thesis (thē'sĭs)

A dissertation advancing an original point of view as a result of research, especially as a requirement for an academic degree.

methis (mē·thĭs)

A somewhat lengthy, entirely informal treatise advancing an original point of view as a result of introspection, reflection and a desire to cut back on television; not a requirement for an academic degree, an augmentation rather.

Me This.

By Ben Rogers

Fall 2001-Spring 2002

University of Nevada, Reno

A toothy grin in the forest

A methis submitted regardless of the requirements for the degree of

Master of Science in Mechanical Engineering

By

Benjamin S. Rogers

Drs. Me, Myself, and I / Methis Advisors

May, 2002

May, 2002

I

BENJAMIN S. ROGERS

recommend that the methis
prepared under my supervision by

BENJAMIN S. ROGERS

entitled

A toothy grin in the forest

be accepted in partial fulfillment of the
requirements for the title of

He-Man, Master of the Universe

Ben Rogers, Advisor

Ben Rogers., Committee Member

Ben Rogers, At-Large Member

Jill Rogers., Wife & Associate Dean & Breadwinner & Best Friend

May, 2002

ABSTRACT (THOUGHTS)

When I was in eighth grade, I gave a speech. I said I wanted to work on the Mexican border patrol. Not so much because I wanted to catch sad, skinny Mexican families crawling through sewers on their way to a decent life in America—I was just a naïve bigot looking for a couple cheap laughs from the busty girls in my speech class.

I went to college. I studied mechanical engineering. I was sure that engineering wasn't for me so I decided to switch. During my search for a suitable alternative, I stuck with engineering. Five years later I graduated a mechanical engineer. Journalism had tempted my fancy. But internships at three newspapers and visits to a couple journalism conferences led me to believe the profession was chock full of underpaid, overworked Hemmingway wannabees, and thank God for them too. The first amendment would be de-clawed without our "fourth estate," the press.

I had mistakenly equated writing with journalism, and this simply isn't the case: my experience told me the best journalists were ultra-curious types, more interested in uncovering corruption and getting to the bottom of budget debacles than crafting beautiful prose. Just the facts ma'am. Headlines and deadlines. Often objectivity stifles creativity, and for good reason. But that just wasn't what I wanted. I want stories stretched. This isn't to say there aren't incredible writers making money in journalism. There's two or three.[1]

Now I've got a master's degree in mechanical engineering. And in the process of laboring over my thesis about the atomic force microscope I realized that no one would really want to read it. So I wrote this thesis type thing, which I called my methis, for my wife, my parents, my brothers, Joe and any other people who give a shit about me. As for my desire to nab illegal immigrants, well, I *do* live in a gated community now.

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[1] Yup, still naïve.

1.0 MOTIVATION

Though a football game is quartered conveniently into 15 minute segments, even Martha Stewart will tell you that televised games last longer than 60 minutes. To the sagacious spectator, the two-minute warning is not so much a warning at all. A sitcom could squeeze itself into the viewing time remaining before the final whistle. Every weekend during football season (and sometimes Monday nights, too) three more hours of my life dissolve before my eyes like microwave popcorn in hot tomato soup.

After games I find myself on the couch, emotionally exhausted, with nothing gained by my fandom. I'm probably dumber with every field goal I coax with body language through the uprights. I might even be reverse evolving, which would explain some of the stray hairs on my back. I don't even know all that much about football. I played tennis in high school. However I *did* attend the wedding of Dave Sloan, tight end for the NFL's worst team in 2001, the Detroit Lions. The blissful nuptial atmosphere no doubt contributed to the volume of red wine I imbibed and, long story short, I puked in my future father-in-law's car. Indeed I am becoming a dumber person.

Anyway, figure three hours in front of the boob-tube every Sunday. To that number tack on the occasional glimpse into the intoxicatingly suicidal world of the *Crocodile Hunter*, where, in the guise of science, a delirious bloke and his patient wife scour the Australian Outback in search of scaly animals to hold off the ground by their tails. Then maybe I catch an episode of the West Wing. Oh, and I love to watch movies. I even received a DVD player for Christmas and now feel strangely superior to my former brethren, the lowly VHS renters. A friend of mine and fellow DVD owner says he'll now pass a VHSer at the video store and wonder to himself: Do they all smell like you? DVDs give viewers myriad special ways to waste their Friday nights, including special features like behind-the-scenes interviews

with pretentious directors. I can also watch alternative endings that were once deemed editable but now touted as "exclusive." I can even see previews for the movie *after* watching the movie.

One can derive an equation for my average annual televisual input:

(3 movie hours per week)(52 weeks in a year)

\+ (3 general TV hours per week)(52 weeks in a year)

\+ (3 sporting event hours per week)(52 weeks in a year)

468 hours in a year

Now I'm no engineer[2] but I can tell you that 468 hours of television is arrogant idleness, especially considering this estimate is probably conservative. God gives you one present, on your birth day. It's some time. Lucky ones get, say, 75 years, or 657,000 hours. If I watch 468 hours of television a year for 75 years, I've squandered over five percent of my life. That's like exchanging God's gift for store credit. I suppose it's still better than smoking cigarettes—which is more akin to torching God's wrapping paper then defecating on the gift to smother the flames.

I sleep about 8 hours every night, so there goes another whopping 33.33333333333333 (add 3s until you get the point) percent right there.

You see where I'm going with this.

One day I decided I wanted to spend at least a few hours doing something more meaningful, at least for me. I've always liked writing[3] so I thought I'd stick with that. Obviously, I've enjoyed no notoriety or even so much as a printed version of anything I've

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[2] Yes I am.

[3] "Thank you for submitting your short story to our contest. Unfortunately, it sucks and subsequently will not be published in our magazine, nor will you receive any money, recognition, or readership in return for your labor of love. Please keep your childish vignettes coming! We always buy cheap jug wine with your entry fee, then read and re-read aloud your stories, chock-full of worn out archetypes and poorly edited dialogue—providing the whole lot of us with hours of sidesplitting laughter and general gaiety.

Sincerely fuck off, The Selection Committee."

written in any publication whose readers were not one of the following: the contributors, the contributors' next of kin, the contributors' old high school English teachers. This being said, if you are reading this now and did not (a) give birth to me or otherwise contribute to my conception (I can only pray there is but one person falling under each criterion), (b) marry me, or (c) make me recite Chaucer in Old English, then I appreciate your having made it thus far, seeing as how you are no more obligated to read this than I was to write it. If you find something—anything—in these printed words, that's my gift to you.

Your eyes moving across this page left to right and simultaneously translating this English, this code, into precious thoughts are your gift to me. Even though I don't get to see them move, they're a gift.[4]

So there it is. This little Methis isn't much. Actually, that's not true. It's a lot. It's not very long, but the 49ers did go to the playoffs this year, and the World Cup only comes every fourth summer. You understand.

What it is, this Methis, is a quick glance at some of the things I considered worthy of note during my tenure as a graduate student in mechanical engineering at the University of Nevada, Reno. I wrote it because I'm conceited.

College is a time measured not in days or months, but semesters. I was there two. I saw a lot. I learned. I was lectured to. Entire books were poured down my throat. I read with great intensity myriad scientific journals, dozens and dozens of papers with titles like "Tapping-mode atomic force microscopy and phase-imaging in higher eigenmodes" and

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[4] Dear [insert your name],

Thank you very much for the time you devote to my words. I've always wanted your time and it fits me just perfect. I will wear it all the time. I will think of you when it keeps me warm on cold days. Hope all is well.

[insert salutation commensurate with the level of passion in our relationship],
Ben

"Detailed analysis of forces influencing lateral resolution for Q-control and tapping mode." I wrote a thesis.

Tough thing is, some of the most noteworthy things in real life and in college require time to distill. And when you come to filter your past through the sieve that is the written word you realize which things are worth retelling. By then, the juicy details have been forgotten. For example, I vaguely remember my friend, Nicholaus, on numerous occasions leaving the grad student office to go to the bathroom. But only recently did I learn that one time he took a permanent marker with him. On a wall in one of the stalls, some punk kid had scrawled "ANARCHY" among the ever-present doggerel. Below it, Nicholaus had penned something to the tune of: Don't you realize that the same government that educated you enough to understand that word and provided you with the toilet you're shitting into and built this university building which now shelters you is the same entity you wish to eradicate?

Thing is, by the time I sat down to write about what Nicholaus did, what he wrote had already been painted over and the whole thing had become more of a punch line than an entire story—an anecdote I might add so as to elicit knowing guffaws from my readers, the majority of whom live at my parents house.

Moving on.

2.0 BACKGROUND

If you asked the rest of the world, the year was September 11th.

But other things happened in 2001. Mr. Rogers changed out of his jacket and into his sweater for good. Lance Armstrong donned his 3rd consecutive yellow jersey even though he was supposed to be dead. Sharks chewed on surfers in Florida. Harry Potter frolicked amongst us mere Muggles. Dale Earnheart took a wrong turn into heaven. Timothy McVeigh rode the lightening into the eternally sodomized sector of hell. And Gary Condit obscured and obstructed the national consciousness. But the surprise war waged on two of America's tallest towers and its biggest pentagonal building was far more important. People were dead, and dead people always make living people think. We look at our wives and our friends and our children and our brothers and our sisters and our mothers and our fathers and our pets and we say: I love you. That's the only good thing about it.

However, three days before 2001 became for Americans a single day, it already had for me. I already loved everybody and everypet. On September 8th I had married my best friend.

Jill. She's delicious and nutritious.

Some math:

Eq. (1)	Jill	=	Love
Eq. (2)	Love	=	All You Need[5]
Therefore, by the transitive property of equality, Eq. (3):	Jill	=	All I Need

At the wedding, the preacher forgot to read two entire pages of the ceremony, including the always-optional ring swapping part. We didn't notice. We were too happy.

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[5] Lennon, J. & McCartney, P. Album: *Magical Mystery Tour.* Track 11 (3 min., 48 sec.) Recorded: June 14, 1967 at Olympic Sound Studios, London, England.

We celebrated afterward under a clear night sky in the Sierra Nevada. Our wedding party pulled one another into the pool and danced in their saturated, chlorinated tuxedos and bridesmaid dresses. The unprecedented levels of joy and hedonism took its tool on my youngest brother, who the following morning had only my grandmother to hold sweat-soaked bangs out of his face while he puked his first hangover into the hotel toilet. (It's okay, Tyler, we all have our wedding/vomit stories. Ask Mom about hers.) My father later returned the tuxes, which, astoundingly, neither shrunk nor faded.

Jill and I settled in Reno together where I had just enrolled in graduate school. I had 18 credits and a thesis to write, but, as I said, my priorities were already in order. I ditched school for a fortnight and took a Costa Rican honeymoon with an old pal turned new wife.

We had already moved all of our worldly possessions into an apartment in the windy hills north of town. Returning home, we began a new life with a kitchen full of robust, brand-spanking new, Teflon-coated, dishwasher-safe cooking tools, as well as new candleholders, pillows, linens, serving platters and vases. Domesticity snuck up on me the way I suspect tidal waves can. While you're busy sculpting sand castles, the whole ocean recedes and you look quizzically up and down the beach. The ocean then returns. In the ensuing deluge, your beer cozies float away, followed by bars of soap with embedded curly hairs and the freedom to take open-door growlers.[6] Bereft of bachelor amenities, a man quickly finds himself sipping from wine goblets and lathering up with puff scrubs. I even began showering as often as *once a day*.

In the mornings I would drive to school and she to work. My education was an investment, a blue chip stock. Her job was a sandwich, a roof, a light that came on.

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[6] The most liberating of bowel movements, the open-door growler is characterized by uncouth vocalizations of satisfaction. It affords the growlee a view of the 49ers game on television in the next room.

Reminds me of a graduation party we went to for Jill's maid of honor, Jaime. Though Jaime's scheme had been to stay in school one last semester and enroll in yoga and kayaking classes in order to stay in mom and dad's pocket, she changed her mind. Just a few days shy of the December graduation ceremony, she told her parents and friends she "would be walking." The party was at her parents' house. While there I got to talking to a gentleman who referred to himself as the "resident dirty old man." He was a friend of the graduate's grandfather, who was standing at his side. They asked me about me. The dirty old man sipped bourbon on the rocks. He had a well maintained crew cut. Despite a few rotten incisors, his smile was enchanting and his wit quick. He wore a bright Christmas sweater.

"I graduated in May," I told him.

"Good, good. What are you doing now?"

"I'm back in school. Getting a master's."

"And what are you studying?" He brought his drink to mouth. The ice cubes slid up to his lips, then tumbled back and restacked themselves.

"Mechanical engineering. My wife—that's her over there in the denim jacket, the blonde—"

"Pretty girl," said grandpa.

"Yeah, she's alright. Anyway she's footing the all the bills while I go to school."

"Lucky you," said the dirty old man. He took another sip. His breath was sweetened with the liquor. "You know, a lot of these fellas nowadays get their pretty wives to put them through these professional schools. They get their degrees and run off with some other younger, pretty girl when they're done."

The mother of the graduate overheard this. She was holding a tray of fudge cake. She set it down and, sucking a bit of stray frosting from her thumb, put her arm around the old man. She studied me closely.

"Ben here doesn't look like the type to run off with some sweet young thing," she smiled. "You know, when I married Bill, I told him: you ever screw around on me, I'm knocking you out cold and castrating you."

We all shared a laugh. The old man hugged her tight. "That's my girl," he said.

"Dear, dear," said Jaime's grandpa, looking to me. "You're scaring this poor bastard."

"No, you didn't scare me," I said. It didn't scare me because my wife had put down a similar ultimatum, minus the humane knocking-me-out part. "Plus it probably wouldn't be so bad," I added, "I bet a good surgeon could sew it right back on, good as new."

She picked up the tray of cake again, and as she headed off to circulate it she stepped between me and the old man. In passing she whispered: "Not if I put it down the garbage disposal."

Across the room, my wife dipped a stock of celery in a tub of ranch dressing. She snapped off the creamy end using torque from her molars, then tugged at the tenacious, splayed strings of the stock left dangling. Not privy to the castration conversation, my beautiful wife blew me a surreptitious kiss, then polished off the rest of her celery.

"Cheers," said the old man.

I asked him if he'd been castrated yet.

"Do vasectomies count?"

3.0 THE AFM

It's empowering and humbling all at once to glimpse inside a droplet of water and see it come alive with scooting, darting creatures—none of whom seem to realize they're victims of my voyeurism, nor concerned about the sanctity of Israel or what everyone thinks about my N*Syncish new haircut. A microscope takes me places where I'm just a big, clumsy alien. Such is its magic.

The lenses of a microscope are rabbit holes to the wonderland of Microscopia, where a grain of pollen becomes a prickly planet, the innocuous and dinky mandible of an ant takes on horrifying, man-eating proportions and a shard of glass turns out to be a landscape, replete with deep chasms, dusty desserts and looming mountains. Scientists can get lost down there in Microscopia, sometimes for life, and sometimes at the expense of their macro-scale existence—their marriages, their mortgages. But these scientists come much, much later in our story. Before them, in fact before the microscope, there are other scientists. They invent the microscopes.

Dr. Calvin Quate, Dr. Christoph Gerber and Dr. Gerd Bennig are such people. In 1985, they invented the Atomic Force Microscope, or "AFM". With an AFM, we can see individual atoms.

Stop! Go back, go back. Reread that last sentence. It may have been too easily swallowed whole. Without tasting anything. Without sliding the i-n-d-i-v-i-d-u-a-l atoms around on your tongue like caviar and bursting them one by one between your molars.

Atoms. *Mmmmmmmm.*

To get a feel for the significance of this achievement, consider this: if you were to take an apple and make it as big as the earth, then the original apple would be the size of an

atom in the big one. The AFM does the equivalent of seeing a single apple on earth from space.

Equally astounding is that the AFM does not see with its eyes the way most microscopes do, but rather with its hands. It operates in much the same way Stevie Wonder enjoys a book. Just as he moves his hypersensitive fingertips over the Braille language, the AFM moves its tiny probing finger over things like unzipped DNA molecules or live yeast cells. The AFM's "finger" is a cantilever beam less than half a millimeter long, like a tiny diving board, with a very sharp pointed tip protruding off the bottom like the needle of a record player. This sharp tip is dragged back and forth across a specimen. Depending on how much the cantilever bends, cute little umpa lumpas[7] inside the computer draw a topographical, three-dimensional picture of the specimen's surface with up to one-million times magnification. That's enough to see the last remaining molecule of blackness in Michael Jackson's body.

Such badass resolution means the AFM can, among other things, read a layer of silicon atoms like a Braille book. And not only can the AFM feel such ultra-small things, it can pick them up and move them around. It can *make* the Braille, tell the stories.

And it tells some whoppers.

Like so many tales of precocious, phenomenal kids—the story of the AFM must begin with its father's story. If the AFM's day of birth can be considered March 3, 1986—the day a succinct journal paper titled "Atomic Force Microscope" appeared in the pages of *Physical Review Letters*—then the AFM was just seven months old when its daddy, the Scanning Tunneling Microscope, or STM, won its inventors the Nobel Prize in Physics.

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[7] See Chocolate Factory, Charlie and the

Earlier, when the AFM was merely a twinkle of photons in his eyes, Bennig built the STM with Dr. Heinrich Rohrer at their laboratory in Zurich, Switzerland. By moving a different type of special tip over a surface and keeping track of how many electrons jumped, or "tunneled" from the tip to the surface, the STM could also draw topographic pictures. It could see atoms too. Yet, while most certainly deserving of Nobel recognition, the STM had drawbacks. For starters it could only take pictures of things that conducted electricity, ruling out most anything not made of metal, including biological samples like the King of Pop.

During a sabbatical spent at Stanford University, Gerber joined forces with Bennig and Stanford Professor Quate to modify the STM into a more versatile instrument. When the AFM paper was first submitted, it was rejected and called farfetched. More than any other of the paper's claims, the one that raised the peer reviewers ire most was the one stating that the new instrument could be used to "measure forces on particles as small as single atoms."

Turns out, it could. The paper's later acceptance is widely considered a seminal event in modern science, rivaling the invention of the spork.

Numerous scientific discoveries over the last century made the AFM possible; of course there's the AFM's father, the STM and its grandfather, the SEM. So, can three men really take credit for the idea of the AFM?

Yes, I think so. Collaboration, schmolaboration. Lightening *does* strike. The muse must have paid a visit to one of the AFM inventors. Did she sing in Quate's ear? Or Bennig's? Maybe Gerber's? Many have asked this question in attempts to get to the bottom of who really dreamt up the AFM, who *really* cleared the mental hurdle separating the STM from the AFM.

My thesis advisor, Dr. Jesse Adams used to work with Quate's AFM research group at Stanford University. He told me that prying the juicy details of the AFM's invention out of his mentor was all but impossible. Though Adams' desk was in the very lab room where the AFM was born, he's only been able to glean stray details about its conception.

"Cal [Quate] will tell you: 'It was on my nickel,' " Adams says, referring to the fact that Quate provided the labs and resources during the development phase. "But you go over to Europe and Bennig just says: 'Cal has good ideas.' They won't say, really. It's like some unspoken pact. There's a real respect there. I don't think anyone will ever know."

What Adams does know is that sometime in the mid-1980s, Quate visited the Zurich lab and was given a demonstration of the STM. On his plane ride home over the Atlantic, it struck him that a tiny spring, or cantilever, could augment or all-together replace the STM's sharp conducting tip.

"Then it was just a matter of *building* that small spring," Adams laughs.[8]

But of course, innovation must also be managed. After all, these are no longer the days of Thomas Edison. One man can no longer toil alone in cramped, disorganized attic laboratory and expect to crank out a gadget as complicated as an atomic force microscope.[9] Be it a gas-electric hybrid car engine or a new microscope, a team of innovators must be enlisted. After the idea, it becomes a team process. And any team needs a manager, a zen-enlightened Phil Jackson—someone to hold the reins and make a mix of personalities behave more like a single, multitalented person. An imaginary superhuman who does it all—sings *and* dances *and* acts, like David Hasselhoff.[10]

So who micromanaged (so to speak) the AFM?

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[8] Science joke, don't worry about it. We're dorks.
[9] Stick around and see how hard I toiled to accomplish much, much, much less than that.
[10] The antichrist.

All signs point to Quate. He furnished and oversaw the laboratory and supplied the resources. He was the business man. Though Quate will modestly insist he is not smart enough to be an academic—the reason he says he only works on gadgets—many feel his contribution to the AFM was overshadowed by the STM's Nobel Prize—a recognition he may also deserve.

I had dinner with Quate. He wore old running shoes and a loose, tattered sweater vest. An aquiline nose juts out between his kind, pea-sized eyes. He looks part William Defoe, part Einstein. He's soft spoken and listens intently. If it's possible to be a wise listener, he's one.

"I've known people who were really upset when Quate didn't get the Nobel," Adams says. "The AFM turned out to be a bigger invention than the STM."

Sucks, huh.

4.0 LEMICH

Deep in the darkest, dankest basement of the Palmer Engineering building works a crotchety hermit by the name of The Reclusive Maniac.[11] As the department's resident machinist, it seems wholly appropriate that his eyes should bore though you like drill bits. He frightens students, especially those he's forced to explain something to: God forbid these students' worthless fathers never taught them to operate a lathe or read a dimension using a micrometer. Every semester or so, a class of unsuspecting freshman are toured through the Maniac's lair. First, they're told to shut up, unless there isn't a professor present, in which case they are told to shut the fuck up. Then they are tortured with a treatise on the sundry and innumerable ways they could meet their untimely deaths in the machine shop. And after

[11] In order to protect Mike Lemich, his real name has been changed from Mike Lemich to The Reclusive Maniac.

such a talking-to, you begin to believe that every machine, if used improperly, will cut your head off—a service he'll vengefully provide should you neglect to return the 5/16 cobalt bit you've borrowed from his set. Never do freshman learn how to operate any of the machines, only how to stay alive in their whirring, murderous presence.

Much like Igor, Hagrid[12], or Smithers[13], the Reclusive Maniac is a subservient sidekick. The chairman of the department, Dr. Wood, keeps the Maniac locked in the basement. At the bidding of Dr. Wood, the Maniac is a dutiful ogre doomed to machine student projects until he croaks. Which, I guess, is pretty sad. Touching. Tragic.

But don't shed tears for this bastard. He doesn't even work all that hard. I often open the door of the lair only to find him sitting with his feet up on his robust metal desk playing solitaire on his computer or mixing relish into a can of tuna. Once I walked in at lunchtime and caught him snoozing.

His desk and cabinets are smattered in newspaper clippings chronicling his son's high school football exploits. There are calendars featuring ladies who seem to have happily traded their shirts and bras for cordless drills. There are photographs of big fish he caught in the river. In one, a trout's limp tail drapes over the lip of a metal sink in a position it seems reasonable to assume was arranged so as to demonstrate the impressive size of the fish.

The Maniac's clothes are spiffy. His silver hair is each day set in a duck-back coif where each comb tooth's track is preserved in Butch wax. His sour demeanor has earned him a *reputation*. We often take our projects to Wade, the Physics department's machinist, so as to avoid justifying the project's merits to the Maniac ("What the hell you wanna build that damn thing for?"). At least we used to take our projects elsewhere...

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[12] Rowling, J.K. (1997) "Harry Potter and the Sorcerer's Stone." p. 14
[13] *Ex-cellent.*

One day I was sitting in the back row of my dynamics lecture when the Maniac scuffled by in the hallway. The classroom door was ajar. As he passed it, he glanced into the classroom. Eying me, he halted. Alone in the back row, I was the only one afforded a view of him.

He grimaced. Then, in a gesture usually reserved for melodramatic after-school specials about fight-inciting playground bullies, he pointed at me. Then he pointed at his own chest. Then he pointed straight down. I inferred that I should: 1) see him in Hell, or 2) meet him in his lair, post haste.

I waited until after class to go. I took the two flights of stairs down, down. Deep into the building they led. I opened the heavy metal door and surprised him at the mill. He was boring out a hole in a chunk of steel. He saw me and flipped a switch on the machine, bringing it to an abrupt silence. It was quiet as he tugged off his safety goggles, letting them snap back in place across his forehead.

"You're taking work to Wade now, eh?" he asked.[14]

"What?"

"Right behind my back. Don't think I don't know about it. People talk. Makes me look like a damn fool. When were you planning on telling me?"

"Look. Maniac[15]—"

"So, now I'm not good enough to do your projects? You gotta take it over there? Just talked to the physics boys this morning. They were asking me why I can't handle work from my own department." Out of habit, he fingered the gigantic ring of keys clipped to his belt loop.

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[14] This conversation is nearly verbatim. I wrote it down right after we had it.
[15] Of course I used his real name, which is Mike. Mike Lemich.

I should have told him right then and there that we took our work to the Physics department because it saved us half an hour of argument. Instead I said something to the effect of "you're hard to work with."

"Well you know what this is, Ben? It's a real pecker in my ass. That's what it is." He actually demonstrated: his fist served as the pecker, his other hand as the asshole. One good thrust and the fist penetrated the sphincter. I could almost feel the pressure on my own colon.

We take our projects exclusively to the Maniac now, though we are more judicious about what projects are worth the trouble. Regardless, he finds reason to complain. I'll open the door to the lair, find him ogling four-wheelers on the internet, and ask him to drill a few holes for me. He inevitably pouts and chortles, then assures me there is no imaginable fucking way I can expect the holes to be completed before next week. I always accept this, knowing that within the hour, he'll walk into my office and throw the completed part across my desk—each hole drilled cleanly to 1/1000 of an inch tolerance.

The Maniac is a great machinist.

5.0 ROOM AT THE BOTTOM

It was the mid-1980s, a decadent decade smack dab in the heart of Space Age, the Information Age, the Atomic Age, the Genetic Revolution and the coked-out big hair band movement. Ever since the Age of Siege Warfare, when in 1000 A.D. Chinese scientists perfected the recipe for gunpowder, each age of technological evolution has been characterized by general trends. For centuries, technological progress came in waves and these waves came one at a time. The Age of Siege Warfare became the Age of Exploration,

which became the Age of Astronomy, then the Industrial Revolution, then the Age of Invention.

Of course, no age saw only one type of progress. Not long after China's explosive creation gained widespread popularity, the Italians invented spectacles with convex lenses, and 37 years before Christopher Columbus failed to fall off of a flat globe Johann Gutenberg gave the world a printing press.

But by the time the AFM was born, the world was a different place, scientifically speaking. The pace had changed in all things tech. Ages no longer arrived in successive waves, but rather concurrently. And from all directions. Most noticeably, the waves came faster. As early as 1962 Intel co-founder Gordon E. Moore noticed the swift, even parabolic rate of technological progress, especially with regard to semiconductors and integrated circuits. With a prediction that after four decades has held true and become known as "Moore's Law," he put his finger on the pulse of one today's most prolific and influential industries and took its pulse. His prescient prediction: computer processing power will continue to double every 18 months. And it has, sometimes even faster. The first billion-transistor DRAM chip was built in 2002 after 27 doublings since Moore's visionary prediction. The AFM would not be possible without these Speedy-Gonzalez circuits.

Equally prophetic was a speech given December 29th, 1959 by renowned physicist and Nobel Prize recipient, Dr. Richard Feynman. The classic talk "There's Plenty of Room at the Bottom" was given at an annual meeting of the American Physical Society at the California Institute of Technology. In it, Feynman begged scientists to look through their microscopes; there was a completely unexplored, untapped world there, he said. It was 27 years before the invention of the AFM.

He discussed, among other things (such as the possibility of writing the entire Encyclopedia Britannica on the head of a pin) the need to improve microscopy, especially the existing Scanning Electron Microscope, or SEM.

"The electron microscope is not quite good enough," he said. "With the greatest care and effort, it can only resolve about 10 angstroms."

Only. He used the word '*only*,' and did so almost scoldingly. A sheet of paper is about one million angstroms thick. (Go ahead, look at the profile of this page and break it up into a million layers. Or try just ten. Or two, try that. Go ahead, we'll wait. You pussy.)

Feynman encouraged his audience to think even smaller, and to make the SEM good enough to see atoms distinctly—which meant improving the microscope's resolution one-hundred-fold. Doing so, he told the physicists, would help their colleagues in other disciplines, especially biology.

"What are the most central and fundamental problems of biology today?" he queried. "They are questions like: What is the sequence of bases in the DNA? What happens when you have a mutation?...What is the organization of the microsomes? How are proteins synthesized? ...Where do the proteins sit?... In photosynthesis, where is the chlorophyll; how is it arranged?... What is the system of the conversion of light into chemical energy? [*Why do birds suddenly appear?*]

"It is very easy to answer many of these fundamental biological questions; you just *look at the thing!* You will see the order of bases in the chain; you will see the structure of the microsome. Unfortunately, the present microscope sees at a scale which is just a bit too crude. Make the microscope one hundred times more powerful, and many problems of biology would be made very much easier. I exaggerate, of course, but the biologists would surely be very thankful to you."

Feynman was a bit of an idealistic visionary, but his optimism sprung from old wells. Over three centuries before his talk, living cells were seen for the first time with a light microscope, which led to the notion of cells as fundamental units of living systems. Revolutions in microscopy quite often catalyze revolutionary ideas in other fields. Feynman encouraged SEM advancement. The SEM gave birth to the STM, which fathered the AFM. Virile family. All these microscopes have enabled invaluable glimpses into tiny worlds tucked quietly into nooks and crannies within our own. Microscopes have revealed things much smaller and even more fundamental than cells.

By 1993, the NSF, America's preeminent scientific governing body, had come to realize the potential of the AFM. In a report issued 34 years after Feynman's speech, the NSF said: "We now stand at the birth of entirely new technologies for observing and manipulating individual atoms and molecules," and driving the resolution of microscopes like the AFM to "ultimate atomic-scale limits" and making them "widely available in an effective way should be a national goal in science and technology."

Since the 1986 publication of the seminal AFM journal article, the flood gates have stayed open. In 1987, ten AFM journal articles appeared. In 1990, two-hundred. In 2001, the American Institute of Physics (AIP) alone listed 371 AFM publications, definitely only a fraction of the total. In less than two decades the AFM has gotten its "hand" dirty in nearly every scientific discipline. There was, indeed, "plenty of room" down there.

5.2 THE SCOPE OF THE SCOPE

One would be hard pressed to find a tool better suited to the Space Age, the Information Age, the Atomic Age and the Genetic Revolution all at once. (Finding books

for this methis meant visiting hella' libraries: a main library, a physical science library, a life and health science library, an engineering library and an adult bookstore.)

As for the Space Age, NASA scientists in charge of designing a Mars rover deemed the AFM worth the additional payload and incorporated one into the Mars 2001 Lander. The project was later postponed until to 2007, when the AFM is slated to perform experiments, such as looking for evidence of water[16], on Martian soil. The University of Nevada is vying to participate in that project.

In the Information Age, the AFM is used for quality control images of integrated circuits on their way out factory doors. Perhaps co-inventor Quate's most valuable role in the evolution of the AFM has been as a liaison between academia and industry. In 1995, *Research and Development Magazine* named him scientist of the year—calling him the genius behind the $100 million scanning probe microscope industry. Quate, the article said, "personifies the connections between business and academia that have characterized much of the development centered upon Stanford University and Silicon Valley. We also salute the killer guacamole he whips up on occasion."

He has made inroads for the instrument into the semiconductor industry especially, where the AFM's cleanliness (it mustn't contaminate the samples it scans), ruggedness (it must be immune to noise and vibration), user friendly-ness (even idiots like me can use it) and ever-improving speed over the years (time is money) have made it an indispensable tool in Silicon Valley, among other places.

IBM has even used the AFM for high-density data storage. The cantilever's sharp tip first makes ultra-small indentations, representing data, on a surface, then the same tip reads the data back.

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[16] The main ingredient in beer.

As for the Atomic Age, well, the 'A' in AFM gives sufficient indication of the instrument's applicability in *that* field, especially with regard to imaging atoms and measuring the forces between them.

Lastly, the Genetic Revolution has been good to the AFM and vice versa. The AFM has been used extensively to study both DNA and RNA. It can even be used to recognize specific strands of DNA and may someday diagnose genetic diseases, leading to earlier treatments. In biology, it has been used to research proteins, enzymes, cell membranes, living cells, mammalian cells like red and white blood cells, platelets, cancerous human cells, sperm, all types of animal cells, plant cells and bacteria like yeast and e. coli.

This list goes on and on, but the AFM doesn't just take pictures. The über sensitive bending cantilever can measure all kinds of things. Counting calories? The AFM cantilever can count them one-thousand times more sensitively than any other calorimeter. It can also be used to measure minute quantities of heat. Heat is a form of energy measured in joules. Returning to the apple analogy, one joule is about the amount of energy you'd use to lift an apple to the height of your waist (1 meter). The AFM can detect *femto*joules. There are one quadrillion (15 zeros) femtojoules in one joule!

Okay, fine. Small forces. What the hell is the point? Well, let's say you need to know the weight of something nonsensically small, like a speck of dust or one of Joe Goodnight's testicles, and your bathroom scale just won't suffice. No problem, the AFM cantilever works like a balance and can measure *atto*grammes.

There are one quintillion (go ahead, have a look at it: 1,000,000,000,000,000,000) attogrammes in one gram.

There are other small forces too. Among the quirkier stories the AFM has told is the one about the gecko and its amazing sticky feet. Geckos have millions of tiny hairs on their

feet, and those tiny hairs (called setae), when seen under a microscope, have hundreds of thousands of tiny hairs on them (called spatulae). Hairs on hairs. These secondary hairs enable geckos to scramble up sheer glass walls and cling to ceilings.

The AFM tells us how. Spatulae are so small that scientists believe they are attracted by intermolecular forces, such as the van der Waals force, of things geckos climb on. Van der Waals force acts when two atoms get close enough to attract one another. All of my new, nonstick kitchen equipment is coated so as to minimize this force. Such minute forces are usually swamped by many of nature's stronger forces—ranging from gravity, which can be felt at distances of 100 trillion light years, to friction, where objects rub against each other. But not in the gecko's case.

University of California, Berkeley[17] researchers used an AFM to measure the amount of force with which gecko spatulae hold onto things. They attached the bases of spatulae to AFM cantilevers, then dragged the opposing sticky ends along polished glass. The gripping force could be deduced based on how much the cantilevers bent. Of course, it turns out to be a very miniscule force, but there's billions of spatulae and the forces add up. If a 180-pound man were to have gecko hairs on both hands, he could scale windows *a la* Spiderman.

Yet the AFM is more than a hand, more than an eye: it's also a nose. Again using its multitalented cantilever, it can "smell" chemicals, which makes it ideal for medical applications, biochemical analysis or creating new perfumes. Using electrical signals just like the human nose and brain, the AFM can recognize the difference between Chanel N° 5 and Chanel N° 19, Coke and Pepsi, or Jack Daniels and Wild Turkey.

As for the slim ideological difference separating modern Democrats and Republicans—they're working on it. But c'mon. That's hard.

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[17] Roll on you bears!!!

6.0 RESEARCH

What am I doing when I don't know what I'm doing? Research. My advisor thinks of it as throwing darts in the dark and then flipping on the lights to see if you hit bull's-eye.

I view it thusly: A long time ago God hid answers inside mountains and gave men picks. Some men find fissures in the rock, weak points where one judicious strike can create a landslide, laying bare the mother lode. Darwin and Newton were such men, as were Dylan[18], Picasso[19], and Bob[20]. Graduate students don't start many landslides, but they do blow shit up.

Research is failing in every way possible until, at last, you fail to fail. This is success. It is usually an accident. The best engineers, I mean the very best, know when an accident is a discovery and when it is just another failure. The adhesive backing on 3M's ubiquitous sticky notes was a failure at first. The goal was to design a strong adhesive, but some engineer realized that the failed recipe produced a glue that could stick to stuff and then peel off easily, without leaving a residue, over and over again.

In research, most days do not end in results. Answers maybe. For example: Why does shit keep blowing up when I try it this way? Answer: I don't know; try it another way. Researchers must come to grips with the possibility of No. No, it doesn't work. No, it's not feasible. No fucking way. The thing that keeps a researcher probing and exploring is the hope that one day their tenacious pick will break free a chunk. The dust having settled, a glittering vein is left exposed. All veins change the world in some way. Every. Single. One. The cure for polio was under a rock. So was Velcro. Cancer's cure still is. Trust in that.

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[18] Bob
[19] Not Bob
[20] Everyone makes a contribution, even him.

But science is not quite the same as engineering. In general, engineers are less interested in raw discoveries than they are in the pragmatic application of those discoveries. This is well illustrated by an old tale about a mathematician and an engineer discussing Zeno's paradox. The familiar paradox involves an arrow shot at a target. The arrow cuts the distance between itself and the target in half, then in half again, and again. Theoretically, it could halve the remaining distance infinitely many times, and still never ever reach the target. As they ponder this quandary, the two men see a lovely young lady walk by. The mathematician considers Zeno's paradox and is saddened by the prospect of never being able to actually reach the girl.

The engineer allows that he could "get close enough for all practical purposes."

Get some, engineer.

The day after Christmas 2001, I spent 10 hours in the lab watching microscopic components of a very specialized machine blow up. The machine was the atomic force microscope and I, *I* was trying to become an engineer—trying to just make something work well enough for all practical purposes.

The microscope parts blew up because they were electric and I was putting them underwater. Think toasters in bathtubs. Of course, we were trying find a way to keep the electric parts protected from the water. Doing so wouldn't cure cancer, but it might make the microscope take better pictures of things immersed in fluid, and that might just help some other researcher take a picture of, say, the DNA of an AIDS virus, and that picture might just help yet another researcher find a way to beat AIDS.

I find a way to make the part waterproof and AIDS is as good as eradicated.

My motives were not quite this altruistic. I mostly just wanted to graduate, and my research was the means to that end. I sat there in the lab, chain chewing a PlenTPak[21] of Juicy Fruit, peering into one microscope in order to see some tiny parts of a different microscope. The work was tedious. I sometimes asked myself if I was doing research because it was required or if I really wanted to strike my own elusive vein. It was both, I decided. A diploma wouldn't mean quite as much to me as a picture of DNA taken with my new part, but I wouldn't sacrifice graduating altogether for that picture.

Until I got a result. Then things changed a little.

6.1 WHEN I GOT A RESULT AND THINGS CHANGED A LITTLE

On October 25th, 2001, I turned 24 years old. In the middle of the day, with a few undergraduates leering over my shoulder and my proud advisor looking on, I took the first tapping mode atomic force microscope image ever using an insulated zinc-oxide actuated cantilever probe in liquid (see Figure).

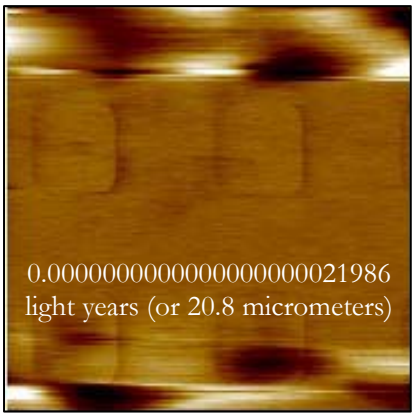

Figure 1: A pretty picture.

Perhaps one hundred other people on the face of the earth can appreciate the merit of such a minute contribution to science. One of them was a doctorate student at Stanford. He was a colleague of ours and we were collaborating with him. He was working toward the same goal as we were, only he went to a college with a $4 billion endowment.[22] The next day, we

[21] 17 pieces, the flavor of each lasting no more than five minutes.
[22] Divide this by 8,000 to find the University of Nevada's endowment. (An endowment is like the cash a university keeps under its mattress.)

called him to rub in the news of our feat. The conversation went something like this:

"You did that?" he asked. "Yesterday?"

"Yup," we gloated.

"Wow!"

"Yup."

"I did that yesterday too."

So we moved on. The image he took was probably better than the image we took[23] and we set about outdoing ourselves. It took us just under three months.

On January 14, 2001, we did it. The image was better. This time, I was alone in the lab. I had spent the previous weekend burying my grandfather[24] and was in a mood better suited to unproductive reflection. When the image began to show up upon the monitor, I looked on indifferently. Here was what I'd been waiting and working for all those long hours, all those dark nights. Was it time to book a flight to Stockholm?[25] I spun in my chair to see if anyone was around. I was totally alone. There was a palpable absence of fanfare. I had to generate my own pride, and to have expressed it would have been superfluous. Who would enjoy it with me? What did it matter if I smiled? Who would see my teeth?

The lab was very quiet, except for the humming of the computer fan. Far, far away some poor sap shuffled swollen feet across the barren sands of Africa, unaware that in Reno, Nevada, in a stuffy laboratory without windows, a graduate student was suddenly a sliver closer to curing him or maybe his grandchildren of AIDS. Simultaneously the student and the sap gasped. We gasped for different reasons. No one heard either of us.

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[23] It was.
[24] Grandpa Tom. (1914-2002). A man who, as my brother Judd said, tended to garden and family with equal patience and love. Grandpa Tom, we miss you.
[25] see prizes, Nobel

No one saw my teeth either, though I revealed all but the molars. They were trees falling in the forest.

7.0 NANOTECHNOLOGY

Nanotechnology is the science of the teensy weensy. We're talking about gadgets in the nano-scale. Nano is a prefix, like milli, centi, and PlenT. It means one billionth. We're talking about nanometers. It's really complicated and you're probably an idiot or at least an anarchist, so allow me to put it in perspective: There are 1,828,800,000 nanometers in a fathom. Moving on.

When Albert Einstein was in graduate school in 1905, he took experimental data on the diffusion of sugar in water and showed that a single sugar molecule is about one nanometer in diameter. My own studies focus on the versatility and speed of the AFM. My thesis advisor likes to call AFMs "the hands and eyes of nanotechnology."

Like genetic engineering and dot-coms in the late 1990s, nanotechnology is cool, even sexy, for now, probably because no one really knows what the hell it is. These days, there's a lot of materials scientists, physicists, chemists, molecular biologists and mechanical engineering graduate students at the University of Nevada, Reno calling themselves nanotechnologists in order to get laid. Sorry, paid *paid*.

See, one of Bill Clinton's legacies was the National Nanotechnology Initiative. The year I entered graduate school, it represented $422 million of federal coinage for eager nanoscientists to squabble over. Clinton gave a speech about it. He mentioned the possibility of one day storing the Library of Congress on a device as small as a sugar cube and producing materials 10 times stronger, and much lighter, than steel.

People are getting worked up about all this stuff, and rightly so. The month of the World Trade Center attacks, the cover of Scientific American was a picture of a magnified atomic force microscope probe tip. There's an article in the magazine by Eric Drexler. He's this guy.

Anyway, he envisions nanorobots that "destroy viruses and cancer cells, repair damaged structures, remove accumulated wastes from the brain and bring the body back to a state of youthful health," among other things. He lovingly recalls the brave pioneers who, using the crude cryogenic storage technology available in the 1960s, had their dead bodies frozen in the hopes of one day being revived by such robots. Guys like Drexler and his frozen cronies believe in specialized nanorobots that could put things together atom by atom. These robots could even construct copies of themselves, which has doomsayers bespeaking dire consequences. What if the robots self-replicate out of control like parasites and in the process of multiplying can't stop themselves and turn the earth into a sloshing ocean of undifferentiated gray goo? What will the starving children in Ethiopia do then? What good is Ben's cure for AIDS in such a world?

Revealing the other side of the coin are intelligent people like Richard Smalley.[26] He calls self-replicating nanobots a "futurist's daydream." He says that, in order to make stuff, you have to adhere to the *laws of fucking chemistry*, which is what you'd expect from the 1996 Nobel Prize winner in the subject.

With so many news pieces and science fiction stories peppered with technological overstatement, laymen and scientists alike are often left feeling more than a little nano-jaded. The economy and stock market are well acquainted with the bearish aftermath of incestuous,

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[26] If you must, insert your own nanojoke about "small-ey" here, possibly incorporating the familiar and oh so phallic version of his first name

industry-specific overhyping of wave after wave of technological revolution. Couldn't this be just a bunch of geeks zealously stoking each other's egos, another dot-com bomb?

Yes and no. Yes: there are ballooning geek egos. No: venture capitalists have short memories, but not that short. Nanoscience is going to have to be legitimate and more economically realistic for it to stick around and have people throw money at it. Results first this time.

Thing is, work on the nanoscale has been underway for decades, and has only recently acquired a catchy title. But that doesn't mean the hype is bad. I've heard some people say that they don't believe most folks are even interested in a more realistic explanation of the science anyway, and that hype serves the important role of communicating to the public the dramatic effects nanotechnology will have on their lives.

"Like all hype, it is exaggerated, at least in the near term," says Steve Minne, another Stanford alum who worked under AFM-co-inventor Quate's tutelage. "In ten years, people will be saying: 'What happened to nanotechnology? I thought it was going to change my life.' Like all progress, it will happen gradually enough so that it is taken for granted."

Gradually enough to be taken for granted. I like that. Applies to a lot of good things.

Perhaps the most lasting and significant of nanotechnology's effects will be the way it has made the sciences overlap, the way technological ages do now. Circuits are grown by chemists. Biologists interact with biomolecules using tiny machines. Minne calls this phenomenon "cross pollination."

Nanotechnologists give things the coolest names.

All that being said, I think all this nanoscience stuff is pretty neat. As a mechanical engineer, it's nice to know there are sexier career options than air conditioning, carburetor fabrication and electric toothbrush design, the caveat being that at any moment the

nanoscience bubble may burst, leaving my chosen field of expertise a barren, jobless wasteland. With all the unexplored and unconsidered ideas still lingering, I'm betting that we won't be seeing any wastelands until at least 2003.

Sometimes, when I'm trying to finagle a bolt into a hole or realign a high precision laser with electrical tape, I think about God. I think, isn't it funny how, 3.5 billion years ago or so, God threw a bunch of nanoscale biomachines into the primordial clam chowder. Today we call these biomachines by a different name. We call them cells. Even 3.5 billion years ago, cells were already floating around, performing tasks like manipulating genetic material, supplying and using energy, and reproducing. Considering this, modern science is lagging nature almost immeasurably. Nanoscience is nascent.

If nanotechnology is a fanatical feminist, then she lives in Afghanistan: nanoscientists have a lot of work to do, and a lot of convincing. Still, there are more than a handful of geniuses out there with teeny tiny picks, trying to unearth gold atoms. There's groundbreaking research being conducted as you read this. Don't be surprised if mountains crumble.

8.0 THE SPOILED GRAD STUDENT

Jill and I live in an exclusive, gated community. It's an apartment complex called Sharlands Terrace. It's exclusive because there's a communal hot tub that's open year round and the only people allowed in it are the renters. It's gated because there's a gate that you have to drive through to get in, and if you don't have an access card, or the car ahead of you doesn't have one, you're just going to have to wait for at least two or three seconds until someone with an access card pulls up. Or maybe the gate's broken again today, stuck in the open position. Then come on in. But don't poach the tub, peon. That's *ours*.

Jill and I were allotted a single, covered parking space beside our apartment. We take turns using it. One particular winter morning I went outside to warm up my engine. My car was not parked in our spot. It was in another one a little farther away. When I got to my car, I noticed that the little Fiero on my driver's side was parked a tad close. Siamese twin close.

Left with no choice, I went around to my passenger door, unlocked it and climbed in. In order to start my engine I had to crawl over the seats to reach the clutch pedal. In doing so I got snow and mud from my shoes on the CD player and found myself straddling my stick shift. I pushed in the clutch and started the car. The temperature outside was 9° F. A frozen belt under the hood whirred irregularly as the engine heated up. I climbed back out and went back into the apartment, packed up my stuff and returned to the car. I put my stuff in the car and climbed back over the seats. I realized the windshield was frosted over. The defogger was ineffectual. I pulled my scraper out of a pocket in the driver door and climbed back over the seats.[27]

In order to scrape the driver's side of the windshield, I had to sprawl out across my snowy hood, as there was no way of standing beside my car on that side. My feet were high in the air as I stretched up and down the glass. I was chin deep in powder snow, humping my hood, scraping up and down, up and down. That's right, get it all, baby! Then I brushed myself off, climbed back across the muddy seats and drove from my exclusive, gated community to school.

Parking at school is embarrassing. But in a good way. You see, my mother used to work at the university in a capacity that warranted the coveted Silver Parking Pass, envy of all others—a placard verifying one's diplomatic immunity to the Parking Nazis. Because my

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[27] My fourth sexual encounter with the stick shift before 8:00 a.m.

mom retired before her pass expired, she willed it to me. It is a gift for which I will never be able to fully repay her. My mother gave me life, and she gave me this pass.

Parking is scarce at the University of Nevada, but I can park in any lot on campus. Most of my professors park by the train tracks a few blocks from campus, then hike in. I know from experience that that particular walk can suck on snowy days when the cold air nips at every exposed appendage.

I park about ten yards from the mechanical engineering building, beside Dr. Wood's burly diesel pickup. And despite the happiness and convenience this arrangement affords me, on 9°F mornings I can't help feeling twinges of shame as I drive past my professors, toiling through the snow drifts and weighed down by big book bags and laptop cases. I try not to let them see me getting out of my car, lest they question my undeserved parking status. I really, really try not to let them see me. As in, I pull my hood over my face. As in, I don't get out of my car until they're out of sight. As in, I slip in and out the building's backdoor like a paparazzi-stalked starlet.

My advisor, Dr. Jesse Adams, is also forced to park off campus. Some days he risks it in the 30-minute meters outside the buildings. These meters are free, but every half hour you have to run across campus and re-turn the knob. The Nazis keep close watch on these meters, knowing full well people abuse them.

Dr. Adams and so many of his fellow professors sit patiently at the bottom of a triple-digit waiting list for their long overdue parking passes.

For this and other reasons to be named herein, I hereby deem myself Most Spoiled Graduate Student at the University of Nevada, Reno, during the Spring 2002 semester.

My advisor likes to call me a "young Jedi." (The 'F' in AFM does stand for 'force.') I am fair-haired Skywalker, naïve yet eager. Like all young Jedi, I too have the potential to turn Evil[28], but the choice to instead serve the interests of Good. And like all Jedi I am blessed.

I am blessed with an advisor who cares not for traditional teaching. After receiving his Ph.D. at Stanford under the pedagogy of Dr. Quate, Dr. Adams (or just Jesse, as we know him) came to the University of Nevada to shake things up. Furiously writing for grant money and seeking out willing venture capitalists, he started what is now the Adams Group—a nanotechnology-focused research team on which I began as the sole grad student.[29] This is why I am spoiled. My graduate research becomes the group's as well. All sub-tasks are divvied out to undergrads. I handle some of the thinking and the actual experiments. I have a whole support structure under me to push my research along at an alarming pace—especially for a brand new group at a small university without a whole lot of funding. As far as I can see, this is pretty sweet; few graduate students at UNR enjoy such support. I don't deserve it. And I don't dare turn it down.

I am blessed because Jesse thankfully does not subscribe to the school of thought that says graduate students are indentured research servants. He let me finish in one year. This makes him unique. Graduating in one year doesn't mean I did less work. It does mean I stretched some longstanding rules.

Somewhere in the graduate school's office there is a file with my name on it. This file is thick with memos requesting special permission for all kinds of things. Jesse finds out there's a rule we aim to break and has me write a memo, which he promptly signs. I carry it

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[28] Being lured into working for the emperor, Bill Gates.
[29] Now there are at least two, maybe more on the way.

over to the graduate school and, viola! We were never turned down. Here are actual excerpts taken directly from these memos:

To: Dr. Marsha Read[30]
From: Jesse Adams
Re: Ben Rogers
Date: August 9, 2001

As Ben's graduate advisor, I am requesting he be allowed to enroll in 18 credits this Fall 2001 semester. I am aware that the maximum allowable credit load is 16 credits; however…

To: Dr. Marsha Read
From: Jesse Adams
Re: Ben Rogers' Graduate Assistant Pay
Date: October 11, 2001

As Ben's graduate advisor, I am requesting he be considered a graduate assistant even though he is currently enrolled in 18 credits this Fall 2001 semester. I am aware that the maximum allowable credit load is 16 credits and that in order to be eligible for a graduate assistantship a student cannot carry more than 12 credits; however…

To: John Green
From: Jesse Adams
Re: Ben Rogers's 791 credits
Date: December 27, 2001

As Ben's graduate advisor, I ask that he be allowed to put 9 credits of ME 791 toward his degree requirements. I know that the general catalog stipulates that only 6 credits may be used, but this is a special case…

I am blessed because, in addition to having my tuition waived, I am paid to go to school, so long as I do 20 hours of work each week. Thing is, 19 hours or more of the work I do relates directly to my thesis. It's work I would have to be doing anyway. Mind you, I

[30] Dean of the Graduate School

do not make a lot of money, which is to say my paltry monthly stipend would have me on a Top-Ramen-and-tuna diet if it weren't for my sugar mama.[31]

All in all, I feel spoiled, and I am. I get to do cool research with smart people and postpone picking out 401k plans for 12 months.

Envy me.

[31] Jill—bringer home of bacon (and other more expensive foodstuffs). Well, actually, Jill's health consciousness rules out any kind of bacon except turkey bacon. Ever had it? It's pretty damn good. It's not pork, but it's not cardboard.