdue, call. The guys on Nickel were reassigned to do another five-and-a-quarter disk drive, which was code named 'Coyote.' Coyote went on to be a very successful product and it gave birth to HP's entire five-and-a-quarter inch product line.

Not too long after this decision, while Eagle was in its lab prototype phase, Doug was recruited away from HP by the offer of an executive position in a California high tech company. DMD's manufacturing manager, a big guy named Don Curtis, was tapped to be DMD's new division manager. I know John was also considered for this promotion, and I've often wondered if the combination of BFD's cost overrun and the MR head-Nickel train wreck didn't have a lot to do with Don getting the division manager job. Not too long after Don took over the division, John accepted an opportunity to go to Bristol, England, to start up a 'sister division' over there that would manufacture disk drives in Europe and would also work on developing HP's line of tape drives. Steve signed up to go with him and so for a few years Steve and Chris moved to England. Instead of replacing John as R&D manager, the decision was made – for reasons I never really understood – to split DMD's lab into a 'high performance lab' (Eagle) and a 'low cost lab' (Coyote) with separate lab managers for each. Eagle's section manager, Scott Anderson, became my new lab manager. I'd expected Ken to get the other lab manager job but instead this went to a guy who came to Boise from one of HP's Colorado divisions. His name was Doug Clifford. Why this particular decision was made I never did find out. One of Eagle's project managers – a guy named Winston Mitchell, who had been the project manager for the 7911/12 – was tapped as our new section manager. Mitch's part of Eagle was moved under Greg and so, just like that, Greg found himself with about double the management responsibility he'd had more or less overnight. I sure didn't envy him for that. But he handled it with flying colors which, more than anything else I can think of, proved how good he was.

DMD continued to grow but at a more manageable pace. We still weren't overflowing with 'old' people, but by now we did have more experienced people than inexperienced ones. The new projects were considerably less frantic than the previous ones had been and the new leadership seemed to be more realistic in their expectations. I generally had the impression that the stress of working here was much less now than it had been, although DMD never did become what anyone could call a 'stress-free work place.' There was a pronounced difference between how Mitch ran our section and how Ken ran his. Mitch had the attitude that problems were normal, to be expected, to be found and brought out into the light and fixed. I liked this attitude a lot. Ken on the other hand, while I'm sure he also knew problems were to be expected, tended to emphasize the positive. A visitor to our section would be told about all the things that were currently wrong and were being worked on. A visitor to Ken's would be told about all the things that were going right and all the progress that was being made. The two sections developed rather different engineering cultures. Outsiders tended to see our section as being kind of 'gloom and doom' although in fact we weren't. Folks outside the Coyote section tended to see it as 'never is heard a discouraging word,' and this, too, was an exaggeration. As it happened, both leadership styles worked, both sections were successful, and both took about the same amount of time to develop the new products.

Eagle and Coyote were not the only products under development, of course. DMD also started into what became known as 'the box business,' which was an outgrowth of one of the basic ideas of the '08

and '11/12. A 'box' was an integrated storage product. While both Eagle and Coyote involved the invention and development of new disk drives, a 'box' would buy disk and tape drives as components, supply an 'integrated storage controller,' power supply, and package, and the end result was a standalone mass storage system. In the long run this turned out to be a very lucrative business. I don't know who had the idea to enter this business, but whoever it was made an excellent call.

After the MR head was canceled, a lot of the people who had been working on it were reassigned to improving the quality and manufacturing volumes of HP's new thin film disk technology. The disks had been second fiddle to the MR head when that was going on, and as a result they had a lot of nagging quality and process problems at the time Eagle and Coyote started. As I mentioned earlier, HP was the first company to commercialize this new technology, and like all new technologies the manufacturing process had a lot of initial bugs that had to be worked through. The technology section people worked hand in hand with the disk drive projects to improve our thin film disk technology.

Because I was working on my own project and Greg pretty much let me handle it however I wanted to, this period was for me the lowest-stress time I ever experienced at DMD. As Greg came to understand what my research was about, he became enthusiastic about the potential practical benefits it could have down the road. Basically, he saw that what I was doing could eventually be turned into a computer-aided design and analysis tool that would improve the manufacturability of our products, and this did in fact happen later. Greg was always a very practical, level-headed guy.

As for me, in addition to acquiring a great deal of specialized expertise in magnetic recording theory, I was also acquiring a great deal of expertise in system theory and, in particular, what I have since come to call 'general modeling theory.' What I mean by this term is the art and science of making precise quantitative theories ('models') of complicated systems and the development of efficient computer-aided methods for precisely describing how these complicated systems behave. This turned out to be vital for my work on electronic brains and also ended up being vital when I entered the field of neuroscience. Model theory is a mathematical science and it is interdisciplinary in the sense that it can be used in any technical field. Any branch of engineering, any part of brain science, economics, psychology, you name it. All fields of science use models. Model theory is the science of *how* to model things. It isn't a very widely recognized discipline, but I made of it a discipline in its own right, so much so that today I think of my academic specialty as 'model maker.' When I need a more blue-nosed description to tell people what it is that I do, I tell them I am a 'system theorist.' Today when I'm speaking to other neuroscientists, I tell them my field is 'computational neuroscience.' But, basically, I'm a model maker. I take the diverse pieces of different specialized sciences and put them together to understand the bigger systems of which they are the pieces.

Although I spent most of my time doing my research, I was embedded – as the current saying goes – right in the middle of the Eagle section and not at all isolated off in some corner somewhere. My desk and Greg's were in the same two-man cubicle so I got to overhear pretty much everything that was going on when my section mates came to talk with Greg. I also worked pretty closely with a lot of the folks in the technology section since my research involved both disk and magnetic head devices. They were the people with the detailed knowledge of the specific 'pieces' of this part of my research. They, in turn, were quite interested in my computer models and they made me a kind of unofficial member of their section. Through them I got to know the people at HP Labs down in Palo Alto who had originally developed the basic ideas of our thin film disk. From these contacts I was able to better understand how the basic electrochemical 'recipe' for making disks fit into the bigger picture of the read-write process. Finally, many of my friends – including Vern and Rick Hilton – were working on Coyote and I often dropped by their part of the lab to visit and to see what they were doing. After all, what I was doing wasn't just for Eagle. For my work to be broadly useful, it had to be applicable to all our disk drive projects. All in all, this was an exciting, fun, and very cosmopolitan time for me. Looking back, I never had a better time at HP than I did during my doctoral research.

There was only one part of my project for which Greg and I didn't see eye to eye. In complicated systems it turns out to be critical to be able divide up the theory into different levels of understanding. In science this hierarchy of knowledge is called 'scientific reduction.' For example, the bridge you might have driven over on your way to work this morning is made of atoms. Physicists tell us that if we understand atoms we understand everything. In one sense there is a lot of truth to this, but in a more important sense this is just romanticism. The guy who designed the bridge you drove over doesn't design a bridge by thinking about atoms. Between atoms and bridges there is a vast prairie of knowledge rising up from atoms to bridge design. The different levels of understanding make up what can be thought of as rungs on a ladder describing levels of scientific reduction. Scientific specialists spend their careers working on just one of the rungs and different specialists work on different rungs. Modeling theory, as an interdisciplinary science, can be thought of as working on the rails of the ladder that connect these rungs.

In my research project there were three rungs involved. One, the lowest rung on my particular ladder, was the physics of magnetic heads and disks. Next was the 'signal processing' rung, which is concerned with the electric and magnetic signals produced by heads and disks. Finally there was the read-write rung, which is concerned with things like achieving low rates of errors in storing and recovering information. Knowledge at all three levels had to be obtained and integrated in order for what I was doing to be useful. Greg understood the top two rungs – signal processing and read-write – very well and he knew how these rungs are used in disk drive development. However, the lowest rung – the physics rung – is more remote from everyday disk drive engineering and I'm afraid I didn't explain its importance to him very well. My explanation made him think the work I wanted to do at this level was too far removed from the basic objectives of the project. It wasn't, but as I said, I didn't explain it well enough. In truth, I hadn't yet developed the vocabulary that would have made a clear explanation possible.

The part where we didn't see eye to eye involved a very specialized technique called micromagnetics. I didn't invent this discipline. That had been done all the way back in the 1950s by a physicist named William Fuller Brown, Jr. Researchers at IBM and elsewhere had developed some basic techniques for doing micromagnetic modeling, although there were what I regarded as some glaring holes in the technique. The most important *practical* hole was that micromagnetic modeling at the time was very expensive to calculate on a computer. 'Expensive' here means it takes too long for the computer to crunch the numbers and give back an answer. (Time is money). It takes so long that a micromagnetic model is impractical to use at the level of the signal processing rung on the ladder. What I wanted to do was find a way to merge the outcomes of modeling at the micromagnetic level with the type of modeling used at the signal processing level. At the time no one had published anything about this problem and, in fact, it wasn't known how or even if this could even be done in a practical and accurate way. I wanted to find a way to solve this problem, but to do so I would first have to build a micromagnetic model of our disks. Greg quickly understood that a micromagnetic model was impractical to directly use as a computer tool for read-write engineers and so he saw developing this model as a waste of time. Since I hadn't done the work needed to solve the problem – indeed, I didn't yet know if the problem *could* be solved – I wasn't able to explain it well enough to justify doing it.

As a result, Greg wouldn't let me make the micromagnetic model part of my work objectives. From where he sat, this was an entirely reasonable decision. I didn't agree with it, but I didn't argue with him about it either. I had plenty of experimental lab work I still needed to do and this work could only be done using our research facilities in Boise. I also knew that the time was rapidly coming up when I'd have to go up to Moscow and fulfill my on-campus residency requirement that was part of our deal with the university. And I knew that while I was up there I wouldn't have to review what I was doing with Greg. I'd just do the micromagnetic part of the work up in Moscow, where John Purviance was very excited about it. After all, while I was on campus Johnny was my boss.

And that is what happened. I moved up to Moscow in the spring semester of 1984 and finished work on the micromagnetics rung while I was up there. I was able to find a property of the disk's micromagnetic behavior that I could exploit in making a model at the next rung up on the ladder and this

property provided the 'railing' needed to integrate the two rungs of the ladder.

The way this works is by developing ways to make abstractions in going from one rung on the ladder to the next rung. At the lower level there is a whole host of details that are necessary in obtaining an accurate description of the phenomenon. But these details are not used at the next rung up the ladder; only a mathematical description of the final outcome is needed there plus a theory by which measurable physical quantities are to be used in setting the higher-level model parameters. The technical term for this in system theory is 'generalized model order reduction.' It means finding a good but approximate mathematical description that is practical to compute but still retains everything necessary about what one knows from studying the lower rung. In a real sense, modeling theory is the art and science of balancing scientific reduction (higher rung to lower rung) with model order reduction (lower rung to higher rung). Finding a way to do this for magnetic recording was one of my original contributions to knowledge from my doctoral research project.

All scientists in all scientific disciplines make and use models. In a way, learning the models that became the 'standard models' in a given field plus learning how to use them constitutes the bulk of a science education in college. But learning how to *make* models tends to be treated more as an art than as a science. Physicists often call their models 'theories.' Biologists and psychologists tend to call their models 'hypotheses.' A model is really nothing more and nothing less than a reasonably accurate and practical description of our knowledge of the natural world. How accurate it is depends on how much we know. The models at any one rung on the ladder of scientific knowledge are, of necessity, reasonably simple because to be useful they have to be practically computable. I wasn't making any real contributions to models of this sort. What I was doing was developing a scientific approach to *integrating* models across different levels. The currently popular term for this is 'interdisciplinary science.' I wasn't the first to recognize the need for this type of science. Two books I bought at the Stanford Bookstore when I lived in California talked about the problem and these books had a big influence on me. One was by a physicist named Henry Margenau; it was entitled *The Nature of Physical Reality*. The other was by Gerald Weinberg and was entitled *An Introduction to General Systems Thinking.* These were my guides in turning modeling theory from a need into a practical science.

To make a long story short, my work up in Moscow turned out to be very successful and when I came back to Boise in May of 1984 my research was done. My new model gave predictions that agreed perfectly with the experimental data I had measured and explained several previously unexplained phenomena that had turned up during my experimental work. All I had left to do for the project was to write my doctoral dissertation, which also served as my documentation to HP on the outcome of the project. I called it *System Theoretic Modeling of High Density Digital Magnetic Recording* and in the front of it I placed a quote from the American philosopher George Santayana: *Reflection gathers experiences together and perceives their relative worth; which is as much as to say that it expresses a new attitude of will in the presence of a world better understood and turned to some purpose.* I felt then and I feel now that Santayana had described perfectly what research really is all about: to better understand our world so human knowledge can be put to good use for the real benefit of all humankind.

The computer programs I had developed became tools we put to use in disk drive design. The model was used to make other predictions in the years that followed, and every one of them turned out to be true and accurate. I went back up to Moscow in January of 1985 to defend my dissertation, the final exam for the Ph.D. degree. After my presentation and the questions and answers that constitute the examination part of the defense, I went off to the faculty coffee room and had a cup of tea while the professors decided whether or not I had passed. A short time later Johnny came to the coffee room to fetch me back down to the room where my committee was gathered. As he walked into the coffee room his first words to me were "Congratulations, Dr. Wells." I thought of my old advisor from Iowa State, Dr. Triska. I now had the 'union card' I would need to someday have a job like his: college professor. I'd completed one of my life objectives. □

In previous presidential election years there had always been a lot of political discussions at lunch over the summer and fall leading into November. 1984 was different. Aside from a few Orwell wisecracks and occasional references to 'Ronald Ray Gun' – a reference to the 'Star Wars' program – there was hardly any talk about the upcoming election at all. The Democrats put up Walter Mondale as their candidate. Former Vice President Mondale was a liberal's liberal and I didn't like him at all. He had opposed the space program when he was in Congress and he was in favor of all the things I saw as the worst parts of the liberals' ruling agenda. So it was that, even though I was becoming disappointed by and uncomfortable with the noticeably right-wing shift that had taken place in President Reagan's administration, there was no question but that I was going to support President Reagan once more. I had plenty of company. President Reagan got fifty-four million votes that November, almost 59% of the total, vs. thirty-seven million for Vice President Mondale, and he carried every state but Minnesota and the District of Columbia. It was the biggest landslide in U.S. history.

Vice President Bush visited HP's Boise site and made a speech one day. All in all that was a pretty interesting event. A few days prior to the speech the Secret Service descended on the site to prepare for his arrival and beef up security. For most of us it was our first look at what *real* site security looked like. They took over all the guard posts from HP's own security people and handed our site management a list of names of employees who were to be told to take the day off when Vice President Bush was there. One of the names on that list belonged to the project manager of the Eagle disk controller team. Peter's grandparents had been Communists back before World War II and even though Peter was anything but a Communist – he *was* a liberal – his name was still on their watch list two generations later.

The speech took place outdoors in an enclosed courtyard surrounded on all four sides by HP's buildings. Everyone had to pass through a metal detector to get to it and listen to the speech. Secret Service agents were scattered all throughout the crowd and were also posted on top of the buildings. One of the guys perched up there wore this very odd looking, wide-brimmed hat that didn't go with his suit. He was the only guy there wearing a hat. Keith Whitaker and I were looking up at him and speculating on what the purpose of that hat might be. We decided that if he took it off we were going to hit the deck and hug the ground.

I couldn't resist trying to talk to the Secret Service agent nearest me. I kind of drifted over beside him, and he gave me a pretty thorough looking over as I approached. I guess he decided I was harmless because he then resumed sweeping his gaze across the crowd around us. "This is pretty good security," I said to him.

"You ought to see it if Reagan was here," he replied, his head never ceasing to turn back and forth.

I didn't want him to get the idea I was trying to distract him, so I stood there beside him and listened to the rest of Vice President Bush's speech. When it was over I said to the Secret Service man, "That was a pretty good speech."

"Try listening to it twenty-seven times," he replied. □

Eagle had been preparing to enter the production prototype stage when I took my trip up to Moscow to defend my dissertation. When I got back to Boise, a newly minted Ph.D., my first job was to help move our lab furniture from Building 83 Upper down to the transition team area next to the factory floor in Building 82 Lower. It occurred to me as I was moving desks, workbenches, and so on that there's nothing like a little manual labor to remind a person that HP was a classless society.

At Delcon and on the '08 project we had done the production prototype phase in the R&D lab. But Mitch believed the best and fastest way to get Eagle ready for its release to manufacturing was to embed us as soon as possible right down with the production people. He was right about this, too. The whole idea of a production prototype is that it can be *produced.* By having us located in a place where we had daily contact with the production line we found out about problems almost as soon as they popped up. In a product as complicated as a disk drive there are always nagging little problems that don't show up until

you start trying to produce the product in greater volumes. Production proto phase is where you wring the last of the bugs out of the design.

Since I hadn't had any direct design responsibility on Eagle, Greg decided to use me as a kind of staff scientist/engineer helping to analyze and understand the last of the major problems we knew were still in the design. The biggest one we knew about was 'servo margins.' In engineering terminology, 'margin' refers to how much parameters can vary from the ideal design center and how sensitive or insensitive the design is to such variations. The servo system of a disk drive is supposed to achieve proper mechanical alignment between the heads and the tracks of data stored on the disk. There are a great many mechanical and electrical parameters that affect how well a disk drive can do this and the final design had to be able to handle the entire range of normal parametric variations that were going to happen in production. Our servo margins weren't good enough yet and there were two problems that were responsible for this.

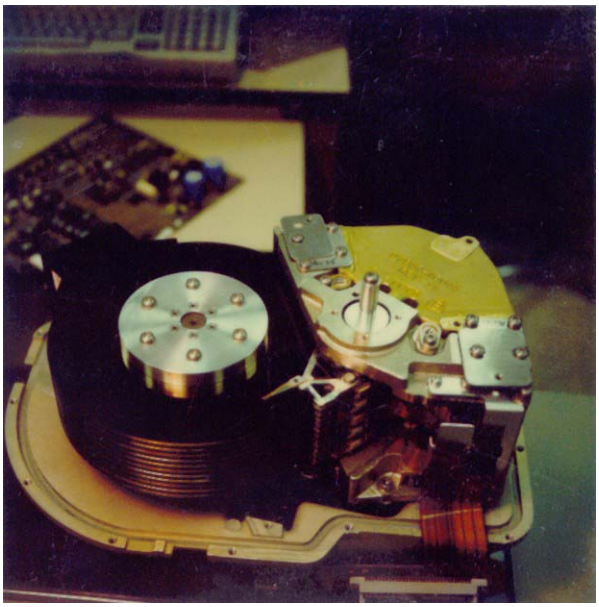
The first problem was called 'servo gain variation.' The electrical signals coming back from the heads that the servo system uses are tiny, less than one one-thousandth of a volt. This signal has to be greatly amplified – roughly by a factor of about one thousand times – in order for the servo system to be able to use this signal. How the final voltage is related to the head position relative to the data track is called the servo gain. Keith Whitaker, who had been given the task of evaluating our servo gain, had documented a very strange fact. Almost every time an Eagle wrote a sector of data the servo gain would change by a small and apparently random amount. This was the first time any of us had ever seen this effect and its cause was completely unknown. Because Keith was the guy who had measured and characterized the effect, we dubbed it 'the Whitaker effect,' which was a tag Keith wasn't thrilled about.

The measured variations in servo gain that he'd seen weren't large but the fact that the root cause of the variation was unknown was very scary because none of us had any idea of how big it *could* get when production began cranking out Eagles by the thousands. One of the things Keith was able to do was to narrow down the possibilities for where the problem might be originating and had managed to show that the effect was coming from either the heads or the disks. Because of the way servo gain variation behaved the odds heavily favored the heads being the source of the problem. My research work had made me HP's foremost authority on how magnetic heads and disks produce signals so Greg assigned the task of understanding and explaining the Whitaker effect to me.

Keith briefed me on what his experiments had uncovered and showed me his data. That helped narrow down the possibilities for what kind of physics was at work here. As it turned out, there *was* a property of magnetic heads I already knew about that might contain the explanation. Basically magnetic heads have an 'effective magnetic width' that is not the same as their physical width. This is caused by certain properties inherent in the material from which heads are made. Furthermore, the nature of the physics was such that this 'magnetic width' could be expected to change every time the head was used to record data. I already knew from my own earlier experimental work the range of parametric variation due to this factor. The question was: Was the magnitude of this effect capable of explaining the total gain variation Keith had measured? The total impact of magnetic width variation on the servo system was more complicated than just being a matter of how much magnetic width variation took place in the head itself but nobody had ever presented any technical papers addressing the overall problem and no one had ever presented a quantitative model for analyzing it.

The model I had developed for read-write wasn't capable of doing this either, and so I set to work extending this model in order to be able to apply it to servo system design. This turned out to be easier to do than I had expected because not many years before an academic researcher had published a paper on the mathematics that were necessary to analyze this particular situation. I merely had to incorporate his mathematics into my model and conduct a few experiments verifying that this did in fact provide an accurate model of the situation. The other guy's theory worked and so I was able to then carry out a complete analysis of servo gain variation in disk drives. The results were in outstanding agreement with Keith's data and, as a necessary additional benefit, my extended model let us calculate the worst case

amount of variation production would see in high volumes. There wasn't any practical way to remove the source of the variation itself – the source was an inherent property of the way magnetic heads were made – but at least we knew now how much variation the servo system would have to withstand. The margin loss we suffered from this effect had to be made up by reducing margin loss elsewhere in the design. After the model was proved to be correct and accurate I was even allowed to publish a paper on the general theory of servo gain variations – although not of any Eagle specifics – in the technical literature.



The Eagle Mechanism. The actuator is the gold-and-silver-looking thing to the right and disk spindle is the silver and brown thing to the left. The disks are eight inches in diameter.

This brought the second big remaining problem into the picture. This second problem was called 'the actuator resonance problem.' Real mechanical parts aren't perfectly rigid bodies. Think of a tuning fork, for example. Everyone knows if you lightly tap on a metal tuning fork it vibrates; you can even hear the sound this makes because the vibrations set up pressure waves in the surrounding air. A tuning fork will vibrate at a particular vibration frequency and this frequency is called 'the resonant frequency' of the tuning fork. The actuator resonance problem was basically the same thing except that different parts of the Eagle mechanism vibrated at different resonant frequencies. There was one frequency in particular that was our real problem and the question was: What part of the actuator was causing this resonant frequency? If we could identify what was vibrating then we could fix it. Until then we were in big trouble.

The resonance problem had been around for quite awhile by then and the mechanical engineers, especially one of my friends named Dave Woito, had been working very hard on it but without sufficient progress. Dave was still a relatively young engineer, although not a rookie by any means, and when the problem had first popped up Eagle's mechanical engineering staff had consulted with the division's oldest and most experienced mechanical engineer, a guy named Roger Sleger. After listening to the description of the problem, he offered the opinion that it was probably a 'bearing resonance.' The actuator is a rotating motor and uses two rings of steel ball bearings. The idea was that if these ball bearings were undergoing compression and decompression the result could be the resonance phenomenon Eagle was seeing. Dave and our other mechanical guys had been working empirically on that premise since then.

Mechanical engineers do receive some introductory training in system theory as undergraduates, but unless they go on to graduate school and specialize in it, they don't really receive enough training in the theory or the specialized tricks of the trade to effectively deal with systems as complicated as the Eagle actuator. That was why our guys' work on the problem had been based on experiment and hypothesis. By the time the Eagle team moved downstairs to the factory, the resonance problem was becoming mission critical to finishing up the project. Greg was getting worried and he asked me to see if I could make a model of Eagle's actuator and see if I could find the root cause of the problem. Now that I was a 'Doc' this kind of problem was supposed to be right up my alley. And, of course, he was right.

I sat down with the mechanical guys and they gave me some fast technical training on how the Eagle actuator was built and many of the fine details of how it worked. Dave provided me with copies of his measured data characterizing the resonance problem, and I got to work. It took me a couple of weeks to put together a basic mathematical description of the actuator and figure out what the key physical parameters were. For many of them I was able to get approximate numerical values from the mechanical engineers, but there were a lot of other parameters that were completely unknown. However, using the

data Dave had gathered I was able to come up with numerical estimates of their values by forcing the model to agree with Dave's data. This took another two or three weeks to accomplish and it wouldn't have been possible without the work Dave had done previously. Finally, though, my model was done and was providing an accurate description of the resonance dynamics. It was time to identify the root cause.

It turned out that the bearings actually had very little to do with the resonance problem. The real cause was a plastic coil form around which the coil of motor wires was wrapped. This coil form wasn't stiff enough and, under the very large forces being produced in the motor, it was bending. This was the source of vibration responsible for the actuator resonance problem. I reported my finding to Dave.

Dave was pretty skeptical at first, and with good reason. During any project everyone always has a lot of things to do, and both electrical and mechanical engineers often try to get each other to take ownership for accomplishing different tasks. However, since everybody is always very busy, people are naturally reluctant to take on 'someone else's problem.' I might go over to Dave and say, "Dave, could you do this?" He'd respond, "That's an electrical problem. Do it yourself." If he came to me with something, I'd say, "That's a mechanical problem. Do it yourself."

I was no different in all this from anybody else, and my eventual solution was to give all the mechanical engineers the idea that I was a total klutz at all things mechanical. I would build these Rube Goldberg mechanical contraptions and then insist on public exhibitions of them, at which I would always be overtly proud of the awful gizmos I'd throw together. I also bought a one dollar book published early in the twentieth century entitled *Teach Yourself Mechanical Engineering* and had boasted to Dave that with this I, too, could be a mechanical engineer. The book was about things like anvils and hammers. It worked and I'd convinced all the mechanical guys that, regardless of how good an electrical engineer I might be, when it came to anything mechanical I was a complete moron. The ruse was so successful that any time one of them saw me pick up a screwdriver, he'd rush over and take whatever I was going to build away from me with a paternal, "Here, I'll do that." I was a walking embarrassment to the mechanical engineering profession.

Consequently, it was completely natural for Dave to doubt that I, of all people, could possibly be able to tell anyone anything about the resonance problem. But things were getting kind of desperate, nobody had thought of looking at the coil form before, and basically the guys were running out of ideas. Dave was too good an engineer to just dismiss what I'd told him, even considering the source. He checked it out and quickly found out my analysis had been correct. Once he knew where to focus his effort, he solved the resonance problem in almost no time at all. All I did was point out where to look; I couldn't have actually solved the design problem myself. That took Dave's skills to accomplish.

My actuator model was really a pretty nice little model and I would have liked to publish a paper on it. But once the model had proved itself on the resonance problem, it was pretty clear to me and to Greg that the model was going to make a good computer-aided design tool for use in our next disk drive project. It would give us a competitive design edge – especially over the big Japanese companies who were our major competitors in the disk drive business – and so we decided this model should be classified as a trade secret. I never published it and we did put it to good use on the next project in doing the servo design.

One other really nasty problem came to light during Eagle's production prototype phase. It was the 'head shift' problem. Almost all materials, the notable exception being water, expand when they heat up and contract when they get cold. In the Eagle mechanism we had different parts made out of different materials, most notably magnesium and stainless steel. Different materials expand and contract by different amounts as temperature changes and each material is characterized by a physical parameter called the 'coefficient of thermal expansion.' It was discovered that as Eagle underwent wide swings in temperature the magnetic heads would shift – each one by a different amount – and ruin the precise alignment needed to keep the heads reliably over the top of the recorded data tracks. Some of this shift was elastic, which means it went away when the temperature came back to normal. Some of it was

plastic, which means that even after the temperature came back to normal some residual head shift still remained. At the least head shift hurt the performance of the disk drive. At the worst it could cause the disk drive to fail to work at all. Head shift was such a serious problem that it threatened the success of the entire project. It absolutely had to be fixed.

When the seriousness of this problem was recognized the Eagle disk drive controller was in pretty good shape, very close in fact to being done. Mitch therefore assigned Peter, the controller's project manager, to take charge of solving the head shift problem. Since my 'theoretical malingering' days were now over, Mitch assigned me as the engineer who was supposed to solve the problem. I was aghast. "I don't know anything about head shift," I protested to Mitch.

"Neither does Peter," he replied. *Ooookay,* I thought.

Well, you can't fix it if you don't know what's broken. I set to work and designed a series of experiments to find out what the characteristics of our head shift problem looked like. It took several weeks to figure out what experiments to do and how to do them. After carrying them out, we had a much better idea of how the actuator and heads were deforming under temperature, and this pointed towards particular areas within the mechanism that were being affected by temperature. Once I had this data I was in a pretty good position to admire the problem. But, "I don't have the first clue how to solve this," I said to Peter. The problem went right to the heart of machine design, which is something mechanical engineers are trained to do but electrical engineers are not.

Peter, now armed with the facts, went back to Mitch and told him we needed a mechanical engineer to work on fixing the problem. Mitch agreed – thank goodness! – and assigned Joe Wood, a very good mechanical engineer, to take over the design of the solution. Joe is a very practical, down to earth, no nonsense engineer who knows how to get the job done. He also has a pretty good if somewhat earthy sense of humor. Now that I was no longer 'the theoretical malingerer' most people called me Rick again, a few called me Doc, but Joe tagged me with the nickname Elmer. If you phonetically pronounce 'Ph.D.' it comes out 'Fudd.' I was Elmer Fudd, the hapless rabbit hunter from the Bugs Bunny cartoons.

Happily for me, this nickname never really caught on. Happily for everybody, Joe knew how to go about solving the head shift problem. He would make changes to the design, I'd re-run my experiments to test how close we were coming to the solution, and I'd report these back to Joe. I couldn't begin to tell you all the things he had to do to finally fix the problem, but fix it he did. Eagle had cleared the last major technical hurdle it had to get over before it could go into production. □

Bristol, England (1985)

By the summer of 1985 I was ready for a major vacation. Chris and Steve had been living in Bristol, England for a bit over a year by then and Chris had come up with a great idea for one: sailing the Dodecanese Islands of Greece in the Aegean Sea. She made arrangements for us to charter a sailboat out of the Turkish resort town of Bodrum and in mid-July I boarded a plane and set out to join them in Bristol.

Except for that long-ago fishing trip to Red Lake, this was the first time I'd been out of the United States. It was a long flight and as the plane descended for its landing in London I was enthralled by the beauty of the English countryside passing below. England was a lush, green, grassy land with small rolling hills speckled with small woods and dotted with numerous small towns. For all the world it reminded me of Iowa in the summer. We landed at Gatwick and from there I took the train to Bristol where Chris and Steve would meet me.

The English countryside seen from the windows of the train was every bit as pretty as it had looked from the air. I would have liked to have seen every second of it but I was having a hard time keeping my eyes open on the train trip. I'd heard of jet lag but this was the first time I'd experienced it. It was a beautiful morning in England, but to my body it was the middle of the night and I was very tired. There was a woman with her little boy sitting in the seat across the aisle of the train car next to me, and I was enchanted by her British accent as she talked softly with her child. Even though I was a foreigner in this land, there was something that seemed to permeate the very air of England that made me feel very much at home. It reminded me that my own ancestors on Dad's side of the family had come from this land very long ago and I couldn't help but have this strange feeling that somehow or other their ghosts lingered in the air, come to welcome their long lost descendent back to his native land. After returning from Greece and Turkey I planned to spend an additional two weeks in England, and I was looking forward to seeing and exploring much more of this ancient island.

I stayed in Bristol with Chris and Steve in their flat for the next couple of days. This gave me some time to get over the jet lag before we all departed for Asia. They had recently had their first son, Timmy, and Chris' mom had come to Bristol to look after him while the rest of us were away. He was a beautiful baby and I was a little amused, although not surprised, by the way Steve couldn't seem to get enough of cradling him in his arms.

One bit of news greeted me when I arrived in Bristol. Back in America the country was undergoing an economic downturn and while I was somewhere over the middle of the Atlantic HP had announced the company was going on what we called 'the nine-day fortnight.' The company needed to reduce its payroll by ten percent. Rather than laying off ten percent of us, though, the company instead went to a schedule where all of us worked only nine days out of every ten and everyone took a corresponding temporary cut in pay. Bill and Dave had first instituted this policy as an alternative to layoffs during the recession of the 1970s. When the economy emerged from the recession, HP's workforce was intact, ready to respond to the opportunities when business recovered, and we went back to a full work schedule. The nine-day fortnight didn't come as a big surprise. I'd been expecting it for some time. Back home, I'm pretty sure my colleagues in the R&D lab were probably voluntarily coming in on the tenth day anyway. New products were the lifeblood of the company and because the company's management was so loyal to all of us, that loyalty was reciprocated by HP's people when the company was in need. I've always thought the nine-day fortnight was a brilliant policy. Layoffs over the short term are short-sighted and downsizing is the symptom of a dying, badly-managed company. HP in those days was a growing, vibrant company and the nine-day fortnight was a symptom of our underlying corporate health. As for the across-the-board ten percent pay reduction, it wasn't going to present any real hardship to me. My main reason for always making sure I put money into savings and investments was retirement, but a second important reason was to make sure I'd always have a 'rainy day' cushion against the unexpected. For that reason, the fact that I landed in England making less money than I was making when I boarded the plane in Boise didn't dampen the prospects for fun on this vacation in the slightest.

After a couple days in Bristol, which let me start to recover from the jet lag, we all journeyed back to London and boarded the plane for Turkey. It ended up being a long flight. For some reason we were never told, the plane had a long delay before takeoff and by the time we were finally airborne we had missed the 'window' during which the plane was allowed to fly over the Iron Curtain countries of Europe. Instead we had to make a longer flight over France and down the west side of the boot of Italy. From there the plane turned east. We also had to make a detour to stay out of Greek airspace. This was because we were bound for Izmir in western Turkey and the Greeks wouldn't allow any plane going to Turkey to use Greek air-space. The two countries just don't like each other very much.

As a result of the delay and all the extra air miles, by the time we landed in Izmir there were a lot of people on that plane who very badly needed to use the john. One of the things about the airport at Izmir is that the airport facilities do not include western-style toilets. Instead they have a little flat porcelain gizmo about two inches deep that is set flush to the floor. What you have to do is crouch down and let fly

without sitting down. I watched a big herd of British women go stampeding into the women's john at the airport. A couple of minutes later they all came flooding back out again with looks on their faces of varying degrees of disappointment and distress. I got quite a chuckle out of that. I don't like these Asian sanitary facilities either, but I didn't have to go just then and could afford to feel humorous about it.

I got my first hint at how laid back the Turks are when we went through customs. We had a tourist's guidebook that said, among other things, that you are only allowed to bring one camera and only up to ten rolls of film into Turkey duty free. I had two camera bodies and considerably more than ten rolls of film in my camera bag, so I got into the 'something to declare' line at customs. When I finally got to the customs agent, he opened my camera bag, looked in, and then looked at me with a puzzled expression. He didn't speak English and I don't speak Turkish, but I smiled, held up two fingers, and pointed to the two camera bodies. "Two cameras," I said. He just rolled his eyes and waved at me to go on. I was holding up the line. I didn't have to pay so much as a lira.

In the States you always hear all these horror stories about how hard-nosed the Turks are, so all of us naturally felt more than a little leery about what kind of a people we'd meet when we got to Turkey. It turned out all those stories are grossly exaggerated. It was true that the Turks were all pretty dour looking when I'd first meet them, but I also found out that if I smiled first every one of them would beam right back; it was like the sun coming out from behind a cloud. By the time we left to go back to England two weeks later, I'd come to greatly like the Turkish people and their land. Every one of them I met was a warm, hospitable person, very friendly, and hugely likeable. Forget everything you might have heard about Turkey. It's a wonderful country of marvelous, marvelous just-plain-folks people.

Bodrum seen from atop Bodrum Castle

From Izmir we boarded a bus for the three hour bus trip south to Bodrum, where we would meet the English owner of the sailboat, a man named John. I sat near the back of the bus, just in front of the big piles of luggage, next to one of the Turkish guys who worked for the bus line. Neither of us spoke the other's language, but by using signs and gestures we still managed to have a great conversation all the way to Bodrum. He was able to make me understand what it was I was seeing out the windows of the bus and even managed to teach me a few Turkish words, such as the words for 'water' and 'mosque.'

One of the things I noticed during the bus ride was that if there were any traffic laws at all in Turkey, they were considerably looser than in America. The roads were two-lane roads but several times we met pairs of cars or a car and a truck when one was passing the other. Whenever this happened, our bus and the car being passed simply moved over to the road side and the passing vehicle would just go in between us so that we passed three vehicles abreast. Nobody except us westerners paid the slightest attention to this; it was normal. After the first four or five times I stopped paying attention to it as well.

Western Turkey is desert country, much like southwest Idaho. It is not the kind of sandy wasteland such as was depicted in the *Lawrence of Arabia* movie. It has a rugged beauty all its own and was sprinkled with numerous towns and villages, each of which had its mosque easily identifiable by its tall and slender tower rising to a point at the top. At sundown the rays of the setting sun painted the countryside in spectacular red light streaked in shades and shadows. It was beautiful.

It was after dark by the time we arrived in Bodrum and the bus dropped our party off in front of what turned out to be the marina. The bus continued on taking everyone else to one of the local hotels and we found ourselves alone in the dark on the deserted street. John, the boat owner and our captain for the charter, had expected us to get off at the hotel and had gone down there to greet us. Not knowing what

else to do or where he was, we just milled about for awhile trying to figure out where we were and whether there was some place we needed to walk to. That short interval was the first and only time during the trip where it really came home to me that I was in someone else's country, a foreigner not even able to speak the language. It was an eerie feeling but, fortunately, it didn't last very long. After we failed to get off the bus at the hotel, John came looking for us and, since we were already right there at the marina, we were soon aboard his boat, the *Dark Star,* and got ourselves settled in. The *Dark Star* would be our floating hotel for the entire trip.

Bodrum marina. The *Dark Star* is the brown trimmed yacht in the center of the picture with her bow pointing outward.

Counting John, there were seven of us aboard: Myself, Steve and Chris, another American husband-and-wife couple named Rick and Karen who lived in Bristol, John, and an adventurous young English girl named Jane. The *Dark Star* slept five below decks. Steve and Chris took the stern accommodation, Rick and Karen took the forward accommodation, and I took the bunk amidships. John and Jane slept on deck where, among other things, it was cooler at night than it got below deck. The boat carried its own bathroom complete with western style commode and a shower. This came in handy more than once when the authorities turned off the water supply ashore. Being desert country, water shortages were common in the summer and when the Turks needed to conserve it they'd simply turn it off. No prior warning would be given; that would defeat the whole purpose because people would have rushed to fill bottles and canteens. You'd just wake up in the morning and discover there was no water. That, however, never bothered us on the *Dark Star;* our commode and shower drew water from the Aegean and so our facilities never got shut down when all ashore was bone dry. We carried bottled drinking water with us.

The next morning John collected all our passports and took them down to the local port authority. Our plan was to spend a couple days seeing the sights in Bodrum itself. The three women took charge of the food and we breakfasted on yogurt. At first this was pretty tasty but by the time our two weeks on the boat were over with I'd come to heartily detest yogurt and have never eaten any since. Bodrum is a very picturesque town catering heavily to tourists. Its streets are narrow and most of the local shops set up their wares outside with big cloth sheets stretched overhead between the buildings on either side to provide shade. Leather goods were very inexpensive; I bought a pretty nice leather bag for the equivalent of about two dollars fifty cents in American money. My guess is that this price was probably pretty expensive by the standards of the Turkish people, but compared to America Turkey is a poor country and while none of us were rich back home, we certainly were rich so far as the Turks were concerned. I bought a number of leather goods there as well as a small water pipe, commonly known as a hookah although this is not the Turkish word for it. If you're wondering, I smoke tobacco with it. Nothing else.

In ancient times Bodrum was called Halicarnassus and had been the capital of the region. It was the birthplace of Herodotus, the Greek father of modern history who lived in the fifth century B.C. The region is rich in ancient history, having passed back and forth between Greek and Persian hands a number of times. Easily its most visible and attractive feature today is Bodrum Castle, a great fortress built starting around 1402 A.D. by the Knights of Rhodes. Today it is a museum featuring many ancient artifacts on display there.

Bodrum was where I got my first taste of real Turkish cuisine. That evening John took us to a local restaurant next to the sea. Turkish food is one of only three truly distinct cuisines, the other two being French and Chinese. People who know all about food say everything else is a mere derivative of these three. I have pretty close to no idea what I ate there that evening – although I know octopus was part of it

– but I've never eaten better. Words can't really describe it, but absolutely everything was delicious. Even the octopus. It was accompanied by sweet Turkish tea and, despite the fact Turkey is a Moslem country, some very fine wine. Like everything else in Turkey, the service was very laid back and they took their time about bringing out our first course. So long, in fact, that we started to wonder if they'd forgotten our order. But when we signaled to the Turkish head waiter, who was lounging casually in a doorway keeping an eye on his domain, he just gave us a hand gesture that in any language says, "Be cool," and a few minutes later dinner started coming. Once it started coming it seemed like it was never going to stop either. There's no concept of 'fast food' in Bodrum. Dining out isn't just for eating. It's for making a whole evening with friends, food, and conversation under a beautiful star-lit sky. By comparison the best restaurants in America are like little more than hamburger joints. Except for that Cajun restaurant in Louisiana where I ate during my interview trip to Dupont so many years earlier. That's the only one I've ever known that can compare with the little seaside restaurant in Bodrum.


Under sail. Left: John, Karen, Chris, Jane at the wheel. Right: from left to right, Karen, Jane, John, Steve, Chris.

Dark Star was built to sail the open waters of the ocean and after a couple of fun days in Bodrum we got underway to visit the Greek islands. The summer waters of the Aegean were a little choppy but not too bad and were a gorgeous blue color with occasional whitecaps. The wind was brisk, blowing out of the northeast most of the time, and we made good way. Only once during our trip did the wind rise to near gale force, which provided a terrific and exciting sail that day. Usually we weren't entirely out of sight of land, but the Aegean's a big place and every once in awhile we'd find ourselves in open water with no land in sight. We flew the British Union Jack on our stern along with either a small Turkish or a small Greek flag, depending on whose waters we were in. John told us that the Greeks especially were picky about this flag and it was a huge mistake to sail into any Greek port flying the Turkish pennant. We did in fact see a number of Greek naval vessels, mostly patrol-torpedo boats, frequently when we were in Greek territorial waters. Bodrum, in contrast, had no military presence whatsoever that I saw.

Ancient ruins on Kos

Our first stop was at the Greek island of Kos, which was the birthplace of Hippocrates (fifth and fourth centuries B.C.), the father of medicine. Kos town was very much a tourist spot and picturesque enough. I thought the most interesting sight there was the ancient ruin nestled within the modern town itself.

Like the Turks, the Greeks of Kos were pretty dour when I first met them. Unlike the Turks, they were unimpressed by Yankee overtures of friendliness. I rather quickly got the impression

the folks on Kos didn't care too much for Americans. I didn't see any police officers on Kos but I did see a number of soldiers patrolling the streets casually carrying submachine guns under their arms. 'Laid back' was not a description I'd say applied to Kos. No one there was overtly unfriendly, but I didn't meet anyone there I'd say was friendly either. It made an interesting contrast with Bodrum. The morning we were set to sail two uniformed Turkish officials came to the boat with our passports, ostensibly to make sure each passport matched up with its owner. In fact, all they did was go down below decks with John long enough to sneak a beer apiece before coming back up and wishing us a pleasant journey. They just left our passports on the table below and didn't even count us, much less match us to our passports. I had a distinct impression Kos was not quite as informal about such things.

About the first order of business I had as soon as we came ashore in Kos was to visit one of the local banks to exchange some British pounds for drachmas. Given the hostility the Greeks felt toward the Turks it was obvious without anyone having to tell me that it would have been useless and probably stupid to try to exchange Turkish lira for Greek drachmas. I figured the less the Greeks knew about our travel itinerary the better for all concerned.

The first thing I noticed was the British pound didn't go as far in Greece as it did in Turkey. When I'd exchanged a few hundred pound notes for lira in London before boarding the plane, the bank teller proceeded to count out a big pile of twenty thousand lira notes. These turned out to be useless everywhere in Turkey except at banks and Turkish rug merchant shops. Nobody else could even make change for that much Turkish money. In contrast, the exchange rate in Greece was closer to about four drachmas for each one pound note if I remember correctly. At the same time, prices for goods when expressed in native currency were more or less comparable in Greece and Turkey so while we were 'well off' in Greece, we weren't 'rich' there like we were in Turkey.

After getting some Greek money my next stop was at a small shop where I bought some postcards. I thought Mom and Dad would enjoy hearing from me at different stopping points on the trip. Both of them had been more than a little unhappy when they learned I was visiting that part of the world. I guess they thought it was too close to Israel and Palestine, which was at that time as it is today a pretty dangerous part of the world. I'd had to explain to them that western Turkey and the Dodecanese islands were hundreds and hundreds of miles away. Even then they were nervous. Getting regular postcards would, I hoped, ease their minds. I'm really not a reckless person but Mom, Dad, and Sherri all tended to think I am and that it would be just like me to walk straight into some dangerous situation and tug the lion's whiskers.

After mailing my first postcard I set out on foot to have a look at Kos town. It was a nice, clean place although not especially exotic. The dominant church I noticed was Eastern Orthodox Christian although I did see what looked like it might be a church belonging to some other Christian sect. I didn't have any set plan for where I was going. I figured I'd just wander around and see what I came across. I wasn't worried about getting lost because I could see the sea from just about everywhere and wherever I might get off to, I knew it wouldn't be hard to find my way back to the harbor and the boat. Kos town isn't tiny, but it isn't all that big either.

I was just meandering around taking in the sights when I turned a corner and all of a sudden found myself standing at the edge of some ancient ruins. *That* really gave me a pick-me-up because it was just exactly the sort of sight I most wanted to see on this trip. I was surprised at how deserted it was. The only other person I saw there was a small boy who was playing by himself at the edge of the ruins. I spent a pleasant hour or so wandering among them, soaking in all the history and admiring the marble work. Even though the site was in ruins, it was easy to imagine how grand it must have looked in its day.

As far as I could tell, one day was about all it took to catch the sights in Kos town. Kos was green and pleasant, decorated with palm trees and nice, well manicured gardens. As evening approached I made my way back to the harbor and the boat. As the sun began to set John introduced us to a fine British tradition: the sundowner. We sat on deck sipping our drinks and watched the shadows lengthen without a care in

the world. In Turkey we were pretty careful about not flaunting alcohol in front of the Turks. Islam forbids alcoholic beverages and we wanted to be polite guests in the places we visited. Greece, on the other hand, had no fundamental objection to drinking and the sundowner became a regular and relaxing part of the end of each day while we were in Greek waters. Only Rick and Karen, who were Mormons, didn't participate in this aspect although they did keep us company and drank some kind of fruit juice.

My turn at the wheel. Chris and me bound for our next port of call at Kalimnos.

Only about a dozen statute miles separates Kos and Bodrum so the first day's sail had been quick and easy. After spending one day on Kos we talked it over and decided to leave the next morning to visit the island of Kalimnos, which was about twenty statute miles north and west of Kos.

It was a perfect day for sailing and John had no objections at all to having us take turns piloting his boat. He was, naturally, the most experienced sailor among us. Jane turned out to be a pretty good sailor, too. Among the rest of us, I was the only one who had done any sailing previously and I couldn't wait to try my hand at piloting *Dark Star*. She was a fine craft although I thought she didn't have as much rudder as I would have liked. It made her sluggish in turning with several seconds of delay between the time the wheel was turned and the time she responded. John was entirely used to this, but it did give me some trouble and took a lot of getting used to. By the end of the trip we had all gotten to take our turns piloting the boat, mostly in open water well away from rocks and land where if mistakes were made they wouldn't be catastrophic.

We had a long, pleasant sail to Kalimnos and put in at a tiny fishing port. There were no signs to identify the name of the town, only some graffiti in Greek letters painted on a little outhouse building on the pier. The town was made up of numerous small white houses that spaced themselves out into a lush valley of orange trees. My best guess is it might have been the town of Vathis, but I have no way to know for sure and I didn't think to ask John.

Kalimnos was a mountainous island, although I wouldn't say the mountain was very big, and above the valley it was sparsely vegetated. Steve, Rick, and I decided to hike the road that wound along the side of the mountain and so we set off after arranging for the boat to pick us up again farther down the coast. It was a hot hike made interesting by our discovery of many small, ruined stone walls and houses scattered about in the valley along our route. We also saw several small little Eastern Orthodox churches built from white stone. Steve and I guessed that the ruins probably dated back to sometime during the Byzantine empire but we had no way to know for sure and our guide book hadn't mentioned them at all. None of us thought to bring along any water or anything else to drink so by the time we finally met up with the boat again I was pretty thirsty.

After being picked up again by the boat we sailed on around the island to Kalimnos town. It was a surprisingly big city, very bustling and modern. Originally the main enterprises on Kalimnos were the orange groves and the numerous sponge fishermen before tourism became big business for the island.

Kalimnos town at the main harbor

Kalimnos town was spread out for a very long way in a narrow strip along the coast. The harbor was packed with boats moored side by side. There were local fishing boats, a number of sailing yachts, and many power boats. Near where we moored there was a British guy who owned a small and, I thought, rather modest power yacht. I didn't think it really looked very seaworthy but it must have been good enough to get him to Kalimnos across the open water of the Aegean.

It soon became clear that this Brit wasn't exactly a descendent of Lord Nelson. Not long after we tied up, he powered up his boat and began backing away from the wharf. I hadn't been paying any attention to him until a little Greek fisherman began shouting at him frantically. The only word he was saying that I could make out was 'propeller.' I looked and, sure enough, the guy was backing his boat right into the fisherman's anchor rope. The Brit was just looking at the fisherman, neither saying a word nor looking around to see what the warning might have been about. Uh-oh, I thought. Sure enough, he backed right into the anchor rope and fouled it around his propeller.

I thought the fisherman was going to have a fit right there on the spot. The guy in the motorboat didn't say a word all during this although he did power down once his propeller got entangled. John went over and spoke with the fisherman; he also informed his fellow countryman what it was he had just done. There was no expression I could read on the guy's face at all. He made no offer to help fix the mess he'd just caused. After making sure the guy wasn't going to power up again, John jumped into the water and dived down to try to untangle the anchor rope. This turned out to be hopeless and in the end he had no choice but to tell the fisherman he'd have to cut the rope. The fisherman was plenty mad about it but he didn't have much choice. He nodded and John dived down there again with a knife. Soon enough he'd freed the rope from the propeller, losing the fisherman's anchor in the process. The guy with the motor-boat fired her up again and got himself out of there and away from the fisherman as fast as he could, still without offering one word of apology to the fisherman. I watched him. He motored down to the far end of the wharf, came about it, and ended up tying up again on the opposite side probably not even two hundred yards from where he'd been.

I thought it was probably best not to point him out to the Greek guy but I did point him out to John. "I wonder what the sense in that was?" I commented. As far as I could tell, one spot here was just as good as any other.

"He's a twit," John replied. It was clear John thought this guy had no business operating a boat at all.

Kalimnos was a lively town at night. There was no rolling up the sidewalks here. We went out to dinner later that evening to a cafe that had sidewalk tables. For some reason I wasn't very hungry that night and decided a salad would fit the bill for me. There was something on the menu called a 'Greek salad' so I ordered one of them. When it came Chris started laughing. The 'Greek salad' was nothing else but an enormous bowl full of sliced tomatoes. Chris knew perfectly well that I hate tomatoes and the look on my face must have told the whole story. As far as I'm concerned, the three uses for tomatoes in this world are tomato soup, pizza sauce, and ketchup. How a bowl full of tomatoes qualifies as a 'salad' is something I've never figured out to this day.

Although Kalimnos was, by local standards, a pretty 'happening' town we decided not to spend too much time there. Nightclubs weren't rare back home and we had come to see things we couldn't see at home. Chris was in favor of pushing on to Patmos. It was a long haul but we figured we could make it in a good day's sailing. So it was that we bid Kalimnos farewell and set out for the Biblical isle of Patmos.

Leros.

Patmos was about thirty-five statute miles north by northwest of Kalimnos and under ideal circumstances would take the better part of the daylight hours to reach. Unfortunately, conditions that day weren't ideal. The wind had shifted a little and we found ourselves having to sail directly into it on the straight course from Kalimnos to Patmos. As a result we had to make a series of very long tacks, which more than doubled the sailing distance to the island. By late afternoon we were only about halfway to our destination. We talked about pushing on through the night to reach it but none of us thought the urgency was so great as to require that, especially when the island of Leros was near at hand.

We hadn't planned to stop at Leros. The guidebook basically said it wasn't a very interesting place. But it did have a harbor and one restaurant in the main port of Lakki, so we decided to put in there for the night. As we approached we could see that Leros was lush and green with many trees, altogether different from the more barren looking landscape of Kalimnos. Even from out to sea it was a pretty island. To enter the main harbor we had to sail between two tall cliffs, atop each of which was an enormous statue. The two statues were placed facing each other and overlooking the harbor mouth. Once through the narrow opening between the cliffs Leros opened up into a wide, pretty bay. Off to our starboard side we could see a collection of buildings and houses that John said was the Greek naval base at Leros. Pearl Harbor it wasn't, but the harbor was busy with a few PT boats.

We tied up at a pier just across from the Restaurant Pizzeria, which the guidebook said was the most 'prominent' restaurant on the island. The buildings and architectures on Leros had a look more Italian than Greek and the town wasn't exactly overflowing with tourists. Leros itself had been under control of Italy from 1912 until World War II. It was most well known for being a battleground during the war when the British occupied it after Italy's capitulation and then the Germans invaded it using paratroops and decimated the five thousand man British garrison.

We docked not long before sunset and decided to check out the cuisine of Restaurant Pizzeria. The idea of eating pizza in Greece struck us as kind of an irony and we were actually curious how pizza here would compare with pizza back home. Back in Boise we had a tradition of following up our softball games with pizza and beer at the Round Table Pizza. Our expectations here weren't very high, which turned out to be just as well. The local pizza was thin as a tortilla shell and came without any meat items at all. Steve didn't mind that; he always ate cheese-only pizza anyway. But my own more carnivorous taste buds thought this Greek – or perhaps Italian? – style of pizza left a lot to be desired. Still, though, it was food and there weren't any huge bowls of tomatoes anywhere in sight.

I slept pretty soundly that night. It had been a long day. I'm not so sure my companions slept as well as I did. You see, I snore a bit, especially when I'm tired, and the others were constantly ribbing me about it. Even John joined in the fun, saying that I made it necessary to sleep up topside. Steve described the noise as being like having a bear trapped in the bilges and so I became known as the Bilge Bear for the rest of the trip. The kidding was all good natured fun, which was just as well since there wasn't anything I could do about my snoring anyway. Besides, *I* couldn't hear it. It didn't bother me in the slightest.

However lacking in city slicker attractions Leros was, I thought it more than made up for it in the natural beauty of the place. I wasn't ready to leave it until I'd had a chance to do a bit of hiking around the island to take in the scenery. I also wanted to get some pictures of those two giant statues guarding the harbor mouth. Nobody else was interested in this expedition so I set off by myself along the little coast road that ringed the island.

Trees rimmed both sides of the road and I hadn't gone too far out of town when I noticed there were a series of antiaircraft guns placed at intervals between the road and the water. They were fairly well hidden from the sight of passersby on the road but not *that* well hidden. None of the guns were manned that day and I thought about taking a picture or two of them from the roadside since the idea struck me as ridiculous that somebody thought these things were necessary in case the peaceful Turks were suddenly to attack Leros. But after thinking about it a little, I decided against it. I was a foreigner in this land, too, and didn't have any trouble imagining how the Greek navy guys might react if they found out I'd been taking pictures of their gun emplacements. The thought of being jailed as a Turkish spy didn't appeal to me at all. No, sir. I kept my camera in my camera bag and kept walking.

As I hiked I kept looking for a good place from which to get my photos of those harbor mouth statues. After a bit of a long walk I finally found a spot that looked like it would do very well. I left the road to go into the trees on the shoreward side and got to work setting up my camera tripod. It was going to be a pretty long shot and I didn't want the camera to wiggle at all as I took the picture. I'd just gotten set up and ready to take the shot when I heard the noise of a little motor scooter on the road behind me. It was a uniformed Greek Navy shore patrolman. He saw me back in the trees, stopped, and walked over to where I was. "No picture," he curtly informed me.

I gave him my most winning smile and pointed to those harbor statues. "I'm just taking a picture of those statues," I reassured him.

He didn't speak English. "No picture!" he repeated.

Although I figured it was probably futile, I tried again to reassure him I wasn't taking pictures of his naval base, just those statues. He didn't understand a word I said and decided I probably hadn't understood him either. *"Deutsche?"* he asked me. He wanted to know if I was a German.

"Nein," I replied. *"Amerikaner."* No, American.

He rolled his eyes at heaven and I didn't need a translator to read the expression on his face. Geez, he was thinking, a bloody idiot American. *"NO PICTURE!"* he said, with feeling and emphasis. Okay, no picture. He stood there and watched me while I took my camera mount down and put it all away. Once he was satisfied I wasn't going to take any pictures he got back on his scooter and left. I was tempted to continue my hike and maybe find another spot to shoot from, but I figured if I was stopped again with my camera out by this guy or another shore patrolman it was probably going to be hard to talk my way out of an unpleasant situation. So I gave up my hike and headed back to the boat.

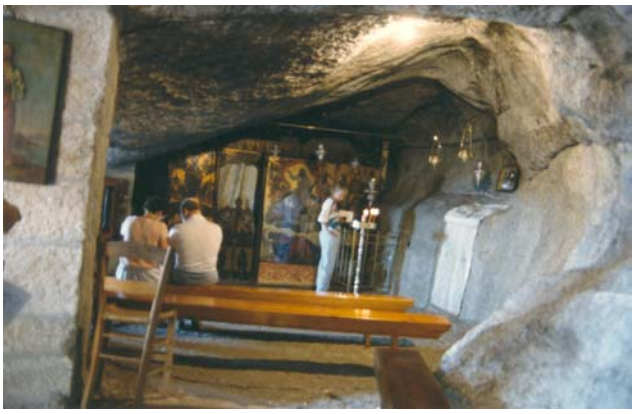
Skala, the monastery of St. John the Divine (brown castle-like building on the hill top) and Chora town (on top of the hill) from across the harbor on the island of Patmos.

When we set out for Patmos the wind was still blowing in our face and so we had another long day of sailing. While the island was still many miles away we could make out the imposing brown outline of the castle-like monastery of St. John the Divine perched prominently atop the island at nearly its highest point. It wasn't until we were very close that we could make out the white houses and buildings of the town of Chora, the old town that surrounds the monastery. St. John the Divine is – or was – who you think: the guy who wrote the Book of Revelations after being exiled to Patmos by the Romans near the end of the first century A.D. Our guidebook said the main specialty of Patmos was 'religion' but that turns out to not quite be true.

Patmos has one harbor, the town of Skala, and we finally reached the island and docked in the late

afternoon. Patmos is a popular tourist destination and the Port of Skala consequently was a pretty busy place every day. After tying up our first order of business was to get something to eat at one of the little outdoor restaurants.

The place we chose is worth describing a little. The dining area consisted of outdoor tables set in a pleasant little garden. There was a small building where the food was cooked, after which they brought it out to the table. There were no menus. Inside the restaurant building was a row of several white cafeteria-like food cases with glass fronts so you can see what was on display. The way it worked was you walked along and pointed to what you wanted to order. Literally. Whatever you pointed out to the proprietor and his helpers was taken right out of the case and that's what you were going to end up eating just as soon as they cooked it. No imagination required. You don't even need language, although there are two words I recommend as being very useful. I developed a real fondness for authentic Greek calamari (squid) and pretty much anything cooked 'soovlahki' (spit-roasted). Yum, yum. A little wine to wash it down with and I was one contented tourist. If you're wondering, 'calamari' in most non-Greek restaurants in the States bears a closer resemblance to onion rings than it does to real Greek calamari. Yuck. We ate well on Patmos. A man could live happy there. As the natives liked to say, 'No problem on Patmos.'



The Grotto of St. John on Patmos

Being the only one in our party who knew the Greek alphabet – a fringe benefit from my frat days – I was the designated sign reader and we needed one on Patmos. Our first full day there we hiked the road running up the hill to Chora to visit the monastery. On the way, just down the hill a ways from the monastery itself, we came to the Grotto of St. John, which was the cave where he lived on Patmos and where, presumably, he would have had his revelation. The church folks have turned it into a regular shrine complete with works of art, benches to sit on, electric lighting and so forth. A small white building has been built around the cave entrance. St. John didn't have it so good in his day. Along one wall there are two indents in the stone which they claim are John's hand marks from where he'd do all his praying. I'm pretty skeptical about that. There *are* two dents in the stone and they *are* about hand-sized. But it's not a limestone nor a sandstone cave and I have a hard time seeing how human hands could have possibly dented that rock no matter how much praying the guy did. Instead I suspect real estate developers aren't an exclusively modern phenomenon.

Inside the Monastery of St. John the Divine. The person waving is Chris.

The monastery itself is a magnificent and imposing building. From a distance it looks like a medieval castle but once you get up close it becomes obvious that it isn't. There are too many wooden doors in its walls and any competent feudal army would have no trouble breaking into it. It would, on the other hand, prove pretty effective at keeping out less militant unwanted visitors. Only a small part of the monastery is open to the public and I noticed the monks kept altogether out of sight from the visitors. Personally I thought the seventy drachma admission fee ought to have been worth at least a fleeting glimpse of a monk or two.

Skala and the harbor seen from the top of the Monastery of St. John the Divine

The public entrance to the monastery opened into a small and vaguely Spanish style courtyard. Numerous arched passages and doorways led off to the other areas within the monastery. We explored every nook and cranny we were allowed into. The monastery housed a small museum where interesting artifacts were on display. Fine paintings decorated the walls everywhere I went and there was a glittering gold-leafed alter in one room. The roof of the monastery offered a panoramic view looking down on Skala and the harbor below. While I was up there I saw one of the huge cruise liners steam into the harbor. It docked and disgorged a horde of passengers onto the streets of Skala.

The guidebook had warned us of the monastery's dress code. Shirts and long-legged pants were required. No shorts. No bare chests. Forewarned is forearmed, so before leaving Skala I had stuffed a pair of hiking rain pants in my backpack. When I got to the monastery I simply unslung my backpack, pulled out the rain pants, and slipped them on right over my hiking shorts. As I did peels of cackling laughter filled the air. A short distance away there was an old Greek woman – the very picture of an old crone – who had a souvenir stand. Apparently she thought my putting my pants on was pretty funny and she was laughing uproariously at me, complete with thigh slapping and the whole works. I'm not sure what it was she found so funny. Maybe she thought my hiking shorts were underpants or something. Technically I suppose they were since they were now under my long-legged pants. Whatever the reason, she waved mirthfully at me and I gave her a grin and waved back before going inside the monastery.

She was still there when I came back out. It was a hot day and I didn't want to walk around with long pants on, so I stripped them off and put them back in my backpack. Peels of cackling laughter erupted from the old woman again and she waved at me to come over. Truth be told, I thought it was pretty funny that she thought *I* was funny, so I walked over to her wearing a big grin.

It turned out she sold these pretty little stones that were naturally decorated by colored veins ringing a solid colored background. They were all natural, you understand. No painting. She handed me a very nice one, all chocolate-brown in color with purplish veins decorating it like necklaces. I offered to pay for it but she wasn't having any of that. She just waved my money away and wouldn't take whatever the Greek equivalent of a nickel is for it. It was a present from her to me for giving her such a nice laugh. I still have it today.

Typical street in Chora. This particular one is lined with souvenir shops.

This friendliness was typical of the people of Patmos and a great contrast to the glum and more or less unfriendly people I'd encountered on Kos. Of course, most of the people I met on Patmos were trying to sell me something and that might have had a little bit to do with it. But there is no doubt the people here were friendly to us.

The streets of Chora were narrow and winding. It didn't seem possible to get a car down many of them although the Greek taxi drivers looked and acted like they were apt to try almost anything. Many small souvenir shops lined what I came to think of

as Chora's 'business district' and I loaded up on souvenirs to send home to Boise. These included several small statues – including a bust of Socrates – some porcelain coffee cup coasters hand painted with images of ancient Greece, a very nice painting, and my Greek fisherman's cap. I like hats and on that trip I started a little tradition of buying a local hat when I visited a foreign country. I did make an exception in the case of Turkey, though. Somehow I thought I just didn't look right wearing a fez. I now have a lot of hats at home, but my Patmos cap is the pride of the collection.

My usual sail boarding posture

I thought it was interesting and more than a little ironic that Patmos, of all places, also featured the best nude beach we saw anywhere on that trip. It was located a bit farther up the coast in one of the many little inlets all along the island's coast and we sailed over there and dropped anchor in the middle of the inlet. *Dark Star* had a small rubber dingy we used to go back and forth from boat to shore. These memoirs being a family-rated work, I won't show any pictures from that beach other than the one to the left here. If you're wondering, yes, I'm wearing swimming trunks in that picture. The beach was situated well outside Skala and the only natives I saw there were the vendors renting sail boards or selling snacks and beverages. Most of the tourists lounging on the beach, with the exception of the Germans, chose not to go bottomless. The German goddesses lining that beach provided a different sort of Revelation. In a word, *Wunderbar!*

We all tried our hand at sail boarding while we were anchored at the nude beach. Of the lot of us only John was any good at it. It was a bit of a comfort that our captain knew how to master a sail board. The rest of us were pretty lubberly. I'd say Jane was better at it than any of us (except John, of course). Must have been that British seafaring tradition; maybe it gets into the blood. I couldn't get the hang of it at all. I'd manage ten or twenty yards and then *splash!* over I'd go headfirst into the warm, salty water of the bay. When I'd come back up to the surface Chris remarked that I looked a little like Poseidon rising from the deep. All I needed was a trident. It was easy to swim in that water because all the salt made it really buoyant. Tailor made for a Bilge Bear.

One twice-daily entertainment at the beach was the running of the goats. Just around breakfast time we'd hear the jingling of a bell coming up the nearby road and the next thing we'd see was this big herd of goats coming around the bend and running like mad. A local Greek boy – I'd say he was maybe twelve or thirteen – ran with them, switching them along with a slender little stick. Up over the hill they'd go, their small hooves pounding on the road, as they went off to what I presume was their daytime pasture. Just around dinner time we'd hear the bell around the neck of the bell goat coming back and the herd would explode into sight from over the hill. Down the road and around the bend they'd go with the boy still running with them. The Return of the Goats would signal that it was time for sundowners.

Coming into Güllück, Turkey

We lingered for three full days on Patmos and it wasn't without reluctance that we finally bade farewell to that idyllic place. But our time in the Aegean was coming to a close and we had to start making our way back to Bodrum. From Patmos we decided to make our next stop back in Turkey at the seaport town of Güllück. Güllück was a little over fifty-five miles from Patmos, almost due east and a little to the south. The same wind that had impeded

us in sailing north now aided us and we made the crossing very rapidly. Not far out of Patmos a school of dolphins discovered us and playfully kept us company for many miles on route. I tried to get some pictures of them as they'd come leaping out of the water, but I didn't have an auto-shutter with me and it proved to be nearly impossible to catch them in flight before they dropped back into the water.

We made Güllück harbor just as the sun was starting to set, having carefully remembered to switch our Greek pennant back to the Turkish crescent before entering it. As we came up to the dock we passed a big freighter that was moored there and was taking on cargo. The Turkish sailors aboard her lined the deck to stare down at Jane, who was wearing a bikini. I couldn't blame them for staring. I'd been doing as much staring at her as politeness allowed all through our crossing. But it did remind us that we weren't in Greece anymore and Turkey is a Moslem country. Jane blushed and went below to put on some less revealing clothes.

Because of the freighters that came in and out of Güllück we anchored offshore a ways out in the harbor and used the dingy for going to and coming from the shore. There were several other yachts anchored out there, one of which belonged to a French party. The French, despite being where we all were, unconcernedly entertained themselves by diving off the stern of their boat and doing a little topless swimming. The young French women were pretty gorgeous and I noticed they were drawing a bit of an audience from the teenage Turkish boys on shore who were watching from the tree line while trying at the same time to look like they *weren't* watching. Tsk, tsk, boys. What would your *imam* say?

Ancient ruins near Güllück. Left: ruins of what appeared to be an ancient Greek temple. Right: me having a seat in the ruins of an old Greek theater. The stone wall in the background probably dates from the Byzantine empire. The older ruins were often marble. The Byzantine ones were cruder stone work.

Güllück itself didn't have a whole lot to recommend it. Perhaps that's why our guidebook didn't even mention it. But the hills around it were richly littered by many ancient ruins, some dating back to the ancient Greeks, others which were more recent and came from the age of the Byzantine empire. Once we got back into those hills we found ourselves practically stumbling over one ancient site after another. The best ruins we saw on the whole trip were at Güllück. I was a little surprised there weren't more tourists wandering around there. The only other person I saw besides my friends was a German guy who was taking in a little sun at one of the sites. I guess he thought he had the place to himself because he'd stripped down naked and was sitting on the remains of one of the old marble walls. I never saw a more startled look on anyone's face than on his when I suddenly walked out of the trees. I don't think I could possibly be mistaken for a Turk, but this was after all a Moslem country and the sun worshipper wasn't taking any chances. He hurriedly pulled on his clothes and made a quick exit from the site. I'd always figured the French would be the big fans of going *au naturel* but the French had nothing on the Germans on that trip as far as I could tell.

We spent one day exploring the region around Güllück and then it was time to head back to Bodrum. We made the trip hugging the Turkish coast and it was a long sail, slightly over fifty miles. Again, though, the wind was in our favor and we made good time, passing several small Turkish towns en route.

Bodrum marketplace

We had only two days remaining in Bodrum until we had to return to Izmir for the flight back to England. This was when we really threw ourselves into souvenir purchasing. Chris wanted to buy a Turkish carpet and so we made the rounds of the local carpet dealers.

These were interesting guys. One dealer whose shop we visited was typical of the breed. Alone among all the Turks I met, the carpet dealers were the only heavyset men. When we walked into his store, the proprietor greeted us like we were long-lost relatives. “Ah! Come in! Come in, my friends!” He was sharply dressed and wore a Rolex watch on his left wrist and gold rings on his fingers. He exuded friendliness and warmth, although there was something kind of predatory in his wide, toothy smile. I was told the Turkish word for ‘carpet dealer’ translates literally into English as ‘the hunter.’ He did everything but give us a hug. “Please! Sit! Be comfortable! Tea?” He clapped his hands and a skinny Turk materialized almost from out of nowhere bearing a tea tray.

After we were seated and served the carpet show began. A whole procession of skinny Turks began to parade before us, each one bearing a rolled up carpet in his arms. He’d unroll it with a *snap!* hold it up briefly, and then drop it onto the growing pile of carpets at Chris’ feet. Apparently the louder the *snap!* was, the better the carpet was supposed to be. In less than ten minutes the carpet pile on the floor was three feet high. All the first ones we were shown were cloth carpets and Chris asked our new ‘friend’ if there were any silk ones. “Of course! Of course!” he cried, acting like he should have thought of this himself without being asked. He clapped his hands again and the rug bearers began bringing silk carpets out and adding them to the pile.

I have to admit they were beautiful carpets. One of them caught Chris’ eye and she asked how much it was. “Normally two million lira,” our host replied, then he bent down and softened his voice like a conspirator, “but for *you,* my friend, we make a special deal. One million five hundred thousand.” I could practically see the word ‘bargain’ light up in Chris’ eye and she asked how much that was in pounds. “Five thousand pounds.” Steve winced and turned pale. Well, I thought, that would explain the Rolex.

Fortunately for Steve and unfortunately for Chris, it turned out we didn’t have time to buy a carpet. What we didn’t know was that the process of buying a Turkish carpet takes three days. The first day you’re supposed to visit all the carpet dealers just to see what’s available and to decide on which one you want. The second day you’re supposed to go back to the dealer whose carpet you’ve decided on and start bargaining. That’s supposed to take all day and it’s supposed to end with no deal being made. If you buy the carpet on the second day even the dealer thinks you’re stupid. On the third day you come back and strike a bargain. We only had two days so Chris didn’t get her silk carpet. I have no idea how much she might have been able to dicker him down, but back in England later I saw almost exactly the same silk carpet in a London shop. It’s price tag was ten thousand pounds. So our ‘friend’ in Bodrum really did offer the better deal even on the first day.

It wasn’t without regret when the time to go finally came. Back in Izmir we went through all the normal routines of boarding an international flight to return to London. The Turks didn’t have any sophisticated x-ray machines or other western airport security paraphernalia. Instead a skinny young customs official would open our bags and hand search them. All the suitcases and other luggage were deposited on the tarmac next to the plane and as you walked by you were supposed to point to which baggage was yours. Only then would the Turkish baggage handler load it on the plane. Any unclaimed or unidentified bags were left sitting right there on the ground. My guess is that those were the ones where the bombs would be if anybody was trying to bomb the plane. I pointed out my stuff, boarded, and all too

soon we were back in England once again, my brief stint as a 'rich American abroad' now over. □

While my role as 'rich American abroad' was ended, I was still an 'American abroad' and my vacation wasn't over yet. I still had two more weeks reserved to see the sights of Great Britain. The day after we got back to Bristol Vern flew over and joined us. He had declined the sailing trip because he is pretty susceptible to motion sickness and somehow the thought of sailing, sailing over the bounding main hadn't appealed to him very much. He and I overlapped in Britain for two weeks, then he was going off with Steve to do some climbing.

One of the first things I noticed about England was basic staples of life were reasonably priced and anything beyond that was pretty high priced. I'm not entirely sure why that was so, but I was told it had to do with the taxes in Britain, which were still very high at that time. Britain had emerged from World War II victorious and bankrupt, and after Attlee and his Labor Party came into office Britain had embarked on the course of socialism. Whether or not that improved life for the average Brit I can't say. I can say the Brits I met complained just as heartily about their taxes as the average American complains about his and with better reason since their tax brackets were much higher than ours. Our own liberals patterned many of their ideas after the British examples.

Stonehenge

Chris was our tour guide during the weekdays while Steve was working but on the weekends the four of us would visit as many of the interesting places as we possibly could. Although it was August the weather in Britain was chilly and cloudy most of the time and light jackets were the dress code of the day.

One of our first stops was Stonehenge on the Salisbury plain. Stonehenge is by far the oldest man-made thing I've ever seen. It was kind of awesome to stand there looking upon it while knowing that this place was where the Romans had come to see ancient ruins. They had the place roped off when we visited so we weren't able to walk around within the stone circles themselves, but it was still very impressive. Many of the stones were gigantic and all of them come from places pretty far away from the site itself. How prehistoric man managed to transport these huge stones to the site and then erect the stone structures is a complete mystery. It is likewise a complete mystery why they did it. No one knows why Stonehenge was built.

A typical English village. The two people are Chris and Vern.

There were quite a few other ancient stone circles scattered about the countryside near Stonehenge. They weren't as immediately impressive as Stonehenge itself and the stones used were not nearly as large. These old stone circles are also prehistoric in origin and, again, no one is too sure what their purpose was. We passed through many very charming small English villages having very old houses. Many of them had grass-thatched roofs. I thought this was very interesting but also very odd. Why would anyone want a grass roof? And what was under all that grass? I never did find out the answer to either question, but it must work well enough because I saw an awful lot of them and I wouldn't say the people who lived there were poor.

The Roman bath at Bath, England

Another stop we made was at the old Roman bath works in, where else?, Bath. One thing I like very much about the British is how practical they are. What else would you name the town where the bath works are other than Bath? The baths no longer work, of course, and the water was this strange green color. I'd be in no hurry to jump in that water. No, sir. But the site, both above ground and below, was very interesting. A lot of civil engineering went into it and the technology they used back in the days when Rome ruled England is very impressive even in its ruined state. I think today most of us very much underestimate just how advanced classical civilization really was in ancient times. The bath works at Bath were built centuries before the fabled time of King Arthur.

One of the things about England I found hard – impossible, really – to get used to was driving on the left side of the road. Almost every time we got in the car I'd start to get in on what in the U.S. would be the passenger side, only to catch myself as I reached for the door handle and saw the steering wheel. I even found it tricky to cross the streets because I'd automatically look the wrong way first. A couple of times I almost managed to become a hood ornament because I'd look to the left for traffic and the traffic would come from the right instead. It wasn't just that my instincts were wrong; they were exactly the opposite of right. I wouldn't dare try to drive a car in Britain; I'd be an accident looking for a place to happen. One of the most amusing things I saw over there were these strange little three-wheeled cars that seemed to be everywhere. Not four wheels, mind you; three wheels. They were the real version of my old tricycle-car I had when we lived on Anderson St. Why someone would want to build a car like that I don't know, but they must have been reasonably good cars because I saw them everywhere I went.

We often took lunch in one of the numerous pubs that could be found everywhere. Beef was fairly expensive in England but was very tasty. I also enjoyed British fish and chips. It wasn't too clear to me why chips were called 'chips'; the name always made me think 'potato chips' but in reality British chips are indistinguishable from American French fries. British beer was fabulous, too. They serve it at room temperature, which I was a bit leery of before I tasted it. After all, nothing in this world tastes worse than a room temperature American beer like Budweiser or Pabst or any of the older pre-microbrewery brands of American beer. But British beer was completely another story altogether. After I came home from Britain I rarely drank any of the older brands of American beer again. I still enjoy a good micro-brewery beer, either a good stout or a good ale, but the brands of beer I used to drink in college taste like horse urine to me now. The word 'pub' is short for 'public house' and the small pubs we went to were congenial, friendly places where we could rub elbows with the locals. Sometimes it was hard to understand what they were saying; British English and American English parted ways long ago. I imagine many of my American idioms were just as strange sounding to the Brits. But the Brits I met, one and all, were delightful people and I liked them very much.

Naturally, London was one of our must-see spots. We took an early morning train from Bristol to London for a full day of sight-seeing. We left early enough that we took breakfast in the train's dining car. I asked the waiter there for some milk to go with my breakfast and a sad, apologetic look spread across his face. "I don't have any proper milk, sir," he said. "All I've got is this." He held up a pint box of milk no different from what you find in any American grocery store. "It's been ′omogenized," he said. "It's got a funny taste."

I couldn't bring myself to tell him it was no different from American milk. I guess by British standards there must not be any proper milk across the length and breadth of the USA.

The Tower of London. Left: approaching the gateway to enter the Tower. Right: view coming in with the White Tower visible in the center background.

One of our first stops in London was the fabulous fortress and Royal Palace of the Tower of London. The original stone tower, the White Tower, had been built by William the Conqueror after the Norman conquest of Anglo-Saxon England. Over the centuries that followed the fortress was enlarged until it had grown to a huge size and now covers about eighteen acres of ground. From the outside the surrounding walls are huge and I could easily imagine how intimidating they would have been to any soldiers in an army from the Middle Ages that might have wanted to attack this place. The Tower definitely serves as an example of the real meaning of the word 'fortress.'

The Tower is very much a living place, housing a complement of British soldiers popularly known as the Beefeaters but officially known as the Yeoman Warders. A Yeoman Warder is seen in the center of the left-hand photo above. The Yeoman Warders are the custodians of the Tower and the Crown Jewels that are kept there. A Beefeater gave us a very nice tour talk when we first entered the Tower, explaining much of the history of the place. Housed within the White Tower was a fabulous museum displaying old, highly polished suits of armor and countless numbers of historical artifacts. Within the outer walls there are many inside buildings and numerous other towers. The Beefeaters live inside the tower in the many apartments it contains. The site of the Tower had been occupied during Roman times and the remnants of old Roman walls still can be found there. If you ever get a chance to visit Her Majesty's Tower of London, give yourself a lot of time to see it. It will be worth it.

'Bustling' is a good word to use to describe the streets of London. We used the 'underground' – the Brits' name for their subway – to get around in the city. One thing I noticed was that even the panhandlers in the parts of London where we encountered them were nicely dressed and not as pushy as panhandlers in San Francisco were. One of them, a young woman, approached Vern as we were passing. "Do you speak English, love?" she asked him. "No," Vern replied and she went off to panhandle someone else.

St. Paul's Cathedral, London

After visiting Parliament, the Tower Bridge – which many Americans mistakenly think is the London Bridge – Big Ben, Trafalgar Square, and Buckingham Palace we went to see St. Paul's Cathedral. St. Paul's is a seriously immense church, very beautiful, and a mammoth work of art in stone. Its rotunda is called the 'whispering gallery' because it has a profoundly unique acoustic property Steve showed me. He and I stood on opposite sides of the rotunda next to the outer wall, and Steve started whispering. I could hear everything he said perfectly from all the

way across on the other side because the sound waves carried along the wall. It was an amazing phenomenon of physics built right into the structure of the building.

Westminster Abbey

We also visited Westminster Cathedral and Westminster Abbey, two more seriously beautiful churches. Some of the most famous people in the history of the West are entombed in these churches including Lord Admiral Horatio Nelson (St. Paul's) and Queen Elizabeth I, King James I, Mary Stuart, and Sir Isaac Newton (Westminster Abbey).

Like me, Steve reads a lot and since we were in London Chris also wanted to hit some shops; and so we also visited a number of downtown London stores. Aside from one where I saw a silk carpet similar to the one that had caught Chris' eye in Bodrum, the only thing I remember from that little excursion was a place that billed itself as 'the world's largest bookstore.' It may well have been just that. The place was five stories tall and packed with books on every conceivable topic. I had to restrain myself; it would have been too easy for me to go nuts in that place and spend a small fortune. But I limited myself to picking up just a few books on non-linear system theory, which I was studying at the time as part of my brain research project.

Caerphilly Castle

My vacation in Britain could not have been complete without going castle-hopping. There are numerous old castles, many of which are in ruins now, dating back from the Middle Ages after the Norman conquest in Wales and Scotland. We set out to visit as many of these as time allowed. The majority of these are fairly small as castles go, limited to one tall stone tower. But there are some very industrial-strength castles, too. The two most impressive ones we visited were Caerphilly castle and Caernarfon castle.

Construction of Caerphilly began in 1268. It is an enormous fortress occupying thirty acres of ground. Three rings of stone walls protect the innermost part of the castle complex. At one time the inner two rings were protected by a moat. Each wall gets progressively higher as you move inward toward the center of the castle, and so any attacking army that breached the first wall would find itself an easy target for archers stationed on the next as well as those still occupying the wall behind. I tried to imagine what it would have been like to be a foot soldier in a thirteenth or fourteenth century army trying to storm this place. Not fun at all, I decided. Without the technology of cannons, I couldn't imagine any practical way to conquer this place other than trying to starve out the defenders.