

Knights of the Rainbow Table

Chapter 2

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—Cory Doctorow (doctorow@craphound.com)

The day that our lawyer told us that the DA had added a federal conspiracy charge to the rap sheet, I immediately flashed on what Abbie Hoffman said when they served papers on him for the Chicago 8 conspiracy trial: “Conspiracy? Man, we can’t even agree on where to have dinner!” I would have said it, but just after Moszkowski gave us the bad news, our waitress showed up and asked Sir Tristan what he wanted to order.

We Knights of the Rainbow Table had always had a problem with restaurants: that problem’s name was Sir Tristan Erkko, who was intolerant of lactose, processed carbohydrates, salt, vegans, forks with bent tines and people with poor grammar. Tristan never spoke above a whisper, and he affected a huge mustache that made it impossible for waitresses to read his lips, which made the lengthy negotiations even longer. Normally, the Knights of the Rainbow Table tried to find quiet restaurants where Sir Tristan could dicker at length without having to whisper directly into the server’s ear, but Moszkowski had chosen the place, a busy pizza parlor on Telegraph Hill filled with noisy Berkeley kids. I suppose he thought it would allow us to converse without being overheard. He was a paranoid old civil rights fixer, but Knights of the Rainbow Table could have taught him volumes about the practical limits of privacy.

The three of us stared uncomfortably at one another until Tristan had conveyed his exacting pizza parameters, Lady Tracey and Moszkowski took their turns, and then it was my turn.

Here's the truth: I might make fun of Sir Tristan's ordering peccadilloes, I might sneer at Moszkowski's privacy naiveté, I might turn up my nose at the pineapple and anchovies that Lady Tracey eats with such gusto, but the fact is, at least they can all *eat,* which is more than you can say for me.

"I'll have a glass of water," I said, and endured three pairs of eyes looking at me with that mixture of pity and disgust I've come to know so well. My stomach growled at me, a sound I felt to my eyebrows, and I touched my midriff with one bony finger, a feeling like a dried out drum-head, the skin stretched so tight and desiccated that it rustled.

The waitress reached out with a chewed fingernail and tapped the scratched sign on the table that said, "\$10 minimum order per customer." I'd already noticed the sign. I slid out the \$10 bill I'd placed under my fork and knife and passed it to her. "It's cool," I said.

She rolled her eyes with youthful eloquence and walked off, leaving our conspiracy to get back to business.

"You know," I said, "for a gang of supercriminals, we're a pretty sorry bunch."

Moszkowski said, "I'm going to pretend you didn't say that."

Sir Tristan reached across the table and took my fork and held it up to the light, inspecting the tines and comparing it to his fork. Wordlessly, Lady Tracey handed him her fork, too, and after some deliberation, he picked one and passed the other two back.

Lady Tracey waited until he'd carefully squared the fork up on his napkin, keeping it evenly spaced with his knife and framed by a uniform border of white paper napkin. Then she darted out one hand, snatched the fork he'd so carefully chosen, and licked all its tines, front and back, and returned it to its spot.

Sir Tristan glared at her and then set the fork aside and picked up the remaining three and chose the one with the second-most-uniform tines and once again set to squaring it up on his napkin. I saw the demonic glee light up Lady Tracey's eyes as she made ready to lick this one, too, and I put out my hand and caught her wrist. "Don't," I said. "Come on." My cracked skin rasped over Lady Tracey's smooth fingers and she shuddered involuntarily.

"All right, children," Moszkowski said. "Enough. You're being arraigned tomorrow and I need you all to be on your best behavior. The Computer Fraud and Abuse charges are bad, add the conspiracy count and there's a serious chance you're going to end up in a cell until your trial. None of us want that, do we?"

Here, at last, was something that all the storied Knights of the Rainbow Table could agree upon.

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Once upon a time, in the Duchy of Berkeley in the mythical kingdom of Bayarea, three brave knights did swear an oath to fight the forces of trolls, creeps, identity thieves, snoops, spooks and the whole motley army of Internet Evildoers, lo until they breathed their last breath.

We didn't set out to become knights. We set out to test a cluster. A big, big cluster. Tristan got the idea after going to an art installation in which 1,000 antique PCs were networked across row on row of fake Metro wire shelving, each with a 3.5" floppy in its drive. The artist had done some clever mojo to span a single, redundant 1GB filesystem across the whole cluster, which was used to store and retrieve a constantly updating loop of video shot with a single camera fixed into the ceiling, looking down on the exhibition. The artist had hired about a dozen kids on roller-skates to ride around the racks, swapping out floppies as they went corrupt, the video on the big screen juddering every time this happened and the filesystem recovered.

"So my idea was why not build something you know useful out of all the old computer junk around here like a cluster or something?" Tristan always had the least punctuation of anyone I knew, but he made up for this by inserting extra excited spittle between his words as he talked.

"Where would we keep it?" I said. At the time, Tristan and I were sharing a one-bedroom apartment near campus. I slept in the living room. When we had houseguests (itinerant hackers, mostly), they slept on an air mattress on the kitchen floor.

"What about the electric bill?" Tracey said. She'd bossed a colo in Texas before she moved to Berkeley for college. She could quote the formula for calculating the net amperage-per-flop for the chillers from memory. "What about administration? What about backhaul?"

Tristan shrugged and twirled up some of his mustache and stuck it in his mouth. Neither of us took any notice; he'd been doing that since freshman year, when we three had aced a joint project together that led to frequent hanging out and then roommatehood and even a short-lived and mercifully painless romance between Tracey and me. "I don't know but what about a cluster? I mean a big one like a teraflop or bigger I just thought it'd be cool."

We admitted this was so and went on to the next thing and the next and several days went by before Tracey forwarded us both an email about the

engineering faculty inheriting a semi-derelict brick factory near the docklands as a bequest on the condition that they not sell it for 10 years. Tristan wrote most of the proposal (he was much better in print than he was in person), Tracey filled in the technical details, and I made the pitch to a prof we all liked and he passed it up the food chain and we ended up with 10,000 square feet—about one tenth of the available square footage.

We rigged the water-cooling ourselves, using sea-water. Our faculty supervisor carefully ensured that he didn't know what we were doing. At first, there were a few other groups that applied for space in the Brick Shithouse (as the factory was instantly dubbed, thanks in part to the faint sewage smell that no amount of airing could get rid of). But no one really wanted to haul ass out to the Shithouse and soon we had the place all to ourselves. Our 10,000 square feet quickly grew to nearly the whole building, row on row of PCs of every description salvaged from campus and nearby, wiped and enlinuxed, networked and left to wheeze for as long as they went on working. At any given time, about 15 percent of the cluster was nonfunctional, and we made good use of impressionable freshmen whom we sourced via Craigslist and threw at the problem machines, letting them keep whatever they could fix. This sounds zero-sum: if they took everything they fixed, wouldn't that mean that the dead machines would disappear? But fixing computers is like eating potato chips: most people can't stop at just one. Each one is a perfect puzzle of vendor defects, material wear, capricious software ghouls, and emergent phenomena. The brain-reward for restoring a genuinely threadbare PC to active duty was more psychotropic than anything for sale in People's Park.

How much power did we have? Less than Google; more than all the radio astronomers in Europe, combined. The number isn't important: to buy an hour's worth of as much CPU as we assembled in today's cloud marketplace, you'd have to work for two hours at minimum wage. Our pizza waitress could blow us out of the water and still have enough left for rent, assuming she had a roommate.

What did we do with all that power? At first, we just entered various big computation projects, throwing our farm at Folding@Home to do some handily parallelizable fast Fourier transforms in order to help fight AIDS and cancer and such. This is extremely altruistic work, but it's not very interesting from a research perspective. As interesting as it was to step into the frigid Shithouse and be engulfed in the white-noise jetwash of all the computers, we weren't learning anything about our cluster or its individual components.

It was Tracey who decided to go after rainbow tables, these being something of a holy grail in the security field. It was Tracey who made us the Knights of the Rainbow Table, and set our destiny in motion. But I forgive her.

To understand rainbow tables, you need to understand hash-functions. These are fundamental units of the cryptographic arts, and what they do is easy to grasp but requires either a large amount of math or a large amount of faith. For the purposes of this account, I will go with faith.

Take it on faith, if you will that there is a way to convert one blob of text (the password) into another blob of text (the hash) such that it is mathematically certain that:

- (a) No amount of work will permit you to determine which password is responsible for creating which hash; and
- (b) The same password always produces the same hash.

If you will permit me this axiom, we can proceed without equations. Should you require equations to accept it, by all means, go look them up and then come back, you faithless wretch.

Hashing functions are bipolar: you can never determine what password created them, but you can always redetermine the hash by feeding the same password back to it—they are mysterious and deterministic all at once.

Imagine that you have created a “good” password: that is, one that does not appear in any dictionary that has been written, nor any dictionary that some clever person might create (say, by taking all the words in the English language and substituting 1 for L and 3 for E and so forth). You visit a website and the server says, “Please give me a good password.” You supply it. The server computes its hash and sticks that in a database, and throws away your original password.

The next time you visit the site, it will ask you for your password again. When you provide it, it runs it through the hashing function again (again discarding your original password, which it does not want to know!), and compares the hashed value with the stored hash on file. If they match, it knows that you have entered the password correctly—but it still doesn’t know what the password is!

A computer that only knows hashes and not passwords is a secure little beast, because even if the file of hashes leaks into the wide world, there’s nothing a hacker can do with them. Even if she’s captured the hash of your WiFi password or your banking password or your ereader password, it will do her no good: she can feed them to the WiFi network or the bank or the ereader

without gain. In order to gain access the hacker needs to know the password, not its hash. Thus a computer can be secured with a minimum of secrecy, and that's good, because secrets are very hard to keep (more on this anon).

Think of hashed passwords as the language of a dead culture with no progeny, a remarkable, forgotten people who had an equivalent word for every word in every contemporary language and even for our non-words and nonsense and who left a key for translating our written phrases into theirs, but with no key by which we might go in the opposite direction. As these foreign words have no cognates with our own, there is no way to guess, merely by reading a word in Hashese, what its contemporary equivalent might be.

Enter the rainbow table. Imagine that you fed a dictionary into the hashing algorithm and made a table of the hashed equivalent of every word, and even non-words, such as words in combination, words with simple substitutions, slang, vernacular, foreign words, common phrases. Then, having captured a password's hash, you could compare it with every one of those hashed words—look it up in your handy English-Hashese/Hashese-English dictionary—and out pops the secret password, no longer a secret. Now you have the password, which is all you need to successfully impersonate its owner to some naive computer, and mischief awaits.

“What would we do with rainbow tables I'm no crook,” Tristan muttered from under his mustache, as he idly punched the product ID off a potentially faulty network card into Google to see if anyone had written alternative drivers for it.

Tracey started to answer, but just then one of our undergrad technicians came to the door of the Shithouse's little office, reporting a fault in the cooling system. The cooling system had a *lot* of faults, because water-cooling systems that use sea-water are just stupid, given that sea-water gradually eats everything that contains it, and what it doesn't eat, it chokes with a sclerotic crust of dried salts. Not that we had any choice, because running traditional chillers would have clobbered the Shithouse's annual budget in a matter of weeks, and without aggressive cooling, the place would spike at 60' C in about five minutes, and then it would be a race to see whether the assembled computers fused and died before they could start a fire that killed us all.

Cooling took priority.

When Tracey came back—it was a minor pump problem that we'd all fixed a dozen times and it was mostly just a matter of knowing where to kick and how hard—she said, “Why rainbow tables? Two reasons: first, they are cool, and; second, they parallelize.”

That was the kicker, parallelization. A parallelizable problem is one that can be worked on in lots of different places because no step relies on the output from a previous step. Think of stuffing envelopes with friends: one group of friends can address envelopes, another can fill them, and a third can run them through the postage meter. That's pretty parallelizable—if you finish with the meter before the stuffing group is done, you can grab a stack of metered envelopes and start stuffing, too. In theory, one slow doofus won't leave a roomful of people sitting around, fuming.

Now, compare that with a serial task, like assembling a jet engine on an assembly line. First, Alice screws on one dingus, then Bill attaches a dingus to that, and Carol attaches a dingus to *that,* and so on, all the way to Zeke, fitting the cowling at the other end of the assembly line. If Alice had a wild night last night and is dragging her ass as a result, Bob, Carol and the rest, yea, unto Zeke are going to be stuck with thumbs firmly planted up their alimentary canals. It might be possible to redesign a jet engine factory to run with more parallel tasks—think of the famed Japanese car companies where small teams assemble whole cars, where one team's dragging doesn't hold up the factory—but there's a lot of computation where the next step depends on the previous one and the more of that there is, the less you can do with a big parallel cluster.

Of course, there's always some extent to which problems are serial. If there's one guy who's really slow with the address labels, eventually, you're all going to be sitting around waiting for him to finish off his sheet, looking meaningfully at your watches and trying to figure out when the last bus goes.

The Shithouse was full of computers which were, basically, that guy. We didn't discriminate when it came to the rescue animals we took in, nursed to health and set to productive use. The basements and dorm rooms and storage lockers of Berkeley vomited forth a steady stream of junk hardware, stuff that the granoloid masses couldn't bear to send to a landfill. Every time CNN showed another exposé featuring blistered, engoitered Chinese kids laboring over acid vats to strip apart e-waste, we got a fresh shipment of guilt and shame and obsolescence.

Combine that with the screaming doubling curve that computer power rides and you got our shelves, where a given computer might be, quite literally, a million times faster than its neighbor (and like as not, it would be consuming a tenth of the power: talk about eco-guilt, we were a one-building carbon crime wave). We had heterogeneity for days, and with that salmagundi came any number of chewy, interesting clustering problems: Which computers should be in charge of working (translating passwords into hashes), and which computers should be in charge of apportioning work? How do you index what's on which

computer, and what do you do about recovering a computer's lost work when it dies? Should more common words be stored on faster computers, or more computers, or both? Or does figuring out which password to put where cost more than we'd save by just dumping passwords into computers at random? These are meaty and interesting subjects and we waged arguments back and forth and up and down about them and wrote feverish code to prove our points of view and never got around to writing up any papers for publication, though we sure started plenty. We could have had an ACM journal dedicated to us: *Journal of Incomplete Research Into Distributed Computing.*

The Rainbow Tables Project had been up and running for a month when Tristan called me from work—he had a wage-slave gig fine-tuning some semi-fraudulent search engine optimization tools at a doomed Oakland startup where he was (get this) the best adjusted programmer on staff.

“I'm thinking of worm trails or ant trails or something like that,” he said.

“Nice to hear from you, too, Tristan,” I said. We didn't use phones for voice-calls much, various IMs being much cleaner, cryptographically sound, and suited to multitasking. But sometimes Tristan needed to say things aloud to make sure he knew them. But his phone manner was dreadful.

“So when you look up a password you just ask a random computer and if it doesn't have it it asks a random computer and so on and so on until it finds the password. Then the computer with the password tells the next computer and it tells the next and it tells the next and they all store the passwords. Like a pheromone trail. Like ants. So the more you ask for a password the more available it becomes the more pathways there are to it like. It gets more robust the more you use it. Plus we'll be able to see which passwords are commonest over time because the network will evolve to match them.” I could hear the spittle flying. He was on a roll.

And he was right. Tracey saw it right away and helped me with a formal proof. But even before I'd finished that, Tristan was coding it, Tracey was debugging it and I was writing test cases for it and you know what? It worked.

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Moszkowski sends us email in the clear, no encryption. He relies on the security of his home and office networks and the interconnections between his ISPs and ours to protect and secure our communications. Moszkowski hasn't figured out yet that all that stuff is an open book—or if he's figured it out, he hasn't felt it in his guts or his blood or his balls or wherever you need to feel a hard truth before you really know it.

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And after a while, the cluster got big enough to recompute against any new salt in pretty short time, especially with our information about the most-common passwords. We were pretty self-congratulatory, I must admit—very proud to have out-thought all those silly engineers and product managers.

Of course, none of *us* had the foresight to imagine that the day was coming when you could replicate our work for \$12 worth of time on a cheesy cloud host in Bulgaria or some other exotic place. No, we were too busy forming an order of knights.

“Knighthood?” Tracey and Tristan looked at me like I was insane.

I felt my chin jut out at a belligerent angle and I reeled it back in. “It’s either that or a league of super-heroes. Look, with great power comes great responsibility. We need a moral compass to ensure that we use our powers for good. We need chivalry, a code. Now, superheroes are cool and all, but the ‘Justice League of the Rainbow Table’ isn’t nearly so cool as ‘Knights of the Rainbow Table,’ is it?”

We’d been building up these enormous tables, and theoretically, we hadn’t touched them except to try them out on our own tame little testfiles. The reality was much more sordid, of course. I’d made a project of cracking the WPA passwords for at least two routers in every place I frequented, so that I could use them as I roamed the city. And once I was on them, well, it was only natural that my curiosity would compel me to have a sneaky-peeky at the traffic on the network, snaffle up some email and tweets and Facebook nonesuchs. Not that there was anything there worth looking at—I could play *Rear Window* all day and night and the most sordid thing I’d find was a little tax cheating, some unimaginative dirty talk, people losing their tempers at each other and snorting and steaming like Yosemite Sam without any capital letters or the benefit of spellcheck.

But I couldn’t look away. At first, it was the horror of how naked it all was, the sheer volume of unencrypted credit card numbers, login credentials, and assorted Personally Identifying Information—PII, the smog of the 21st century, ubiquitous and impossible to be rid of.

Even after the shock of other people’s technologically naive vulnerability wore off, I *still* looked, because I couldn’t look away. I’m a monkey, I’m descended from monkeys, and the monkeys I’m descended from beat all the other monkeys by figuring out how to work together, and the secret to that is

keeping track of all the other monkeys to make sure that they're not sleeping in a tree while you're gathering the fruit. I could not look away. If you could, well, you're a better monkey than me.

"Me too," Tracey admitted. "The kids next door are really creatively vicious about some other kid at school, a girl who picked on them who they've been quietly sabotaging for weeks now. Lots of fake social network stuff, imaginary boyfriends asking her to send topless photos, the whole lot. It's like a car-crash with a side of child porn, so icky but I bet you can't eat just one."

Tristan blushed and looked down and looked up and looked down. "My neighbor's got a bunch of IP-enabled CCTVs in his house and he picks his nose and I can't look away."

"Look, it's not the locks that keep you from breaking into your neighbor's house, right? I mean, any of us could figure out how to pick a lock in about a day, right? It's ethics. Social contract. It's a belief in the nobility of doing right and being good and doing unto others and all that. A million daycare workers who told you to share your toys, no punching, don't eat off that other kid's plate." I'd been up all night tossing and turning about this, in between watching an insomniac somewhere on my block get into a vicious Wikipedia edit-war over the history of Glock semi-automatics with an intensity that made me suspect he had a basement full of the things and had spent a lot of time contemplating what he might do with them.

"What I'm saying is, here we have all this power and if we want to be a force for good, well, that won't happen automagically. We're going to have to do something, something substantial and you know, formal if we're going to steer clear of being creepy evil voyeurs."

"Creepy evil voyeurs?" Tristan said.

"It's a term of art," I said.

"Yeah, the peril of CEV beckons," Tracey said.

"So why not a knighthood? After all, isn't that what knights were all about? We've got swords and armor and training and we could theoretically go around beheading and disemboweling willy nilly, but instead we'll develop some sort of formal code that we'll all abide by that specifies exactly whose head we're going to remove and whose bowels we're going to dis."

"What's wrong with not disemboweling altogether?" Tristan said. He was a pacifist at heart.

Tracey crossed her eyes at him. "You're joking, right? Once you've got swords, you can't *not* have swords. Are you going to take apart the Shithouse?"

Just the thought of it made my neck and shoulders tighten up like a tennis racket. “No one’s going to shut down the cluster.”

“Course not,” Tristan said. He looked even more scandalized than me by the thought.

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The day we took the Shithouse apart was one of those unexpected sunny, dry days that reminded you that the Bay Area was in fact part of California and not a distant satellite of some gloomy, rain-drenched place up in Oregon or Washington. All it took was one tiny whisper of a police investigation to cause the university administration to suddenly remember that they owned the Shithouse and had been paying our increasingly substantial electric bills for a decade. It had been so long since we’d seen anyone who wasn’t one of our overworked free undergrads at the Shithouse that none of us really knew what to make of the campus security people who strutted into the Shithouse office. Lady Tracey was napping on the couch and I was playing a German board-game with Sir Tristan, and we all roused ourselves and looked up when the door opened and admitted five boxy guys in boxy coats with boxy utility belts and boxy walkie-talkies. My first thought was, “It’s been years since we cracked the password on those walkie-talkies, why haven’t we been listening in on them?”

Actually, that was like, my third thought. My first thought was, “Who are those guys?” and my second thought was, “Oh crap, we are so hosed.”

“Can I help you gentlemen?”

“You’re going to have to leave,” said one, an older guy who seemed to be in charge. He had a close-cropped horseshoe-fringe of grey hair and his campus security jacket was threadbare and shiny at the elbows, but he had a personal presence that asserted itself and made it clear to all of us that he was the boss and expected to be obeyed. I guess he’d been at it for a while.

“Is there something on fire or something?” Tristan said.

The old guy cocked his head at Tristan, seemed to get the measure of him straight off. I guess he’d been working campus security long enough to recognize Tristan’s species of spacy otherworldliness as genuine.

“No, son,” he said with near-gentleness. “You’re no longer allowed to use this facility. We’re shutting it down.”

“You can’t do that,” said Tracey.

“Ma’am,” the old guy said. His badge said N. STRUBE. “Ma’am, I’ve been asked by the dean’s office to close this place down and remove every person

I find from its premises. I've been asked to remove you, in other words. But I haven't been asked to take you into custody or even take down your name. That's a curious thing, isn't it? Almost like they don't want to have to admit that they knew what was going on in this place. Are you taking my meaning?"

Tracey nodded. "Perfectly," she said. Perfectly—as in perfectly composed, which she was and I wasn't. "But I don't think you understand mine: if you shut down the cooling system before you shut down those computers, the temperature in this building is going to hit 160 degrees Fahrenheit in about five minutes flat. If you're lucky, the computers will burn out then, but my guess is that a large number of them will be on fire before that happens."

It was right, of course, but I couldn't believe Tracey was saying it so calmly. She must have rehearsed this scene in her head. We all knew that there was a chance we'd get caught some day, but when I considered that possibility, I jerked my mind away from it as though I'd grazed a raw nerve. So Tracey was acting out some longstanding nightmare scenario, just as in charge as Mr. N. STRUBE. He seemed to recognize it.

"That's a very interesting fact, young woman," he said. "It wouldn't happen to be one of those very convenient facts that you just happened to have to hand for a situation like this, would it?"

Tracey cocked her head. "Sir, I'm not nearly that cunning." She was, in fact, lots more cunning. "But hey, these computers started out as trash, they're probably headed back into the trash after this, so I guess there's no reason not to incinerate them. But it seems unnecessarily messy, if you take my meaning."

"I don't suppose you have an alternative?" He was trying to keep a small smile off his face. He wasn't trying very hard. Authority figures loved Tracey when she was doing her little mischievous scamp thing.

"Well, I was thinking we could go around and power them all down clean, take them apart, make it possible to salvage as much as we can." She shrugged. "I guess it's probably university property in some sense or another." She shrugged again. "Your call."

But she had already moved to a keyboard, started to login—she had an improbably long password, we all did, for obvious reasons—and shut them all down.

N. STRUBE cleared his throat. "What, exactly, are you doing?"

"Shutting things down," she said.

"I thought you said it was my call."

She gave him a look that was one part good-natured ribbing, one part withering scorn. "Seriously? OK then, you make the call."

He stopped trying to hide his smile. “Yeah, all right, shut it down, take it apart, whatever it is you do.”

I wanted to call up some of our undergrad slaveys and put them to work unpulling the cables, disconnecting the power-supplies, bringing down the hinky, freaky cooling system clean. But Tracey told me not to be a simp and pointed out that this was all on the d-l, a tacit understanding between her and the forces of N. STRUBE, and that bringing in a bunch of bigmouthed frosh would clobber all that.

So we did it ourselves. First, Tracey sent out a broadcast command to all the servers to begin erasing their hard drives, starting by nuking the catalog file on the data-partition and then going to work on zeroing out all the sectors with multiple passes, a process that could take a very long time. We didn’t have a very long time, of course, but: “It won’t hurt. Just start yanking the power cables and bundling them up and rolling up the network cables. Stack the machines out on the loading bay and take your time, so we zero out as many sectors as possible. Anything to screw up the forensics.” N. STRUBE pointedly pretended that he didn’t hear this.

It was dusty, hot work. The computers’ fans had sucked all the brick-dust and pigeon guano and skin cells that had sifted down through the Shithouse’s high rafters and spat it out along the backs of the shelving, mixing with the moisture in the air to form a gunky crust that stuck to our hands and clothes and got in our mouths and up our noses. But as unpleasant as that was, it wasn’t nearly so terrible as the realization—which washed over me every minute or two—that we were done for.

There came a point when nearly all of the machines had been terminated, gutted and stacked, hundreds of them in sloppy, teetery towers on the loading bay floor. N. STRUBE had been examining our cooling system carefully, and he broke off to meander over to Tracey. I joined them. Tristan kept coiling up Ethernet cable. “It seems to me that we could take it from here. Nothing’s going to burst into fire at this stage, right?”

Tracey shrugged. “I suppose not.”

“And that big red shut-off button for the cooling system, that’ll do it, yeah?”

Another shrug.

“Well, then, I expect that you’d better be off. We can take it from here.”

Tracey nodded, defeated. “We’ve got some personal things up in the office.” Some personal things? For years, we’d been dumping everything that didn’t fit our crackerbox apartments into the office—everything from old sofas to Tristan’s obsessive German board-game collection.

“Well, gather up what you can carry then, and clear out.”

“You’ve been very kind about this,” Tracey said. The hard physical labor had baked out all her mischief and wrung out all her fortitude, leaving her small and tired.

Now, Sir Tristan, on the other hand—it was like he’d absorbed every erg of energy that Lady Tracey had lost. It was the thought of abandoning his German board-game collection, I think. It gave him the strength of 10 men, like a mother lifting a 16-wheeler off her baby. He used Ethernet cables to make huge bundles of the games, four of them, each ten feet high, and ferried them down the stairs from the foreman’s office to the front door in four trips.

“Now what?” Tracey said. “I’m not carrying those things.”

Tristan shook his head. “Just help me load up.” He bent double, hand braced on his knees, back flat. “Stick ‘em on in order.”

He’d left long yokes of category-5 enhanced cable dangling off the game-bundles. The nearest bundle was the tallest, but had the shortest yoke. I heaved it up onto his skinny back and threaded the cables over his shoulders, helping him get his fingers twined in them. The next pile of games was a little shorter, but with a longer yoke, long enough to reach past the bottom bundle and get into his fingers. The third pile was smaller, with a longer yoke still, but by the time I had it piled on his back, his knees were trembling and he was making horrible little *unh unh* noises like he was about to split open.

“I’ll get the last one, Tristan,” I said. I hefted it onto my own back. It was the smallest of the four, but it was still so heavy that by the time I’d made it out to the main road, I was gasping and groaning. But Tristan was still moving, actually managing to lift and shuffle his feet along, each step coming with a chorus of grunts. When we got to the curb, he whimpered, “Get them off God get them off.” I hastily set down my bundle, then began unloading him. I was reaching for the last stack when he collapsed forward, face first into the curb. I shoved the games off him and rolled him over. His face was streaming with blood from his nose and chin, which was split and filthy with gravel. He bucked and began to throw up, the vomit streaming down his cheeks and up his nose.

Knights don’t surrender to squeam. I rolled him back over, helped him to his knees, pulled up his t-shirt and used it to wipe his face clear. He stank. I stank. We’d been moving computers all day, disturbing all that dust. I didn’t even *like* Tristan very much at this stage. But we were both Knights of the Rainbow Table.

“How will we get all these home?” was the first intelligible thing he said.

“You’re welcome,” I said.

“I can’t leave them here,” he said.

Tracey caught up with us then. She’d been talking with N. STRUBE, squaring something away. “Thanks, guys. You managed to make the shittiest day of my life even shittier.” Lady Tracey wasn’t big on the chivalric code.

“Can I borrow your car?” I said. She was the only one of us with a car; in the Berkeley student circles we ran in, owning a car was only slightly less reprehensible than eating veal.

“Not if you’re going to get fluids on it,” she said.

Tristan looked up from his labors, tears and bile dripping off his sunken, stubbly cheeks. “I can walk,” he said. “Just take the games.”

He did walk. It turned out later that he’d partially herniated a disk, broken two ribs and torn up his intercostals muscles pretty badly. We saved all the games. They’re still in my living room. I haven’t used—I haven’t *seen*—my sofa in six months.

###

Moszkowski sent us another email: “We need an expert. No one in a black t-shirt with vaguely threatening slogans a judge won’t understand on it. Someone in a tie. Someone with a major university would be good. Your asses are on the line.”

“I’ve got a crazy idea,” I said to Tracey. We’d gone to her house to meet because my place was full of board games and Tristan was living in a residential hotel that averaged three tweeky meth-freaks per square yard. Tracey’s run-down bungalow was in a crappy neighborhood and the water in the faucets ran brown and stank, but compared to us, she was the picture of middle-class respectability.

“Hit me,” Tracey said. Tristan was staring out the window, seemingly oblivious, which either meant he had drifted off into the realm of pure thought, or he was listening intensely and not giving any outward sign of it.

“What if we ask Niratpattanasai?”

“Yeah, that’s a stupid idea all right,” Tracey said.

Niratpattanasai was the undoing of the Knights of the Rainbow Table. We’d happened upon his router on a reccy mission through the Outer Richmond, sniffing it with a clever little protocol analyzer that Tristan had bodged together. It could look at the way that a router broadcasted its ID and managed unsuccessful login attempts and make a highly accurate guess as to the make, model and firmware running on it. Every router had its idiosyncrasies,

and Tristan had made a protracted assessment of these and loaded it onto his phone. Tristan's phone had begun its life as a slim and elegant example of the mobile designer's art, but he'd rubberbanded four external batteries and an ugly, solder-spotted antenna to it, so it looked more like an IED.

But it could spot an out-of-date router at 2,000 yards, snaffle up enough packets to get a lock on its encryption key, blast it through the rainbow tables, and have root access in five minutes flat. Tristan wore out three pairs of shoes a year, walking the streets of the greater Bay Area in search of misconfigured and out-of-date wireless networks. All that walking had melted off the few ounces of fat he'd started with and left him looking like a crosshatched anatomical drawing with a deep farmer's tan that was nut-brown below the sleeve mark and fishbelly pale above it. He had it set to vibrate and kept it in his front pocket, and he stalked the streets of San Francisco at a brisk pace, holding an ereader up to nose height and reading the day's papers. Sir Tristan read an average of forty daily newspapers a day. He was the 20 percent of readers who account for 80 percent of sales. Actually, he was the one percent of 20 percent who accounts for 80 percent of the sales to the 20 percent. For someone as otherworldly as an elf, Tristan knew an awful lot about current events.

On that day, he was plowing through the day's digital edition of the Singapore *Straits Times*, a paper that was closer to a comic-book than a news-source, being heavily censored by Singapore's fun-loving Ministry of Information. But Tristan read for quantity, not quality. His phone started to buzz as he was finishing a report on a wedding-ring expo at the International Convention and Exhibition Centre. He finished the article, tucked the ereader into his back pocket, pulled out his phone and checked the screen.

It had found a late-model Linksys router, running a two-generations-back version of the firmware—the firmware that it had shipped with, most likely. Most people never update their routers; it's one of the top vectors for serious, life-destroying pwnage. Tristan's phone had already cracked the password:

```
H*bq#(6BFEqdJsdj`W3j|P*u_a/Ln,VkW0NeSMxxW'mSxTEFh2J
BK.40Dg2"erk}XS,[;d^Z/*6P1B})$+_Xd6Z+BSbt9pKFi&KC8mfu8+o$
Y<QUxP=f:f\{:m1<:6Pip}i_T3?T0vO[{L$6QE"*&&B[P=hH72",R*y&n
>oj}IEI$;pg$r1MFQ_jSSYq||hds]-!T$W_nCHkFMXgye7q`VfR'V^@
(B6kXY()7p29$,JQ?H0*-bVFcQg[!-XYD
```

256 characters of extremely pseudorandom gibberish, well beyond the capacity of all but the most obsessive human being to recite, remember, or manually enter. A damned good password, in other words, and not the sort of thing you'd expect to find on an out-of-date router, unless it had been set up

by a security conscious friend or relative (say, a visiting granddaughter) and then forgotten.

Not that it mattered—our tables ran four times as deep, 2⁷⁵⁰ more complex. And Tristan had the latest-and-greatest version of the router firmware on his phone. It took about eight minutes for his phone to install the patch, reboot the router, and restore its configuration file, including that insane-o network key.

It was during that eight-minute period that VJ Niratpattanasai, a freelance security expert and sometimes columnist, noticed that his router was going screwy. He already had his own protocol analyzer on the network and it logged every detail of Tristan's session. Niratpattanasai used a webcam situated on the old TV antenna on his roof—installed, he said, to help participate in a songbird census years before—to capture some pretty high-rez pictures of Tristan as he stood in place, reading a report on shipping container losses in the **Straits-Times** while glancing at his phone's screen from time to time. From those grainy images, Niratpattanasai was able to run a reverse-lookup against one of the new snoop sites that applied face-recognition to the photos on the web in order to make guesses about identity. Tristan wasn't hard to find: there'd been photos of him on the web going back to the time he was 14 and built his first homepage on Geocities. But all the recent photos of Tristan featured two other people: an angular-jawed woman with straight bangs and glowering eyes and a slightly pudgy, slightly bald guy who liked to wear high-tech giveaway golf shirts and loose-fit jeans with his Birkenstocks. That would be me. Our identities were easy enough to ascertain, too.

Tristan was long gone—he was updating the firmware on three routers in succession at a low-rise apartment building on the next street—but Niratpattanasai was still on the case. We didn't know it, but he was peeling our lives like onions. He was good at that.

Tracey was very careful about her activities: she didn't need to stalk the streets to find places to perform her good deeds. Instead, she ran network probes through a series of anonymizing proxies, looking for improperly updated server software—mostly content management systems that had fallen behind in their patching schedules. She'd exploit the vulnerabilities, harvest the password file, grab the administrative passwords, take over the machines, update their back-ends (and any ancillary software she found there) and nuke any malware that had been installed before she got there. She averaged a dozen machines a day, day in and day out, and never missed a day, not even when she caught some kind of awful flu that had her seeing cross-eyed and barfing up her lungs for a week.

Back-tracing Tracey required someone a lot more clued in than any of the admins whose machines she was fixing. But some had made half-hearted attempts at it, dead-ending at her blinds and false-fronts. These abortive attempts had been documented on various security message boards, and once or twice Tracey had out-clevered herself by weighing in on these discussions with false clues. She wasn't as subtle as she thought, and Niratpattanasai combined these with some clever guesses and some shrewd detective work to turn up some damning evidence that was thoroughly linked to Tracey in about a dozen ways.

And me? I was the stupidest of us all, really. I used my powers to penetrate wireless networks, snoop on their traffic, pluck weak passwords and poor security practices out of the electromagnetic spectrum, and then I would use throwaway webmail accounts to conduct impromptu security masterclasses with the sloppy, the misinformed, and the careless. "Teach a man to fish," was my thinking and, at any given time, I had about a dozen "students." I'd gotten good at approaching people about their security lapses but it was inevitable that some people freaked and blabbed all over their Facebooks and such about the weird stranger bent on teaching them to protect themselves on the intertubes. Niratpattanasai found them, too, put two and two together, and wrote a major expose about us for the Sunday *New York Times* magazine, snagging the cover.

They held the presses until noon on Saturday so that they could add in the quotes he got from us as the FBI swooped down on us while we were eating bagels and vegan schmear at a hippie place near Tristan's favorite game store. I say "swooped," but they were very civilized about it. After they'd stationed guards at the front and rear entrances, three officers came in, showed us their badges, read out the charges, and asked us to come quietly.

Niratpattanasai rode in the back of the police wagon with us and used his phone to record a forty-five minute interview as we fought traffic to the federal courthouse where we were to be booked and held for arraignment in a crowded and miserable holding cell with an odd assortment of losers, the luckless, and villains. I can barely remember the questions he asked us, and I've never brought myself to download the audio file he posted in his "reporter's notebook" special on nytimes.com. But he didn't use any of my quotes in the article, which probably means I was boring. Tristan got three quotes: "I don't understand. I fixed your router!" and "What kind of phone is that?" and "Is it running up-to-date firmware?"

Tracey got *eight* quotes, most of them what they used to call “unprintable,” except the *Times* printed them, because when Tracey gets angry, she’s like a thesaurus of profanity. It’s practically poetry, and it’s got educational value in a world of dull, unimaginative cursing.

I knew a lawyer, my freshman year roommate in fact, who’d made junior partner at one of those Silicon Valley firms that specializes in patent litigation, finance, and bailing out high-tech executives who’ve flown their Soviet surplus jets too close to city limits or mixed an unwise cocktail of high-performance cars, smart drugs, energy beverages and Humboldt County’s stinkiest, stickiest ganja.

The Feebs had a cybercrime creep who confiscated all our electronics and such and spirited them away from us, but he turned out to have a heart, because he retrieved Albert’s—my ex-roommate’s—number for me from my phone. Of course, he made me tell him my password in order to unlock the phone. He also made me wait while he did some kind of whole-disk copy from the phone’s memory to an external drive, just in case the password I gave him was an alternate one that zeroed out the phone’s storage, which made me feel flattered (that he thought me capable of such subtlety and forethought) and embarrassed (that I hadn’t thought of it). He seemed disappointed when he checksummed the phone’s storage after the password had been entered and saw that unlocking it hadn’t altered it. I shrugged and wrote down the phone number on my arm with the soft-tipped Sharpie that was the only kind of writing implement we were allowed to have.

Albert hadn’t changed his cellular number in years—he was good like that—and he picked up on the third ring, sounding sleepy.

“Lo?”

Something about the quality of the line and the texture of the quiet said ‘overseas hotel room.’ “Where are you?”

“France.” He blew his nose. “Haven’t heard from you in a while.”

I did the math in my head. 3PM here was, uh, 7AM there, on a Sunday. “I’m sorry to wake you up. I, well, is there someone you might recommend, a lawyer, for a federal Computer Fraud and Abuse arraignment?”

I heard him sit up, fumble with his glasses, a light switch. “Who’s been charged?”

“Um,” I said.

“You? You seemed like such a nice boy in school. Where are they holding you?”

I told him, and spelled Tracey and Tristan’s names for him. “Do you have any money?”

“Not the kind that your firm charges,” I said. I’d once recommended him to a client I was freelancing with and the client had called them up and then pointed out that they were proposing to charge more than his company’s entire annual budget just to review a deal.

“We’ll sort that out. But you’ll need some assets or cash if you’re going to make bail. Cars, houses, stocks? Your parents’ house?”

“I’d hoped I wouldn’t have to talk to my parents.”

“You seriously think that having a difficult conversation with your parents is the worst thing that’s going to happen to you at this stage?”

Ouch. “Well put.”

###

“Niratpattanasai did all those interviews and articles and TV appearances but he never once accused us of wrongdoing. He went to great pains to say that we were doing good.”

Tracey skewered me on a very Tracey-ish glare. “He went to pains to say that we **believed** we were doing good. He also took pains to say that we were lawless vigilantes who had committed thousands of felonies.”

Normally, I would have backed down to Tracey. We both did, most of the time. But ever since I stopped eating, I’d found new wellsprings of willpower, new bravery I’d never had before. “Moszkowski said we needed an expert who would testify that we’d acted without malicious intent. I think Niratpattanasai’s got integrity, he’ll say that if they ask him. And who could ask for a better expert? I mean, really!”

Tristan nodded. “I think he’s right. Niratpattanasai would be great. I like him.”

Tracey tried the eye-laser thing on Tristan but the beams just bounced off his impenetrable shield of weird. “You like him?”

“He did really good work tracking us down. It can’t have been easy. For all he knew we were bad guys going around messing everything up. I think he could have been a Knight if we’d asked him early enough.”

“You mean, before he got us arrested?”

“Yeah. Sir Niratpattanasai.”

Tracey readied another volley but I put up my hand. “Look, forget the cut and thrust and **think,** Tracey. Whatever else Niratpattanasai is, he’s not a liar or a fool. He may not understand or like what we did but, if someone puts him on the stand and asks if we were doing anything malicious, he’ll tell the truth.”

She balled up her hands into fists and took two deep breaths. Then she opened her hands. “Fine, that’s no stupider than any of the ideas we’ve had so far and

smarter than most of them.” She hit the intercom button on the phone on the board-room table. “Can you please tell Mr. Moszkowski we’d like to speak to him?”

The law firm had given us use of one of its small boardrooms because we couldn’t agree on any other meeting place—I couldn’t abide restaurants (obviously), public places gave Tristan the heebie-jeebies, and Tracey couldn’t stand to be in either of our apartments (“They smell like unwashed boy,” she’d said, with characteristic candor) and she wouldn’t have us in her place (“*You* smell like unwashed boy.”)

Moszkowski listened patiently as we explained our thinking to him. “You can’t call the prosecution’s main witness in your defense,” he said.

“Is that a law,” Tristan said.

“It’s not a law. It’s just common sense.”

“Oh, that,” Tristan said. “We don’t really do that.”

“At last, something we all agree on,” Tracey said.

“Yeah,” I said. “Common sense is something that happens to other people. We’re more about, you know, higher purposes and all that.”

“And look how far that’s got you,” Moszkowski snapped. But I could tell that he was weakening. He’d done some showy, flashy things in his long and storied career and he clearly saw that this was going to be one for the scrapbook (assuming he could pull it off.)

All that remained was to call on Niratpattanasai.

###

Of course we knew where he lived. If Tristan hadn’t found his house, none of this would have happened and we could have gone on breaking the law forever. Or at least, until someone else figured it out. Niratpattanasai wasn’t the only smart person on the Internet.

“You knock,” Tristan said. He didn’t like touching other peoples’ doors. Plus, we were all a little worried that Niratpattanasai’d answer the door with a shotgun or a crossbow or one of those huge two-handed Klingon disemboweling swords.

Tracey did her decisive thing and made a fist but I was already rapping at the door, tapping into that reserve of strength I’d found when most of my body melted away.

He answered the door in bare feet and jeans, his hair wet from the shower. He was wearing a t-shirt advertising a German board game called Elefanten-Parade, which I happened to know that Tristan worshipped. We’d played it a few times with Tracey and even she had to admit it was a pretty engrossing and clever bit of design, plus the wooden elephant tokens were really beautiful.

“That is such a great game,” Tristan said, without preamble.

“Nice to see you, too,” Niratpattanasai said. He was Thai, and a little short by American standards, about Tracey’s height. He had friendly eyes and one of those faces that looked like it would seem very young until it suddenly seemed very old. “Um, you’re not here to beat me up or anything, right?”

Tracey made a rude noise. Tristan asked him where he got his shirt. I held up my hands with their matchstick fingers and said, “We come in peace.”

“You’d better come in, then,” he said.

It was a nice place, but not crazy-nice, the home of a moderately well-off tech freelancer in San Francisco. There were framed photos of vintage computers in the hallway and a \$5,000 coffee machine that looked like a brass Dalek in the kitchen (I know exactly what it costs, because I’d priced them myself just about every time I came into a little money, but it was never enough). He made us espressos, grinding the beans in a heavy, noisy burr grinder that looked like it had been to the wars. “I brought it to Burning Man,” he said. “Getting the playa dust out meant totally disassembling it and then I lost part of the housing for a while and just used duct tape until I found it at the back of a cupboard. But it’s a great machine.”

The espresso was black as licorice and it sported a velvety cream that was sweet and bitter at once and everything I imagined that particular espresso machine would be if I could ever afford it. I was suddenly and immensely jealous of Niratpattanasai. We’d been off doing good deeds for years while he worked the private sector and pulled down enough money to buy really top-notch coffee gadgets. My life sucked.

It was about to get worse. “Can I use your toilet?” I said.

Niratpattanasai must have seen the alarm on my face because he almost sprinted up the stairs, me on his heels. I barely got through the door before the coffee came back up again, landing in the toilet bowl with a spatter. I’d had enough practice at puking that I hardly made any sound. Afterwards, I rinsed out my mouth with water from the faucet and dried my hands and face on a damp towel that hung from the shower rod. The bathmat was damp, too. I saw that he used the same shampoo that I used, a peppermint hippie brand that was certified to be organic, fair trade, phosphate-free, not tested on animals, and produced by a unionized workforce. I liked it because it smelled nice.

When I came back to the kitchen, Tracey looked at me with a mix of disgust and pity. Tristan was geeking out over a poster printed with a million-digit prime (in very small type). Niratpattanasai asked if I was OK.

“Yeah,” I said. “It’s fine. Just a thing.”

Tracey said, “He can’t eat anymore. Every time he tries, whoosh, up it comes.”

“Have you been to the doctor?”

I wished Tracey hadn’t said anything. I hated explaining this. “I’ve had a bunch of tests. Everyone’s pretty convinced it’s stress-related.”

“He’s crazy,” Tracey said.

“Thanks, Tracey.”

She rolled her eyes. “It’s not like he couldn’t figure that out for himself. So, are you going to do it, Niratpattanasai?”

“You already asked him?” I said.

“While you were in the john calling Europe on the porcelain telephone, yes.”

I turned to Niratpattanasai. “So?”

“Look,” he said. “I just don’t know. To tell you the truth, I feel pretty bad about this. I mean, you guys—”

Tracey cleared her throat loudly.

“You *folks* seem like nice people. Weird, but nice. And I’m sorry about your, you know, health thing. But look at it from my perspective: from what I could tell, you guys had been running around, breaking into every damn kind of system there was, from home routers to big websites and installing arbitrary code. From what I could tell, you were a three-person crime-wave. I wanted to keep people safe—”

“But that’s all we were doing,” Tristan said, a petulant note in his voice.

“Yeah, I figured that out when I checksummed the firmware update you stuck on my router and saw that you’d been trying to help out. But it’s creepy, you understand, right? What gives you the right to go around breaking into people’s systems, even if you’re just ‘fixing’ them? What if you patched something and broke something else in the process? What if you took some hospital’s life-support system offline when you updated its router?”

“Oh, I usually mapped out the whole network and checked the patch-levels of everything inside it before I updated anything,” Tracey said.

“So you mitigated the harm from breaking into peoples’ systems by breaking into more systems? Nice one.”

“We had a code,” I said, heading off Tracey before she could get into an epic flamewar in Niratpattanasai’s kitchen.

“A code,” he said.

“A chivalric code.”

“Great. You’re LARPers.” He drew himself up and then made a leg and bowed low over it. “Prithee, good knight, do telleth me of yon chivalric code, that I dost mightest come to a full understanding of thine good deeds.”

Tristan laughed, an unexpected sound. “Dude that’s terrible medieval dialog. ‘Yon chivalric code?’ ‘Telleth?’”

“He was being sarcastic,” Tracey said.

Tristan’s eyes sparkled. “So was I,” he said, and I suddenly remembered that in addition to being an otherworldly pain in the ass, Tristan Erkkko was one of the smartest people I’d ever known. It was easy to forget. Some smart people are very stupid. Just look at me.

“Look,” I said. “I know it sounds stupid, but look, it’s no more stupid than any other law, rule or code you’ve ever heard of. It’s just a social contract: we developed a great power, so we took responsibility for it.”

“Spiderman,” he said.

“That doesn’t make it any less valid,” I said. “What is it that stops you breaking into your neighbors’ houses? You’ve got a sweet set of lockpicks on your keyring over there.” I’d noticed it when we first came into the kitchen. They looked like they’d been handmade and well-finished, not a burr or a rough spot on them, and they were worn smooth from lots of handling. “Those Yale locks your neighbors use, you could go through ‘em like a knife through butter. You work from home, most of them are out during the day. So when you run out of sugar or need a bit of milk, why don’t you just let yourself into your neighbor’s kitchen, help yourself and replace it when you get back? What’s the harm?”

“It’s wrong,” he said. “It’s an invasion of their privacy. I might scare someone. I’d hate it if someone did it to me.”

“And it’s illegal,” Tracey said.

“That, too,” he said.

“You notice how the law was the last thing on your list? How you left it off your list until Tracey reminded you? The law isn’t what keeps us in check. Social codes, voluntary and largely unspoken are what keep us from cutting up our neighbors, taking their things, punching them when they cut us off on the freeway. But social codes take time, they don’t automagically appear as soon as new technologies arrive. In the heat of the moment, sitting there with power your neighbors don’t have, asking yourself whether using these new powers is ethical or unethical—well, it’s pretty much guaranteed that you’re going to choose the most self-serving, easy rationalization you can sneak past your own flinch reaction. Reading your neighbors’ email isn’t like opening their mail or

holding a glass to their door, because, well, because their WiFi is in your living room, so it's like they're dangling their email on a clothesline at eye-height in front of your sofa.

"But we didn't try to formulate moral codes on the fly, when temptation was before us. We sat down and coldly, rationally decided what we would do in the future. We did it when we were comfortable and relaxed, we made an agreement, and we stuck to it."

"And what was this 'ethical code?'" Niratpattanasai said.

"First: To use our cluster only to detect vulnerable systems and machines. Second: To bring those systems into less-vulnerable states. Third: To retain no credentials that would allow us to regain access to the systems once they had been improved. Fourth: To work only in the service of improving systems, and to do nothing that wasn't part of that goal."

Niratpattanasai opened his mouth, then closed it and visibly thought about what I'd said. He drummed his fingers. "OK," he said. "That's not bad. But man, there's a lot of wiggle-room in there. There's a large amount of stuff that you could pry into on the way to making sure that something is secure."

"We rattled the doorknobs to make sure they were locked, and when we found unlocked ones, we locked them," I said.

"OK, but did you try the windows and the chimneys, too? Did you snip the burglar alarm wires to see if it could be shut down with a pair of pliers?"

"There's no security in obscurity," I said. "We tried to fix every vulnerability we could imagine, because bad guys would try to attack every vulnerability they could imagine. Why should we do any less?"

"Is that the same as saying there aren't any loopholes in your little chivalric code?"

I shrugged. "No. It's not an algorithm, it's a heuristic. It's meant to be interpreted by good people who want to do good and are of good will and good faith."

"Goodness gracious," he said.

I shrugged again. "It comes down to this: you saw the work we did. Now, either we spent most of our time going around making the world a safer, more secure place, or that was all an elaborate cover for some kind of leet haxor thing where we were really pwning all these boxes to rip people off and spy on them."

"Those are the only two possibilities? What about the possibility that you were imperfectly chivalric? Maybe you had this code that said you'd stay on the up and up while you were spelunking through private, sensitive systems and

maybe you *also* sometimes slipped up and got a peek at peoples' secrets and private lives and looked a little longer than you could possibly justify."

Whatever is the opposite of a poker face, that's what I have. Of course I had. I wasn't proud of it, and I hadn't done anything with it but, when you discover that someone sweet and lovable is privately trash-talking his sainted mother or having cybersex with a life-insurance salesman in Norway, it's impossible not to look. Like a car crash.

"Aha," he said.

"Never voluntarily, never for long, and never to anyone's detriment."

"You sound like you've practiced that."

He was really, really smart, in that annoying way of people who notice exactly the thing you hope they won't notice. I felt the shame burn in the tips of my ears. "You've got me. But we never set out to be anything except a force for good."

"Every vigilante could say the same thing."

There it was, the v-word, the one we avoided even amongst ourselves. "Vigilantes go after bad guys, we helped innocent people defend themselves. We never strung anyone up."

"No matter how guilty they were," Tracey said.

"It's a fine distinction."

"But it's a distinctive one," I said.

He nodded thoughtfully. Tracey and Tristan stared at me with a mixture of fear and surprise. I was once the persuader of our little group but I hadn't been doing much talking lately.

"What the hell," Niratpattanasai said. "I suppose it is at that. Yeah, fine. You've got yourself a witness for the defense. But I'm going to tell the truth, the whole truth and so forth. Even the embarrassing parts. You seem like essentially nice people and I can't really say I believe that my tax dollars should be spent on imprisoning you."

I managed some dry toast and a smoothie with bodybuilder powder that night, which was a banquet by my standards.

###

I've had a little online presence since the gofer days, just an ugly, mostly text vanity page with links to some stuff I'd made or done or admired. It ran on a thin little webserver that had all of 85 lines of code, and I kept it all religiously patched. Of course I used a secure password for it, 256 pseudorandom characters that I kept stashed—along with all my other passwords—in a file that I kept on a

thumb drive and on a remote server. The file itself was encrypted to the longest password I could remember, a mnemonic derived from a deck of shuffled cards that I'd memorized using a technique I found online and practiced for two months before I had it down cold. My 52-character password (one character each for value) wasn't the sort of thing that you expect anyone to break, which is why I felt OK about downloading the file over untrusted networks even though someone might have sniffed it as it came down to me.

But of course, I wasn't the only guy in the world with a cluster. Anyone and everyone could rent an unimaginable amount of compute time for rock-bottom prices these days, the result of Moore's Law and relentless competition. Cracking my little 52-character password was probably the easy part. The hard part, of course, would have been arranging to be on a network from which I downloaded my file.

As it turned out, that part wasn't too hard. The denial-of-service attack on my site hit just as I was headed into Moszkowski's office for our weekly meeting. It took me about ten minutes to notice my mail-server (on the same machine) wasn't working, and then, of course, I downloaded the password file. Whatever hacker or group of hackers or spook decided to get me, they knew their stuff. Must have cracked the law office's wireless password well in advance, and it wasn't like that part of San Francisco lacked for inconspicuous spots where you could sit with a laptop that was snaffling up all the wireless traffic and decrypting it. Having snagged my password file, it wouldn't have taken much to take it to pieces, and then the bad guys could get into my bank, could sign legal documents on my behalf, could read my online archives, could do anything and everything they wanted with my mail and my web-server and whatever you want. That file was *me,* as far as the digital world was concerned, and it wasn't like there was much of a distinction between the real world and the digital one these days.

I pieced this together after the headlines, naturally. The email dump came simultaneous with the first news-story, and I'm pretty sure that the reporter—an online site infamous for its grabby headlines—had done a deal to get first crack at the messages. But I couldn't prove anything.

It's not like there was much that was that damning in the mail dump, of course. Tracey and I had traded some uncomplimentary emails about Tristan, but Tristan already knew he pissed us off all the time. And Tristan and I had been pretty crude in our discussion of the cluelessness of the security procedures at Moszkowski's office, which was a ho-ho-the-irony-it-burns moment good for a million pageviews.

Mostly, though, the public were interested in WHITE HAT HACKER CONSIDERED HIMSELF A KNIGHT CRUSADER and similar headlines and all the business where we'd hashed out the chivalric code. We had planned on downplaying the knight stuff while making sure the judge knew that we were only trying to help. Tristan liked to use renfaire speak in his emails on the subject, which made for great comedy moments, and even a bunch of meme-y photos of Tristan walking the streets of San Francisco, holding up his e-reader, brow furrowed, eyes nested in a hashwork of squint-wrinkles. He'd already been a legendary San Francisco character ("The Ebook Walker," they called him, and put him in the pantheon that included Emperor Norton and Frank Chu and all the other street-nuts who'd made San Francisco great)—the news that he was also a member of the Knights of the Rainbow Table made for great captioning opportunities: FORSOOTH, I DOTH BE IN THINE NETWORK, PATCHING THINE FIRMWARE.

One thing I never did figure out: the person or people who pwned my webserver replaced my homepage with a picture of me from my fat days and a bunch of crude fat jokes. Meanwhile, they pulled off a hack that put a page they controlled into about ten million browsers over 24 hours. Couldn't they come up with anything more interesting to say to that many people? Hell, they could have just stuck some crappy ads on the page and made a couple thousand dollars, assuming they had the nous to put together an untraceable bank account for the money to land in. But my nemesis or nemeses apparently had nothing much to say to the world, only that I'd once been a "fat fuck." People are weird, their motives unknowable. This is a problem.

I had to pay a couple hundred bucks in hosting fees for all the traffic the hack generated, which was a kind of injury-to-insult moment, but given that I had already borrowed an entire mortgage's worth of money from my parents for our defense, I hardly felt the additional debt. But the email dump and the ensuing bad feelings from Tracey and Tristan made my life appreciably worse. Even though we'd stopped being anything like pals years before we'd been busted, we'd been comrades at least. Now we could barely stand to be in the same room together.

The email dump was a godsend to all the borderline personality types who assumed that anyone who tried to do something for good must be broken or awful or crazy. People who already hated us with the white-hot heat of a thousand suns pored over every line in a million emails stretching back to my high-school days (I have never knowingly deleted a non-spam message), mining them for the most embarrassing nuggets they could find. Like I said, there was nothing damning—nothing criminal, nothing a judge would care

about—in there, but there was plenty that I never expected to have stuck in a tarball and torrented to a million bilious Internet trolls to laugh at.

But what got Moszkowski was that they leaked the fact that Niratpattanasai had agreed to testify on our behalf. He'd kept that as his ace in the hole and had planned out a whole dramatic revelation that would maximize his effect on the jury. Now that plan was blown and Moszkowski swore that the DA would be riding Niratpattanasai like a rodeo bull to get him to back out.

"I thought you were Mr. Security Guy," he said, finally, after a good twenty-minute rant about all the various and sundry ways in which our case was thoroughly, totally hosed.

"I am."

"So how the hell did this happen?"

I shrugged. "It happened because someone was determined enough to make it happen. Look, what we did was go around and look for stuff with obvious vulnerabilities that could be exploited at little or no cost, usually by automated attackers. But what happened to me—that was the work of someone really dedicated. What us Mr. Security Guys call an Advanced Persistent Threat. These used to be governments or major crime syndicates but, these days, all it takes to be an APT is to have a really intense bug up your ass, some spare time, and the ability to use a search engine and follow a recipe. The gap between APTs and automated, opportunistic attacks is narrowing. Give it a few years and it'll cease to exist altogether."

Moszkowski looked at me with his basset hound stare, the litigator's zero-emotion poker-face. "I'm pretty sure I understand what you just said and it scares the shit out of me."

I nodded. "Me too. It's not like it was hard to predict, either. It's been on the way for years. Look, we built our cluster out of garbage, but Moore's law means that by the time you've finished building your cluster out of free junk, you'll be able to buy the same amount of computation in factory packaging for about what your junk-cluster cost."

"So you saw this coming, huh?"

"In a way," I said. "Hence all the chivalric code stuff."

"But in another way, no," Tracey said. "None of us really wanted to confront what it means if passwords stop working."

"Wait, what? Passwords stop working?"

Tracey and Tristan and I shared a look. It was hard to remember, sometimes, that we lived and breathed something that other people thought of as esoteric and bizarre. It was like being a pathologist who saw little life-shortening labels

attached to every hazard, while others tripped blithely past them, shoveling poison into their mouths, endangering their lives with vehicles and sex and sports and recreational chemicals. For a moment, I had a sense of what Moszkowski must be feeling, a vertiginous dropping-away of the safe crust over his world, revealing the yawning pit below.

“Not all of them. You can comfortably password-protect your hard-drive for quite some time—maybe forever. But for anything that lives on a network, anything that can be analyzed in private without shutting down after too many bad password attempts, well, I think we can safely declare them dead.”

“I don’t understand—which passwords are dead?”

“Pretty much anything other people can access. Wireless networks. A lot of stuff you do on wired networks, too. Any file you leave out there in the wild world, counting on a password to protect it.”

“Is that all?” he asked. I’m pretty sure he was being sarcastic.

“Pretty much,” I said. “I mean, give it a while. The future is here, it’s just not evenly distributed, like the prophet O’Reilly said.”

“He was quoting Gibson,” Tristan said.

“Pedant,” I said.

Moszkowski fisted at his tired, baggy eyes. “Just don’t talk about this stuff in front of the judge, OK?”

“Why not?” I’d actually been thinking about how to frame it all. I mean, now that we were sure to be asked about the Knights and the code, I wanted to make sure that everybody understood that beneath all the play-acting there’d been a serious point that was going to affect them all.

“This apocalyptic talk, it’s going to make you look like a nut.”

The three of us looked at each other and then at our lawyer. “Which part of that was apocalyptic?” Tracey said.

“The part about passwords becoming useless,” he said, as though he thought she was being sarcastic.

“Hal,” she said, “everybody knows that.”

“What do you mean, everybody? Our IT person still assigns passwords to our networks. She’s not an idiot. So, does she know this?”

“Yes,” Tracey said. “If she’s not an idiot, she knows this.”

“So why does she bother?”

“Well, because for now, it’s enough to stop most automated attacks and they’re in a different threat category to your APTs. APTs, they’re like ninjas who can pick any lock and sneak into any house. But there’s not a lot of ninjas, and they’re expensive, so you either have to piss off a ninja or someone rich

enough to hire a ninja, otherwise you're OK. We pissed off a ninja, which is surprisingly easy to do, because setting out to become a ninja is a kind of mentally unbalanced undertaking—”

“Not like setting out to be a knight,” I said, quietly. Tracey gave me the finger without dropping a syllable.

“While automated attacks are like, well, like if the guy who smashed your car window and stole your GPS could do it again, in perfect stealth, from anywhere in the world. Or if *all* the guys who *might* smash your car window and steal your stereo could reach you, all at once. It's worth defending against those guys.

“But give it another couple years and those guys will be able to do most of the stuff a ninja can do, at least when it comes to passwords. They'll be able to replace expensive computers with cheap computers. They'll be able to replace cleverness with cheap computers. And there'll be a lot of cheap computers.”

“So give it a couple years—”

“For the future to get evenly distributed,” I said.

“And—”

“And?”

“What do we do then? How do we protect ourselves?”

“Dude, if we knew that, we'd be billionaires,” I said.

“No, you wouldn't,” Tracey said. “You'd be making someone else a billionaire. Some investor who bankrolled you and then ripped you off and kicked you out of your own company.”

“No way,” I said. “I'd totally have a great lawyer to help me like Hal here.”

Hal shook his head. “She's right. You'd lose your shirt. Fine, it's not your fault, we're all going to hell in a handbasket, security is dead, the future isn't evenly distributed. Have I missed anything?”

“Well, there's the fact that whoever snaffled up my password file could have been watching your web-traffic and reading your email—that's why we kept nagging you to start using GPG.”

He groaned. “I had a training session on it booked for next week.”

Tracey patted his hand. “It's OK, everyone sucks at security.”

###

A funny thing about having your secrets all exposed in one big whack: it's over quickly. I may have had a hobby that was as weird as a two-headed snake but, apart from that, I was a monumentally boring individual. It pains me to admit it but it I was essentially a harmless kook.

The world took a hard run at my email corpus and pretty quickly extracted any messages having to do with sex, finances, or where I called someone a nasty name. Everyone had a good chuckle over these and then returned to their regularly scheduled porn, political arguments, and operating system advocacy.

Just like that, I was a nobody again. I took advantage of the lull to refurb an old computer and slap in a big hard-drive and download anything I'd stuck in the cloud to my local storage, wiping it all out behind me as thoroughly as I could. Most importantly, I stuck my master password file on the disk and not on the network, even though that meant I now had to concern myself with keeping backups separate from my machine. Moszkowski was good about letting me stick a drive in his desk drawer and back up to it every time I went by the law office. Every bit on it was encrypted with a new 52-character password that I memorized from a freshly shuffled deck of cards.

This may be the only positive aspect of being bankrupt and facing a jail sentence: I didn't really care about all those lost online accounts and I didn't really care that any loser could authenticate himself to my bank and pose as me and raid my empty bank accounts.

But I *did* feel a kind of hollowness that was even worse than the hunger that gnawed at my guts all day and all night. A feeling that I'd lost something, like I'd misplaced an internal organ. It wasn't something I could talk about with Tracey and Tristan—after all, a substantial portion of their email had been exposed along with mine, since I'd saved all the email they'd ever sent to me. Moszkowski would have lent a sympathetic ear but he wasn't really a member of my subspecies and there was some stuff we couldn't discuss.

There was really only one person I knew who was still on speaking terms with me. Unfortunately, he was the guy who'd gotten me in trouble in the first place.

###

Niratpattanasai answered his mobile phone on the third ring. "What can I do for you?" He knew who it was, I was already in his contacts database. He was that kind of organized.

"Where are you?"

"Why do you want to know?"

"Because I'm at your house and I've been ringing the doorbell for ten minutes and you haven't answered, so I'm assuming you're not home and hoping you're not too far away."

“Oh,” he said. “OK, fine. You know, some people call *before* they come over. It’s often considered the polite thing to do.”

“So, are you far away?”

“I’m in the back yard,” he said. “Can’t hear the bell. Come around.”

I found him standing over a large, gleaming gas barbeque fitted out with two propane bottles. He was working a hand-cranked coffee roaster with a large, battered scorched drum, wearing old clothes and a broad-brimmed, fraying straw hat. The smell was bitter but not unpleasant.

“You roast your own?”

“I’m learning,” he said. “I’ve been practicing for a couple years now but I still can’t get the hang of it. Trying to get a bean that’s as good as the stuff the Australian cafe down the road sells.” He shrugged. “I wish I could say that my beans taste better because I’ve roasted them myself, but I’d be lying. I’m an amateur and the lady who roasts for Cobbers does a new batch every week.” He turned the crank for a while longer. “I’m getting better, though.”

“The coffee you served me the other day was amazing.”

“I cheated,” he said. “It wasn’t my roast.” He turned a while longer. “And you vommed it up about ten seconds later.”

“Ah,” I said. “Nothing personal. Just a thing I do.”

“So I gathered. I think that Tracey’s right, you need to go back to the doctor about that.”

She’d sent several pointed emails on the subject. “You had a look at the corpus, then?” Calling it “the corpus” helped me distance myself, damped down the visceral reaction I had whenever I thought about all that mail sitting there online.

“Couldn’t help myself. Wish I’d signed up for your chivalric code, I might have been able to stop myself from peeking.”

“You’d be the only one,” I said.

He turned some more. “Well, it’s bound to happen to lots more people soon enough. ‘Course, you know that better than most people. No one can plug all the holes. It’s like trying to stop burglars all by yourself, with bars and locks, instead of cops and social norms. Eventually you find yourself living in an armed compound, or losing everything. Look at me with my out-of-date firmware on my router.”

“Nobody’s perfect,” I said.

We stood in silence for a time. He checked a timer stuck to the barbeque and stopped turning, killing the propane. He slipped on some oven mitts and did some after-roast arcana with tongs and bags and funnels. The smells were

incredible. He piled his working instruments up on a picnic table and took off his gloves.

“Sucks about your email. How’d they get you?”

I told him what I’d guessed. He nodded. “Yeah, that would have gotten me too. You memorized a 50-character password?”

“52. Took some doing,” I said. “But you could learn how to do it.”

“Look, I’ve been in tech a long time, but I prefer to learn my skills at least ten minutes before they go obsolete.”

“Good policy.”

“So I guess that’s it, huh? RIP, privacy, just like the Google Man said back in the old days. Christ, what an asshole.”

“Oh, this is bigger than privacy. RIP, remote authentication is more like it. Or lots of kinds of remote auth. Passwords, anyway.”

“Good riddance. Now I can free up all that disk space in my brain I’ve been devoting to storing and retrieving meaningless strings.”

He led me inside and made some coffee for himself and got a glass of water for me. We sat down on his overstuffed, cat-hair-strewn embroidered sofa and sipped.

“Think you’ll go to jail?”

“Don’t feel guilty,” I said. “If it wasn’t you, it would have been someone else.”

“I don’t feel guilty,” he said. “You had it coming. Chivalry or no, it’s just creepy-wrong to let yourself into other peoples’ computers and networks and poke around. If your point was to create a social norm of not breaking into other peoples’ computers, maybe you could have tried *not breaking into other peoples’ computers.* It’s crazy, I know.”

I hung my head. “Well, yeah,” I said. “We could have done that.”

“I should probably be angry at you,” he said. “You know that there’s going to be a million kids out there who try to copy what you did and justify it by saying that you did it.”

“Well, not after they make an example of me and throw away the key.”

“So you *do* think you’re going to jail.”

“Let’s just say that my lawyer’s advised me to think seriously about a 5-15 year hiatus from my career.”

“Rough,” he said. “How about your, uh, health issue?”

“Yeah,” I said. “Well, it came on suddenly, maybe it’ll go as quickly.”

“You’ve had everything tested?”

I tapped my temple. “All in my head. Had every test you can name. I had good insurance. Anyway, maybe I’ll memorize a few more pointless passwords

and crowd it out of my brain. Always wanted to lose a couple pounds. Saving loads of money on food.” I stopped. I could go on in that vein for a good ten minutes. “Sorry, I’m weirding you out.”

“A little.”

“Well, change of subject then. Do you think I could ask you something?”

“Based on all available evidence, I believe the answer is yes.”

“That’s a very Tristan sort of answer. He’s a little frustrating but the neurotypical are so . . . boring. So look, the thing is, you got angry at us for doing what we did, which is fair enough. But that was about the whole *package,* right? It wasn’t personal, it wasn’t because Tristan fixed your router, right? I mean, you know he didn’t look around when he was in, right? He was reading the *Irish Times.* It’s a thing he does.”

He got a guarded look. “Why are you asking this? I agreed to testify for you, I’d think that’d be all the reassurance you needed.”

I spat it out before I could stop myself: “I just want to know if this feeling, this, you know, this *violated* feeling, if it’s just me being a wimp or what? Do you think it’ll go away? Did you feel it?”

“Oh, that. Huh. Well, in some ways, you’re just feeling what every celebrity feels when the tabloids get hold of their voicemail. But, of course, there’s a lot more than voicemail that you lost. I’m betting there’s pretty much anything you could want to know about you in there. I know if it happened to my mail, I’d be, I don’t know, it’d be like being paraded naked in front of the world forever.”

“Yeah, that’s about how it feels.”

“So, I guess that’s a feeling a lot more of us are going to have to get used to. There are games we can play with per-password salts that’ll give us better security, but there’s so much legacy stuff out there, and so much password re-use . . . You’re just an early adopter in the radical involuntary transparency world, buddy.”

I didn’t feel comforted. “I have this weird idea that I’d like to do it back to the kids who got me, whomever they were. Spread their lives out on the net, see if they’ve never committed anything embarrassing to email. Maybe if we all do it enough, no one will remark on it anymore, and it’ll be too unremarkable to anyone to bother with anymore.”

“I don’t think that’s how it works. I don’t think we can look away from the spectacle of other peoples’ humiliation. It’s a reflex. I think if we all got stripped bare and paraded in front of the world, you’d just have more humiliated people looking for revenge and wanting others to go through what they experienced. Eye for an eye and that sort of thing.”

“Then the future is a place where more and more of us are more and more humiliated by more and more people in a positive-feedback loop that’ll spiral out into infinity and destroy the entire species?”

“Something like that. It might take a while.” He smiled weakly. “Look, fine. Yes, I think that this stuff is scary as hell. For my whole life, information security has favored well-informed defenders: if you knew what you were doing, technology gave you an advantage over people who wanted to get at you. But now we’re heading to a point where some of that advantage goes away. Not all of it. If everyone sent and received encrypted email, breaches like yours wouldn’t be so bad. But that’s hard to do when you’re using remote mail, and it’s a pain in the ass to explain and use. And it screws up email search, which means you’ve got to be a lot more diligent about your filing, and for most people that’ll never happen.” He stopped. “Listen to me, I’m already trying to figure out how to mitigate it, like it’s a brain-teaser, playing what-if? I guess that’s how I keep from getting too freaked out. Treat it like a puzzle.”

Neither of us said anything.

“You know, it’s a pretty beautiful dream, the idea of a world where people don’t use vulnerabilities for evil because there’s a social norm against it.”

This made me unexpectedly angry. “You’re going to say, ‘But that’s just not human nature’ or something like it, right? I’ve heard that so many times—but nearly everyone I know is nearly always pretty good. As far as I can tell, ‘human nature’ is to be good to your neighbors and behave yourself. It’s only a tiny minority of sociopaths or people who’re having momentary lapses who do really bad stuff. I hate that we design our world for the worst of us, not the best. Where does it end? Do we take all the steak knives out of the restaurants because someone might stab someone else? The thing that really gets me is that the more we pander to crazy jerks, the more legitimate they seem. Talk about social norms! When you call being a depraved psycho ‘human nature,’ you let every troll and dipshit off the hook—they’re just being true to their nature. So don’t tell me about human nature.”

“I don’t think I used the words ‘human nature,’” he said.

I mentally played back his words. He hadn’t. “Oh,” I said. “Sorry.”

“For what it’s worth, I happen to agree with you. Mostly, most people are good. I’d rather live in a world organized around the good people than the nutcases, too. Mostly, I think I do. I don’t carry a handgun or put bars on my windows. But every organism needs a membrane between the rest of the world and itself.”

A funny thing happened to me on the way to the courthouse. More specifically, a funny thing happened to the prosecuting attorney and all of his witnesses.

I didn't have anything to do with it. First of all, it would have been insanely stupid for me to hack a bunch of people who had it in their power to put me in jail—and stupider still for me to stick a giant torrent online of all their email, their private status updates, their friends-only photos, their banking details and search histories, their browsing histories and voicemail transcripts, their location trails and map searches . . .

It was quite a dump.

Listen: if you are the person who uploaded that file, or if you know that person, thanks but no thanks. I mean it. It was a sweet gesture, and I'm sure (or I hope) your heart was in the right place. But even if you don't end up in prison—and you might!—it's not helping.

It's not helping.

###

It doesn't matter if Moszkowski doesn't believe me when I tell him that I had nothing to do with it. It doesn't matter that Lady Tracey and Sir Tristan and Niratpattanasai are sure I didn't do it.

What matters is that *I didn't peek.* Not once. And I won't, ever.
Someone bang the gavel, let's get this trial underway.