

MARK RUSSINOVICH



ROOGLUE
OODDIE

A NOVEL

ROGUE CODE

MARK
RUSSINOVICH

THOMAS DUNNE BOOKS
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Memorandum

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Haim Bodek deserves a special thanks for the information he shared with me, initially and unknowingly via his Web site, book, and participation in documentaries on HFT that I researched, and then later after I contacted him, in our long conversations over Skype and in the comments he gave me on book drafts. I'm grateful for his foreword, which sets the tone perfectly for the book. His position as an industry insider and pioneer of market microstructures makes his warning that HFT poses risks to our economy when looked at as not just low-latency algorithmic trading that can spiral out of control in algo-vs-algo trading, but as including the secretive-order types that give insiders unfair advantages, something that we should all heed.

I also want to thank my agent, David Fugate of Launch Books, for his staunch support of the Jeffrey Aiken books series, and also for helping me secure the sale of its movie option. Peter Joseph, managing editor at St. Martin's Press, did a fantastic job of guiding the book through to publication, even somehow compressing rigid publishing schedules to hit target dates when my day job got in the way and slowed my delivery. Thanks to Melanie Fried and to the editorial production staff at St. Martin's Press for their painstaking passes over multiple drafts of the manuscript, somehow finding typos and grammar mistakes in passages that I read dozens of times.

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FOREWORD

When I first read *Rogue Code*, I thought, “Here is a thriller that is really tuned into the dangerous potential of electronic trading.” Mark Russinovich paints a picture of what most would consider the nightmare scenario of what could go terribly wrong in the U.S. stock market. It is a dystopian view where electronic capitalism might lead us.

And yet, *Rogue Code* shows us a Wall Street which is all too familiar—think it a synthesis of age-old business practices that thrive on exploiting the grey areas of financial regulation *and* modern electronic trading systems whose *opacity* is the only thing keeping computerized criminals at bay. The end result is a fictional portrayal of a global-market system that is hauntingly familiar in both its vulnerability and its propensity for financial crisis.

Mark is impressive, detail-oriented, hands-on. He aims to introduce you to the technical mechanisms, hacks, and exploits that are longstanding practices in the field of cybersecurity that have rightfully associated with critical vulnerabilities in our national market system. More importantly, Mark has tied together two disciplines that must cross-pollinate: cybersecurity and computerized trading. After you have read *Rogue Code*, you will believe these two fields are on a collision course.

Still, I confess that as I read *Rogue Code* I couldn’t help but smirk inappropriately at times. *If I only knew*, I thought. As the financial crisis proves, often Wall Street itself can be its biggest threat.

Rogue Code is a work of fiction. The bad guys don’t run multibillion-dollar hedge funds that have institutionalized illegal insider trading into a business model. They don’t run massive Ponzi schemes affiliated with unusually successful trading companies. They don’t publicly brag about their multi-year zero-loss trading days fueled by “secret sauce” that only recently has caught the attention of regulators.

In my experience, the current threat to Wall Street isn’t going to come from abroad ... it has already firmly embedded itself into the fabric of our marketplace.

We don’t need foreign agents to compromise our markets. We are quite adept at causing the flash crash and more than *twenty-five thousand* “mini flash crashes” all by ourselves.

We don’t need a foreign agent to rig an exchange to provide a benefit to an affiliated trader—we are quite adept at creating conflicts of interest, self-regulation of for-profit entities, and regulatory loopholes that naturally evolve into collusive arrangements.

We don’t need super-hackers planted where they can exploit the order matching code for their own benefit, as the most lucrative career path for a developer is to cycle from exchange to trading company, back to the exchange space, and then onward to the most elite trading firm having attained the “goods.”

And I should know. Over a decade ago, I was awarded my first major promotion at a major investment bank for exploiting a back door in a European electronic exchange to get prices faster. Back then, we discovered holes. At some point, the game changed, and the industry started creating

holes.

The search for what we in the industry call an “edge” led exchanges to manufacture artificial advantages in order to satisfy their most-favored clients. What else differentiates an exchange, when the primary service that traders want is to extract a profit in what nearly always is a zero-sum game for short-term traders? The money has to come from somewhere, doesn’t it?

And so many years later, I decided to blow the whistle on high-frequency trading to regulators, citing numerous undocumented features designed by exchanges to accommodate high-frequency trading strategies at the expense of the public customer. It was the road not traveled for one of my background.

Mark is an outsider to high-frequency trading, but that is what makes his contribution all the more sobering. What if Wall Street lost its stranglehold on a system where complexity and volatility equate to trading edge? What if outsiders indeed targeted the very systems which regulators readily admit they cannot monitor or control in any meaningful manner?

And that is probably the most terrifying conclusion one can draw from *Rogue Code*. Wall Street, having grown so accustomed to exploiting and circumventing its own system, is dramatically unprepared for real enemies, those who have no stake in the bedrock of our capitalist system.

—HAIM BODEK
MANAGING PRINCIPAL
DECIMUS CAPITAL MARKETS, LLC

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MEMORANDUM

DATE: October 13

FROM: Walter D. Winterhalter
Inspector General
Office of the Inspector General
U.S. Securities and Exchange Commission

TO: Eleanor Kaschnitz
National Security Advisor

RE: Concern

I wish to personally express my deepest concern about the possible intentional or inadvertent disclosure of the actual events that occurred last month, regarding the New York Stock Exchange and Euronext. The potential for incalculable harm to our financial institutions and the world financial system is extreme. While speculation is rampant in the media, both traditional and electronic, the diverse nature of the speculation tends to cancel out fears, though the attention has had a dampening effect on the trading public. Only the passage of time will inform as to what extent. For now, I must urge in the strongest possible terms that no official account of events be made public and that every step possible be taken to prevent a credible source from leaking what we know and are learning.

I cannot emphasize this more forcefully.

cc: POTUS

DAY ONE
MONDAY, SEPTEMBER 1

NYSE EURONEXT SECURITY REACHES NEW LEVEL

By Arnie Willoughby

September 10

Bill Stenton, director of NYSE IT Trading Platform Security, has confirmed a rollout of new security measures designed to make trades within the Exchange the most secure transactions in the world. In public comments Saturday, Stenton said, "There are two realities in security trades in the 21st century. The first is they must take place with great rapidity, as this is a digital world and traders will settle for nothing less. The second is that trades must occur within a system that is completely secure. We believe the NYSE Euronext system provides both of these [requirements]."

He went on to describe in general terms the scale of the measures now routine within the trading platform's software. Special software continuously seeks out anomalies as well as attempts at penetration. "The software is continuously updated to keep it current and to provide the best trading platform possible. To assure its near seamless operation, we are constantly searching for what we call hiccups in the system. These [hiccups] appear most often when we are merging new subsystems with existing ones."

Regarding attempts at penetration, Stenton admitted that the problem is ongoing. "We have the most sophisticated security system in the world. I cannot recall a single instance in which anyone has penetrated our first wall, let alone the subsequent security measures. You can trade with absolute confidence."

Asked about the recent appearance of a common malware bot on one of its Web servers, Stenton dismissed the incident as insignificant. "The security of the system was never in doubt." Despite Stenton's assurances, knowledgeable sources expressed reservations. "The presence of a bot on a public site of this significance should be a wake-up call, but I fear it is not," said one informed source who asked to remain anonymous.

Henry Stolther, a frequent NYSE critic and publisher of the *Stolther Report*, responded to Stenton's comments, focusing on the speed of trades within the system. "The NYSE has moved too rapidly in accelerated trading," he said. "The Exchange is competing in a highly competitive industry and wants to make its system as user-friendly as possible. As a consequence, certain abuses now possible with current computing power have gone largely unregulated."

Asked if he was referring to high-frequency traders, Stolther said, "Absolutely."

READ MORE: STOCK EXCHANGE, NYSE, TRADING PLATFORM, SECURITY

US Computer News, Inc.

WATERFALL GLEN FOREST PRESERVE DARIEN, ILLINOIS

8:13 A.M.

Vincenzia Piscopia, known as Vince to his American colleagues, sat on the cool gray boulder, feeling more than a little strange. He'd never done this before and was now having second thoughts. He glanced about the small clearing. He was alone. Maybe I should just go back home, he thought, pretend this never happened.

Vince was thirty-four years old and had spent his entire life in the digital age. Though he hiked as often as possible, he was a trifle overweight and soft. Computers and the Internet had always formed an integral part of his life. He even made his comfortable living as an IT operations manager for the New York Stock Exchange, working out of the Chicago IT office. Originally from Milan, Italy, where he'd been employed by Siemens, he found he enjoyed America more than he'd expected. His only real complaint was of his own doing—he just didn't get out very often.

Vince had always been a nerd, and social media formed the greatest part of what passed for his social life. He tweeted, maintained two blogs—one on life in Chicago for an Italian expat, the other about computer security, a particular obsession of his—and he'd been one of the first 100,000 to have a Facebook account. He'd seen the value of Facebook from the beginning and had opened his account almost from the day the company launched. Between his iPad, iPhone, and home computer, it seemed to him that when he wasn't sleeping or working, he was social networking.

Even on his long solitary hikes, he brought along his iPhone and had a connection nearly everywhere. He wasn't alone in that regard. Just the week before, he'd hiked some six miles on the very trail, found a lovely spot to take a meal, and while sitting there had checked for messages. Just then, he'd heard a chirp. Not twenty feet away, he spotted a woman of middle years answering her cell phone. He'd just shook his head at the incongruity of it all—then texted a few replies of his own.

But today was different. Vince was here to meet someone. It was all very twenty-first century, he'd told a colleague at work. And while for others this sort of thing happened from time to time, for Vince it was a first. As a result, he found himself fretting about his appearance. He'd been honest with the photographs he posted on Facebook, and Sheila had assured him that she was as well.

He wasn't concerned, though he knew that Facebook friends were often disingenuous in that regard. He'd know soon enough if Sheila was the stunner her photos showed, or a fake. If the latter, they'd hike a bit, and then, once he returned to his apartment he'd unfriend her. That would be that.

And he'd never do this again.

It was a bit cool for September, but Vince liked the typically brisk Illinois autumn. He found it invigorating and at moments like this, on a remote trail far from the popular routes, he could imagine

himself back home. He was getting cold and zipped his Windbreaker up higher. From nearby came the gentle murmur of a stream.

It was Sheila who'd suggested they meet on a Monday when there'd be few hikers and that they take this moderate hike in the DuPage County forest preserve. He'd been pleased that it was one she knew about, since it was already his favorite. The nine-mile trail snaked around the Argonne National Laboratory, the loop passing through rolling woodlands and savannas, the contrasting scenery adding to the charm. Though all but within the Chicago suburbs, the preserve had a very rural feel.

The main trail was layered with crushed gravel, and it crested a few difficult hills. There were usually hikers such as himself, joggers, and those training for marathons. The only negative was that horses were permitted on the wide pathway, and they brought with them their unique problems; which was why Vince preferred the smaller side trails where the horses didn't go.

He heard movement and turned with anticipation. But instead of Sheila, there was a man, another hiker. Vince smiled and nodded a distant greeting. The man nodded back and continued toward him.

Their exchanges had started just the week before. Sheila was the friend of a friend on Facebook. She lived in Chicago and also worked in IT. A few messages established how much they had in common, so they'd switched to e-mail. Sheila had spent a summer in Europe after university backpacking locally in some of the same places Vince knew. She took her work in software security seriously, and from the first complimented his blog. She'd never been married and had no children. In fact, she'd never even lived with a man, she told him. Like Vince, she worked long hours, and at twenty-nine had decided it was time to get out more.

The other hiker stopped where the trail widened. He was tall, physically fit, with fair hair. He placed his foot on one of the smaller boulders and slowly retied his shoelace. When finished, he lifted the other foot and repeated the process.

Vince thought about the man's presence for a moment, wondering if it was good or bad. Sheila had suggested this quiet location off the main trail for their first meeting, hinting for the first time at the possibility of romance by mentioning how she often came here alone, wishing someone special were with her.

He chuckled at his thoughts getting ahead of reality. He was about to see a woman he'd first met on Facebook, that's all. The other hiker meant nothing. You don't have a private romantic rendezvous on a public hiking trail, he told himself.

Vince scanned back along the trail and saw no one new. He frowned, pulled out his iPhone, and checked for messages. Nothing.

He glanced up. The hiker was finished. He smiled as he approached the Italian, looking as if they were about to say something. That's when Vince spotted the heavy branch held loosely in his hand.

"Have you seen this?" the hiker asked just as he reached Vince.

Vince looked up into the man's face, then quickly at the upraised branch and only in that final second of his life did he realize what the branch meant.

**NEAR WALL STREET
NEW YORK CITY
10:17 A.M.**

In the dimly lit room, the frosty glow of flat-screen monitors bathed their faces in a silver light. One of the men licked his lips in anticipation. The other stared keenly at his screen as his fingers raced across the keyboard.

They'd been at this for three intense weeks. Neither had said as much to the other, but both believed that today they'd succeed in penetrating the New York Stock Exchange trading system—last. First they'd speculated over whether it was even possible. For the last few days, they'd been certain it was.

Once they infiltrated the system, they'd be free to do anything they desired. They'd be able to change whatever they wanted at will, free to bring trading to a halt, free to let it run amok, free to alter billions of dollars in transactions—free to loot any account, anywhere, with impunity and in secret.

Theirs would be digital financial power of nearly unimaginable dimensions. And their electronic trail would be hidden within tens of millions of lines of code and terabytes of monitoring and audit logs.

For all the time they'd worked on this assault, it was not so long as each of them had spent on previous similar operations. Though access and speed were vital components of the Exchange, so too was security. It was essential that its digital walls be perceived as impenetrable, and so the Exchange presented itself to the trading public as a model of security. It could afford the best and brightest and claimed to employ only the most up-to-date and finest security technology.

Which, of course, was nonsense. The so-called walls resembled those of a fortress castle of the Middle Ages, designed and constructed to withstand any siege. Until the invention of the cannon, such fortresses had rarely succumbed to so direct an attack. Instead, when they fell, it was most often because of a vulnerability to an assault team, often no more than two or three men, who found their way beneath, over, or around the outer wall, then through the subsequent protective labyrinth until they'd identified a weak point and exploited it. With that access, they'd leverage the security open and admit the besieging army.

So it was for them as well—except that they were both the assault team and besieging army folded into one.

For these last weeks, the two had probed, managing to approach the core of the NYSE Europe network from every angle their skill and knowledge allowed. When their efforts had proved a dead end, they retreated and tried again.

But the time had not been wasted, for they'd established which servers they could reasonably

expect to compromise. They then spent hours scouring internal Web sites and file servers, scanning documents, spreadsheets, and group user directories. Using bits of information—some from a file here, others from a report posted on a team collaboration site there—they'd determined who in the company had access to these same servers, how they accessed them, and what systems they used.

The work had been tedious, but they were well suited to it, and the time passed quickly. And despite all the setbacks, days of them at a stretch, there'd been steady progress. A fragmented view of the internal organization of the Exchange and its IT infrastructure emerged, like a jigsaw puzzle only partially complete. Systematically they gathered, analyzed, and cataloged every piece of information and document they encountered, as they couldn't know what detail might prove helpful to them in time.

Once they'd mapped promising paths through the system to their goal, they attempted to inject themselves into points on those paths. In that, they'd had help. Vulnerabilities in software the Exchange used were publicly reported, so instead of crafting a hole on their own, they explored to discover a zero day opening or if the Exchange had failed to patch any bugs. They'd found no zero day opportunities but did find vulnerabilities in at least one application used internally by the Exchange. Their continued efforts led them to code written by FirstReact, a cybersecurity research company that discovered and reported bugs to the Exchange for a substantial fee.

Even then, their attempt at penetration failed with the first three servers they'd targeted. But they persisted and at last hit upon what they'd sought, what they'd been certain would exist if only they persevered. One of those well-educated, highly paid, bright minds on the NYSE Euronext IT team had yet to seal a vulnerability. That was all they'd needed to ooze through the inner workings of the Exchange's network, and from there it hadn't taken long to locate a path to the doorway of the trading engine systems. Today, as anticipated, they'd managed to plant their code on that doorway known as a jump server.

Neither had said a word when they realized what they'd done. It was in many ways a sublime moment, best savored privately. After a short pause, one of them began to determine the extent of their penetration, as there was much yet to be done, more barriers to surmount, a complex of security measures to bypass. It would all be demanding, but they had the lever bar in place. When they pressed it would create a yawning hole they'd exploit relentlessly. Finally, with a sigh of satisfaction, one of the men pushed himself back in his chair and said, "We've got them."

"That was too easy," the other answered, reaching for a fresh Red Bull.

"You know, we shouldn't be able to do this."

"That's their problem." He leaned forward. "We still have a long way to go yet."

Their next step was to establish access known only to them, a simple means to gain entry even after the portal they'd just opened was closed. Known as a backdoor, it would allow them ready access up to the jump server. After the backdoor was installed, they spent several hours setting up a command and control system for their personal use. It would be the external platform from which they could conduct their operations.

In the past, attackers had been compelled to compromise legitimate servers or establish business accounts with hosting companies that rented out servers. Both options were problematic because traffic to outside servers could be suspicious and because renting a server usually required a legitimate credit card. Now, with the advent of public cloud computing, they could instantly establish a trial account using nothing more than a burner cell phone number and set up a free command and control server anonymously.

Next, the pair planted within the system their own carefully crafted code, software that would

allow them to remotely send program commands. Those commands, taken as genuine by the system, would enable them to do anything—absolutely anything—once they had full access.

“So,” the taller one said to the other, “just how rich do you want to be?”

**HASTINGS STREET NE
GRAND RAPIDS, MICHIGAN**

3:46 P.M.

“I’m going to see Ryan now!” Connor Stern all but shouted at the shocked woman as he barged by her desk, storming up to the closed door of his broker’s office and pushing it open.

Ryan Kramer looked up, startled. “Connor, I’m—”

Stern slammed the door shut behind him. “You know why I’m here! Don’t pretend you don’t!” He raised his fist above his head. In it he clutched several sheets of paper.

“Connor, sit down. There’s no need for a scene. I can explain it all.”

“That’s what you said over the phone. Well, that isn’t going to work! I’m entitled to answers. More importantly, I’m entitled to my money and I don’t intend to leave without it!”

The telephone rang. Kramer hesitated a moment, then picked it up, gesturing at the chair in front of his desk. Stern appeared to compose himself before taking the seat, and he leaned forward in agitation.

“No,” Kramer said. “Just bring us some water.” He replaced the telephone, then sat back in his chair. “That was Vivian. You scared the hell out of her. She’s afraid to come into the office.” He looked at the man evenly. “Connor, you need to get control of yourself or I’m going to have to call security.”

“Security? I was with your dad for eight years and never had a complaint. When you took over he asked me to stay on, so I did out of respect for him. When my wife and I came to you thirteen years ago and told you our retirement plans, you wrote up this very impressive proposal, with an investment arc that got us where we needed to be. Well, I’m sixty-eight years old now. I had a mild heart attack last month. It’s time to cash out while I still can. We talked about this last week when I gave you the sell order. You of all people know how tough it’s been since the crash, that I’ve had to work three years longer than I wanted. I should be on the beach in Florida right now, planning my next fishing trip.”

Just then, there was a light rap at the door. Kramer’s secretary entered, glancing nervously at Stern. She carried two glasses of water, which she set on coasters on the desk before quietly retreating. Stern licked his lips, then reached forward to take a glass. He was a big man, perhaps thirty pounds overweight, with thinning gray hair and a ruddy complexion. He took a sip, then a long drink before placing his glass back on its coaster.

“You know it’s been hard for me,” he continued. “I’ve run up over a million dollars in debt to keep the company going. I laid off everybody I could. I’ve got a daughter who won’t talk to me, because I had to let her husband go, and he can’t find work. I’ve even had to use my own assets as collateral. I’m upside down in a house I owned free and clear eight years ago. I’ve worked seven days a week

dig myself out of this hole I'm in, one I never caused." He looked at Kramer, no longer visibly angry. "We talked, Ryan," he continued. "We talked a long time before I decided to pull the plug. I needed two million. According to the workup you did, we were supposed to have more than five million now. Okay, I understand that you can't guarantee a rate of return, that you don't control the stock market. I get that. Nothing's certain in this world. We were way down, but when we crawled back up to two million, the missus and I talked. Sell now and we still had some time to retire before old age did us in. I could pay off the debt, give Uncle Sam what I had to give, and we'd have half a million left. That's not much, not nearly enough for the life we wanted, but it would do. With that money we can buy a cheap condo near Miami, draw on the rest when we had to, living mostly off Social Security. That was the plan. Not much, but we could live with it. Ryan, I told you all this." Stern raised his fist. "Then you send me this!"

Kramer spread his hands before him defensively. In a measured voice he said, "I didn't do this to you, Connor."

"You told me two million! That's what we were going to get when you executed the order. That's what you promised!"

"I make it a practice never to promise, Connor. I gave you the prices of the stock in your 401(k) and told you the figure if we executed the order at those prices."

"That's right! And I said do it! It wasn't easy settling for so little. Every dollar over a million for me was money in our pocket, money to retire on."

"I understand." Kramer glanced at his wristwatch.

"Do you? I don't think you do. You sit in this fancy downtown office, punching numbers, running spreadsheets, taking your cut. A business your father gave you. You never worked a day in your life to build it up! Tell me, Ryan. You're not making any less now than if I'd got the full two million, are you?"

"I ... I'm getting less. I'd much rather see you get the figure we talked about."

"'Figure we talked about'? What's that? It was two million dollars! Not some figure. It's my life here. My life!"

"Connor, I executed the order," Kramer said testily. "I sent you the statement."

"One million five hundred twenty thousand. That's what I've got here." Connor shook the paper in his fist. "That leaves just over a hundred thousand after I pay my debts. Then there's your fee, odds and ends. I ran the numbers, Ryan. Fifty-two thousand dollars. That's it. No half million. What the hell happened?"

"The sells were supposed to go at specific price points, but the record shows they were executed much later than that and at a much lower price. This happens from time to time," Kramer added archly. "The stock market is volatile. It's in the paperwork we gave you. It's just the way the stock market works."

"I'll bet the big boys never have it happen to them. No, they get theirs. My order was at the back of the line and got the scraps. You promised me!"

"I never promise."

"You know what fifty K means to me? Nothing! Absolutely nothing! Maybe we can buy some crummy one-bedroom condo with it. Then we get to scrape by on Social Security, eating dog meat. Medicare's not free, you know. I've still got to pay, and pay through the nose."

"You can always file for relief."

"You mean bankruptcy? You're a moron, that's what you are. I wish I'd seen it sooner. If I file for bankruptcy, I'll be tied up in court for two years at least. Two more years of snow and ice. I don't even know if I'll be alive in two years! And the lawyers will take every penny I've got." Stern slumped

back in his seat. "It wasn't supposed to be like this. It wasn't."

Kramer stared at his watch pointedly.

"Hell," Stern said in sudden surrender. "Why am I all worked up? With my ticker in the shape it in, I haven't got much time anyway."

**CENTRAL PARK
NEW YORK CITY**

4:31 P.M.

Jeff Aiken's shoes slapped the track as he picked up his pace for the final mile. It was good to be running again, good to breathe fresher air, good to be away from the busy Manhattan streets, even only within the illusion of Central Park.

He followed the old Bridle Path of the Lower Loop because he enjoyed its beauty and because his feet and knees liked the forgiving dirt. He ran steadily, passing a few slower runners, yielding to others. Though hugging the reservoir, from time to time he caught a striking view of the park.

He closed his mind to all thought, focused on his body, the rhythm of the run, the sensations of pain and pleasure that coursed through him. Seeing the end within sight, he kicked into his final sprint, his side aching and his lungs a bit ragged from his recent inactivity. He pressed himself hard.

* * *

More than ten years before, Jeff lost his fiancée at the World Trade Center. Working then for the CIA, he and his team had uncovered clear indicators of the pending 9/11 disaster. But when he met with his superior, he was unable to persuade him or anyone else to act. He even failed to save Cindy's life, though he'd known she'd be in Manhattan on the probable day of the attack.

They'd spoken just moments before her death.

The experience was devastating. Afterwards he'd left the CIA to start his own cybersecurity company as he struggled to deal with the tragedy.

Jeff was born the youngest of two sons. When he was six years old, his parents and brother were killed in a two-car accident. He'd been with his grandparents at the time and remained with them thereafter. They were loving surrogate parents. Jeff's elderly grandfather died when he was a sophomore in high school, and his grandmother passed when he was in college. Until Cindy came along, he'd remained largely a loner.

He'd gone on to obtain his doctorate and then taught at Carnegie Mellon before joining the Cyber Security Division of the CIA's Information Operations Center. Though he spent most of his time before a computer, he'd played rugby at the University of Michigan and worked to stay fit.

When he'd next been in Manhattan, he went to Ground Zero at the start of the new construction drawn there by deep emotional currents. But seeing the gaping hole, the busy construction, had offered nothing except painful recollections. Over the long decade following her death, his memories had slowly dimmed, though there were moments when some reminder would bring back the sharp pain of loss.

Now his work had drawn him to Manhattan once again.

~~He'd loved Cindy deeply and was sure he'd never experience such a relationship again. But late~~ during the frantic chase to stop a planned al-Qaeda cyberattack on the West, he formed an unexpected bond with Daryl Haugen. He'd known her as a colleague for several years, and both of them were surprised by this development, as neither had been looking for a companion.

He and Daryl had entered into a passionate affair that blossomed into what each believed was a lasting relationship. She'd left the United States Computer Emergency Readiness Team, known as US-CERT, where she'd headed a team and served as assistant executive director of the Computer Infrastructure Security Unit at the Department of Homeland Security, or CISU/DHS, before joining him. He'd formally organized his cybersecurity company, calling it Red Zoya, the name coming from the zero day applications used in the al-Qaeda attack. They'd set up their lives and business in a Georgetown town house.

Following the climactic events in Turkey the following year, Daryl was briefly hospitalized. It had seemed to him then that the chronic separations that previously marred their life together had come to an end. During the time of their recovery from their injuries and wounds, Jeff came to believe that a full and lasting love had blossomed within both of them. Working together, they were a unique and highly regarded team. It seemed to him an ideal life, joined as lovers and professionals.

But they were each often consumed by their work. One or both of them was frequently absent on assignment, and even when they were together at the town house, they were heavily involved with their business. Daryl had assured Jeff that she would make their relationship a greater priority, and for a few short golden days it seemed she would. But their intended monthlong vacation in Italy after her release from the hospital in Turkey was cut short within a week when an old colleague had called Daryl, desperate for her help. Unable to do the job on the road, she flew back to the States and that had been that.

Afterwards, nothing changed. They rarely saw each other, and when they were together it was as if they weren't. Jeff raised the subject of their relationship again and Daryl reassured him—again—but finally he decided they had no future, not like this. His had been a rational decision, though not an easy one. Continuing as they were wasn't healthy for either of them. He'd seen other working couples go on as they were for years, never remaining connected at the most important level, interacting with each other superficially, as colleagues at work, their sex life little different from a coupling with a stranger. They both deserved better.

This wasn't what he wanted. He'd hoped that presenting her with what was in effect an ultimatum would jar Daryl into reality, cause her to carefully examine her priorities. But when he finally managed to get her attention and a bit of her time, the conversation had not gone well. Initially, Daryl had given another assurance, and then, realizing how serious he was, she turned angry. Finally, when the inevitability of his position became obvious, she became stoic.

Jeff was disappointed and unhappy that she'd chosen to disconnect rather than put their relationship first. It seemed to him that Daryl thought the relationship was going okay and had been offended that Jeff would accuse her of not being committed. From his perspective, she should have been able to see what was taking place. It could not have been more obvious to him. He was deeply frustrated that he couldn't get her to acknowledge it. All he really wanted was for her to understand that she needed to make a decision, needed to make the right decision for them. But that wasn't how she'd taken it.

In the end, before he felt they'd really discussed things, she abruptly moved out while he was on assignment, taking her possessions. She'd given him the benefit of the doubt with those acquisitions.

that could reasonably be considered jointly theirs, her fairness just one of the many things about her he loved. Her move was impulsive, he thought, something else about her he loved, though not when she was on this end of her actions.

The tragedy, if that wasn't too strong a word for it, was that it had been obvious to Jeff that she still cared about him as much as he still cared for her, but regardless, their life choices drove them relentlessly apart. And though it was his hope they'd remain friends, he couldn't see them ever getting together again as a couple. Someone would come along in either of their lives, and in time the other would receive a wedding invitation. He'd seen it with former couples he knew and now accepted that fate as his own. In seeming confirmation, Jeff and Daryl had not talked in the year since the breakup.

Ironically, Jeff's reaction to that life change had been to throw himself into work with even greater zeal. During those hours he wasn't working or asleep, he was most often at the gym. He'd taken up taekwon do, finding he enjoyed the physical contact and flexibility it gave him. One of the unintended consequences of Daryl's departure was that he was in the best shape of his life.

But despite the efforts of attractive women to start something new with him, Jeff had so far declined. He simply couldn't take that next step. He'd given it considerable thought but didn't understand why he was stuck. He found himself wondering about Daryl. Was she dating? Living with someone already? He didn't know and felt he shouldn't try to find out.

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