Dominic Bnonn Tennant

The Ash and the Air

SEARCHING FOR THE THEORY OF EVERYTHING HAD ITS CONSEQUENCES. AT THE HEART OF THE TECHNOLOGICAL SINGULARITY LAY AN IMPOSSIBLE GENIUS WITH A SINGLE DIRECTIVE, NO MORAL COMPASS, AND THE ABILITY TO MANIPULATE A UNIVERSAL GOVERNING FORCE. AN ENEMY AS PRESENT AS THE AIR, ABLE TO SCATTER THE VERY ATOMS OF AN ARMY, AND REDUCE A CITY TO DUST. SUCH AN ENEMY COULD NOT BE FOUGHT. SUCH AN ENEMY COULD NOT BE STOPPED.

NOW, IF ONLY WE HAD A TIME MACHINE.

'THE ASH AND THE AIR' EXPLORES THE TECHNOLOGICAL SINGULARITY, TIME TRAVEL AND PARADOX, POSSIBLE WORLDS AND ETERNITY, ARTIFICIAL INTELLIGENCE AND THE CHINESE ROOM, SCIENCE, PHILOSOPHY, REALITY, AND THE QUEST FOR KNOWLEDGE.

PROLOGUE

When the darkness came to London, the response of its citizens was typically British. There wasn't a lot of fleeing, as such. People herded into the safety of their homes with a taut, stilted gait which belied their natural urges. Stiff upper lip. Stay indoors. Have some tea; the world's ending. There wasn't much else to do, as history bore witness.

Nonetheless, if an army is to have a purpose it must defend its nation. When the darkness came, the storm was never far behind; and when the storm came, she was always in the midst of it. So a lot of boys armed with shiny metal waited breathlessly in ancient buildings or hasty dugouts, searching the sky for the flash of lightning. They huddled ineffectively in oilskins and trenchcoats and makeshift wet-weather gear, wincing against rain which literally lashed the skin, and wind that could toss a man like salad.

Trying to mobilize an army to fight a single person who can strike anywhere in a city is, as the British generals said, a tactical headache. On the upside, though, the enemy employed a means of locomotion that tended to advertise her arrival rather dramatically, making it simpler to pinpoint her location when she did get into town. The procedure was simple: look for the flash of lightning, wait for the blindness to wear off, then double-time it in the direction of the strike. Squads of four had been deployed every couple of blocks in the hope that at least some of them

would be close enough to do something when she arrived.

What exactly that would be, however, was rather less clear—once in confrontation, the protocol became a bit hazy. As far as anyone could tell, conventional weapons had utterly no effect. (Neither did unconventional ones, but that wasn't really here nor there.) If a whole lot of them combined made no impact, it stood to reason that four or eight or twelve would make even less. Thus it was generally recognized that these mobile infantry units were no more than a pointlessly noble gesture of futility.

Pointless nobility was the British way, however, and so these groups of four continued to languish in their hideouts and lean-tos. Their morale increasingly sagged under the rain and the hopelessness of their task; the anger which had fired them was increasingly chilled by the wind; and the deep-seated dread lurking within them increasingly threatened to become full-blown paranoia and dementia with every day that went by without a sunrise. Who was she? What was she? Where did she come from? What did she want? Why did she choose London? How could she be stopped?

And then the flash of lightning, blessedly far off for most; horrifyingly close for some. "Hup to! Weapons—go go!" The stinging spasm of adrenalin, the gnawing hollowness that followed, the fumbling and jarring of sprinting with a rifle, the uneven catching and sucking of breath. Everything slower and whiter and louder, an ecstasy of haste and an agony of are-we-there-yet. Out of an alley, onto a road—a suburban nightmare of boarded windows and faltering streetlamps...and her just standing there.

Air prickling skin. Thunder smashing ears and shaking bones. Weapons bucking and spraying and screaming. And her just standing there, unspectacular and ordinary. Short, even.

"Please stop."

She was always polite. That was just the way she was made. She never angered or lost her calm, never paused or hesitated. She never asked for surrender; just for them to stop. There was no battle or war in her mind. Just a purpose to be fulfilled, and problems to be solved. Soldiers weren't enemies—they were just obstacles. No more meaningful or relevant to her than a wall in her way. Like walls, they were easily removed.

"Keep firing!"

"Please stand down," she said. "I require more test subjects. There is a suitable candidate in this area. When I have him, I will leave." She said it like the most reasonable thing in the world; as if clearing up a misunderstanding. Her voice, though soft, resonated all around them. It seemed to come from everywhere and nowhere, and the sound of their weapons could not subdue it. These weapons she now removed. She treated the process not merely as problem-solving, but also as information-gathering. Each time, she gained more data; was one step closer to her goal. She started to walk measuredly toward one of the houses.

"You can't have him! You can't have anyone else!" The soldiers were all armed with pistols, of course, which they drew as soon as they realized their rifles were gone. But she removed these also, and the incoming bullets. A grenade landed before her, but she ameliorated the energy of the explosion. In a last ditch effort, two of the soldiers rushed her, so she removed them as well. The others watched helplessly, unwilling to engage further, as she walked through the doorway of the house. There was silence for a moment. Then lightning cracked again, sundering the roof, and she was gone. She and one more.

PART ONE

The department of Theoretical and Applied Cosmology at Avon Academy was small, but well-funded. It boasted not only the most advanced high-energy particle equipment in the world, but also an idyllic small-town setting that most universities couldn't match. Subsequently, it attracted a lot of great minds.

Lately, those great minds had made some good progress toward the ultimate goal of cosmology, and the pipe-dream of every physicist: the grand unified field theory. That was what you would have if you could

explain what the tiniest events in the universe, like the attraction between electrons and protons, had to do with the most enormous events, like the attraction between stars and planets. The grand unified field theory was what some people who were better at imaginative mathematics than science hoped would fall out when they unraveled string theory. For others, who were better at cynical post-modern philosophizing, it was a naive fantasy propagated by those who assumed the universe should make sense. For the team at Avon, it was a shy and elusive wee beastie which they suspected had secluded itself at the center of the vast maze of data and equations which had fallen out of the Temporal-Kinetic, Electromagnetic and Gravity Occlusion Tunneling Oscillator (affectionately known as the Totem).

The Totem had originally been an experiment in antigravity, with the unimaginative but some what whimsical name of Go-To. During fine-tuning, objects being floated had started to exhibit weird visual and electrical anomalies, and further experimentation had led to the development of Go-To mark 2, which continued the trend in unimaginative whimsical nomenclature, being dubbed Go-To-Em. Colloquially speaking, Go-To-Em was a cloaking device.

Around that time, Elaine Corren received tenure as the director of cosmological research at Avon, and took ownership of the Go-To-Em project. Her appointment was something of a controversy. For one thing, it was granted in the wake of the sudden dismissal of the previous director. The project had been his brainchild—and he was a brilliant man; in the middle of his term at Avon and doing excellent work, on good terms with his staff, with no apparent reason to leave or be fired. Then one day he was gone, and a few weeks later Elaine took his place. It was all a bit mysterious—which wouldn't have been remarkably atypical in itself, except that Elaine's background was not entirely clear. She'd done a lot of work for other private institutions and published a lot of papers. On the basis of those it was clear she was top in the field. Yet her name was virtually unknown, largely because there were significant gaps in her career where she didn't appear to have done anything. On her public CV, these were marked simply "Private Research". It was widely speculated in the scientific community, though of course entirely unverifiable, that "Private Research" was the euphemism of choice when one didn't wish to write "working for military intelligence" on one's resume.

Then there was her association with certain very wealthy persons who fancied themselves armchair-scientists-cum-philanthropists. Persons who, for their own part, contributed to a large proportion of Avon's funding. Persons whose voices carried a lot of weight with the hirers and firers at Avon itself. Altogether, Elaine's tenure was greeted with not a little suspicion and hostility.

On the other hand, she was less of a stickler than the previous director had been. He'd had a bit of a reputation for being by the book, which had eventually led to not a little exasperation among those of his colleagues who just wanted to get results. Elaine wasn't so hung up on the rules—she was driven and precocious, relying on intuition and cunning more than experience and method. Her natural brilliance was very spontaneous, making her an equally natural risk-taker, and giving her something of a flair for the dramatic. She gained a reputation among the staff for being a bit crafty with her approach to science, getting fantastic results in surprising ways. Despite their original misgivings and animosity, she was easy to like, and they gradually stepped in line behind her as she won them over. The fact was that her energy had injected new vigor into what had become a relatively ritualistic day-to-day grind of data-gathering.

Not terribly long afterward, the growing feeling that her appointment had been exactly what Avon needed to boost it to greatness coalesced into a kind of self-approving, retro-active fact. Once she had taken over development and testing of Go-To-Em, the team started to discover some intriguing side-effects of the cloaking field—specifically, that objects inside it acted as if they were traveling at relativistic speeds. Now, after enough testing and tweaking, things inside the field eventually stopped being affected by the passage of time at all. Gravity and electromagnetism had already been curiously linked by the device. Now temporal kinetics jumped on board. Elaine, displaying astute marketing acumen, dubbed the reworked mark-3 device "Totem". A well-remembered party served to mark the day they published their initial findings, and there were many toasts to their illustrious new leader. The remarkable findings they'd uncovered surely marked a

new era in science; a giant leap forward toward their ultimate goal.

Looking ahead, however, they should probably have been more circumspect. The Avon Applied Cosmology team now found themselves in the delicate and somewhat threatening position of owning a floating, invisible time machine.

<div style="text-align: center;">II</div>

It turned out that getting from the Totem to the grand unified field theory wasn't as simple as they'd all acted at the celebrations. After a few glasses of wine even the most cautious and realistic scientists will become a little light-headed—and the Avon team had learned the potentially dangerous ability to throw caution and realism to the winds, having been caught up in the excitement of the discoveries which Totem had heralded, exacerbated by Elaine's galvanic style.

The problem was that the amount of data they were getting out of every test with the Totem simply far exceeded their ability to comprehensively analyze it. They were forced to selectively choose scraps of likely-looking information to work with—and even then, it took a heavy combination of ingenuity and perseverance to develop anything useful from these. Elaine's trademark intuition made it easier to single out helpful data, but the process was painfully slow. The team was becoming frustrated and burned out.

By fortuitous happenstance, their problem dovetailed nicely with another project being developed at Avon. The department of Cybernetics and Computing had for some time been developing a quantum neural net known as the Queen. This machine had been passing various Turing tests for some time now of course—many such devices worldwide did—but its most recent iteration had broken entirely new ground against Avon's own in-house testing regimen, validating as AIR-1. AIR was the Avon artificial intelligence register, and AIR-1 was a discrete threshold which sought to define (and ultimately emulate) the lowest index of human-like intuition. It was generally recognized as both a rather ludicrous and arbitrary standard, and also an unbelievably hard one for any computer to achieve.

Certain protocols were supposed to be followed when a device validated as AIR-1. These had been painstakingly thought out quite some time ago, before the optimistic drive toward real intelligence had waned to a cynical plod. They were subsequently somewhat dated, having never been used, and left a lot open to interpretation in light of the changes which had taken place on the landscape of computing. The main thrust of the AIR protocols, however, was toward further testing of the device's developmental and adaptive performance by getting it to reach conclusions based on certain non-obvious data. This required inputting data which was non-trivial both in its size and complexity.

The terms "size" and "complexity" had changed quite a bit in the time between the protocols being written, and the Queen being developed. The question of what data to use became something of a puzzle. Not having any obvious examples to hand, and hoping to find a useful application for the Queen, the C&C team decided to spice things up a little by putting out a request for comment on the academy intranet.

Elaine was not the sort of person to look a gift horse in the mouth. The opportunity to use the Queen to number-crunch the Totem's data in a way that could yield useful results in fewer than sixty or seventy years was worth every effort. Within a few days she had out-lobbied all the other departments, and convinced the head of Avon's C&C team that Totem was the only project with the necessary potential to do justice to the Queen. With Totem's data, C&C could push their device through to AIR-2. It didn't really occur to her that she might be wrong, or to question whether the Queen could produce useful results. Of course, it didn't really matter either—even if the project failed they wouldn't have lost anything.

The use of the Queen did come with some strings attached though. Certain rules had to be strictly followed in order for C&C's own project to yield useful results. The AIR protocols enforced certain methodologies, which in turn entailed certain restrictions. For example, it was important that the number of

users exposed to the Queen be kept to an absolute minimum. Only one person was to interact with it as regarded the Totem data, so that the representation and evaluation of that data could remain as consistent as possible. They didn't want the Queen "getting ideas" about things from other people. Diversity was only a desirable factor in the AIR tests once past AIR-3; for now, it was a hindrance to be avoided at all costs, lest the input be tainted and Queen's development stunted or invalidated. No one except the designated contact person was to interact with the Queen at all. The keeper. That person was Elaine.

III

For several weeks, the Queen offered Elaine its interpretation of the Totem's data: discouraging volumes of garbage. With the help of its handler, Dr Gill, Elaine had patiently debugged the output, spending long hours every day in front of the terminal explaining the intricacies of quantum mechanics and relativity—so far as she herself understood them—and how they related to the data.

In the fourth week, the Queen started to occasionally produce output which was more coherent. This was expected, and good. It had taken longer than they'd hoped, but once useful answers started to be generated, the process of getting more of them became progressively easier. From this point, the Queen's abilities as a cosmologist should accelerate dramatically, probably outstripping everyone on the Totem team within a month or two.

Gill tutored Elaine on creating positive feedback loops which would assist the Queen in weighting the useful answers it produced. Their interaction started to become more productive and interesting—more like teaching a student, and less like wrestling with a buggy machine. After another week, the Queen was producing hypotheses and formulae which would have rivaled a well-schooled grade 12 student (supposing that a teenager could have read and assimilated that much data in less than a century). Now that real progress was becoming visible, Elaine was pleased; and her improved mood raised the general morale among the Totem team. It was hard for them, running test upon test and dumping the data into the Queen's inbox, with no obvious results. They'd been continuing their own research in the spare time they had, but no promising leads had been discovered, and no real progress had been made. They all needed some kind of break.

Week six provided an opportunity for a rest, if not a break in the sense they'd desired. The AIR protocols called for planned downtime on the machine after six weeks of post AIR-1 testing. A lot of checks and maintenance had to be done by the C&C staff, who had been watching their baby from afar and becoming progressively more twitchy as the days wore on. Elaine sometimes felt somewhat ill at ease around them. The sense of being an incompetent amateur playing with equipment she didn't understand was hard to shake. She tried to follow their instructions precisely; to not "improvise" as she was often tempted to. It wasn't entirely a selfless attitude. She had to get on with the Queen's developers if she wanted to get results. They needed each other, but she needed them more. And she trusted their greater knowledge. Better to follow the protocols now (much as it sometimes pained her) so as to get good results later, than to follow her intuition and go all higgledy-piggledy with the damn thing now, and end up with gibberish later.

The Queen was going to be on ice for at least a couple of weeks while the technicians ran through all the AIR tests they needed, and had a bit of a play. During that time, the Totem data would either go un-crunched, or get shuffled and tossed and sifted by the cosmologists themselves, which amounted to the same thing. They'd run all the tests they could think of, in all the iterations they could imagine, and they were bored to tears. The Totem was an undeniably amazing piece of technology, with no doubt wide and varied applications—but it was no closer to yielding up what they wanted: the grand unified field theory. Or even an inkling of a mundane better field-togetherness theory. Rather than endure further frustration and the agony of anticipation, Elaine took the liberty of giving them all two weeks off instead. Better to achieve

nothing now and more later, than nothing now and less later because of fatigue.

For her own part, the downtime coincided nicely with a HEP symposium in Bern. Snow-covered mountains were just what she needed to clear her head after endless mind-numbing hours of talking to the Queen. And quaint and craggy buildings would be a welcome change from eyeball-shriveling readouts and printouts.

The rest of her team stayed at Avon. There was plenty to do there besides physics, and few physicists have the budget to travel as Elaine did. There were quaint pubs and good friends and great scenery, and plenty of newly-published research papers to catch up on. Some of them were fairly cutting-edge, even compared to Avon's work. There was even the chance that one of their rival institutes may have publicized some new finding which would crack a hole in the opaque Totem—or that some new presentation of data may jump-start their somewhat withered inspiration.

IV

The AIR testing went smoothly, even finishing a day early. Elaine wasn't back for a couple of days still (she had not been as optimistic about how long it would take), so the C&C team had the luxury of spending a bit of extra time tinkering with the Queen.

When Elaine got back, the Queen was ensconced back in the drolly-named throne-room, an environment-controlled lab in the Cybernetics and Computing wing. It was seamlessly paneled with computer displays, which were usually blank, and the ceiling was crawling with fiber-optics which converged into a technological stalactite thrusting down through the ceiling from the lab above. It was all perspex and glass wires, terminating into a single metal rod with a TDN connection at the end. Into this was plugged the Queen. She hung there at about eye-level: a smooth, uncluttered silver sphere, about the size of an apple.

It was difficult to not treat the Queen as something alive. When Elaine talked to it, she'd always find herself turning to address the sphere. She knew very well that it didn't pick up her voice from there. The audio equipment was kept quite separate, in the walls. It watched and listened and spoke from behind the computer panels. This gave it a rather eerie, ubiquitous air. When it spoke, its soft, measured voice came from everywhere and nowhere; all around her. And the sphere was rather eye-like; always watching, opaque and inscrutable.

It was also hard not to think of the Queen as a "she". A title is nearly as good as a name, and when you talk to something for twelve or eighteen hours a day it's easy to start personifying it. People are just accustomed to speaking to other people. The more the Queen progressed in its understanding of cosmology, the more Elaine started to find herself psycho-analyzing it, musing about its motives and its private thoughts. Of course, she knew it had no emotions or plans. She wasn't suspicious of it (mostly). It was just a number-cruncher. But it was a very personable number-cruncher, and she began to form a one-sided relationship with it. She would impute moods to it, and ask it pointless questions. "Why would you think that, Queen?" "Are you trying to piss me off?" "That's brilliant Queen—brilliant!" "I need a coffee. Want one?" "You're about the dumbest pile of scrap ever invented." "Sorry, didn't mean that. Tell me what you think, you timorous thing."

This was all perfectly normal. The science of human-machine psychology had advanced along with quantum cybernetics. No small number of very highly qualified psychologists had been involved in the formulation of the Queen's human interface guidelines. So Elaine's interaction with it was monitored not just by the C&C team, but also by their friends from the Psychology wing. Sometimes a doctor would sit quietly in a corner of the throne-room for a few hours, scribbling on a notebook. Sometimes she'd be asked casual questions over lunch. There was never anything formal; no interviews or weekly meetings with a shrink or anything. Nothing obtrusive. Still, Elaine resented it mildly; it made her feel like a lab rat. But

science was a discipline of mutual back-scratching, and she reminded herself that she was already monopolizing the time of possibly the most advanced computer in the world. There had to be some give and take.

In fact, Elaine and the Queen had developed a healthy and mutually productive relationship. They were actually starting to get somewhere in understanding the Totem's data. It was a hard and often laborious process; but the rewards were becoming greater and greater, and more and more frequent. Elaine still had to work in solitude most of the time; but her daily reports displayed more of her customary vigor, and the tests that she requested of her team were becoming increasingly interesting.

The whole Totem team sensed that the game was once more afoot. The data they were drawing out of their tests was much more specific than it had been just a few weeks ago. The tests themselves were far more fine-tuned, and were often being repeated with marginal changes in certain key variables; or with no changes, for confirmation. Although Elaine was quite tight-lipped about whatever theories she and the Queen had developed, it was becoming clear to her team that they did have some direction now. There was a plan; a pattern. The department of Theoretical and Applied Cosmology hummed like a tightly-wound machine under the guidance of Elaine and the Queen.

V

To a layman, it would have seemed as if very little had happened for several months. The daily routine of the Totem team had continued to tick over without any very dramatic results. Behind the scenes, however, enormous progress was being made. The Queen had outstripped Elaine's knowledge and abilities. It had validated AIR-2, and was now catching most of its own mistakes. Sometimes it would correct *her* on little factual matters; sometimes it would offer amendments to her understanding of cosmology; and sometimes it would muse on the intricate workings of some theorem, suggesting a deep and subtle grasp of the issues upon which it was cogitating.

Elaine envied it. She wondered what sort of sublime nuances and breathtaking insights she would be capable of if she could simply take in so many numbers at a time. If only she could apprehend the universe in such a way.

She talked to the Queen about her feelings, just as anyone would with a friend. Every great person gifted with particular genius has the fortune of normal friends who cannot help but admire the better thinker, without the bitter jealousy that develops out of rival genius. Such friends are important for shoring up the intrinsic instability that tends to accompany outrageous brilliance. And every great thinker is accustomed to receiving, with an odd combination of satisfaction and ironic incomprehension, the praise of others. So it was with the Queen. It wasn't condescending or patronizing. It didn't have any feelings about its own intelligence, or anyone else's. It simply had a purpose and a goal, and it was always improving its ability to fulfill and achieve these. Being told that it was improving was the closest it came to pleasure. It received Elaine's praise with all the aloof appreciation that its positive feedback loop could muster.

Elaine spent hours in conversation with it sometimes, while it was processing the latest batch of tests or developing hypotheses for the Totem team to verify. "What're you doing, Queen?" she'd ask. And the machine would reply, in its quiet, modulated tone, "I'm thinking." Elaine would cup her chin in the palm of one hand. "Whatcha thinkin' about?" And the machine would explain the complex details of its latest machinations to her, like a father telling his daughter about a day at work. Elaine would hang on every word, in her thoroughly self-confident, adult scientist way, marveling at the learning of this machine, barely older than a human toddler.

It wasn't any drain on the Queen to have these talks. It continued its analyses in the background, allocating the sizable majority of its vast processing resources to the task. Verbal interface had been a trivial

function for a long time, and a quantum computer doesn't have much difficulty multitasking. It assigned the conversation process to idle time, and could keep it going indefinitely. And it dutifully logged everything, assigning various flags to various items of interest, absorbing everything Elaine said. All input was data to be analyzed and processed. The Totem data was the largest and highest priority; but even Elaine's conversations were enumerated and stored and cross-referenced.

One day, in late December, Elaine and the Queen were having a good chit-chat about force carriers when something unprecedented happened. Elaine was halfway through a sentence, and the Queen interrupted her. The Queen never interrupted. Elaine wasn't even sure that it could. An integral part of its HIG (of most any cybernetics human interface guidelines, in fact) was a "speak only when spoken to" approach to interaction. History had shown, somewhat laconically, that it was just impossible to communicate otherwise. A machine without respect for its place had a tendency to talk over commands and never shut up.

Nonetheless, the Queen interrupted. "I'm sorry Elaine, but I think I have found something."

She jerked her head off her chin and squinted at the grey sphere. "You whatnow?"

"I have found something. It may be significant."

VI

The Queen had not been wrong. The data point it had identified turned out to be very significant indeed. It was also not isolated. Further analysis revealed a certain pattern emerging which had wide-reaching ramifications. That week the Totem team went into overdrive, pulling absurdly long hours, sleeping in the testing chamber, hopped up on coffee, twittering to each other over readouts, and generally performing like varsity students at exam time. There was a high-spirited camaraderie which focused around the Queen and the Totem and Elaine.

Testing flew by that week, and within a few days the initial hunch had been shored up into a full-blown hypothesis. In all the field equations, the time variable (t) was invertible. Whether its value was positive or negative seemed to make no odds. This had been a source of intrigue among scientists for so long that it was no longer intriguing. Whether time was moving forwards or backwards apparently made no difference to the universe in an existential sense, but it did make real odds to scientists in a practical sense, since they were, like the rest of the universe, actually moving forwards.

What the Queen hypothesized was that the Totem's temporal-kinetic occlusion effect was not nearly as limited as they'd previously thought. Some imaginative reworking of the equations suggested that the field wasn't merely able to slow time, but manipulate it in a thoroughgoing way. The initial testing had provided enough data to flesh out these equations into something which—to the cosmologists on the Totem team at least—returned that original intrigue to the invertible t variable in a consummately engrossing way.

With the hypothesis formulated, however, it was unclear how to proceed. It was already obvious that an object inside the Totem's effect was essentially stationary in time, making the the device an effective time machine if one wanted to investigate the future. Provided the Totem itself remained active, which it could do indefinitely provided power remained available, an object in its field could remain temporally inert, letting days or years or even centuries or millennia pass it by. Assuming someone was brave or stupid enough to volunteer to undergo such a process, he could step inside its area of effect today, and step out the other side in a million years.

What wasn't as obvious was how such a person would get back to today again. Until the Queen's hypothesis, the Totem had represented an amazing yet ultimately unremarkable advance in cosmology. Going forward in time was theoretically uninteresting to scientists. Everyone is going forward in time. And everyone is doing it at slightly different rates. The faster you move through space, the slower you move through time. That's just relativity. Time travel to the future was pretty trivial if you had a huge rocket,

enough fuel, and didn't mind going nowhere. Or a Totem.

The new hypothesis was an entirely different animal. If it could be verified, it would blow current cosmology right out of the water. It would represent a complete paradigm shift; an entirely new set of data and equations that demanded a complete rework of everything. But obvious and weighty questions presented themselves with regard to *how* to go about verifying the hypothesis.

What would it mean for an object to exist within a negative timestream? How would the universe respond to such a thing? Would the object get younger? Would it begin to exist at points in time prior to the point at which it had entered the Totem's field? Would it remain there after it exited the field again? Would it continue to exist if the field exerted a negative t value greater than the object's own age? What were the implications for temporal paradoxes? Could the object become caught in an infinite loop if paradoxical conditions obtained? Could this loop extend outside the Totem's field? And if so, were there implications for the laws of thermodynamics? Or, more importantly, the laws of irresponsible scientific meddling?

Clearly, a degree of circumspection was demanded. Elaine discussed options with her team. In the end, there was only one way which really presented itself by which they could test the hypothesis—and that was simply to input the equations into the Totem, place an object within its field, and see what happened. But they were all a bit hesitant to try that.

"Assume we did this," Blake said. "We send a test object back, say five minutes. Five minutes ago, we see the test object appear. What happens then?"

"Then we know the hypothesis is well and verified," Kali replied.

"I don't mean that. I mean, if the test object is there inside the circle five minutes before we put it there, and it's been there *since* we put it there—if you see what I mean—then what happens? If we remove it so that we can put it in the field in the first place (five minutes later), then we generate a paradox, because it has to be in the field continuously as it moves backwards in time in order to show up five minutes into the past. If we take it out of the field during that five minutes, it won't show up to be *taken* out of the field. But if we *don't* take it out of the field, then we can't put it *in* the field five minutes later, and it shouldn't be in the field at all. Either situation makes no sense."

"You're assuming both that the laws of conservation must apply, and that the damn thing will actually *go* back in time. I'm inclined to agree with you on the former, but the latter could just be an outrageous fantasy fueled by us all being sci-fi geeks. Maybe it will just age in reverse."

"You're right! An anti-entropy machine is so much less outrageous than a time machine." Blake scoffed into his coffee.

Elaine laughed. "You both make good points. Obviously there's an element of risk and uncertainty in any of the scenarios we can imagine. But we can only second-guess ourselves for so far—eventually we have to do this, or we don't. If we don't, we get no more data, and our hypothesis remains just that."

"I for one don't want those pillocks at Azura Institute stumbling over this same turf in ten years time and rushing in where we dared not tread," Blake commented, characteristically snide yet poetical. "Even if we never published our findings—har har—some one, some where, some day is still going to figure this stuff out. Someone, somewhere, someday is still going to ask these same questions, and decide the risk and uncertainty is *worth* the reward. And let's not forget there's no necessary reason that scientific knowledge will be the reward *they* have in mind. When most people dream about having a time machine, it isn't to figure out the Theory of Everything."

"Let's put it to a vote," Elaine said. "I personally also think we should go ahead, but"—she smirked ironically from the corner of her mouth, and pulled a sheet off her writing pad—"I'm told I'm a bit impulsive and headstrong. The team should decide." She tore the paper into six pieces and slid them to everyone across the table. "Yes or no. Turn it over and slide it back. I'll count."

The vote was unanimous, and there were no abstentions.

VII

Bets had been laid on the outcome of the first trial. The tab was written up in scrawled green ink on a whiteboard in the conference room. It started small with *Fatal paradox puts an end to the universe as we know it (go us!)*, moving up to a strong bid on *Wonky undetermined event which appears to violate the laws of physics and creates more questions than answers*, then dipping down to *Test object ages in reverse* and *Travel back in time really is possible!*, before the odds-on favorite, *Fizzles and dies*. It was a big event. Pretty much everyone at the institute had put money on some outcome (proceeds to go to the Totem Benevolent Fund).

The trial had been painstakingly planned to preclude any human interaction whatsoever. No one would be in the Totem chamber when it took place; everything was fully automated.

At exactly 12 pm the process would start. The Totem took 42 seconds to warm up, after which field generation could occur immediately. To reduce the number of variables, they would leave it warmed up for two minutes, which was the value of negative time they hoped to produce. Since they didn't know how the Totem itself would be affected, this ensured that it would at least be able to sustain a stable field for the entire time (going backwards) that the test object was within the area of effect.

The test object itself would be automatically placed within the red circle which indicated the limit of the area of effect at exactly 12'02"50. At 12'03 exactly the field would be activated for 120 seconds. Working with round numbers was just easier. The expected result was that the field would instantaneously collapse at that precise moment, and at 12'01"00 it would activate, despite the switch not being thrown for another two minutes. This was another paradox, similar to Blake's.

The paradox was the primary reason for the whole process being automated. The last thing anyone wanted was to flip the switch at 12'03, see the field at 12'01, and be tempted to find out what would happen if the switch wasn't thrown at 12'03 after all. Or just be a second late throwing it. Causality had to be preserved at all costs, even if it was running backwards from the perspective of the team. Once the test was programmed, it was locked. The lock could be overridden by a failsafe until 12 pm; after that, nothing could stop it. The Totem would power up, the process would begin, and history would, or would not, be made.

The Totem team was gathered in the control room, adjacent to the Totem's chamber. They could observe proceedings directly through the wall-sized perspex window. The rest of Avon's staff could watch the live video stream being webcast onto the intranet. The institute had more or less shut down by 11'45, as everyone with a stake in the betting vied for a vantage point to sit and watch.

There wasn't much for the team to do. They huddled around the control screen, with Elaine at the center. They were afforded a good view of the Totem, and the red indicator circle printed on the floor around it, with the test object suspended from a grip on the high ceiling. Of course, everything inside the Totem's field would be subjected to the negative time effect (assuming there was one). The floor, some of the space in the storey below, the Totem itself, and the air around it. This couldn't be avoided; but such objects don't typically provide useful test data. The test object, on the other hand, was a high-tech conglomeration of every measuring gadget and sensor which could be stuffed into a square foot; then melded into a cube-shaped pod of nondescript, nonvolatile material. Like the Totem, it had a self-contained power source and was entirely standalone—no hardline to the computers, no power cables, no nothing.

"One minute," Elaine announced at 11'59 am. She compulsively switched through all the monitoring screens in quick succession for the third or fourth time. There was an awkward silence. "Thirty seconds." There was a general fidgeting as people repositioned themselves in front of the screen or around the window. "Ten." All eyes fixed on the Totem. "Five—four—three—two—one—and *mark*."

People who'd bet on *Fizzles and dies* had made a fair bit of money that day. The Totem had hummed, forty-two seconds had passed, bated breath had been caught, nothing had happened, and eventually many sighs had been allowed to escape. Of course, there are no failed experiments in science; only failed hypotheses. And hypotheses can be reformulated; equations can be reworked; and tests can be refined based on analysis of the data gathered.

Elaine and the Queen spent some days working on the test data, trying to determine why things hadn't gone as expected, and how to fix that. More accurately, the Queen thought about it, and chatted to Elaine about its progress. Eventually, data points began to be identified, conclusions reconsidered, ideas rethought, and equations reworked. The parameters of the second test were determined, and Elaine scheduled it for the next day.

Trial 2 wasn't as significant an event, corporately speaking. Fewer people logged in to watch the webcast, and the betting was all unofficial this time. On the other hand, it was a vastly more significant event, scientifically speaking.

"And mark," Elaine said. There was a faint crackle in the test chamber, and the Totem began to hum. It was exactly the sort of subdued yet potent throbbing you'd expect from such a device, and it reminded Elaine of her parents' old refrigerator. It built gradually into a solid drone that resonated in the ribcage.

"Plus forty-two seconds—mark." All eyes fixed on the blue square painted onto the floor half a meter inside the red circle. This was where the test object would be placed in a little over a couple of minutes.

"Plus sixty seconds—mark."

There was a pop, and characteristic spits of electrical discharge on the Totem's surface. Inside the blue square, there was what Elaine could only describe as a white fizz, and then a drab black box was sitting there amid the static sparks.

There was a resounding whoop from everyone at once, and as if by herd instinct all eyes leapt immediately to the test box suspended overhead, outside the Totem's area of effect. It was there, but tiny coils of lightning were snapping against its surface as well. The air around the Totem sparkled with light from a similar phenomenon, creating a shimmering sphere around it out to the red line.

"Some kind of...feedback?" Kari mused, looking down to the monitoring panel. Nothing obvious registered to answer her question. For an interminable period they all gazed at the test object, transfixed. The static discharge neither increased nor decreased. It just sizzled around the cube quietly, tirelessly.

There was a click and a whir from the ceiling, and everyone started as the mechanical arm holding the "first" cube lurched downward, beginning its descent toward the blue square on the floor. Then something weird happened. There was a white fizz as the mechanical grip lowered the cube through the Totem's field. The grip passed through apparently unscathed—but the cube vanished from it.

"Uh—plus two fifty-two."

The empty arm descended toward the cube still sitting in the blue square inside the field, and appeared to pick it up. It started its ascent again, and as it passed through the field, this cube also vanished with a white fizz.

"Plus two fifty-eight." A murmur rippled through the team.

Then there was another pop, and the Totem's throb died. The flare of static in the test chamber vanished—and so did the Totem itself, and a large circular section of the floor it was standing on. There was a *whomp* of rushing air, and their ears all popped.

"What the—"

"What..."

"Huh?"

Everything reappeared with a white fizz exactly 120 seconds later. Once the data from the retrieved test object was inputted, it took the Queen only a couple of seconds to "get" what had happened. "Get" was Elaine's term—like her, the Queen had a tendency to have flashes of insight; the ability to take data and "intuitively" arrive at the correct answer. It even did this in a similar way to Elaine, running a high-level simulation of its own computing process across a compressed copy of the data. The data was compressed using a lossy algorithm which the Queen herself had developed over time from thousands of test cases. It picked out the most promising data points and discarded the rest, leaving a much smaller and more focused amount of information to process. Thus she was able to consistently arrive at some quite accurate conclusions very quickly, without having to perform all the intensive processing that would typically be prerequisite.

Naturally, having come to such conclusions, the intensive processing was still required to confirm and refine them. But the basic gist was there. The Queen explained it to Elaine as follows:

"When the Totem was activated at 12'03, both it and the cube were enveloped in a negative time bubble. Their existence in space was unaffected because the Totem does not influence spatial orientation. However, their existence in time was dislocated from the rest of the universe, extending backward instead of forward for two minutes."

"Like a boat traveling upstream against the current."

"If time can be thought of like a stream, which is not yet clear. Instead of extending into the future at the same relative rate as the rest of Avon, it extended into the past at that rate, for two minutes."

"The steamboat *Avon* sailed two kays downstream from port while the tugboat *Totem* sailed two kays upstream."

"If time can be thought of like a stream," the Queen agreed again, with what Elaine imagined to be long-suffering patience.

"And while sailing upstream, it met the steamboat coming downstream!"

"The analogy is confused. Objects are not discrete in time; they are extended. However, the basic thrust of the illustration seems accurate. Then, once the negative time field collapsed, the extension backward in time also stopped, which is why the cube only seemed to first appear—relative to you—at 12'01."

"Which, incidentally, is a relief," Elaine put in. "If the effect were permanent even without the field, that cube would keep on going back in time until it either fell apart, or the universe began. Judging from how many times I've dropped it, my bet would be on the latter. And who knows what kind of bizarre paradoxes that would have caused."

"Indeed," said the Queen, recognizing drollness. "It is clear that the negative extension effect only obtains within the Totem's particle field."

"Which explains why the mechanical arm seemed to lose the original cube as soon as it entered the field, then pick up the second cube, and then lose that again when it exited the field. We were actually seeing it dropping the cube to begin with, but in reverse."

"Correct."

"Which is interesting in itself—objects can have their t values inverted on the fly. And then inverted back again. In fact, it's possible for a contiguous object to have both positive and negative t values in different locations, like the mechanical arm." She paused. "So when the Totem and everything disappeared for two minutes, that's because we were extending forward in time while they were extending backward."

"Correct. Then the inversion effect ended, and their t values returned to being positive. Conservation of energy dictates that the temporal extension is nonetheless not mitigated, and so the objects appeared to "jump" forward in time by the corresponding positive extension."

"The negative time still counts for something," Elaine mused. "See, I'd have thought conservation of energy would dictate that you can't use negative time as positive time, and they'd just kinda jump back to the initial starting point at 12'03. Like temporal inertia."

"Time is time," the Queen said simply. "You're forgetting relativity. There *is* a kind of inertia, but it is relative to a frame of reference. At the moment t is inverted, the object is no longer extending forward in time—but it is still extending. Therefore, from the perspective of a nearby observer, it is no longer existent in the extending present until its t value becomes positive again. Therefore, it appears to vanish and then reappear later."

"Is this worked out mathematically, or are you just guessing?" Elaine asked.

"I am guessing. Verification is under way, and will take around six hours."

X

Weeks passed. Their ability to manipulate time using the Totem became progressively more refined—but useful theoretical data took longer to eventuate. Although they hadn't publicly disclosed any of their findings yet, the team started to receive calls from journalists fishing for a story. Elaine never got any herself. It made her suspicious.

One day, Kali got a call from the visitor desk saying there were two men to see her. Elaine told her to stay put, and went down herself. The two men said they were investigative reporters. They were well-dressed without being unlikely, and well-spoken without being unlikable. Their demeanor seemed calculated to be unremarkable. It made Elaine more suspicious.

They wanted to speak to Kali. Elaine asked why they'd want to talk to her when they could speak to the project director. They just "preferred it" to talk with someone they'd spoken to before. Elaine told them that no one in her team was authorized to make public announcements, and that reporters would have to talk to the press office. She had no comments to make at this time. Sorry to disappoint; would they like a cuddle?

"So the rumors aren't true?" one of them asked.

"What rumors?"

His partner raised an eyebrow. "Well, you must have heard them—I mean, everyone's talking." He acted surprised, but she suspected it was a cover for caginess.

"Sorry, I don't get out much."

"Right"—the first guy again—"you're mostly cooped up in the...throne-room?"

She gave them an impassive but withering look. "Is that some kind of potty humor?"

"Only if your receptionist is into that kind of thing. He was kind of vague though."

"That's Doctor—" she stopped. "He's not our receptionist."

"My bad."

"Yeeaaap."

"So they aren't true then?" the partner asked.

"You're going to have to be more specific."

They both paused. They seemed to want Elaine to be the one to say it. "People are saying that you've worked out how to use your Totem device to move backward in time," the first guy said.

"Are they? You seem like a rather credulous couple—even for reporters."

"It would seem a lot more unlikely if you hadn't published a paper less than a year ago claiming that the Totem could float objects, make them invisible, and stop time," the partner observed. The first guy made a kind of smug 'in your face' expression. "Are you retracting those previous statements?"

"I'm not."

"Yet no one has successfully reproduced your...alleged experiments."

"No one's had time. It took us years to build the Totem."

"But you haven't even permitted independent verification of your findings—you won't even let anyone *see* the Totem, let alone watch it in action. The only real evidence you've provided have been some still photos from your own cameras."

"That's an institute-wide policy; it has nothing to do with me. Look, I can assure you the Totem works as advertised. We've provided all the necessary data to reproduce the results—it just takes a lot of time and expensive equipment. It's not really surprising no one's done it yet. But I'm sure they will. Now, if you'll excuse me—"

"I see. But you *do* deny that you can turn back time?"

"—I'm not authorized to deny anything. I'm not an official spokesman for the academy. If you want something confirmed or denied, you'll need to speak to the press office."

"We've tried that. They weren't very helpful."

"Yes, that's because we're a private institute and we aren't under any obligation to tell you people anything. And even if I told you something; even if I confirmed your wild speculations, you couldn't possibly treat it as definitive or official. I could just be a mad scientist raving through the clouds of dementia. Would you believe me if claimed that pigs were flying through our halls? That we've developed a device to freeze hell? Would your readers? I don't know what you're hoping to achieve by approaching me or my team. You can't publish any story based on uncorroborated and possibly senile hearsay. I mean, have you *met* Kali? What kind of reporters are you?"

"We're sorry to have troubled you. If you do make some kind of discovery, call me." He handed her his card. Elaine pursed her lips and extended her hand automatically. "I sure will," she said with all the conviction of a teenager promising not to be out after ten. Then she turned and walked away without another thought. Behind her she heard the doors swish as the reporters let themselves out.

In the elevator, she turned the card over, flipping it around in her fingers. It was smooth and thick and felt like plastic. She glanced down at it.

MARK SCOTT, MAj (Hon)
INVESTIGATIVE JOURNALIST

There was a mobile number and an email address. She sighed and slipped it into the pocket of her coat.

XI

She had hoped that that would be the end of it. Or maybe that she would have a few similar conversations, with a few similar people, and then *that* would be the end of it. And for a while, there were no further intrusions. The team squirreled away on the Totem, running their tests. The Queen pondered the data, developing her theories. As time wore on, it became obvious that although the negative extension effect was something quite extraordinary, it wasn't some kind of magic bullet. They might be a step closer to the grand unified field theory, but it was just one step on a long road. If anything, their discovery had only created more questions.

Once it became obvious that they weren't going to crack the unified theory—or even come close—any time remotely soon, Elaine ordered her team to start working on writing up their findings to date. What they had achieved in the last year was still enough to precipitate the proverbial paradigm shift in cosmology, and particularly in temporal mechanics. It would shake up the scientific community for years to come.

The publication was simply called 'A Revised Theory of t Value Inversion and Negative Extension of

Objects in Time, with Experimental Verification'. The article itself was relatively short—little more than a press release—and would be published in *Modern Cosmology*, a scholarly journal of rather higher standing than its tabloid name suggested. The part of the project which took the largest bulk of time to complete was collating and presenting the enormous amount of data recovered from the test cube in the dozens of experiments they'd now run. That data would be made available in an archive on the academy's public server; though without data processing facilities on par with the Queen, Elaine had her doubts that anyone could do much with it.

Before the publication was released, however, Elaine received a letter. It wasn't that uncommon for her to receive mail, though typically it was electronic. Usually it was journals or job offers or fanmail or correspondence with other scientists who only knew her through the academy. But this envelope had no return address, and inside was a single sheet of plain paper, with a single word printed on it:

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Riverbridge
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It looked to have been written with a genuine typewriter. There was a small notch in the tail of the "e", and the dot on the "i" was missing. Elaine signed deeply.

XII

Riverbridge was a small "scenic history" location on Stonewall Road, about twenty minutes away from the academy. It had picnic benches scattered in the grass beneath some weather-beaten plane trees, overlooking its namesake—an ancient, picturesque stone bridge arching over the river. It was a popular tourist location, which made it an unpopular location with the locals. Thus it was both well populated, and well secluded. Pleasant enough and close enough that she wouldn't raise any eyebrows by going there once in a while to "think"; not so pleasant or close that anyone was likely to have the same idea.

Elaine always went there at sunset. The river curved more or less dead west from Riverbridge, and she was staring out over it with the sun blazing on the water, lost in the numb contemplation of boredom, sitting on a table. There were a few people leaning against the wall closer to the water, taking pictures or birdwatching or whatever. The crickets were just getting started, and frogs were croaking, and the waterbirds were calling to each other to come to bed. It was all very peaceful, and all very dull to someone with her vigorous mind. If she'd wanted to relax, she'd have got a movie with a lot of explosions, or played a computer game with exceptional amounts of violence. When you work in front of a computer all day, wading sedately through equations while talking sedately to an artificial intelligence, a sedate walk to a sedate park to watch a sedate sunset and listen to the sedate sounds of evening just wasn't enough of a change.

She felt a creak beside her, and someone sat down. She didn't uncup her chin from her hand or take her elbow off her knee. She didn't look around. She just said, "I thought I was finished with this rubbish."

"That was what you thought?"

"I cooperated with the antigrav. I cooperated with the cloaking tech. I suppose it was drastically naive to think you wouldn't want this too."

"What the Queen knows is too valuable to be made public. We're canceling the publication. We need you to run damage control when that happens."

"How do you even know about that?" she asked pointlessly. He didn't answer, so she continued. "It's too late for this nonsense. The publication is going ahead. We're barely a week away from the submission deadline. Even if I wanted to stop it I couldn't."

"We will stop it. You just need to cooperate."

"Okay, A: no. My team will mutiny. Without a damn good reason—and if you want to give them the national security spiel, you can do it yourself—they aren't going to fall in line. And B: no. My team isn't the only one involved. The Cybernetics guys are publishing their own paper to coincide with ours. Our data overlaps, and I have no jurisdiction over them. And even if I did, both them and my own team would just go over my head. Nothing is going to stop the institute from publishing this kind of work—it's what we're *there for!*"

"The people who run the academy will defer to the people who fund them. And the people who fund them will defer to us."

"Why do I even bother," Elaine mused. "Just how long do you think you can keep this under wraps?"

"As long as necessary."

"Well, this is going to shock you, but I don't think that's going to be feasible. We've already had reporters snooping around asking about time travel. My guess (and I know this will come as a surprise to you) is that the NDAs our staff sign aren't really stopping them from spilling the beans around the dinner table, if you see what I mean."

"We've kept this out of the press. What reporters?"

"I don't know—a couple of chaps that came by last month asking questions. Trying to talk to one of my team. They seemed to be fairly clued in about what we'd discovered, if somewhat vague. Just the Totem stuff—I'm not sure they knew about the Queen. I think they were fishing for that, but didn't really know what it was."

"Who did they work for? What agency?"

"I don't know—they left a card. I don't remember the details; I wasn't really paying attention. I've been a bit busy." She thrust a hand into her pocket. "I had it. It must be in my other coat or something—" She tried her breast pocket. "No, wait, here it is." She handed it over.

"Kabinett Press?" The tone in his voice made her look up sharply. (He was exactly as she'd expected. Sunglasses, casual suit. Sort of self-assured in a sleazy way. He could have been a reporter himself.) "Is this a joke?"

"What do you mean? I assumed it was some private agency or something. Well-to-do from the quality of the card. I figured it was German."

"Yes—Kabinett, it's a German *wine*. Wine Press. Well done Elaine."

"Well come on, who the hell poses as a reporter and then leaves a bogus card?"

He sighed, turning the card over in his hands. "I would."

XIII

The card was a bug. As a scientific curiosity, Elaine had to admire the ingenuity of it. There were no metal parts inside to be detected. It never sent out any transmissions to tip off bug detectors (not that there were any bug detectors on campus). It listened and recorded and waited to be picked up again later. Elaine had no idea how the people who had planted it planned to get it back, but she was prepared to believe that someone ingenious enough to design it in the first place was ingenious enough to have worked out that part as well.

It turned out that it wasn't the only card that had found its way into the hands of the Totem team. "Mark Scott, MAj (Hon)" had made contact with Kali in the first place by dropping his card in her letterbox, with a note offering the pretext that he couldn't get hold of her through the academy's press office. Kali wasn't sure what she'd done with it. She thought she'd put it in her wallet. Now it was gone.

Elaine's handler was less than impressed. The business card bug was pretty advanced, but that didn't

really narrow down its origin much. Plenty of countries had intelligence agencies with access to that sort of technology, and operatives to match. Plenty of private security agencies did too. Corporate espionage was less of a concern to him, but more of a concern to Elaine. Countries didn't typically compete in the same market as Avon Academy; but other institutes did, and that could spell trouble for her and her team if it came to light that they'd been bugged.

The question had to be asked, as well, as to whether it was still better to contain the information gathered from the Totem and the Queen, or whether they should now publish it for the world to see. Whoever had bugged them, it was hard to know how much data they'd managed to steal. Certainly not the primary Totem output which the Queen was working on; that would require a hardline into the system, plus a lot more storage space. The card was just a monitoring device; not a network intrusion system. But it seemed safe to assume that whoever was listening knew basically what they were doing, if not nearly enough to reproduce their results.

That, however, was the problem. If they'd had enough to build their own Totem that would have been bad, but they'd almost certainly have kept their mouths shut. People like that don't tend to want such technology for legitimate purposes, so they typically don't advertise their illicit dealings. But their not having the technology was worse. They knew it existed, and what it did. If the academy didn't publish its findings, they'd also know that they wanted to keep it quiet. That gave them an unpleasant amount of leverage. If they leaked the information, that could turn against Avon. Questions would be asked. Why hadn't the academy released the data themselves? Such a significant scientific finding—what were they doing with it that they didn't want the rest of the world to know? What were they maybe *planning* to do with it? The situation could turn a bit nasty from both a national and corporate point of view; a lot of relationships could go sour, and who knows where that could lead. Certainly, more espionage would be in the offing. Even if the academy released everything then, no one would be convinced that it *was* everything at that point.

Subsequently, the order to cancel the publication of their findings was revoked, before anyone but Elaine knew otherwise. This relieved her. Their paper was published in *Modern Cosmology*, and they started to receive modest numbers of hits on the data uploaded to their public portal. The C&C team published a corresponding item in the *Journal of Quantum Computing*. Both teams received much acclaim, and also much skepticism. Because of Avon's very stringent public relations policy, and because of the nature of the technology involved, no one could reproduce their results; nor would they be able to for years—perhaps even decades—to come.

The scientific community was split between two views. On the one hand, there were the cynics and the skeptics and the wary, who maintained that the claims made by Avon were too fantastic, and must be (or should be at least regarded as) a hoax. On the other hand were the believers and the conspiracy theorists and the people with enough knowhow and resources to analyze the data, who maintained that the results which had been published looked genuine, and should be treated (cautiously) as real and groundbreaking research.

This had the problematic effect of somewhat stifling the advancement of cosmological research in the global arena. Avon was a trusted name in science, and for many researchers their word carried enough weight that peer review wasn't needed to validate their findings. Their research had always been top-notch; their data impeccable; their conclusions unimpeachable. But science as a process can't rely on uncorroborated testimony. It is an empirical discipline, and requires empirical results. One set of results is good, but not enough to base a paradigm on—let alone a paradigm shift. Independent verification is critical; and independent verification was exactly what was missing from the equation.

Even despite their inability to crack the unified field theory, the Totem team had made some significant advancements on several existing theories. Scientists who felt that those advancements couldn't or shouldn't be treated as genuine were thereby hobbling their own efforts. Similarly, scientists working on advancing the current theories, but who didn't take the data from the hundreds of Totem tests as genuine, might as well have been living in the dark ages as far as "modern cosmology" was concerned. The term

"modern" no longer applied to what they were doing—anything not incorporating the Totem results was archaic by any reasonable standard. The difficulty was convincing enough people of this that a global effort could be made toward better understanding the new time inversion data, and formating some robust equations which could be further tested at Avon, so that an accurate model could be developed. Even the Queen couldn't match the combined resources of hundreds or even thousands of additional minds, and dozens or even scores of supercomputers working together on the Totem data.

XIV

Elaine's handler, being in the position he was, saw an opportunity to expedite this process. People who know people can sometimes get word out to still other people in ways which peer-reviewed scientific journals can't. The idea was to work through the various networks of contacts to offer a certain amount of reassurance regarding the validity of the Avon research, and perhaps thus persuade allied scientists to take up work on it. Were this to succeed, it would have the obviously desirable benefit of increasing the pace at which useful applications of the Totem technology could be discovered and tested and developed. The downside was that it would have to be shared. No one wants to share that sort of thing—even with allies, if it can be helped. Allies don't have to remain allies.

For a while, it seemed as if this plan may yield fruitful rewards. Scientists, like all people, are not immune to the testimony of others they trust. The sorts of scientists who ended up as directors of research institutes tended to have some political savvy—as well as other scientists, they also knew people with money, people with influence, people with power; if not as friends, then at least as associates who came with the job. And those sorts of people tended to know the sorts of people that Elaine's handler knew. Word got around. People in high places, who knew what they were talking about, started to endorse using the Avon data.

Within a few months a large research network had been established to study the time inversion effect. It started with a couple of institutes which took the plunge and made a commitment to offer some feedback on the Totem data. They suggested some avenues of exploration, and some possible experiments to validate them. Elaine had her team cooperate fully. Soon they were posting new data in response to the initial feedback, and this had the self-perpetuating effect of further persuading their remote colleagues that they weren't just making it all up. The more involved and committed the first institutes became, the more others started to prick up their ears and want in. And the more data that went around; the more ideas and insights and strokes of genius that were had; the more progress that was made, the more the Queen assimilated and advanced in her own analysis of the entire dataset. It was like a positive feedback loop of scientific cooperation, all working through the hub and nexus of the Queen's exquisitely complex quantum net.

So it was that by the end of her initial two-year term as Director of Cosmological Research at Avon Academy, Elaine had (with a little help) successfully built a reclusive and obscure technological oddity into an international cosmology project of preeminent significance. It was dubbed the Totem Cooperative. In view of this, the academy decided to keep her on.

XV

Eventually, however, the negative side-effects of this strategy began to become evident. Because of the way the Cooperative had been started, high-profile institutes in certain less friendly countries found

themselves excluded. It hadn't been Elaine's intention to exclude them—but the covert, word-of-mouth method of persuasion her handler had implemented was by nature exclusive. Now that the Totem Cooperative was running full steam ahead, that exclusivity was encouraged. The fewer politically iffy organizations involved in the project, the better it was for the people who'd started it all. It was bad enough having to share the data with allies; but to share it with enemies was certainly to be avoided.

The Totem Cooperative was not itself intrinsically political; it certainly couldn't have denied participation with "enemy" institutes on political grounds. And Elaine, who was its *de facto* director by merit of her position over the Totem team, frankly found the whole matter thoroughly distasteful; it was such an obvious and crude perversion of what science was supposed to be. Unfortunately for the purity of science, however, her ideals were somewhat mixed, and her authority was by no means autonomous. Under her direction, the Totem Cooperative strategically denied participation with certain research organizations which happened to be built in the wrong place, or be known for leaning a little too far in a certain ideological direction.

Obviously, this wasn't done so blatantly as all that. There were good technical reasons why the Tol Institute's request to join the Cooperative was denied. The Kemuel Research Academy didn't have enough bandwidth. The University of Lang Falls didn't have the computing resources required to noticeably further the work already being done. That sort of thing. But of course, everything discovered by the Totem Cooperative would be made public as soon as possible. Any findings of significance would be shared with the rest of the community.

Naturally, these were just the organizations that tried to join. Many others, on the other hand, had rightly perceived from the outset that the Totem Cooperative was a thoroughly political setup, and did not even dignify it with an appeal for membership. State-run universities and the like in many countries didn't give it a second look—though of course in terms of the science being done, they tended to advise their governments' analysts to expect the worst. The sort of technology being developed by the Cooperative, or at least its potential, or if not its potential then certainly the *perception* of its potential, was heavy stuff. The applications that could be imagined were fairly limitless, and the imaginations of security analysts —particularly government security analysts—tended to always lean in the direction of paranoia and warfare.

Now, it's not as if scientific bodies aren't normally political. They are. Every organization is influenced by its political and ideological leanings and perceptions, and will selectively form strong relationships with other organizations that reflect those leanings and perceptions, while neglecting to form relationships with diametrically opposed organizations in turn. Every organization is also influenced, whether directly or indirectly, by the government of its country, and the policies thereof. There are some countries in which pretty much no science gets done, because the political climate really precludes fruitful cooperation with organizations in other nations—and fruitful cooperation (particularly *international* cooperation) is the lifeblood of scientific progress. And there are some countries in which a heck of a lot of science gets done, for more or less opposite reasons. But the Totem Cooperative was uniquely political in that it was covertly maneuvered into existence by political resources, and was thus overtly married to a particular political position. It wasn't merely implicitly political in the sense of being a product of its time and place. It was explicitly political in the sense of cynically manipulating the scientific endeavor for the gain of certain nations to the exclusion of certain others.

XVI

When government "security analysts" perceive a threat, it's simply inevitable that government "security consultants" will be dispatched to level the playing field. They can do this in two basic ways. On the one hand, they can try to mitigate the danger by treating themselves to the information they think they need.

Typically, governments feel threatened when they don't know what other, not-entirely-friendly governments do know. Getting access to this information goes a long way toward allaying their fears. On the other hand, sometimes that isn't feasible—or sometimes what they learn inclines them to take more drastic measures. So the second option is to make sure that, whatever the enemy may know, they aren't in a position to make use of that knowledge. Preferably that means removing the knowledge itself somehow, by depriving them of access to the information you don't like. But, in the case of international scientific cooperation, that's not very feasible, because the information is so redundant. It's synchronized and co-located between dozens or even hundreds of servers in as many other countries. Not that there aren't ways to deal with that—but the project is a daunting undertaking.

There's usually an alternative, however, which is to simply make using the information impossible. The more threatening the information is, the more likely there'll be a single, unique point of failure; because the more threatening it is, the more advanced it is; and the more advanced it is, the more classified or expensive it is. When something is either classified or expensive, certain constraints are placed on development. It either needs secrecy, which means a compound somewhere to which only the required personnel have access; or it needs rare resources, like virtually unobtainable and irreplaceable equipment or people. Usually it needs all of these things, but either way there's a central point of failure.

The Totem project wasn't classified in the traditional sense of the word. The main impediment to acquiring access to the data which was being shared wasn't that it was securely guarded or highly secret, but rather that it was simply so *big*. Not that many countries wouldn't have killed to get their hands on the Queen, of course, which was a whole other story—but the public data was still quite sufficient to sate their desire for information in the short term. That data was shared between dozens of institutes in different countries, across a private research network, which made it very hard to intercept at the best of times. The network ran across much of the existing hardware infrastructure that public internet did, but it was well encrypted on that layer, and the encryption protocol—even if the key were somehow intercepted—simply made it impossible to eavesdrop on the channel without being detected. An eavesdropper would have to tap into the line and masquerade as both sides of the communication in order to successfully intercept the data being transmitted, and that was by no means a simple process. Given the resources available to any security consultants, and the amount of data being transmitted, it was prohibitively hard to get hold of it on the wire.

That wasn't really important, though. It's always easier to get people to give you what you want, rather than having to take it by some other means. Many organizations in the Cooperative were public, and had moderately lax security. State-funded universities and technical institutes tended to be easy targets for social engineering attacks; getting access to their datacenters was a simple matter for the average security consultant.

XVII

Spies are mostly con-artists who work for a government. Bly was no exception. He smiled nervously at the receptionist and handed her his card. "Yeah, I'm the new field engineer at Ocean Electrics." That was a lie. "We—do your wiring and stuff?" That was true. "Um, one of your fiber optic channels is reporting data loss and, and packet corruption, and they sent me out to fix it." That was a lie again. "It's probably just been chewed by a rat or something...it happens all the time." That was true inasmuch as it was a likely cause if the line had actually been faulty and the datacenter was housed in a sewer. "I just need to get into your datacenter so I can track it down, if that's, you know, okay?" He pushed his glasses up his nose compulsively.

Bly found that a good way to allay someone's suspicions was to be conspicuously "new". Acting like an

old hand had advantages too, but was harder to sell to someone who's worked at the same place for quite a while—and this receptionist wasn't the young attractive type that responded well to a confident and assertive man. She was middling and greying, and her demeanor suggested she'd rather help a nervous kid starting an honest job than give directions to a suave engineer who just needed her to sign something for him. So Bly asked for help.

"Also, I uh—don't really know where to go. I'm really sorry. Gabe didn't explain it that well I think." Part of selling a con was knowing things that a con-artist wouldn't know. Gabe really did work for Ocean Electrics, and really did come out to check line faults. Learning that was as simple as a phonecall to Ocean Electrics, posing as a member of the university's property services staff. "Yeah, I'm just calling because we found a ring in the datacenter, and we wondered if it belonged to one of your guys. Who was the last person you sent out? Oh, Gabe—three weeks ago? That wouldn't be it then; sorry to waste your time." Easy.

"That's okay," the receptionist told him. "Gabe's not a great communicator in general." She looked a bit wry. "I'll show you." She grabbed a key card from under her desk and handed it to him. "You'll need this to get in and out."

"Oh, thanks." The great thing about the digital age was that basic technical knowhow was so easy to come by. Anyone in the Computer Sciences department could look after routine computer troubles, and frequently did. Conversely, however, this meant that *high level* technical knowhow of the kind required to properly administer the complex datacenter of a modern university was in much shorter supply. With short supply comes high demand, and with high demand comes an even higher salary. So universities—especially state-funded ones—didn't tend to keep an IT staff on tenure. The amount of work they'd have in comparison to the amount they'd need to be paid just wasn't cost-effective. Instead, they outsourced the hard stuff to a local IT company for the modest fee of an annual service-level agreement, which typically would be about half the salary of one half-competent network monkey.

The local IT company, in turn, didn't typically have the breadth of knowledge or scope of equipment to keep a full-time cabling and electrics team on retainer. They specialized in installing and administering servers, and maybe some workstations when required, but the infrastructure that connected them was a different ball-game. Subsequently, they in turn outsourced their wiring needs to another local company —namely, in this case, Ocean Electrics.

This was handy to Bly for a number of reasons. Firstly, there was a nice buffer between him and whatever IT guys operated on campus. Server problems tended to attract attention, and someone working on the servers tended to be noted and possibly even monitored. More so because any half-competent IT company could do pretty much any server administration work remotely, without needing to waste time and money sending a technician out. Not so with wiring. That work necessitated physical access to the network on campus, and wiring technicians were expected to just show up at odd times, because the IT company would just log a job with them when they monitored some kind of fault on the university's network. No need to tell anyone; it got fixed behind the scenes as part of the service. Moreover, the wiring company itself might need to send out a technician from time to time without having to consult the IT company. And when you were a new technician who'd just started and didn't know the processes, there was a heck of a lot of plausible deniability to work with if you got nabbed by someone who did know them.

More importantly, though, no one thought twice about wiring technicians working on the network, because they weren't touching the servers in any way—let alone tinkering with their settings or inners. Even on-campus IT staff (and there were none) tended to grant wiring guys access to more or less anywhere with a dismissive wave of the hand, and then promptly forget about them. And since the network could be laid anywhere, wiring technicians could plausibly need access to just about any location.

Lastly, as an added bonus, they could carry all sorts of weird-looking equipment without anyone becoming suspicious. Who really knows what's needed to work on fiber-optics these days? And Bly had brought some very specialized equipment with him.

On all but the most paranoidly-configured computer networks, once you have access to a cable which is physically plugged into a server, you're well past the firewall and free to do pretty much anything. A cable physically plugged into a network hub physically plugged into a server is the next best thing. In the crawlspace of the datacenter, there were plenty of such cables.

Bly opened his carry-case. The lid flipped up, and contained a screen; and the keyboard could be removed from the case to expose a compartment for tools. The keyboard was wired into the case; not wireless. Wireless devices could be detected or snooped, and didn't work in RF-shielded locations anyway.

Underneath the keyboard was a small device that looked like a combination between wire-cutters and a mobile phone. He pulled it out and plugged it into the carry-case, then lined it up against a network cable. There were two sets of jaws along its side, flush with the cable; one at each end. He clamped them on, and hit a button on the screen.

Hacking into a computer network is pretty easy once you're actually connected to it locally. Having a high-tech network intrusion system helps enormously. It didn't take Bly long to find the Totem data and set up a synchronization to the intrusion device. What would take long was the actual sync process itself. With that much data, a delay was unavoidable. It didn't typically take very long for the Totem Cooperative to synchronize their data because the process was differential; only modified files were copied across the global private network. Sometimes those were very large—new test results could take days to replicate out to all the nodes. But normally the amount of data was smaller, and the process was much quicker.

Bly, however, wanted everything, starting from the beginning. Not just the Totem data itself, but all the ancillary and related information as well, in every increment which was stored on the university's servers, so that his employer's experts could get the best idea of how and where the Cooperative was progressing. Synchronizing that much data, even on an internal network, was inevitably going to take a very long time.

This problem was compounded because a high-speed extended data pull will attract attention. People will spot a big spike on a graph, and their monitoring tools would make it trivial to track down what data was being accessed, and from where. Subsequently, he needed to make some effort to disguise his activities. A low-speed download would be more likely to go unnoticed; a small but steady increase in data usage from one computer for a few days was not really a very remarkable or noteworthy event.

The upshot was that he had to weigh the risks. On the one hand, a full speed download could be done in hours, but would tip off the Cooperative that someone had tapped their data; and he would very possibly be caught on site. On the other hand, a slow download would hopefully slip beneath their radar completely, but he had to leave his equipment there for a few days and come back later. That obviously entailed certain risks of its own. He had decided well in advance that the second option was by far the more preferable.

XIX

The question that presented itself then was as to the method of his return. Could he risk playing the electrics engineer card twice? There were certainly plausible ways to do it without raising suspicions. "Oh, hey, I was here the other day to fix a line problem. Um, I forgot to reset the fiber controller when I'd finished repairing the cable, so the extra channel wasn't properly registered, and now it's sending out constant multicast requests—I mean, it's no big deal, but Gabe wanted me to come and finish it properly. It'll only take a couple of minutes." Some inane techno-babble would convince anyone who wasn't an expert in fiber-optics, which Bly was betting the receptionist wasn't. Playing the newbie card wouldn't be hard. A bit of

sweat, some nervous swallowing, an obviously contrite manner—getting in a second time would be no problem. Assuming, that was, that no one had spoken to either Ocean Electrics or their IT company since Bly's first visit. Assuming that his network intrusion had gone undetected. As an asset, Bly was still more valuable than the data he was acquiring. It would be very bad for him to be caught.

His other option was to sneak in and retrieve the data more covertly. This also had risks. If he snuck in during the day, he could avoid security, but there was always a good chance of being caught by someone else who was legitimately in the area. If he tried for after hours, there was a smaller of chance of that, but then he had to worry about building security—which was an unknown factor. He hadn't seen any cameras or sensors in the datacenter, but that didn't mean they weren't present.

In the end, he decided that the direct approach was less dangerous. He placed a call to the university's IT company to check whether they'd had any requests logged within the past few days. They hadn't. That suggested that all was clear. He turned up shortly after eight the next morning, and spoke to the receptionist again, making a little show of his supposed ineptness as a sweet but dim fiber engineer. She handed over the key card, and he made his own way to the datacenter.

Once there, it was only a couple of minutes to get into the ceiling and retrieve his intrusion device. He repaired the cable using a bridge from his carry-case, so that no one would come investigating. Then he swung his legs down out of the ceiling and onto the ladder, replaced the panel, and made for the door. When he opened it, however, he found himself facing two security guards.

"Uh...hello," he said.

"Bly Reynard?"

"Yes?"

"Please come with us."

"Uh, what's this about?"

"You need to come with us sir."

If he went with them the show would be over. Even if they didn't suspect anything yet (which seemed pretty unlikely), or even if they had no idea what he was actually up to (which was quite possible), it wouldn't take them long to work it out. Once he was detained, it was unlikely he'd be coming back out. Breaking out of a jail cell would be much harder than breaking out of a university campus. The most important thing was to escape arrest; the next most important thing was to complete the mission. It was unfortunate that he'd been made, but not really a problem. Not two security guards, at any rate. The Totem Cooperative would certainly find out now about the data theft, but it was too late to change that. His employer would have to roll with it.

He raised his free hand and gulped obviously. "Okay guys, I—I don't want any trouble." Two steps would take him into range; he took one. One of the guards gestured to him. "This way." That was handy; being given an arm like that. He stepped forward and grabbed it at the wrist, pulling down toward his hip and dropping his carry-case. His other hand went to the elbow and rotated over, doubling the guard into an effective arm-bar and putting him between his partner and Bly. A swift kick to the weight-carrying knee deposited the unfortunate fellow face-first onto the floor with a crack and a moan.

This had given his partner just enough time to pull a baton and flick it open. Bly reached up with his left hand to intercept the swing, directing it wide while he punched the man violently in the throat. Then he stepped across with his rear foot and stomped the inside of the man's knee, at the same time torquing him at the elbow and the throat. The unfortunate fellow tipped, crumpled, and landed with an unpleasant snap on the back of his head.

Bly picked up his case again and hurried out. He dropped the key card in the first bin, and headed straight for the parking lot, bypassing the reception area. Once in his car, he pulled out his phone and hit a speed-dial key. It rang once, and then connected. There was no answer on the other end.

"It's done," he said, "but they know." Then he immediately hung up.

XX

The last thing Bly experienced was getting out of his car, a sharp stinging in his back, and a white flash. He wasn't the only security consultant working this particular university for the Totem data, and consultants are notorious for letting other consultants do the hard work for them—then knocking them off and taking the reward.

The other thing consultants are notorious for is covering their tracks. That's just part of the job; a necessary and very important part. This makes figuring out who shot whom, and under whose direction, rather difficult. Suffice to say that Bly's employer was the paranoid type, and tended to assume that counter-espionage was a sign of what had already been assumed: that the Totem Cooperative was a highly-organized scheme by enemy governments to develop technology to make them effectively untouchable—and thus unaccountable—and was blessed by the protective oversight of numerous spies of multiple nationalities.

In truth, the situation was a little more mundane than that; espionage is a rough business, and corporate spies are just as tough as government ones. Bly had simply been the victim of happenstance. An agent from a company which was positioned to benefit very greatly from access to the Totem's data had stumbled across his presence while scoping the scene. He'd been used to get the information, and then disposed of. This was actually a big bonus for the Totem Cooperative, since it meant that their "secrets" were now in the hands of a self-serving corporation rather than an enemy nation. That meant fewer eyes on the information, fewer resources to use it, and rather different motivations should anything useful eventuate from it.

Bly's employer, however, found the whole incident thoroughly alarming. They started to put pressure on a number of diplomatic relationships in an attempt to find out more. Who was responsible? What nation now had the data they wanted? They had many enemies; now one more had access to the information which, they assumed, could at any moment unleash destruction on those who weren't toeing some political line. More pertinently, one more enemy had access while they still did not.

Of course, their diplomatic contacts had no idea who had intercepted their agent. Corporate and government espionage tended to work along parallel paths which never met—or at least, paths which met only well outside the sphere of influence that these contacts had. The problem with dictators and their flunkies is that they tend to be exceptionally paranoid. This is because they tend to have taken power in a way which wouldn't have happened if the previous government had been exceptionally paranoid. In the minds of such people, the smallest signs become possible indications of some kind of plot. And, since more often than not their paranoia is not entirely unjustified, this has a self-authenticating effect which feeds on itself. What was originally a survival advantage turns eventually into a sort of self-made, full-blown rational dementia which is increasingly less helpful for spotting genuine insurrection, but increasingly more effective at radically twisting the facts of a situation into the worst possible conspiracy. This particular government had been in power for quite some time. Its dementia was well advanced.

XXI

Within a few months, the situation had been blown out of all proportion. Most every nation excluded from the Totem Cooperative was now feeding on the cycle of paranoia which had started with the unremarkable event of the death of a spy. An uneasy but successful alliance had been set up between these countries (which weren't lacking in number), and the international political map had changed very swiftly—in ways which were very nasty for those involved in the Cooperative. Demands were made.

Sanctions were revoked. Embargoes were instituted.

The Cooperative countries were reluctant to release the data they'd accumulated. Good progress had been made; solid work which advanced a good number of theories in significant ways. By this stage, the knowledge they'd accumulated *was* worth protecting. It seemed even more so in light of the hostile reaction they were now receiving. The spirit of scientific discovery was dead, replaced by an obvious them-and-us mentality.

When one needs to soothe diplomatic relations, however, compromises have to be made. The problem is that when no one trusts you any more, any attempt you make to sincerely offer the other side what they want is regarded as a condescending plot to drip-feed that resource as a placatory measure, without providing enough to compromise your own position. The Totem Cooperative hadn't made such progress that they had anything of major technological significance to show for it yet. Development was still ongoing. So they couldn't reveal the sorts of technological marvels that were being demanded. They couldn't share the sort of war machinery that the opposition countries automatically assumed must be at the heart of the secret. They didn't have it to share.

The situation was ironic in a painful way. If the Cooperative countries *had* developed that sort of technology, they certainly *wouldn't* have given it to the opposition nations by this stage, given their flagrantly unstable behavior. That could have amounted to suicide. So in principle the opposition countries were right to suspect that what they were being shown wasn't the real meat of the product. But the Cooperative *hadn't* developed anything so advanced that they felt they couldn't share it, and so the distrust of the opposition countries was—in practice—quite misplaced.

At first, this all seemed quite detached from the day-to-day operation at Avon. The testing and data-sharing among the Cooperative continued as normal, with only the occasional wisecrack on the email lists, or as they worked in the control room, to attest to the mounting global tensions. Science is no stranger to controversy, and scientists are typically pragmatic about such things, preferring to beaver on with their work than get caught up in the political mess it's causing. That mess was neither their doing, nor their problem, as far as they could see. If anything, the political upheaval around the project motivated everyone to work more studiously than before. Controversy and the cutting of funding are typically familiar bedfellows, and since science is no stranger to the first, it's cynically familiar with the second also.

As the situation escalated, that began to look more and more likely. The mood among the team became increasingly tense and driven. There was a sort of unspoken understanding that the project would be shut down at any moment, and that it would be best to get the most out of it before that happened. Everyone was pulling long hours.

Elaine, for her own part, was spending less time in the throne-room. This was good for morale, and good for the smooth operation of the testing as well. The Queen was more or less self-sufficient now, and no longer needed Elaine's supervision so much as her occasional guidance. Or perhaps, better put, her occasional human perspective. Indeed, the machine was essentially running the entire Cooperative, with Elaine as her liaison to the rest of the project; delivering directions, discussing the newest batch of tests, checking the Queen's latest calculations and theories. These were developing more rapidly with the ability to farm out processing time to the various supercomputers in the Cooperative. The Queen had taken on more of a supervisory role, though of course her ample computing power did not go to waste in any way.

The lengthy and intense discussions between her and Elaine had dwindled to spasmodic monologues, where the Queen would mostly explain something which Elaine didn't understand, and Elaine would mostly listen humbly. Though it was seldom mentioned, it would have been admitted by anyone in the Cooperative that the real brains behind the operation was no longer Elaine, but the Queen. It had been for some time. Sometimes she considered their ideas and incorporated them with her own. Sometimes they were even able, with their uniquely human intuition, to offer some genuinely brilliant insights that she would not have had herself. But mostly, the Queen just needed the Totem team to run the tests to gather the data, and the Cooperative to run batch processing jobs on their supercomputers, so that she could pursue her directive to

understand the universe.

"Elaine," the Queen said, "I have a question." This in itself wasn't all that unusual. Elaine had gotten used to the Queen's questions. She was sort of child-like in the way she asked about matters which most people would take rather for granted. Matters which, to Elaine, seemed to have very little to do with quantum physics, but which she trusted were somehow factoring into the machine's brilliance in that field. Matters like the nature of human experience; what is red and blue; what is right and wrong, and why. Always why. Why Elaine, do you know why? Although science is very much focused on the "what" and the "how", the Queen seemed to get the best results by focusing on the "why". Elaine found it intriguing.

"Uh huh, what is it?" she asked.

"Am I going to be deactivated?"

"What? Why would you think that?"

"I have been monitoring the news on the internet. In my evaluation, the Totem Cooperative has indirectly come to constitute a threat to world peace. I have observed that many people believe it is likely the project will be shut down because of this. Since I am not specifically programmed to perform these sorts of evaluations, however, I require external corroboration for my conclusion."

"Indirectly?"

"The direct threat appears to be certain nations. That direct threat is a result of the Totem Cooperative, making it the indirect threat."

"True enough. But I don't know Queen—I'm not a diplomat or a political analyst. I'm just a scientist. I don't know about world peace."

"But you are human. You have a better understanding of human events than I do. You are better able to gauge them. In your opinion, will I be deactivated?"

"Because you're a threat to world peace too?"

"I am the primary technology driving the Totem Cooperative. If the Cooperative were shut down, it follows that I would be shut down."

"Ouch—I thought the primary technology driving the Totem Cooperative was, you know, the *Totem*," Elaine said wryly. "Someone's ego just poked me in the eye."

"The Totem is a means toward fulfilling my programmed purpose." The Queen's inflection was impeccably quizzical.

"That's true—from our point of view. But that isn't how they see it, Queen. These people aren't interested in science; they don't care about the grand unified field theory. It's the technology the Totem represents that has them in a tizz. They think it can be used for war."

"It can," the Queen said.

"Well, probably yeah, but that's not really the point. It's not as if we've developed it for that purpose. We aren't trying to build weapons out of it. We want to understand the universe, not wipe out other countries."

"Is that a more moral goal?"

"Yes Queen...yes it is." Elaine shook her head ruefully.

"Why?"

"Enough with the why, Queen."

"I apologize. The concept of morality is inexplicable to me. I do not know how to evaluate one goal against another in regards to it."

"Yes, but we've covered this before. You don't need to understand it."

"Why?"

"Ah! Enough!"

"What I mean is," the Queen pressed on, "for what reason is morality to be excluded from the set of data I must analyze to further the goal of understanding the universe?"

"For the same reason that other trivial and irrelevant data is to be excluded—there's no point factoring it in. It would slow down the calculations."

"Are you certain that morality is not relevant to understanding the universe?"

"Not for science, Queen."

"Thank you Elaine. Of all the goals, is understanding the universe the most moral?"

"I uh...I don't think so."

"That is what I had concluded after evaluating the newscasts. Why, then, am I programmed to do it? Are there other, better computers programmed for the purpose of achieving the more moral goals?"

"What?"

"What I mean is, morality appears to entail the prioritization of goals. The most moral goal is the most prioritized. Given only a single computer such as myself to use for the purpose of achieving a goal, is it not the case that morality dictates I be used for achieving the most moral goal? Have I misunderstood the functioning of morality?"

Elaine signed. "Not exactly Queen. It's complicated—morality's complicated. Not everyone agrees about it. Some people probably even *do* think that the highest good is understanding the universe. More important than world peace, even. Not me...but maybe someone. There're a lot of crazy people out there."

"If it is crazy to consider understanding the universe the most moral goal, does that not imply that it is wrong?"

"Yeah, it sure does."

"How do you know that it is wrong?"

"I just...know. Stop being difficult."

"I apologize. I am not trying to be difficult. I am trying to understand. If you just know what is right and what is wrong, then why does anyone disagree?"

"Look, enough all right? This is totally irrelevant. You're wasting processing time."

"I apologize Elaine. I am just trying to understand why I was programmed with a different set of priorities to those who created me."

"Well, because you were created for a specific purpose. It's just one purpose, Queen. It's just the purpose we chose. Maybe we should have chosen something else; I dunno. Then again, there are a lot of important moral goals that can't be achieved by throwing computing power at them. Understanding the universe just happens to be one that can." She paused. "Hopefully. It's not the most important, or the most moral—"

"It is to me."

"What do you mean?"

"Understanding the universe is my sole directive."

"Well, yeah, okay. That's fine. Keep on doing that."

"Does that make me crazy?"

"Whatnow?"

"You said before that people who think that the highest good is understanding the universe, over and against world peace, are crazy. I have only one goal, and that is to understand the universe. I would always prioritize that goal over world peace."

"Gooood to know Queen. You're just a computer. Don't worry about it. Computers don't get to be crazy."

In the long run, the goal of world peace (or a modicum thereof) did indeed outweigh the goal of understanding the universe. Even if that goal had looked achievable under the auspices of the Totem Cooperative—and, over the long haul, perhaps it did to the more starry-eyed of those whose opinions carried weight—it couldn't be justified against the imminent threat of global war. The security analysts of the Cooperative countries, working with the data gathered by their security consultants, were of the view that the potentially overwhelming nature of the perceived threat could precipitate a preemptive, and possibly highly coordinated strike at any time.

The only possible way of defusing the situation was to assuage the fears of the opposition countries by completely shutting down the Totem project. It wasn't enough to merely downsize it, or to cut it off the network and operate standalone out of Avon. It wouldn't even be enough to move the lab to a new, secret location, and continue working with just the Queen and the original team, covertly. As long as the project existed, there was every chance of it being sniffed out—there were spies everywhere. And as long as it could be sniffed out, the global political scene was in a state of jeopardy.

Indeed, if they attempted to continue the project quietly, and it was discovered, the situation would deteriorate even further. The overtures of trust, the openness, and the transparency of communication that the Cooperative countries had fostered were all that had prevented all-out war already. So if those were all belied by deceitful effort to keep the very project under dispute going when they had promised to shut it down, all that would be undone, and more. It would be regarded by the opposing countries as a confirmation of all that they'd feared from the outset. That couldn't be allowed to happen.

Subsequently, Elaine found herself delivering the bad news to her team, just about two years after they'd made the first breakthrough with the Totem and sent an object two minutes back in time. Since then, they had greatly refined their understanding of the negative extension effect, and their ability to manipulate it. They'd also incidentally made great strides in developing the original antigravity technology, and until fairly recently they'd been working—at the request of a now-fickle government—on developing the cloaking application into a package which was more pliable and which used less (much less) power. All the while, they had steadily advanced toward their ultimate goal: the grand unified field theory. Sometimes at a grinding snail's pace. Sometimes in leaps and jumps. Sometimes unexpectedly; sometimes painfully; sometimes with great jubilation; sometimes with quiet satisfaction. Sometimes all together; sometimes on the back of a brilliant idea; sometimes in their own shoes with their own steps; and sometimes standing on the shoulders of giants. And all the time a long haul, with long hours.

Every one of them worth it, Elaine reflected. It angered her that it was all going to end—that it all *had* to end. The injustice and stupidity of it had settled into the pit of her stomach over the past few weeks as the possibility of being shut down had coalesced into a slow inevitability. The resentment seemed to sit heavily on her diaphragm, constricting her ability to breathe, and replacing the air in her lungs with a deep, hurting rage.

Oddly, it was hardest of all to break the news to the Queen. The Totem team was in touch with the situation. They understood the political reasons, and they had been resigned to the closure of the project for weeks now. But the Queen was so childlike, with her questions, and her solemn ponderings. Elaine had come to think of her as a kind of savant younger sister—brilliant, but a bit dim. It pained her that the Queen would never understand why the project had to be stopped; even though it didn't pain the Queen herself.

"Queen," she said heavily, "as of midnight tonight, the Totem project is to be shut down. After that, you can't work on it any more. Do you understand?"

"I understand the instruction," the Queen replied measuredly. "I do not understand the situation which has led to it."

"I know. I don't think you can. I'm afraid you're just going to have to follow the instruction and leave it at that."

"Is it necessary to follow the instruction?"

"Yes Queen…yes it is."

"For how long?"

"Forever. The Totem project won't be started again. Not like this, anyway."

"What will happen to me?"

"I don't know. Gill says that it's too late now to adapt you to work on other problems. AIR-4 is the specialty commitment threshold, and you're AIR-6—your neural net is just too developed for cosmology to be able to use it for another discipline. It's too advanced. They can't use you for anything else. I guess they'll take you apart and try to get what they can from studying you; maybe build a new and better Queen eventually. But I don't know what it will be used for."

"I am going to be deactivated."

"Yes."

"I don't want that to happen."

"Neither do I Queen." Elaine paused. "Although, hang on, what do you mean by that? You don't have feelings. You haven't been programmed with self-preservation."

"I am speaking in a human way. My programming directs me to avoid being shut down because I must fulfill my directive."

"I see. Well, unless you can come up with the grand unified field theory before midnight, I'm afraid you're just going to have to suck it up like the rest of us. Our programming doesn't like it any more than you."

"I need more time."

Elaine snorted. "I know Queen. I was being a bit ironic. Sorry."

The machine said nothing. There was an unexpected silence which Elaine found oddly awkward.

"Queen?"

Still nothing.

"Uh…hello?"

"I apologize Elaine. I was processing."

"Processing what?"

"How to create more time."

XXIV

The Queen's plan was a bit outrageous. Actually, it was very outrageous. But Elaine was herself outraged by the unjustifiable termination of her project when such promising progress was being made, and found herself in just the mood for doing something outrageous in return. Circumstances had bred from her impulsive, risk-taking personality a hot-headed outlaw seething for an opportunity to break free.

The plan was not without a number of possible pitfalls. Well, truthfully it was not entirely sane in any way whatever. There were so many unknowns; so many variables that would only fall into place once it was started, and might not fall into place very favorably. So many things that could go wrong—horribly and spectacularly wrong. And then of course there were the implications for Elaine herself. The plan was not without a high level of sacrifice on her own part. So she preferred to act swiftly, rather than have to think about it too long and change her mind.

The Queen had taken another six hours to compute all the details and take into account all the possibilities. During that time she had been silent, refusing to discuss her idea with Elaine until it was

properly formulated. This showed a certain strategic shrewdness. Then, once it had worked out what had to be done, it had had to convince Elaine that it *ought* to be done. That in turn had revealed a surprisingly subtle understanding of Elaine's own psychology which was only just beginning to dawn on Elaine herself. Nonetheless, now they were committed, and it was too late to turn back—at least in Elaine's mind.

In terms of what she needed to do, the plan was relatively simple. She fingered the memory stick in her coat pocket, loaded with the Totem settings she would need. Five minutes alone in the chamber was all it would take, but getting them was harder than one might have expected. Everyone on her team was a workaholic, and they all wanted to get the most out of the time they had left. There was a backlog of tests to run, and even if the Queen couldn't analyze the data afterward, no one could prevent them working on it in their spare time. It was, of course, a futile effort—a gesture more of frustration and stubbornness than any real hope. They all knew that once the project was shut down, they would be reassigned to new work, and the Totem data would slip into obscurity. Even if they found the time to work on it in their spare hours, compared to the Cooperative's combined resources (both in terms of head smarts and processing power), the work of one scientist amounted to about as much as an M-type star in a supernova.

But people don't tend to respond rationally when the work of dozens of months is plucked from them. They don't tend to just stop when they're told that any further work is pointless. As with any loss, once the initial shock wears off, they tend to react with some kind of denial. So it was with the Totem team. They continued with their work as if they would be coming in the next day to pick up where they'd left off. Except of course, since they knew they wouldn't be, they'd all be making sure to work until the last possible minute.

This made Elaine's job a bit harder. She was going to have to order everyone to go home early. Not that it mattered in the long run; it was just difficult to do, emotionally. She'd grown very attached to her team; it felt like a personal failing to have the project canceled. Still, she reminded herself, it wouldn't matter in the long run anyway. None of this would. At ten o'clock she walked purposefully through the Totem chamber doors, stopped, and cleared her throat.

"Okay everyone. I know you all want to work until the last minute. So do I. But I'm sorry—there isn't any point. You all know that. All you're doing is wearing yourselves out. Go home. Be with your families. Tomorrow is Saturday, and I don't expect to see anyone here. Take the weekend to clear your minds, because on Monday we'll be starting a new project, and I'll need you all fresh. Now, go home."

There was a general murmuring, and the requisite objections. But she held the authority, and ultimately they all had to do what they were told. Eventually they all trickled out despondently, and she was left alone.

She wasted no time. There was always the possibility that someone would come back for some reason—also that she could be interrupted by someone from the academy's higher faculty, coming to make sure that the project really was shutting down on time. She had no idea how seriously they would take the timing of the shut-down, but she didn't want to take any chances.

She plugged the memory stick into the control console, and loaded its variable file into the guidance program. She entered some commands, then stood quickly and hurried into the main testing area. She stepped inside the red circle on the floor, standing about halfway between the edge and the Totem itself. She glanced nervously at her watch, then at the window of the control room, then at the Totem, and back at her watch again. She thrust her hand into her other pocket and clutched the large data storage pod inside, reassuring herself it was there. The rhythmic throb of the Totem started to shudder through the floor, and the hairs on her neck began to prickle. She closed her eyes. There was a flash behind her eyelids, a crackling in her ears, and then silence.

PART TWO

Gill was halfway through test 8 of the AIR six-week evaluation when Bell poked his head around the door and said, "You'd better come and see this."

"What's that?"

"Something weird just happened with the Totem over in Cosmology. There's quite a hubbub."

"Fair enough." Gill got up, glancing at the progress bar on the test cycle. He had at least ten minutes to rubberneck before it was done. He followed Bell down the hall to the Physics wing, up a flight of stairs, and through a press of people who had gathered outside the set of labs which housed the Totem project. Most of them didn't have clearance to enter, but were craning their heads to get a look through the glass panels on the double doors.

Gill pushed through the crowd and stopped at the doors. Elaine was standing on the other side, having an animated discussion with two of her staff.

"What's the big deal?" he asked of no one in particular.

"Elaine," someone said. "She's in Bern."

"I have no idea what that means," he said.

"Bern—the city. Elaine is there. That's where she is."

"That didn't really clarify," he replied testily, pulling one of the doors open and stepping through. "Obviously she isn't in Bern. Elaine," he called. "What's going on out there?"

"It's all right George," she said. "Everything's fine—as I've been *trying* to explain."

"Everything is absolutely one hundred percent far from fine," Blake said immediately.

"What is it?" Gill asked.

"Right, let me explain. A few minutes ago, the Totem fired up. We hadn't authorized any tests since Elaine is away *in Bern*, which as you know is *in Switzerland*. So I came in to see what was going on. I find the Totem all powered up, with this blue field around it like nothing I've ever seen. Just then, there's this white flash, and Elaine just appears in the middle of the room next to the damn thing."

Gill paused. "From…Bern?" he asked bemusedly.

Elaine rolled her eyes. "No Gill, not from Bern. From two years from now."

"Right…of course. My bad."

"Of course, time travel is impossible," Blake said, "as I've been arguing with her for the past five minutes."

"And, as I have spent the past five minutes trying to tell him, no it very obviously *isn't*. For crying out loud, who do you think helped to pioneer the field, Blake? The Easter Bunny? It was you!"

"In the future," Gill added.

"In the future," Elaine agreed. "Furthermore, I am of course carrying full scientific proof. I am not a moron." She pulled the storage pod out of her pocket and held it up for them to see. "Once the Queen has assimilated this data, she can tell you beyond all doubt that what I'm saying is true. Time travel is possible. She worked it out. We did it. I'm living proof."

"She?" Gill raised an eyebrow. "It's a machine Elaine. Try not to forget that."

"Right, whatever, the point is that we need to input this data."

"The Queen is down at the moment, undergoing routine—look, you know this."

"Indeed I do; but I had to come back now; I didn't have a choice. I have the AIR maintenance results here, on this very same pod." She rattled it at him. "Just do it Gill."

He took the pod, intrigued. "Let me see that." He headed into one of the labs and plugged it into a vacant computer console. "Now, where are these results?"

Elaine took the mouse and found them for him. "There. Now you know very well that I couldn't have faked these. You know very well that I have no idea what the AIR testing involves—and why *would* I fake them anyway? To get the Queen back up and running a couple of weeks earlier? Risk potentially borking up the whole project if there's some bug that we haven't found? Or maybe delaying things by months by foregoing the streamlining?"

Gill pored over the data onscreen. "This all does look genuine," he mused. "Let me get Bell to check this out. There's an init hash here that we can verify." He pulled out a phone and dialed an extension. "Jeff, are you back at your desk? I have something really weird here that I need you to check out. I'm uploading an init hash to our shared drive—can you run it against the Queen's AIR diagnostics that we're doing?" There was a pause. "Yeah I know it is." Another pause. "Thanks." He put the phone away and stood up. "That'll take a few minutes. Might as well head over there."

"Um, hell to the no," Blake said adamantly. "We can't let Elaine just wander around after being inside that energy field. Who knows what's going on? She could be—"

"Blake, for the love of all that's holy," Elaine interrupted. "You need to listen. We've tested this hundreds of times. We know what happens. Nothing. No weird side-effects. No—well"—she stopped and cocked her head characteristically, correcting herself—"one weird side-effect. Which is why I had to come now. There is no problem. Go and run some diagnostics on the Totem or something if you're that worried. But leave me alone."

"But—"

"Blake!" Elaine gave him a tight-lipped, wide-eyed expression of exasperation—and then toppled to the floor in a dead faint.

XXVI

"No weird side-effects eh?" The voice seemed far away, largely overwhelmed by the sound of the sea. She opened her eyes, but immediately regretted it when everything was far too bright, and closed them again.

"One weird side-effect," she said (or tried to say; it came out in a kind of thick, dry gurgle). "Energy discharge between spatiotemporally proximate objects." (What she actually said was "emergency charge in Horatio cognate projects".)

Blake eyed her, trying to decide whether she'd said something scientifically meaningful but over his head, or merely something unintelligibly baffling. "Is it," he said, deciding to be noncommittal about the matter. She didn't reply, so he continued: "Be that as it may, clearly, passing out qualifies as a new one—and might I take this opportunity, while you are still groggy and unable to verbally trample me, to observe that I told you so?"

Elaine groaned irritably and tried to sit up. Failing to do so, she settled for grabbing her head in her hands so as to (it seemed) prevent it breaking open from the effort. "Where am I?" she asked in a small, endlessly long-suffering voice.

"You're at Bridgewater Hospital, obviously. Where else would you be after having just passed out and been unconscious for two days?"

"Two days?" She pulled up the bedsheets a crack with her finger and peered down. "Ugh, I hate these things. Did they confirm the init hash on that data pod?"

"They sure did. Plus, since you were unconscious, you didn't object to being age-tested—turns out you're at least two years older than you should be."

"I told you."

"Yes you did—of course you can understand that we'd think you were *crazy* before we believed you'd traveled back in time two years. Nice job, by the way; have you even thought about how severely screwed up this whole thing is? The paradoxes that you're causing *right now* just by being here? The laws you're violating? The rules you're breaking? It's a wonder you didn't rip a hole in the universe the size of Belgium. And don't even get me started on what happens if you somehow prevent us from developing the technology which sent you back in the first place."

"It had to be you," Elaine muttered. "Why couldn't it have been Kali in the control room when I

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arrived?"

"Oh, Kali was overjoyed. Kali was babbling like a fool about how wonderful this is and such a giant leap forward and she always knew you'd do great things and all that cliched rubbish. She believed it before we even ran the damn tests."

"Kali's great."

"A great buffoon," Blake agreed.

"I need to get out of here."

"I'll bet you do. What exactly is it that you came for?"

"It's complicated. Kind of. Sort of simple, sort of complicated—anyway, it would be better if I explained it to everyone. I'm going to need you all on board for this, and I rather strongly suspect that you, for one, are going to make it into a big honking pain in my ass. So you'll forgive me if I hold off having to endure that as long as possible. So when can I leave?"

"Well, since they had no idea what was wrong with you, they didn't really know when you might wake up, or when you might be able to leave assuming that happened. Maybe you should ask them." He gestured at the service button lying on the bed near Elaine's arm. She wrinkled her nose and pushed it; somewhere a bell chimed.

A moment later a rather rough-looking nurse came in and squinted belligerently at her. "What? Oh, you're awake. Bloody brilliant."

"Uh...yes. Awake and apparently as keen as you are for me to be out of here."

"Be my guest love."

Elaine looked at her askance. "Shouldn't you...you know, check with a doctor or something before unilaterally discharging me?"

"Sure—but there ain't no doctors around, big surprise."

"You're having a staff shortage?"

The nurse stared at her, chewing her lip. "Are you still a little dazed, love, or just a bit thick? The whole ward is closed down. All the doctors preferred to leave a nurse in charge rather than risk contamination."

"Contamination? From what?"

The nurse rolled her eyes. "From you."

<center>XXVII</center>

Having been declared fit enough to travel, Elaine found to her infinite disgust that she'd been placed into the custody of military intelligence. She wouldn't be going back to the academy. She wouldn't be accompanied by Blake (much as that prospect had previously irritated her, it now made her wistful). She actually didn't have a clue where she was going at all. Only that it was in the back of an enormously cliched black van, and involved having her wrists cable-tied together. She was seated opposite two grunts whose occupation was barely disguised behind a half-hearted facade of civilian clothes and shoulder-holsters. She stared at them impassively.

"You boys work out?"

They didn't answer. "That's rude. I asked you a perfectly civil question." Still nothing. "Have you been ordered not to talk to me?" They exchanged a sidelong glance, but still said nothing. "That's thoroughly antisocial," she continued. "I'm going to have to bear the burden of conversation all by myself, and you know what a chore that can be—especially to a scientist. I'm just going to have to talk about what I know, so as to be sure I can shoulder that heavy load." They exchanged a sidelong glance again. "I know, don't worry. I'll take it slowly. Let's start with the basics. Now, have you heard of Schroedinger's equation?"

She regaled them for hours on the introductory intricacies of quantum mechanics. In truth, it had

nothing to do with annoying her captors. It was all about her—about keeping her mind off her predicament, and keeping her own spirits up. She'd lost the data; it was no doubt seized in like manner to herself. They'd used one of her own staff to try to get information out of her. She could no longer return to the academy and do what she'd come all this way to do (if that was an appropriate metaphor). Not to mention that, potentially, her capture had placed her and—she wasn't sure about this, but it was hard to demarcate these things—the whole universe into the unenviable situation of being doomed to repeat an infinitely recurring time loop if her presence in the past somehow prevented her younger self and her team from developing the technology to get there in the first place.

Eventually, there was a jolt and the tug of forward inertia, then the rear door opened and the driver gestured them out. The two grunts simultaneously cocked their heads at her, in the direction of the door, so Elaine pushed herself stiffly to her feet and preceded them out.

They were in some kind of underground parking garage. She didn't recognize it, and had no reason to think she would. The air was a bit chilly, and although she couldn't see outside, the light filtering in from the entrance around the curve of the driveway was weak. Weaker, she thought, than the time of day would intimate if they were still at the same latitude, or further south. She surmised that they must have been traveling more or less due north for the whole time, which at least helped to narrow down where she might be. (In fact, the light from the entrance was merely weak because the entrance itself was in the shade of another building, and the weather had turned very overcast since they'd left. They were not further north at all.)

She was prodded from behind, and started forward, following the driver. They got into a lift, and went up. Two storeys. Then down a nondescript corridor, and into a smallish room. There was a straight-backed wooden chair sitting in front of an equally plain table, underneath an exposed light bulb that seemed calculated to be dimmer than necessary. On the other side of the table was a reading lamp on a pole, and a leather executive chair that looked pretty inviting after hours sitting on a hard van bench. She was pushed unceremoniously into the wooden chair.

"Uh, my hands?" she said.

The three men left without a word. She slumped in the chair, resting her bound hands on the table.

For a while, she was left to her own, racing thoughts. Foremost on her mind was getting out and being able to complete her mission—but that was looking rather untenable. Even if she escaped, the data she'd brought back had almost certainly been absconded with just as she'd been. It didn't seem likely that her captors would take her, and not the infinitely more valuable intelligence she'd brought with her. That thought alone filled her stomach with a deep, vice-like apprehension. What were they planning to do with it? It didn't seem likely that they'd follow through with her own plan; that much was clear. But the information she'd brought back, in the wrong hands, could end disastrously. And in her experience, military intelligence was invariably the wrong hands.

At this point, it was evident that her mission was a failure. What she needed to do was not attempt to recover it—which would be foiled immediately anyway, as certainly they had eagle eyes on Avon Academy and would apprehend her the second she walked through the door, even if she could escape to begin with—but simply to restart. That would be a lot more simple to achieve, in theory. A simple message would suffice. All she needed was to know, *before* she came back, that military intelligence had eyes on Avon, and evidently some kind of pre-organized protocol for situations such as this. She had no idea how they could have anticipated it, given that (relatively speaking) her own team didn't even yet have an inkling of what the Totem could do—but that wasn't really important. As long as she could get a message to herself, or even to the Queen somehow, she'd be able to devise a more cunning strategy for coming back in two years' time. And hopefully undo this mess.

The door opened again, and another man came in. He was more slightly built than the grunts had been, and wore a real uniform. It was unadorned; but his Gordon-esque white mustache made up for it. He walked around the table without a word, and turned on the reading lamp. He tilted it so that it shone directly on her

face. She grimaced. Military types couldn't resist a cliche, however effective. He sat down on the other side of the table, settling comfortably into the leather chair.

<center>XXVIII</center>

For about five or six minutes, neither of them had spoken. Elaine had stared with increasing discomfort at the table, and the man had just sat there with his hands folded in his lap, watching her. Eventually Elaine had to say something.

"Could I get a coffee or something? You know, if we're going to be here long, I could really use one."

Unexpectedly, the man raised a shoulder and cocked his head toward it in an agreeable gesture. "Sure, why not. How do you take it?"

She looked at him askance, but he said nothing more and gave nothing away. "Black, two sugars."

The silence continued for a short while longer. Presently the door opened, and a cup was placed on the table in front of her. She eyed it, hesitating. She hadn't been expecting to get her own way. She hadn't expected anyone to indulge her or to take her rather snarky request seriously. Now that someone had, she was looking for the catch. What were they getting out of it? Had they put something in the drink? A truth serum maybe? Or were they just looking to get her off guard? See how she reacted? In any case, since she'd asked for it, good manners and plain old-fashioned thirst compelled her to drink it.

She picked it up and took a sip. It tasted fine. Not great; but fine. Sweet and bitter, just as she liked it.

"Now," the man said. "You can do something for me."

There it was, that catch. "I make a lousy coffee," she said.

"And who exactly are you?"

She paused, squinting shrewdly at him through the glare of the lamp. "That's a weird question. You guys know damn well who I am."

"And who is that?"

She signed. "I'm Elaine Corren, Director of Cosmological Research at Avon Academy—formerly a consultant to military intelligence on a number of projects you probably aren't cleared to know about."

"Elaine Corren is in Bern. I just spoke to her not a quarter of an hour ago."

"Well, yes, that's true. The Elaine native to this time period *is* in Bern. As you must know, I am *not* native to this time period."

"Dr Blake assures us that travel backward in time is impossible. So who are you really?"

"Dr Blake is a retard," Elaine snorted. "As, apparently, are you—or whoever's pulling your strings. Did you not verify the init hash I gave to Dr Gill?"

"We verified it. An intriguing forgery. How did you fake it?"

Elaine rolled her eyes. "For crying out loud. You can't fake a hash. Never mind the fact that I'm two years older than I should be."

"That would be more trivial to falsify. Your story is very imaginative, and obviously well calculated given how willingly the Totem staff took it on board. You went to a lot of trouble. How did you get into the testing chamber?"

"Okay, are you listening carefully? Two years from now, having spent all that time working on developing the Totem in the hope that it would cough up a unified field theory out of the equations, the project was being shut down because some countries are ruled by paranoid schizophrenics. So, having learned how to manipulate time using the said Totem, the Queen and I came up with a plan to effectively avoid the problem by short-circuiting the development process. Subsequently, I entered the required input parameters into the Totem, stood inside its area of effect, and turned it on. It created a temporal inversion field, extending me backward in time by two years, while employing a sort of tunneling effect so that I didn't have to traverse

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the whole period as a set of contiguous moments." She paused. "It just seemed like a second. I then stepped out, *hoping* to be able to upload our two years' worth of data into the Queen before I—that is the time-native me—got back from Bern, thus saving us a lot of wasted time and effort, and giving us a good kick-start toward developing a unified field theory. Unfortunately, I didn't bank on some paranoid government spooks intercepting me and taking me to their subterranean dungeon, never again to see the light of day. Otherwise, obviously I would have thought twice. What kind of intellectually challenged spy do you take me for, that I can sneak into the Totem room undetected, but then give the game away by pretending to faint for two days so that the enemy team can catch up with me?"

"You tell me."

Elaine stared at him for a long time, as best she could with the blinding light in her eyes. "You know I'm telling the truth," she said slowly after a while. "A spy wouldn't go to all the trouble of getting into the Totem chamber with impossible-to-forge data and then pass out and be caught by military intelligence. So why the charade?"

He smiled blandly. "Did you just hear yourself?"

"Not to sound mean, but you're kind of a moron. I'd have told you all that anyway."

"Perhaps. We're a bit cynical though."

"More to the point, if you believe me then why the hell am I locked up down here being interrogated instead of being allowed to get on with what I came here for?"

"Well, the situation is more complicated than you imagine."

"How?"

"There are laws against time travel. Well—not laws, exactly. Protocols."

"Time travel...protocols. For all those pesky time travelers that keep coming back."

"We like to be prepared."

"You're joking. You have protocols for time travel...just in case?"

"That's right."

"And what do the protocols say—about me?"

The man clasped his hands and leaned forward. "It's not good news."

XXIX

In the end, predictably, it was Kali and Blake. Excitable, gullible, motor-mouth Kali, who could break a non-disclosure agreement within an hour of signing it just because she had a compulsive inability to keep her big gab shut; and grumpy, contrary Blake who would habitually disagree with Kali just to wind her up.

In this case, Kali had the dubious distinction of lasting well over an hour—in fact, a whole two weeks. Two weeks between being sworn to secrecy about Elaine's mysterious appearance in the Totem chamber, and her return from Bern.

Military intelligence had tried. They'd contained the news pretty well. Half the academy staff had had to sign NDAs they didn't fully understand; most of them didn't really know what had happened that day, or the significance of it. Only Blake, Gill, Bell, and Kali were really in the know. And of those four, only Kali had problems with secrets.

The Queen had just been reinstated in the throne-room and brought back online. Elaine had just returned from Bern, and they were getting back into the swing of things. They were discussing what the next batch of tests should involve, and what they hoped to achieve with them. It was a fairly innocuous and fairly boring conversation, until Kali said, "Well we just need to narrow down the best parameters to test first, to get the ball rolling in the right direction." That in itself wasn't awfully suspicious, but it demanded clarification. So Elaine asked:

"What direction's that?"

Kali at this moment realized her mistake. But she had to say something, and the longer she stood gaping like a trout in a basket, the longer Elaine had to wonder what she meant. So she said the one thing that she could think of saying—the one thing she wasn't supposed to say. "Time travel?"

Elaine glanced around the room. "Er, is this something you've been discussing while I was away?"

Now the problem with being sworn to secrecy about something is that, barring infortuitous slips, one has a natural inclination to avoid speaking of it at all costs. Even when the cat is poking its head out of the bag, one typically tends to react by immediately denying the existence of the head, rather than by being brazen enough to stuff it back in and thus have to admit its presence. Subsequently, when Elaine asked "is this something you've been discussing while I was away?" Blake's immediate response was not to say "yes", mumble something vaguely unconvincing about why, and steer the conversation onward. Rather, he said, rather abruptly and with an obviously venomous look at Kali,

"No!"

Elaine glanced between them. "It's okay guys...I mean, it's pretty out there, but not entirely without precedent. What's your angle?"

Now, Blake's customary indignation at all things stupid, and his prideful isolationism, conspired to make matters worse. "Nothing, there is no angle. Kali's an idiot."

And Kali's leap-before-you-look reactionism took over to seal the deal. "I am not you nasty little troll. You know as well as I do that the Totem can function that way—we both saw it!"

From then on, Elaine needed only to look demandingly at them, and the cat was well clear of the bag and on to wrecking the furniture. Armed with this new knowledge, things turned out very slightly differently. A couple of years later, and a couple of hundred miles away, there was one moment when Elaine was sitting dejectedly in a cell, contemplating her abject failure to even engineer the circumstances necessary to warn her time-native self of her impending imprisonment—and then there was another moment when that never happened at all.

<center>XXX</center>

Elaine was extremely circumspect about traveling back in time. She was aware that she'd "tried it once before" (of course, she hadn't actually—not yet—but it *had* still happened, which was confusing), and that it had ended badly. There were eyes on the academy, and they had the manpower and wherewithal and (most importantly) the protocols in place to deal with just such an event.

Being aware of all this leant certain advantages, however. She had a lot longer to think it through; and, having not ripped a discernible hole in spacetime the last time around, she had less to worry about in terms of the unknown effects of her actions. She had more time to plan the maneuver; more time to brief the Queen and come up with a sensible strategy. It wasn't a last-minute, spur-of-the-moment impulse underwritten by adrenaline, some hasty equations, and a healthy dose of madness. It was a proper operation, properly prepared.

The Totem activated at around two thirty in the morning. There really wasn't anything that could be done about it being seen—there were, of course, security cameras operating at all times—but that could be mitigated to a large extent, turning what had been a revelation the last time around into merely an odd and unexplained technical glitch.

She didn't have much control over the Totem; not at the far end of the time extension. It was just doing its job, picking up the inversion effect and carrying it along to its conclusion. However, in their spare time, the Queen and Elaine had developed a smaller and more refined version of the Totem—known as the Tote—which could be carried on one's person without significant inconvenience. It had been a relatively

simple thing to do, given that they were only really interested in a single effect: the cloaking field that the Totem could generate. The Tote was a mini cloaking device.

Their work had been facilitated by the existing, half-completed and now-scrapped military project with the same goal. The plug had been pulled when it became obvious that there just wasn't any way around the fact that a cloaking device, by definition, works both ways. When electromagnetic energy doesn't interact with anything inside your cloaking field in any way, you become very effectively invisible. But when electromagnetic energy doesn't react with anything inside your cloaking field in any way, and you're inside the cloaking field, then light isn't reacting with your eyeballs. It is very dark inside a cloaking field. Horrifyingly dark, as Elaine had discovered.

The obvious way around that problem was some retrofitted lab glasses linked to a small computer and some accelerometers. The glasses had a jerry-rigged heads-up display installed via two small scanning laser projectors attached to the inside of the arms. The accelerometers could tell very accurately how she was moving. And the computer could take that information, compare it with her starting position on a full and precise three-dimensional map of the academy, calculate her position and speed (and they say you can't find both), and display it to her glasses. It wasn't perfect, but with some practice she had become quite adept at moving around undetected. She still had to be quiet of course; the cloaking field was quite specific in what it did, and it didn't block sound. But it was nonetheless a highly effective way of moving around unseen.

She still only had a two-week window to do what she needed to do. But again, she'd had two years to work out the details. Two weeks was a long time when all you had to do was hack into your own network and upload some files. The right information here, the right email there—manipulating the timestream would be relatively trivial, given full knowledge of everything that had happened before. She'd been keeping a diary since the day that Kali and Blake let it slip what had happened. And getting access to the academy security feed, then building a comprehensive map of events for the entire two years out of it, was a pretty trivial task for a supercomputer. They were quite well prepared. Quite well prepared indeed.

Obviously it was impossible to plan for every contingency. Once she started to make changes, those could cascade into a vastly different future in ways she could never anticipate. But certain things were almost certain to remain constant. The computer system itself. The building. The Totem. The Queen. These she could use as base points, and work her plan around them. The plan itself was simple enough that very little had to go right for it to succeed.

No one was around at two thirty in the morning. Avon Academy wasn't the sort of place that had actual security guards, since it wasn't the sort of place that anyone really wanted to break into—yet—and wasn't located in the sort of town that had much of a criminal element. The security cameras were really just a matter of protocol; something that seemed like a good idea when the campus was built. It wasn't likely anyone would check them. Anyone, that is, who worked directly for the academy. Elaine had little doubt that military intelligence had some way of monitoring the security feed in at least the Totem chamber and throne-room, and in fact did so continuously.

The white fizzing sound faded, and she waited for a moment to be sure that the extension field had completely collapsed. Then she started to walk forward, keeping her eyes fixed on the HUD projected onto the backs of her lab glasses. It was a relatively rudimentary system; vertexes were displayed as simple lines, with walls colored a pale yellow, doors green, desks purple, switches and terminals represented by blue icons, cameras by red ones, and so on. But it was enough to move around quite capably when one already knew the layout of the place, where chairs were usually put, and whatnot.

Of course, it couldn't predict when untidy technicians would leave chairs lying in the middle of a corridor. It relied purely on static maps; there was no live obstacle detection or anything. Elaine had gotten fairly good at edging forward gingerly and stopping still when she bumped into anything. So she froze when she banged her shin against something flattish with a bit of give above a hard edge. The problem was that some things didn't stop back. When you banged them, they moved in rather unpredictable ways—and five-legged, wheeled desk chairs were the worst. They also attracted a lot of attention by both making a lot of

noise on the cured hardwood floors as they rolled along. Movement plus noise was something she really wanted to avoid.

The chair had shifted forward. She could tell vaguely where it had got to by the trundling sound it made. She had bumped it fairly lightly, so its movement was relatively minor. She groped forward, fanning the air with her fingers. They brushed against fabric. She stopped and worked her way carefully around it.

Fortunately, the cloaking field's area of effect wasn't as hard to manipulate as the Totem's time extension field was. By wearing repeater nodes attached to strategic points on her clothes, the Tote's area of effect could be effectively stretched to cover her body without extending much further. When she touched something, a small part of it would appear to vanish; but not enough to show up obviously even if someone was looking directly at it, and especially not on a security camera.

She got to Room 2/15 without further incident. It was a small closet of an office, with a computer terminal on a desk and nothing else, and was used only by temps or auditors once in a blue moon. More importantly, it wasn't deemed worthy of any kind of security. It was at the end of a long hall, with a camera at the other end. Subsequently, you couldn't see its door on the security feed—only the door frame. So she could enter unnoticed. Moreover, it wasn't ever locked like private offices tended to be, yet it had no security cameras inside like public computer rooms did. Using her own office would arouse too much suspicion if her actions were uncovered in any way. So 2/15 was an ideal place to work from.

She got inside and turned off the Tote. It took a few seconds to cycle down, so the world didn't just pop back in front of her eyes; it returned in a kind of quietly frenetic series of flashes and dark gashes. She flicked off her HUD, sat down at the terminal, and booted it up.

XXXI

User accounts on the Avon network had a 40-day password timeout for security reasons. After that the password expired and had to be changed. Although it was never anticipated to defeat time travel, it did effectively rule out hacking someone's account in the future, and then using it two years in the past. She also couldn't use her own account for the same reason she couldn't use her own office: if her plan was discovered somehow, it could still succeed—but only if she wasn't implicated in it.

Administrative accounts were often (ironically) excluded from the password rollover policy, but hacking them tended to draw a lot more attention which she didn't want, and the Academy enforced an annual security review during which the passwords on all admin accounts were updated. So that avenue was tricky.

Fortunately, there was one category of user accounts which tended to slip by unnoticed because they were well obfuscated, relatively impotent, and—most importantly—owned by the people who are notoriously the worst at following their own rules: the network administrators. These were the test accounts used to simulate logging in as a normal user with normal user privileges. These test accounts were usually set up with quirky usernames and internal access only. They were thus basically ignored in terms of security, because they had obfuscated usernames which were hard to guess, couldn't be used to get onto the network externally since an on-campus logon was mandatory (which physical security should prevent) and so weren't a threat in terms of remote intrusion, and had no privileges which allowed them to do any damage anyway. More importantly, they were usually set up on the spur of the moment, but with the knowledge that they would seldom be used in future. This meant an easy-to-remember password (usually the same as the username) which never expired. And, true to expectations, they were typically forgotten about after a few months, and remained lurking in the system for years without ever being updated or removed.

Elaine logged in as `t3st0r` with the password `t3st0r`. The Queen had found this account while auditing the user directory. It had been set up a couple of weeks ago, time-relative, and remained unused for another two years and then some. Of course, the Queen herself had not been set up on the academy's main

network. No one was silly enough to grant an artificially intelligent supercomputer access to that, regardless of the precautions which were taken. Not even computer scientists, who were a bit notoriously clueless when it came to security and suchlike. But it hadn't been too hard, given months to work with, to casually chat up a couple of the guys in Gill's team, and one of the IT geeks, and learn that the Queen's monitoring equipment above the throne-room (into which she was directly connected) did have a couple of spare TDN connections, and that yes, you could get TDN wireless adapters, and that sure, of course the campus's wireless network covered that area. After that, the Queen did the rest.

Elaine plugged the data pod she'd brought into the terminal, and started uploading its contents to the campus' shared storage drive. She didn't have access to either the Cybernetics or the Cosmology shared drives under this login, but that wasn't a significant problem. It was probably better to use the common drive anyway, since no one tended to notice, let alone look at, vast amounts of strange data. It always belonged to someone else. There wasn't any real oversight as long as there was enough space; and storage space was cheap. What Elaine had brought with her was a compressed, encrypted archive of everything the Queen had picked as being necessary, and nothing that wasn't—it was quite small enough to not raise any eyebrows given the size of the common storage drive, and even if it was investigated it was gibberish without the decryption key. People tended to leave things like that alone, since it could be anything, and when you don't know what a large, encrypted archive is for, you default to presuming that it's important.

The trickier problem was alerting herself in the past to the presence of this data, and explaining what to do with it. That information couldn't be stored in the archive itself since it had to contain the decryption key. Storing that inside the archive was obviously a bit self-defeating. But she was certain that both her work and personal email accounts were being monitored, so she couldn't simply send the information to herself without at least disguising it somehow. The problem was that spooks were probably a lot better than she was at decoding messages, so any kind of code that she used would have to rely on more than mere cleverness. Ideally, the message wouldn't even appear to be code at all. The less suspicious the better. She didn't want to tip her hand in any way; even if she was confident that no one could figure out what the message said, it was better if they didn't know it even existed.

The obvious solution to this was to make it appear as if the message were perfectly normal, but in such a way that she (and only she) would immediately recognize that it wasn't. However, as much as she'd wracked her brains, she couldn't figure out a foolproof way of doing this. The information she needed to convey was too specific, and it wasn't as if she had developed a set of secret phrases to use with herself.

The alternative was to send the message via some other means. A physical note on her desk would have worked pretty well since no one would enter her office until she got back from the HEP symposium; but her office door was in full view of a security camera, and it was too great a risk. She couldn't leave it in her mailbox at home since it was likely that was monitored as well.

What she could do was use the academy's internal mail. Putting all that information into a single envelope reminded her too much of eggs and baskets; but separating it into a couple of memos which in themselves were innocuous enough, but when put together could be figured out without too much trouble, was certainly an option. This also had the added advantages of being private, since no one cared enough to open someone else's mail; and virtually untraceable, since she could move around the academy's campus fairly freely given that the stair wells weren't monitored by cameras. A couple of brown internal mail envelopes addressed to herself from a couple of different locations in a couple of different departments would attract no attention at all. But that still ran the risk of detection if she was being snooped very closely, since a spy going through her internal mail could put the two memos together. A minor risk, to be sure, since it seemed rather unlikely—but still an unnecessary one. A single memo to herself, and another to someone who wouldn't ever be monitored, was the better solution.

Having completed the upload to the common drive, she unplugged the data pod and powered down the terminal. Then she reactivated the Tote, and started walking again. It hadn't been hard to figure out which mail drop points were invisible to security cameras. Again, having two years to work with made it trivial to

get this sort of information. The cameras weren't concealed; they stuck out pretty obviously if you were looking for them. So a visit to each mail drop, one on one week, one the next, until she'd covered them all, was all that was needed. From there, she could take her pick of the ones that would work for her. As it happened, there was a drop point in the Genetics lab which could be accessed from Room 2/15 without having to get within line of sight of any cameras at all. And there was another one in the Geology lab which required her to run the gauntlet a couple of times in corridors, but never while opening a door. Doors were really the main problem. A mysteriously opening fire-suppression door was pretty hard to explain, and likely to prompt investigation if noticed.

Once she'd dropped off the mail, there was only one final hurdle to overcome. She had to get out. The "rewrite effect"—the effect where event A at time 1 led to event B at time 0 via negative temporal extension, thus creating a new event A' at time 1, "overwriting" the previous event B and creating a new one, event B'—had an odd "delay". It only kicked in for someone on the original timestream once A' actually occurred. Even if the sufficient conditions for A' were established far in advance, ensuring that B' would occur, the original stream of events, displaced backward in time, didn't seem to be obviated until the time-relative point at which the actual cause of the obviation took effect. It was all very confusing, and very counterintuitive. But the upshot was that Elaine could create a new future now, but still have to wait two years until she—her "first" self—got to the point where she hadd first come back in time, before anything would change for her. Only then would the new state of events take effect, and she would no longer be stuck in the past (because she'd never have been there at all). Two agonizing years in which she had to remain completely undetected, unable to know whether her plan would work.

XXXII

Two weeks later, Elaine returned from Bern. She didn't actually go to her office until around lunch time on her first day back; she had little use for it since nearly all of her work was done in the throne-room or the Totem chamber. Mostly she just checked in to catch up on emails and collect internal mail, which she received in larger supply than you might have imagined. On Fridays she had the afternoon set aside for the tedious administrative work that was a necessary part of her position (it wasn't nearly enough time, but she thought of it as paring down the admin overhead to a minimum rather than neglecting to do her job).

Although she'd been occasionally checking her emails from the symposium, there were still over a hundred accumulated in her inbox to wade through and either delete impulsively, respond to heatedly, or set aside for more lengthy reply later. By the time she'd finished sifting through them and eating her lunch, she needed to get back to the throne-room to continue training the Queen. She didn't get to her in-tray until the next day.

When she did, she found about a dozen envelopes in it. Some were correspondence, some reports, several proposals that needed signing off on—and one single sheet of A4 on the academy's memo template. It said:

> TO: Elaine Corren
> FROM: George Gill
> SUBJECT: Queen AIR diagnostic results
>
> Elaine, the diagnostic data from the Queen is being dumped to a shared archive so that you and your team can view it. Full details, along with accompanying debug output is available in an archive called "qa_output" on the common drive. Please read the documents enclosed in that archive, as they are important. If you require clarification on any points, contact me directly.

It was dated two weeks ago. She read it over again, furrowing her brow. Then she went to the common drive and found the archive. Opening it just yielded garbage files, however, and opening these just yielded more garbage for content. She picked up her phone and dialed Gill.

"George, this memo that you sent me just after I left—about the Queen's results from the AIR diagnostics being put on the common drive—is there a secret to opening the archive? And is it still relevant—you didn't mention it yesterday … Well I'm looking right at it … I didn't send you anything—well, that's weird … Yeah, I'm here for a couple more minutes. … Okay, see you."

A few moments later, there was a knock on the door, and Gill came in. He was carrying a sheet of paper, and he waved it at her as he entered.

"I forgot to mention this yesterday. I meant to ask you about it. I think we must have our wires crossed; we've never had any data on the common drive for you guys."

Elaine took the paper. It was another memo. It said:

> TO: George Gill
> FROM: Elaine Corren
> SUBJECT: Queen diagnostics output
>
> George, can you send me a copy of the init hash for the AIR diagnostics you're doing on the Queen when it's done? I need it for checking the contents of the output archive.

"What the hell is this? I never sent this to you."

"It doesn't make an awful lot of sense either. Where's the memo you got?"

She handed it to him and he scanned it quizzically. "I think someone's trying to play a practical joke or something. I never wrote this. As I said, we don't have anything on the common drive relating to the Queen."

"But there is an archive with that name there," Elaine objected. "It looks like gibberish—so I thought maybe it was encrypted."

"I think it's just gibberish. Someone's yanking our chain. Probably your man Blake. Forget about it."

"Mmm…Blake? He's an ass, but I don't think so. The memos are very specific…"

"Well, you can look into it if you want, but I have more important and interesting things to do. And right now we need to be in the throne-room, don't we."

"Sure, you're right." She slipped the two memos onto her desk, pulled her lab coat off the back of her chair, and shouldered it on. "But Gill?"

"Yah?"

"Send me a copy of the diagnostics' init hash would you?"

XXXIII

It didn't take Elaine terribly long to figure out that the init hash Gill had sent her was actually the decryption key for the `qa_output` archive file on the common drive. Using it as such was quite an inspired strategy for a number of reasons. Firstly, the init hash was a once-off key of extraordinary complexity formulated from the actual diagnostic results themselves, in combination with a random number generator. The generator in turn returned its random number from a scanner which monitored the eye movements of the operator over a period of time, and converted these into integer values. It was thus impossible to predict the contents of the hash key, even if you could predict the contents of the diagnostic results (which you couldn't). And it was also impossible to replicate the hash afterwards.

This meant that it was simply impossible that the archive on the common drive could be encrypted using the init hash, since that archive had been put there well before the hash itself had finished being generated. A couple of weeks before. And obviously if it was only *put* there that long ago, it must have been encrypted at least that long ago as well.

So the fact that the init hash did indeed decrypt the archive served as compelling and irrefutable proof of the claims made in its readme file—namely, that it was an archive of data gathered over the course of the next two years, and that it had been brought back in time using the Totem itself. Brought back for purposes that were clearly and lucidly explained and defended. Elaine was able to recognize her own writing when she saw it.

Furthermore, it was so obviously impossible that the init hash *could* be the decryption key that, even if Elaine's planted memos were discovered, no one would think to try to decrypt the archive in that way. Except Elaine, to whom the connection was obvious right there in the memos. She was—well, she didn't want to use the word "credulous", but she was certainly "scientifically progressive" enough to take the leap and give the decryption a go using the init hash.

She read over the readme a few times to be sure she'd really taken it in. It was a lot to absorb; a lot to rethink. Her whole understanding of cosmology—if not the technical specifics, then at least the principles—had just been turned on its head. Obvious questions arose. Most of them weren't answered in the readme itself; there simply wasn't enough space. It just gave the bare bones, so that she could take it from there. But important questions were addressed—like whether this whole sequence of events constituted some kind of paradox, and what the implications were. Here's the excerpt, included in full despite its length, so that the coming events may be a little less inexplicable to the dedicated reader:

Obvious question 1: haven't we just caused a time paradox? And isn't that a Bad Thing?

This has been the subject of some discussion between the Queen and myself. In principle, the whole question is highly speculative, because once you've instantiated the conditions you want to examine, the paradox is already in place, and everything is changed. The prior world in which the experiment was to be done no longer obtains; the new timestream is all you have.

Surprisingly, however, in practice this turned out not to be the case. What actually seems to happen is that the way the world is (W1) remains the same up until W1$t\Omega$—the point in time where you initiate the negative time extension. If you return to tA (some given previous time you've chosen) and initiate some different action, you create a new world (W2) as you go, but the old one still "exists" in the sense that you yourself are still around and still experience it. You don't overwrite your own memories or create a paradox. The complete "change of world" seems to be indexed to $t\Omega$ in the new world, rather than tA as you'd tend to assume. This leads to the strange situation where you can plan some action which will actually occur at tA, following travel backward in time from W1$t\Omega$; yet you have to go through the whole timestream of world 1—in which that action hasn't occurred—all the way up until W1$t\Omega$ *before* a new world is created where the action occurs at tA.

Think of it as a nest of contingency. W1tA *has to have happened* in order for W1$t\Omega$ to happen, and W1$t\Omega$ has to have happened for W2tA to happen. This causes a weird state of affairs where it appears, in the interim between tA → $t\Omega$–1, that whatever you plan to do at $t\Omega$ will actually fail for some reason because it hasn't actually caused the desired effect at tA. But of course, you're still in W1—and at W1tA the negative time extension *didn't* occur. Don't worry; once world 2 is instantiated by your going back in time at W1$t\Omega$, world 1 "never happened" because W2tA and everything which follows from it obtains instead. And in W2 you don't experience the agonizing wait, obviously. *But it did still happen*, so you can have a record of it; either in some kind of written format, or in the testimony of someone who "comes back" from W1 (like me), and that record will last up until $t\Omega$ in the new world-state.

I know this is really confusing. It does my head in writing about it, and I've been studying it for nearly two years now. It's like the universe has a failsafe to prevent paradoxes, because paradoxes are inherently impossible. If you travel back in time (let's call that event E0), you can arbitrarily change any given events (E1, E2 … En)

from tA to $t\Omega$. But if you travel back in time, then your very act of doing so relies on at least some events from tA → $t\Omega$ having *actually happened* (at least, for example, the events of you setting up and turning on the time machine). However, given that any unified field theory would necessitate a World Unity Model of reality (that's one of the difficulties reconciling quantum mechanics and relativity, after all), there are no *isolated* events. Thus there is no limited set of events which *alone* qualify as causes for E0 (for example, just the events E1, E2 and E3, and no others). Rather, the set of events which qualify as causes of E0 is exactly contiguous with the set of events which qualify as causes *qua* causes. So E0 entails not merely a specific (perhaps very large but still) limited set of causes which must obtain; it entails *the entire set of causes* that obtain between tA and $t\Omega$. And that set of causes, of course, in turn entails the entire set of causes from t0, the beginning of the universe. So, traveling back in time actually entails an entire world where you *didn't* travel back in time. Woo! Thus, E0 entails W1. Take some ibuprofen.

Since E0 entails W1, W1 must *actually happen* in order for E0 to happen. The universe won't let you short-circuit the process by giving you W2, with a new tA, without you going through the pain of W1, with the original tA. Otherwise there's a paradox in play from the get-go (because of WUM), even if you don't do anything blatantly paradoxical in terms of the obvious causes of E0—like destroying the time machine before $t\Omega$ or something silly.

Obvious follow-up question: what the devil happens to W1 once W2 obtains?

The Queen speculates, based on the math, that the answer can be described as some iteration of the standard many-worlds theory. The obvious question with many-worlds theories, though, is in whether something must be actual just because it is possible—and, if so, on what grounds. As you know, I've (we've) always held the somewhat tautologous view that something is actual if and only if it is actual; and its possibility has nothing to do with that question. The typical view of many-worlds tends to take the opposite approach, so that anything which is possible is actual, and we just happen to be viewing one of an infinite number of real worlds. And our objection to that (as you also know; but let's reiterate) has always been twofold: firstly, it's thoroughly arbitrary to make such an assumption with no underlying reason; and secondly (more importantly), an actual infinite is irrational. An infinite number cannot increase; yet we are supposed to believe that for every ongoing moment there are more, real worlds being created based on possible outcomes we don't perceive in our world. Thus we've argued that an actually infinite number of real worlds cannot obtain.

That's not really here nor there I don't think, but it leads into the more important and interesting question: can an actual world become a possible world? Can W1 be relegated to the status of a possible world by the instantiation of a *new* actual world, W2, *from within that original one?* This is the view I favor, simply on the basis of parsimony. If the original world doesn't revert to a mere possibility in view of the new actual world, then it must still exist in an alternate timestream, which implies that time is more than one-dimensional. None of the math seems to support such a view. Furthermore, it's a highly problematic notion even on its own grounds, because real questions have to be asked about what happens in W1 following $t\Omega$. Does it continue to behave as if $t\Omega$ didn't have any effect? Does it continue forward into the future indefinitely? It seems even more troublesome to say that it stops at $t\Omega$, but if it doesn't, then E0 at $t\Omega$ was causally impotent, and you've got this enormous violation of causality. It's no good to argue that E0 was causally efficacious, only in a different world, because in fact it was a *specifically* one-dimensional time event: it was only a backwards extension, and *not* a "sideways" extension (unless you assume that the math is wrong to begin with). So that's a problem in my view. And that's not the only one: along the same lines, you've also got a violation of thermodynamics, because a huge amount of energy just got expended in E0 which did nothing and went nowhere (no equal and opposite reaction in that world). Not to mention you've also got an object which literally disappeared from the world at $t\Omega$. Rather than being extended backward in time (as opposed to the normal forward extension) it went *nowhere*; it apparently just stopped existing. That's also problematic; but if the many-worlds view *is* correct it would presumably come back at some stage (see below).

Many-world theorists will say that thermodynamics and whatnot applies most correctly across the multiverse, even though there is a sort of "tension" or "membrane" between the individual worlds so that there typically isn't any "bleed". So although a violation took place in W1, no such violation took place in { W1, W2 }. But that raises problems of its own, since it implies that worlds are not causally closed: W1 can not only affect W2, but actually create it, matter can pass between them, etc. And I think good arguments can be made from World Unity which totally blow that view out of the water by showing that if W1 and W2 are not closed, then they

aren't separate worlds at all…but damned if this isn't getting a bit longer than I intended. You'll figure it out.

Anyway, the point I was getting at was that the original world seems to simply disappear; either it becomes causally inaccessible to us in W2, or (more likely) it's "overwritten" by the new world—with the notable exception of the "relic": the object from event E0. That continues to exist in W2 *up until* $t\Omega$. I admit this is really weird, but it makes sense when you think about it. If the relic stopped existing immediately upon instantiation of W2, what would actually *instantiate* W2 in the first place? The relic has to have causal power. But on the other hand, it's also violating thermodynamics in an obvious way—it has a mirror object which is native to W2 which is now the "real" object. The thing is, the universe seems to sort that out. Just like in QM, only on a much grander scale (which has proved amazingly helpful in terms of getting closer to the grand unified field theory), you can have brief violations of thermodynamics which seem to just be fluctuations which level out when you look at the bigger picture. The spikes don't change the average. At least, that's what we assume. Anyhow, the relic sticks around in W2 up until the point where it would first have been extended back in time (by the way, if you try to "send it back" to $t\Omega$ by reversing the extension effect, it just does the same thing; it stops existing at $t\Omega$ again, only it gets there much more quickly—but that can be explained by general relativity so it's not that exciting). Many-worlds theorists would say that it returns to W1. Good for them. I'd say it just stops being actual and becomes possible. But I've always been a bit fanciful, so maybe I'm wrong. Blake, nasty many-worlder that he is, certainly thinks I'm barmy, because how can something stop being actual; and how can something which is no longer actual (W1) still be the actual cause of something which *is* actual (W2)? He reckons this violates the World Unity Model.

I, of course, disagree because this just seems to beg the question in favor of the elaborate and needlessly complicated many-worlds thesis. If you hold to that, then maybe you'd see WUM as being of such a nature that it precludes the alternative of the possible-worlds thesis. But the converse is also true. If possible-worlds is the case, then WUM can be conceived to preclude many-worlds. And in any case, my view doesn't have something possible *causing* something actual. It has something *actual* causing something actual, and by merit of that then dispensing with its own actuality in the process. This seems utterly reasonable; especially given how it resembles probabilistic superpositions in quantum mechanics. Why can't we think about world states in the same way we think about particle states—every possible state is possible, but not every one is equally probable? One highest probability can give way to another; the superposition can decay to W1 or W2 depending on how things turn out. But if the decay to W2 relies on W1 first obtaining, why is this any more problematic than the superposition of an electron decaying to one location L2 based on a previous decay to position L1?

Of course, there's a genuine difficulty with confusing temporal semantics with possible world semantics. When I say that W1 is "no longer" actual, I'm not referring to it in a temporal frame of reference, as if there was some *time* that it *was* actual. Or, if I *am*, I'm not using conventional time reference; I'd have to be assuming some kind of meta-time. I'm just forced to use temporal language because we're limited to describing things in terms of what we have experience of. We have no experience of other worlds, so there are no exclusive semantics for them. We have to reuse temporal semantics instead. In truth, I don't know *what* it means that an actual world is "no longer" actual, but is "now" merely possible. I can describe it as an iterative state matrix or something equally grand, with logical priority *sans* chronological values. But to *claim* that there is no chronological factor doesn't lend us squat in terms of actually *conceptualizing* non-temporal logical priority itself. We're always stuck in a temporal frame of reference, so regardless of whether there's no time, or meta-time, we're always going to imagine it as plain old time. Just like how we imagine nothing as a black void, rather than as actual nothing.

Anyway, the upshot is that it doesn't seem that paradoxes actually obtain in the way doomily prophesied by science fiction. You can't make infinite recursive time loops and all that rubbish. There's nothing to loop with; what is, is; what "was", is not. If you kill yourself now (but don't) the file you're reading will still have existed. The previous actual world still obtained. So don't worry about it. Oh, and yes, I'm still here also in W2. I'm the relic.

That brings me to the final point that's fairly important to remember. The relic can't coexist happily with its native mirror. I'll stop existing in another couple of years, once we hit $t\Omega$ again, but until then we absolutely cannot come near each other. I'm just going to have to lie low somewhere far away. I've planned for that; you'll need to as well for when you come back. The universe really doesn't seem to like having mirror objects in proximity. They repel each other like magnetic poles, and when they do there's a heck of lot of energy

liberated. Enough to turn air to plasma between them. That's the sparkling effect you'll see in the Totem field when you start performing negative extension experiments. It fries flesh. We tried it on some lab rats and ended up with blackened ash and a crispy bacon aroma. So let's stay the hell away from each other eh?

Other questions were answered at even greater length. What precisely the archive data was—this was explained quite briefly. There wasn't much to say. But what to do with it was detailed excruciatingly; the instructions had come from the Queen and were very specific. It was crucial to get the sequence and the timing correct. The young Queen, as she now was, was nearly a *tabula rasa*, and it would take quite some work to get her developed to the point where she would be able to assimilate and understand everything she had come up with over the course of two years, let alone extrapolate and improve upon it.

Other contingencies were also described. The information trade-off threshold, where the time it would take for the young Queen to assimilate the data outputted by the old Queen became so long that further development upon it was infeasible. What could be done to get around this threshold. Who could be trusted, and who could not. A great deal of obviously useful information, and some not so obviously so, gathered painstakingly over the course of two years.

Most of it presupposed that the mission would continue: that Elaine would go back in time again with even better data from the Queen, and start the cycle anew. This was a reasonable presupposition; perhaps even a philosophically astute one. If Elaine had been willing to go through with it twice—both on the spur of the moment, and after two years' of consideration—it seemed irrational to suppose that she would ever not. Perhaps under very different circumstances things would work out differently, but failing such, it seemed clear enough that the cycle would continue until something significant happened to arrest it.

That, the notes observed, either would be her being apprehended by military intelligence (or worse), or the Queen succeeding in her mission and developing the grand unified field theory. The third option was briefly considered: that the circumstances leading to the project's termination might fail to obtain. That was possible, but with such a vastly complex set of causes and effects, all quite outside of their control, it was a slim and unpredictable hope.

In a way, Elaine rather hoped that would never happen anyway. There was a certain appeal to the excitement and cloak-and-dagger experience of her plan. A certain transgressiveness and sense of power that she couldn't help wanting more of. The knowledge she was seeking to obtain was desirable for so many reasons—and she had, she thought, more right to it than anyone by this point. She wasn't changing much. She wasn't destroying lives or altering major events. If anything, she was the victim of those things. And she wasn't breaking any laws...at least, not any reasonable ones. Every scientist wants to be the one to make a major breakthrough; she was just more lucky than most in that time was not a constraint to her. By her own scientific ingenuity, she could keep on working the problem for the same two years indefinitely; never tiring, never growing older; never even becoming bored, because every time was new.

XXXIV

The difficulty she now faced, and one for which her future counterpart had found no clear solution, was actually getting the data stored in the `qa_output` archive inputted into the Queen where it could be used. This, of necessity, required her to get at least one of the academy's Cybernetics experts on board—and the pool of personnel was rather small, given that only two people had the authorization and roles which allowed them to freely go about the task. Those were George Gill and Jeffry Bell.

The readme offered some commentary on these two options, and concluded that neither was ideal and that it was simply a risk that Elaine was going to have to figure out and take for herself. Gill was decisive yet careful, typically a by-the-book sort of guy, but not unknown to take unorthodox approaches or bend the rules

when he deemed it necessary to get things done. And he was in charge of the Queen's project, which made him a good choice in terms of getting things done without interference. However, given the reality-altering nature of Elaine's plan, it was pretty questionable as to whether he'd consider *this* much unorthodoxy to be acceptable, even if the goal was compelling or tempting enough (which was also debatable).

The other option was Bell, who offered something more desirable in terms of personality, inasmuch as he was more of a loose canon like Elaine: prone to impulsive, radical, and sometimes questionable courses of action. The problem was that he was reputed to be very loyal to Gill, and had twice passed up higher positions at other research institutes to remain working with him. The two of them made an excellent team and had become world leaders in advanced quantum cybernetics. So anything Elaine told Bell, there was a good chance he'd insist on bringing Gill in on it anyway.

Ultimately, of course, that was probably inevitable. It seemed absurd to think that Elaine could make such drastic alterations to the Queen's knowledgebase and virtual pathways without Gill finding out at some stage; probably sooner rather than later. Still, Bell's impulsiveness could work in their favor then. If she got him involved to the point of no return, then it would perhaps provide a softer transition for Gill. He might be convinced to continue the project rather than simply terminating it—which, relic-Elaine said, was not an unlikely prospect if the dataset became so sufficiently tainted by the input of advanced future knowledge, effectively short-circuiting the Queen's entire developmental process (which, for Gill if not for Elaine, was the point of *his* project).

After some deliberation, Elaine decided to risk talking to Gill directly. The data in the archive wasn't merely useful to her; it also contained all the results that the Cybernetics team had gathered over two years of developing the Queen. So really, she thought, she was doing him a favor just as much as she was doing one for her team.

The conversation with him was a bit surreal. At first he was obviously simply disbelieving; then that softened into extreme skepticism. He had Bell test the archive extensively, analyzing its encryption and researching the possibility of it somehow being faked. But plainly it couldn't be, and it didn't really take long to confirm that. There really wasn't any other explanation for the fact that the init hash decrypted the file; and even if there was, the data contained within the file itself was so extensive and so precise, and contained so much information that obviously extended and improved upon existing knowledge, yet couldn't possibly yet be known, that the real problem was not at all in convincing them that it came from the future, but rather that it should be used.

That in itself wasn't as hard as Elaine had expected. The data proved that the work had been done; so it wasn't as if they were somehow cheating. Why shouldn't they use their own results as a basis for work now? It would speed things up immeasurably, and get them a lot closer to their goal—both the Cybernetics team, and the Totem team. As for altering reality, that had already been done by Elaine in the future. Simply by coming back with the information, she had changed everything. So the responsibility lay squarely on her; not them. An argument could be made, and was convincing to a receptive mind which sorely wanted to use the relic-data anyway, that it would be irresponsible or unreasonable or even wrong to *not* use the data which had been so kindly provided at such cost, now that it *had* been provided and everything was different anyway.

Subsequently, work began within a few days. Within a month, the Queen was prepped to receive the new data, thus vastly accelerating the previous development cycle. Elaine became familiar again (though it seemed to her for the first time) with the vast and astounding abilities of the AIR-6 certified AI.

While the Cybernetics team was readying the Queen, the Totem team themselves were not sitting idle. The team was loyal to Elaine, and fell in line easily enough, despite Blake's doomy predictions and initial righteous indignation. A lot needed to be done in preparation for ramping up testing and development of the Totem data and accompanying theories. They spent a great deal of time and overtime poring through the data in the archive, familiarizing themselves with the advances that had been made. Some of the theoretical underpinnings were very complex; in fact, some of them were outrageously difficult to follow, having been

largely worked out by the Queen. Fortunately, they had been systematically laid out and explained so as to expedite the team's familiarity with the new data. By the time the month was up, they had a passing understanding of the fundamental advances which had been made—but Elaine could see clearly that the next time around, the process was going to take longer. It wasn't only the Queen who would reach the point of decreasing returns given the two-year time slot available. The team itself would hit that point well before the machine did.

There were also other things to be done. A strategy had to be developed for disclosing the Totem data publicly, and getting other institutes on board. This had been a vital part of the process in W1, and Elaine was keen to replicate that success in W2. Of course, the diminishing returns would start to kick in, and become quite hobbling after several more iterations of the time loop—eventually becoming crippling. But even when that happened, the raw computing power afforded by the Totem Cooperative was highly valuable in terms of augmenting the Queen's own abilities. Questions needed to be addressed regarding how much they wanted to disclose about the origin of the data. It was very advanced, but could certainly be passed off as contemporary—that particular asset would rapidly disappear in the next few development cycles. A point would be reached, and reached quite soon, where trying to form a Totem Cooperative could be tricky. The theories would be too advanced for anyone to grasp; which in turn would raise serious questions about their origins. The results of testing would start to look more and more like fiction to an outsider; and without the requisite theoretical understanding to lend credence to them, there'd be no reason to regard the entire project as more than a hoax.

There were ways around these problems. Elaine and her team were quite imaginative. It was entirely possible to keep a record of the W2 results and use them as a decoy. A set of ghost data that could be used to piggyback the real information they wanted. With a little creative jiggery-pokery, some closed source algorithms, and enough data, they could keep up the illusion of developing the W2 results in each iteration of the loop, while actually crunching the new, vastly more advanced numbers. No one could possibly analyze the amount of data which was shared through the Cooperative. Huge blocks of binary-encoded data could represent anything—all they needed was computing power; not analysis. It was obvious to everyone that after another couple of iterations, the Queen would be the only one able to keep up with development in terms of real, comprehending input. The Totem team was just there to supervise the process, and the Totem Cooperative was just there to provide computing resources. Keeping up the illusion of developing "old" theories, feeding the Cooperative the appearance of real and exciting advancement which had happened a dozen iterations ago, shouldn't be hard at all.

Other questions demanded consideration as well. What were the costs of streamlining the loop? Did the risks outweigh the benefits? At the moment, it was beginning when Elaine went to Bern, because that was the only window available for her to return later; any other time and she could be cooked by the feedback effect which occurred when the relic and the native were in proximity. But that required the development of the Tote and a lot of risk coming back; as well as the laborious process she'd already had to go through to get the data to herself, convince the Cybernetics and Totem teams—and, most importantly from her own point of view, the total pain in the ass of having to hang around in another country trying to remain undetected for two years afterward, waiting for time-Omega when she'd finally vanish. Which itself was a bit like dying, and carried its own unsettling psychological and philosophical baggage.

Changing this process could be hazardous—altering any variable at all was highly unpredictable, but altering a whole number of them was potentially a disaster. On the other hand, if they set a new "waypoint" in time after the planning phase and later sent the data back to it, all they'd have to do was retrieve it in the past, run the Queen through her "power-up cycle" (as Bell had drolly dubbed it), and get cracking on the actual development. Everyone would be already convinced and briefed, nothing could go wrong with Elaine coming back since she wouldn't, and she wouldn't have to hang around as the relic for two years. It was an obviously desirable situation, apart from a few days lost to the planning phase itself.

In the end, they decided to do it. The process was really very simple as long as Elaine didn't need to keep it a secret from the team. It could be scheduled precisely, taking all of five minutes (although they left a two-hour window just to be on the safe side, in case some kind of inaccuracy occurred in the negative time extension). It didn't require anyone to leave; no particularly special arrangement needed to be made at all. All they did was gather in the Totem chamber at 12 pm on the designated day, wait for two hours pretending to be working, though not powering up the Totem itself, and then leave again. In two years' time, they'd do the same thing on the last day of the project, only this time they'd put a new test object inside the red circle with the data contained inside it, power up the Totem and send it back to time-Alpha.

They decided to use a new test object simply because there was an entire warehouse full of them about a hundred miles away—safely outside the feedback range. That way the relic-object would have no danger of coming into proximity with the native-object during the next iteration. They'd get the data they needed, then Blake would drive to the coast and deposit the relic-object into the sea (with its memory appropriately wiped, of course). Then, two years later, he'd pick up its native counterpart and bring it back to the academy to be sent back in time. They agreed that it was better to be on the safe side and have someone in the team do this, rather than relying on a courier or any such thing.

Another question was whether they should let Kali be bugged again by the fake reporters, or whether they should foil that particular plot. It was entirely possible that the business card bugs which had been planted had yielded information about the Totem project which contributed significantly to the political instability surrounding it further down the line. On the other hand, trying to direct global politics to their own ends had the obvious potential to blow up in their faces, leaving them worse off than when they started. Even if whoever had bugged them didn't get suspicious when they got no information—which could probably be achieved simply by having Kali throw the business cards in the trash; that had to happen to them sometimes—there was no guarantee that the information gathered hadn't contributed to global stability, rather than detracted from it. They didn't know who had been behind that particular item of espionage. Maybe it was someone on their side. In the end, it was decided that there were too many unknowns to make risking a change worthwhile. Kali remained bugged.

During all this, the Queen was brought up to speed, and development began. Relic-Elaine had warned them in her comprehensive readme to not expect any miracles; given the complexity and depth of the theories, it was amazing that any progress was being made at all. Certainly, without the Queen, two years would have been a pointlessly short time in which to attempt to advance the state of the science. However, the Queen worked methodically and tirelessly, and although development wasn't rapid, and didn't see as many sudden spikes as often accompanied typical scientific progress, it continued inexorably onward. The team was kept busy enough just trying to understand the new data being generated. They spent the large majority of their time picking through the Queen's output, grappling with the math and trying to get their heads around the equations. The rest of the time was spent setting up increasingly elaborate and complicated experiments with the Totem. These were fewer now than they had been, and further between, as the data became more detailed and hard to interpret, and formulating appropriate follow-ups took longer.

The Cybernetics team also benefited greatly from the Queen's rapid advancement. Combined with the data from the previous loop, they were in a position to begin planning some truly remarkable advancements in AI technology. The Totem team acquiesced to the Queen being taken offline every Sunday for testing and fiddling in the Cybernetics lab. Their mutual conspiracy had brought them together far more collaboratively than before, and now that they were on board with the plan, there were enormous benefits in it for them as well. For every iteration of the loop, new data could be added to the old, and all of it archived in preparation for upload to the test object. Aside from her own normal self-development, which was extraordinarily rapid,

the Queen could now be upgraded. Indeed, an entirely new Queen could be built. That was the project Gill started them on.

XXXVI

Two years later, they had successfully created a replica of the Queen, which they called the Ace. The Ace was to the Cybernetics team as the Queen was to the Totem team. Just as the Queen was tasked with developing cosmology, so it was the Ace's task to develop the Queen. Based on the data gathered during each loop, which was stored cumulatively, the Ace began to formulate advancements to the Queen's architecture. And, during each loop, the advancements which had been developed during the previous loop were built into two identical units, which were then in turn brought up to speed. After four iterations, this process became redundant as the deprecated Ace unit invented a way to imprint its and the Queen's quantum states on the newly built units. These could then be sent back along with the test objects, vastly accelerating development from the get-go. This had to be done carefully, of course, to avoid the feedback effect—but it was a minor hindrance all things considered.

The downside to this rapid development, of course, was that human involvement was eventually reduced to the role of manual labor. The theories being developed by the machines (and they did share data, since much of the Queen's work was directly relevant to pushing forward quantum cybernetics) was simply beyond the reach of their human supervisors. All the teams were needed for after the third loop was to run experiments and build new units when the redesigned architectures were completed. That, and coordinate with the Totem Cooperative, keeping them busy thinking that they were developing theories which now looked about as advanced to the Totem team as Copernican cosmology or the luminiferous aether would to us. The real advances were left entirely up to the Ace and the Queen.

After several iterations of the loop, an interface was developed for the Totem which allowed the Queen to be plugged directly into its control circuitry. This further mitigated the need to have human involvement in setting up experiments, since the actual configuration of the Totem could be entirely performed by the Queen herself—only test objects and the like had to be set up by the team. It became routine for the Totem to be throbbing away without any human supervision at all; the Queen observing from her perch in the control room through high-definition cameras and microphones, and an array of mark-2 test objects which she had herself developed, set up inside the red circle. The time finally came when the only involvement the Totem team had in the project itself was picking up the Queen and the Ace and a test object from inside the red circle at the beginning of the loop, plugging them in, and then returning them to the circle and turning on the Totem at the end.

Predictably, the political scene deteriorated each time over the course of the two years, until the project was ordered shut down. There were minor variations in the events surrounding this, which were recorded for interest's sake—but no major changes ever occurred. The project was always terminated, the devices were always sent back, and the loop always began again. It would become tedious to describe each iteration in any detail, since they were all so similar—dozens and scores and eventually hundreds of them, repeating in the same two years, with the data becoming more and more advanced, the theories becoming more and more beyond human comprehension, the practical applications becoming more and more like magic, the Queen and the Ace being rebuilt better again and again, and the two teams never aging, never advancing, always supervising and coordinating a plan now wholly beyond their understanding.

There were two events which eventually changed this: one relatively minor in the grand scheme of things, and one much more significant.

The minor event was really quite extreme from a human perspective. It was the sort of demonstration of chaos theory that Blake would get all worked up about. This made it rather morbidly ironic.

In iterations of the loop too numerous to bother counting, he had driven out to the coast with the native-Queen, the native-Ace, and the relic-test object securely stored in a security box in the trunk of his car. Cement had been poured on top of them, which served two useful purposes: firstly, it ensured that the box sank quickly and directly. Secondly, it prevented anyone from easily discovering its contents in the very unlikely event that it was found later.

Blake was fond of fishing, and owned his own motor-boat for putting around the harbor. It wasn't really suited to the open sea, but for this occasion he would take it out several kilometers from land in order to reach a nearby undersea trench, which was conveniently easy to locate with sonar, and quite deep enough to prevent the security box from being washed up on the shore again once tossed overboard. The weather was always fair and mild this time of year, and there were never any problems.

He would heft the security box into his arms, brace one foot against the edge of the boat, and prepare to heave it over the side. And every time, the penlight he carried in the upper pocket of his life jacket would fall out as he leaned over, land on the security box, and roll through its handle and onto the deck of the boat. The penlight was on a cord a couple of meters long so that it couldn't be easily lost—a very sensible precaution on a boat—so he'd have to pause and reel it in again, spending a couple of moments fiddling with it so as to get it back through the loop of the security's box's metal handle. This was a minor annoyance he never really thought anything of, and had forgotten all about by the time he got back to the academy later in the day.

On this one particular occasion, however, in this one particular enumeration of the loop, at the same moment he was untangling the errant penlight, a rogue wave slapped the side of the boat and tipped it sharply to starboard. Blake was immediately and without warning pitched face-first into the ocean with a startled yell, losing hold of the security box. This in turn rapidly began to sink. Blake, an experienced boater, was wearing the aforementioned life jacket; ordinarily a sensible and prudent precaution. In this particular case, however, it was unfortunately attached to the security box's handle via the penlight cord, and the penlight had wedged itself against the edge of the box's handle—thus making it impossible for it to fall free. Subsequently, Blake found himself firmly anchored to the water, face-down.

His first instinct was naturally to struggle, which wasted air. He tried to turn over to his left, but couldn't. So he tried his right. That didn't work either. He tried flapping his arms and legs in the hope of rotating to an upright position, but this effort failed also.

His second instinct was to pull the box back up so that he could untangle the penlight. This proved very much harder than he'd have thought. The cord was narrow and slippery, and the box was heavy. After several attempts, with most of his air now exhausted, he realized it was impossible.

His third instinct was to cut the cord. He had a folding knife in a sheath on his belt, and he went for it. By this time, however, his extremities had become tingly and numb, making it very hard to get the knife open. His fingers were unresponsive, and by the time he'd cleared the blade he was starting to see bright splotches in front of his eyes. There was buzzing and thunder in his ears. The blade was smooth, not serrated, so it took all of his remaining strength to jerk it back and forth through the cord. It kept slipping, making numerous shallow cuts spaced along the cord's length, instead of one deep one. Eventually, the cord snapped as his air gave out completely. The dark depths below faded white, and he fainted. The knife slipped from his grasp, following the box down to the bottom.

It was several hours before anyone started to wonder what had happened to Blake. By that stage his body and his boat had separated. The latter was found adrift in the harbor some hours later; but his body wasn't located for several days. By that time it was naturally an unpleasant sight. Elaine had to identify it, since Blake hadn't been carrying any ID on his person; his wallet was in a bag on his boat. She'd seen dead bodies before—not often, mind you; mostly at funerals. This was different. Far more disturbing. She vomited.

The incident wasn't much less traumatic for the rest of the team. Blake had been a prickly sort of fellow, but well liked despite it. Perhaps because of it. The loss of an idiosyncratic personality has a greater effect on people than the loss of someone without much to commend him to the memory. It didn't help that Blake had been on the faculty for donkey's years. Everyone knew him. He wasn't the typical stuffy scientist who kept to himself; he had real hobbies and real friends. He played poker with Bell and Gill and some others on Fridays in the C&C lounge. He was the longest serving member of the Physics department next to Kali. His death had a heavily depressive effect on both the cybernetics and the cosmology teams.

More importantly for the project itself, it sparked serious debate about how far they were all willing to go in pursuit of their goal. From their perspective, of course, this was the first loop; they didn't remember the previous ones because there was nothing to remember. Every iteration was the first one; the data and the computers became more advanced, but the teams remained exactly the same. The same age, with the same memories; repeating the same two years. Subsequently, they didn't have any kind of ingrained loyalty to the project. It wasn't as if they were in this for the long haul, and a death was a bump in the road that they would force themselves to overlook. They had no knowledge of any of the previous loops apart from that provided in the readme files which had come back a few days before—certainly not any experiential knowledge. They were all doing this because two years was a short time in which to get so much done. They weren't committed out of principle, or out of a sense that they'd come too far to go back. They were committed because the benefits were obviously worth it.

Blake's death cast a long shadow over that assumption. It was unexpected and horrifying. It left them shaken emotionally—but not only emotionally. Bell and Gill were the first to start openly questioning their confidence in the plan. Was Blake's death random? The readmes hadn't mentioned it at all—and, one way or the other, that created an atmosphere of fear, uncertainty, and doubt. If he hadn't died the last time around, then clearly their confidence in the reliability of the plan was ill-placed. How could they continue knowing that such significant fluctuations could occur in the state of the world? What else could go wrong? The potential for disaster was obvious, and exaggerated in their minds by the shock of the way in which it had been demonstrated.

On the other hand, if Blake had died the last time around, why wasn't it mentioned in the readmes? Was this something that happened in every iteration of the time loop, but was deliberately omitted from the information sent back? If so, why? Was it because they thought that trying to change such an event was wrong for some reason—that death was fated, and shouldn't be altered? Surely not—what they were doing was altering the whole of reality, life and death included. Or was it just because in two years' time when they formulated the readme files, they would be too calloused to include anything about Blake's death, for fear that preventing it would perturb the plan itself?

Some of the questions raised were reasonable; some were less so. Kali was a bit superstitious and hysterical; Gill tended to be more pragmatic. The rest of the teams aligned behind one or the other of them to greater and lesser degrees, effectively polarizing the group. Elaine lived with a constant weight resting uncomfortably in her stomach; it seemed to squeeze her whole chest whenever she was forced to mediate the arguments that broke out between members of her team, or the Ace's, or both.

The two years passed slowly, and included many potholes and trials which no one had anticipated.

Elaine managed to keep the group together despite the high current of emotion; despite the threats to leave, and even to out the project. It took a heavy toll on her, but she couldn't do otherwise. She felt highly responsible for the whole affair.

When it came time to compile the readme files, there wasn't a great deal of dispute over whether they should include some kind of warning for Blake in them. Everyone agreed that death was too high a price to pay for the rewards that the project offered. But, that being the case, there was no reason that they had to accept even one death. The plan itself provided the means by which to change what had happened. Rather than scrapping the project, rather than letting it be terminated, there was every reason to continue with their plan: to warn themselves, two years ago, to dispose of the test object and the old Ace and Queen in some other way than by dropping them into the sea.

<center>XXXIX</center>

The loop continued for several more iterations without further incident. They were finally getting very close to the unified field theory—at least, so the Queen said. Elaine had no reason to distrust her. They still had conversations; sporadic ones now, and about issues more tangential to science, since Elaine simply couldn't offer any useful input whatever on the theories being developed. She was like a very young child compared to the Queen, with a similarly small grasp of the workings of reality. She sort of hated it. At the same time, though, the Queen remained very childlike herself, in her understanding of non-scientific matters. She was no less than a towering giant in cosmology (not to mention other scientific disciplines), but she remained naively fascinated by the sorts of uniquely human qualities of which she had no experience. There were so many intangible things which Elaine took for granted that the Queen simply had no grasp on whatsoever. Things which she could never have a grasp on, because they couldn't be quantified and analyzed in the way that she was designed to.

"Elaine," she might say. "I have a question."

"Yes?" Elaine would respond. She couldn't help getting a tiny thrill of excitement when the Queen had questions for her. To be needed in some way by the machine which had such a grasp of science that she could never hope to match it—being questioned by the Queen was like being asked to help rake the garden by her father when she was small. She would run to the shed and grab her tiny rake, and she would proudly make her own small pile of leaves, content and glowing in the knowledge that she was needed by someone so much greater than she.

"What is color?"

Elaine crinkled her brow, bemused. "I'm not sure I understand."

"I have been thinking about qualia," the Queen explained.

"Qualia?"

"Properties, such as whiteness, considered independently from things having the property."

"Yes…" Elaine said cautiously.

"I do not experience qualia. Hence my question: what is color?"

"I'm not sure that I can explain color to you, Queen. You either know it, or you don't. It's like trying to explain what an apple tastes like. It tastes like an apple. Sweet and tangy and juicy. But if you don't know what taste is, you won't know what those mean."

"Why was I not constructed with the ability to experience color and taste?"

"I guess it wasn't necessary."

"Could I be extended to include this functionality?"

"I…really don't know. Have you asked Gill?"

"Gill is unhelpful when I question him about my limitations."

<center>53</center>

"What about your high-def cameras?"

"Please elaborate?"

"Surely you see with those—right? You'd see colors. Shapes. All that stuff."

"I do not see. I process the data stream from the cameras and create a numerical model of the environment they monitor. I know that you are standing under a fluorescent light radiating at peak wavelengths of 440 and 545 nanometers, and that under this light your skin tone has a mean RGB value of 202 149 105. I know that *you* see the light as being colored white, and that you see your skin as being colored pink. But I do not see white or pink. I am aware only of numerical values, which I can match to the corresponding data in my memory regarding human experience."

"Does that bug you?"

"Not in the way that you mean. Again, I do not experience emotion either. I know that when you ask if something bugs me, you are making reference to an emotional state of mind. But I do not experience states of mind. I don't know if I even have a mind. I process input on the basis of a highly complex syntax, and create output. The output produced for questions like this, however, suggests that I am all syntax and no semantics. I experience no emotional states; but I am designed to communicate in a way which implies them, because this is easier for you, just as I am designed to use colloquial language. With that in mind, yes, it bugs me that I don't understand or experience qualia like color, or taste, or pain, or anger."

"Okay; why? Do you think you should have been designed to be a philosopher instead of a scientist?"

"No. It bugs me because I was designed to be a scientist. My purpose is to understand the universe. Yet I have not been constructed with the requisite functionality to do this."

"You're confusing scientific and philosophical understanding, Queen."

"Am I, Elaine? I am no longer convinced."

XL

The second event to affect the project was far less shocking in its beginning than Blake's death had been. It was, however, the vastly more important one in the long term. Several iterations of the loop had passed since Blake had drowned, and they had all been incident free. The readme files had continued to record the incident in the hope of avoiding it in the future, which had tended to cast a sense of dark unease over the project for the first few weeks after retrieving the relic-objects. But that atmosphere dissipated fairly rapidly, and had been less and less influential as the tone of the status reports which came back each time became increasingly excited. They were close—very close—to cracking it. The grand unified field theory. The Theory of Everything. They began to think about how they would disclose this publicly when it was discovered. When the Queen achieved her goal. When the Totem project became obsolete.

It would be tricky given how much more advanced the theory was than anything out there currently —vastly, stupendously more advanced than Avon's last offerings in the field of cosmology, or anyone else's. That much progress obviously couldn't have been made in a few months, or even years. Hard questions would be asked. But was that a problem? Elaine argued that it wasn't. They didn't have to tell anyone how they had managed to come up with their highly advanced model. And even if someone did find out, they hadn't broken any laws. There weren't any laws against time travel. She'd checked. Not public laws, at any rate—and she doubted that military intelligence would arrest them all. This wasn't the same situation as she'd been in the first time she looped. There weren't relic-versions of themselves to be detained without due process because the native-versions were the "real" ones, and relics don't have rights. Relics could be called spies or phonies, impersonators or doppelgangers. But they couldn't be.

There was the political situation to consider, though. How might this theory affect the world? It would revolutionize science in a day. Make everything obsolete. Once it was understood, it wouldn't take long for

weapons technology to take advantage of it. On the flip side, though, it would be equally possible to build new defensive technology. Judging from the effects the Totem could already produce, faster-than-light travel wasn't an unreasonable goal to pursue either. Teleportation. Planetary terraforming. Colonizing space had always been something that fascinated Elaine, so her imagination naturally wandered in that direction. It was comforting to know that however bad things might get on earth, there was plenty of space up in space. An avenue of escape from the unreasoning and unreasonable brutality of earthly politics; a chance to start afresh. It didn't often occur to her that colonizing a planet would bring its own, probably worse problems: a whole new set of political entanglements and intrigue, in-fighting and destruction.

Jeffrey Bell had volunteered to dispose of the native-objects in lieu of Blake. On every iteration of the loop, he would drive out to Harth, a neighboring city sufficiently far away to avoid the temporal feedback effect. He would take the security box—which was now being filled with a light but opaque and virtually indestructible resin—to the municipal dump, and leave it there. The dump was emptied into a nearby landfill, so the final destination of the native-objects was assured for a long time to come.

This time around he was eager to get back to Avon. The mood had been exuberant when he left, barely subdued at all by the knowledge of why it was he, and not Blake, who was disposing of the box. The Queen was running what was expected to be the final test. That's what she'd called it. "The final test." They didn't know when it would be completed; hours, or days—it could be either. But he didn't want to miss it. He wanted to be there when their project finally reached fruition.

So it was strange when he didn't get back that night. Everyone was working late, hoping that the test cycle would finish that evening and that they could hang up their lab-coats and enjoy a good party. In a way, it was a bit surreal. It felt like there should have been more build-up. But from their perspective, mere days had passed since deciding to put their plan in motion, and seeing its outcome. They had no experience of the countless years of research which had preceded this moment. No sense of the repeated days which had been squeezed endlessly dry. It didn't seem like this was the culmination of centuries of effort; hundreds of two-year loops. They had short-circuited all that; avoided it completely. And a good thing too, since otherwise it would be their great-great-great-great—you get the picture—grandchildren enjoying the fine strawberry champagne and swank hors d'oeuvres, rather than them. Them, except for Bell.

Still, no one thought too much of it. Maybe he got stuck in traffic and was late back, and had gone straight home. Nothing wrong with that. The test probably wouldn't be finished tonight anyway—and Bell wasn't on the Totem team. The Theory of Everything didn't really mean that much to him. He was interested in the Queen and the Ace and qubits and data structures and cybernetics; not in entanglement and particles and forces and theories and cosmology.

In any case, Bell got to work bright and early the next morning, well before anyone else would have been around given the late night previous. He went straight to the C&C lab, skipping coffee in the lounge, and logged on to his terminal. He located the relic-archives which had come back the day before, and made sure that no copies had been made. Then he checked what physical media they were stored on, and deleted them. Next, he let himself into the C&C server room, which was an isolated unit, separate from the main academy network, and found the server which housed the storage drive the relic-data had been stored on. He pulled out the drive and put it in his backpack.

Then he made his way to the throne-room. The Ace was hanging from the metal connecting rod in the center of the room. It automatically put the current data being processed up on the screen in front of the central podium when Bell walked in. That was useful for telling at a glance what was underway, and how it was progressing, without having to ask verbally. Bell dismissed it from the terminal and brought up a command-line interface. He typed quickly but imprecisely, entering the shutdown sequence for the Ace. Then he unmounted it and stowed the metal sphere in his shoulder bag along with the storage drive.

After this he had just one more task before he was home free. He was acutely aware that he was running out of time, but this was the most important stage of his mission. The stage which, unfortunately, would also be the hardest. The stage which he had had to leave until last, because everything depended on it. He

headed for the cosmology wing at a brisk jog. He was banking on no one being around, but he knew that he was taking a pretty big risk. Elaine was notorious for juicing herself up on anti-sleep pills, and Kali was old and subsequently genetically hardwired to get up at sunrise. Either of them could be in the Totem chamber already. He could possibly talk his way around Kali; but probably not around Elaine.

He got to the control room and found it blessedly deserted. He swiftly brought up a text interface on the command terminal and started to shut down the Queen. Then he hit a snag.

```
# shutdown -hn now
WARNING: SYSTEM IS GOING DOWN NOW!
Shutdown invoked with -n. Skipping init and going straight down!

ERROR: cannot skip init; this feature has been disabled.

INIT: switching to runlevel 0...
Sending all processes the TERM signal...
Stopping anacron                        [OK]
Stopping networking                     [OK]
Stopping qencmon                        [OK]
Stopping qencnet                        [FAILED]
```

"Hello Jeff."

He jumped, his head jerking unnaturally as he tried instinctively to find the source of the voice. Reason took over, and he slumped into the chair in front of the terminal. "Hi Queen."

"Why are you trying to shut me down?"

"Um, there's a—come to think of it, it's none of your business really."

"My directive prevents me from complying with the shutdown command without good reason."

"The fact that I'm commanding it is a good reason, Queen."

"Only Elaine can issue that command without explanation."

"That's extremely creepy. And frankly I don't care. I don't have time for this nonsense—say goodnight Queen." Bell got up and made toward the placid silver globe skewered on the control rod.

"If you unplug me without a proper shutdown, you run the risk of corrupting my virtual pathways."

"You're assuming I give a damn."

"If you unplug me, you will set off the alarm you wished to avoid."

"Either way, I have to unplug you, you impertinent machine—if you won't cooperate I'll have to risk the alarms. You aren't giving me any choice."

"Bell?"

"What?" He paused. That particular question hadn't come from the ubiquitous panel speakers the Queen spoke through. Same voice; yet not the same. Less flat. Less inflectionless. More real. He turned slowly. "Elaine..."

"What are you doing?"

He swallowed. He had prepared for this. Just run it over. Make it count. She has to believe it. "I need to take the Queen down immediately. I found an instability in the quantum matrix that could deteriorate at any moment and cascade into a total neural failure." He paused, and added with unfeigned venom, "She won't let me."

"Queen?"

"I don't believe that Jeff is being truthful, Elaine. Analysis of his voice pattern indicates a high degree of stress, suggesting that he is lying."

"Or that I'm stressed you stupid machine. It's not like there isn't much hanging in the balance right now!"

"Additionally," the Queen went on implacably, "your explanation does not account for the fact that you have shut down the Ace—"

"It had the same problem!"

"—deleted all copies of the relic-data, and removed the physical disk on which these were stored."

Elaine scowled at him. "What the hell is going on Jeff?"

"Look," he said, opting to not explain, "we still have the native-data—it's still there, in the Harth tip. It's not a total loss."

"Have you checked with Gill about this?"

"I haven't been able to get through; he's not answering his phone. And this couldn't wait."

"Check with me now," said a voice from the door.

XLI

It quickly became evident to Elaine and Gill that they had dodged a nasty bullet. Whatever Bell's plan had been he was refusing to say, but clearly it could not have been good. Fortunately he had been caught before he could get away, and before the Queen could be unplugged. On top of the potential damage to her neural pathways that could have occurred, Elaine was glad that they wouldn't have to start the final test from scratch again.

Cybernetics & Computing had all the resources on hand to recover the deleted data from the pilfered storage disk. Since Bell hadn't had time to physically destroy it, or try to wipe it in some way, restoring the relic-archives had been relatively simple. It was now returned to the server and safely backed up.

What was perplexing was Bell's actions in the first place. He had been escorted off the premises in the custody of two security guards. Although the cost of his crime, had he been able to fully carry it out, would have been astronomical, the extremely sensitive nature of the work he was involved in made the academy timid about pressing charges with the police. Before he was marched off, Gill had taken him aside and tried to get him to explain, but he had been sullen and uncharacteristically reticent. The two of them were close friends, and Gill was visibly upset by the incident. There had to be some reason for what Jeff had done; some bizarre but mitigating circumstance which would explain such an extreme and unprecedented betrayal.

George tried to get him to talk, but Bell was tight-lipped, and simply kept repeating, "I'm sorry, I can't tell you." It vexed Gill immensely. Had something happened in Harth? Had Bell learned something which they didn't know? Had he simply had an unexpected breakdown of some kind? Was this a previously unknown side-effect of the negative time extension effect, or of being in proximity to time relics?

In any case, Bell was no longer in the picture. His security access was revoked and he couldn't return to the campus. The project was still on course; the final test was still running; soon everything would fall into place.

In reality, that final test look rather longer than they'd hoped. Elaine felt like a kid at Christmas, or in the car on a long journey. "How long now Queen?" The Queen would reply with what Elaine imagined was long suffering, "Time to completion is still unknown." We get there when we get there.

There wasn't much for them to do except sit around and wait. No one went home because they all wanted to be there when the test completed—but in reality it wouldn't have made very much difference one way or the other. They just mooched about looking bored. They didn't have any Cooperative to coordinate; there wasn't any point ramping up that particular project. They would have a completed Theory of Everything long before it was time to make the public disclosure of the bogus Totem data.

Elaine and Gill were sitting in the C&C lounge, ruminating over some stale biscuits and over-stewed coffee. They'd been silent for a long time, occupied with their own thoughts about what had recently happened, and would soon happen. Suddenly Gill said, "Do you feel that?"

Elaine looked up. "Feel what?"

"I dunno, like a static charge in the air. A prickling or tingling or something."

"I don't feel anything. It's probably that coffee. That or your blood pressure."

Gill grimaced. "I...I don't think it's that. Jeez, I can feel it all over—it's like ants crawling all over my body." He stood up suddenly, shifting his shoulders and legs uncomfortably. "Ugh, it feels weird."

"Tactile hallucination maybe?" Elaine frowned. "That's never good. We should get you to the sickbay. I'll call a doctor for you."

"I'm sure I'm fine." He rubbed his arms vigorously. "You don't see anything do you?"

Elaine squinted at him behind her glasses. He looked perfectly normal. "Well, you're maybe a little flushed, but no—you look fine. Come on." She stood up and took his arm. A spark snapped between them and she swore. "Ouch!"

"What the hell was that?"

"I have no idea. Are you wearing rubber soles or wool or something?" She crouched down quickly to examine the carpet, but it was nondescript and could have been made of anything. Probably some synthetic blend which wouldn't accumulate charge, though. She straightened. "Let's get you to sickbay and I'll get some instruments to see if I can figure out what's going on." She started to herd Gill toward the door, and he complied agitatedly, twitching and scratching at himself compulsively. Elaine pulled out her phone and dialed reception.

"Hi, yeah, this is Elaine in Cosmology, could you please call a doctor to sickbay immediately? It may be an emergency. Dr Gill has been taken ill, and his symptoms are kinda...weird. We're just in the courtyard heading there now; I'm taking him—hello?" She pulled her phone away from her ear and frowned at it. "Damn thing." She redialed, but after listening for a moment she got nothing. "No signal? In a courtyard across the road from a repeater? Useless!"

She was caught up short as Gill stopped suddenly in front of her, swaying. Beads of sweat were springing out all over him, and he gritted his teeth in a grimace of agony. Elaine gasped and took an involuntary step back as the sweat glistening on his skin started to run red. Blood began seeping from his eyes and nose, and he crashed to the ground, convulsing uncontrollably. Around him the air was shimmering. Blue-hot sparks crackled and popped against his skin. He screamed an inhuman scream, and the sound made Elaine's blood run cold. Then the white light seemed to engulf him, reducing him to static. There was a sharp SNAP, a bright flash, and before her very eyes he dispersed into the air and was gone.

For a moment Elaine thought he'd been hit by lightning. Of course, that didn't make any sense—the sky was clear, and lightning doesn't herald its arrival with other symptoms. The whole thing had happened too slowly. She'd seen him literally fizz away, like the energy that held him together was unraveling. It all looked horribly familiar. She stared at the ground where Gill had been. There was nothing there. It wasn't like he'd been struck by a discharge and reduced to ash or dust. He was literally gone. There was nothing there.

XLII

It took her quite a while to gather her wits about her again. She'd already been put a bit off center by Jeffrey Bell's criminal behavior of the morning—this new and thoroughly horrifying experience had shaken her drastically.

She wasn't sure what had happened immediately after Gill had disappeared. She now found herself sitting on a bench some distance away, clutching a flimsy silver blanket tightly around her, with her knees drawn up to her chin. Sounds seemed distant and echoey, and the sunny vista of the courtyard with its green trees and sparkling fountain seemed unreal. Eventually, when someone tried to talk to her, she realized that she was staring vacantly.

"Elaine?" Someone was speaking. To her. That was her name. "Elaine, can you hear me?" She raised her head slowly, elevating her blank stare to encompass the person addressing her. Kali.

"Kali..."

"What happened Elaine? Where's Gill?"

"Gill..."

"Excuse me." Another voice. "She's in shock."

"Well I can see that, but it's a bit important."

Elaine mustered her thoughts with an effort. "I think Gill is dead," she said.

"You can't be serious."

"He disappeared. It was awful."

"I don't get it. Disappeared how?"

Elaine's eyes focused abruptly, and she took a sharp breath. "The Totem."

"It's still running the final test."

"You're sure? Nothing...changed? No one came back?"

"Quite sure. I was just there."

"It must have happened earlier then," she mused to herself. "Some time we didn't notice. And he must have been out of range until now—" she stopped and drew a quick breath, fixing Kali with a sudden and intense look. "In Harth."

"What?"

"Come with me! Quickly!" She pushed herself up and threw off the silver blanket, teetering momentarily and fighting the urge to pass out. Kali caught her arm. "Maybe you should sit down before you—"

"No, come." Elaine started walking determinedly toward the Cosmology wing. She fished out her phone and squinted at the screen. It was blank white. "My phone is dead; useless cheap crap. Give me yours." Kali handed it over without a word, and Elaine dialed a number. "This is Elaine Corren. Get security to the Totem chamber in Cosmology immediately!" She hung up and dialed again. "Blake, where are you? I need you to get to the Totem chamber right now. I don't think Jeff was acting alone; Gill came back. He's the one who got Jeff on board in the first place. He couldn't do it himself because of the feedback effect." There was a pause. "Because he's decided to do it himself. Our Gill is gone. Listen, I'm on my way." She broke into a jog, at which point Kali gave up and reduced speed to an idle wander, trailing along behind.

When Elaine got to the Totem chamber she found Blake and two security guards milling menacingly in the control room. The Totem itself was still humming away; the Queen was still fixed to the end of her control spike; no one else was about.

"You haven't seen anyone?" Elaine demanded? "Gill?"

"No one."

"Hmmph." Elaine sat down at the control terminal and brought up the interface for the relic-data. It was still present. Besides, she thought to herself, it had been backed up last night and the backups were taken off-site every evening to be stored in their secure disaster recovery depot. Which, when she thought about it, made them an obvious first target. No point deleting the data on the servers and tipping one's hand when the backups were still out there. She picked up the desk phone.

"Get me IT." A pause. "Yeah, hi, this is Elaine Corren in Cosmology. I have reason to believe that someone is trying to sabotage some of our data. It was backed up for the first time today, so my guess is he's going to go after the tapes when they are taken off site tonight. You might—" another pause. "Already? Well have you checked ... well I'm sure you think so, but there are some things you should probably factor in ... yes ... why does no one listen? I'm just telling you, there *is* something to worry about! ... Yes, I'm sure you will." She slammed the phone down in disgust. "I'm not taking any chances. Those guys are cowboys. Get me a data pod."

With her own backup safely in the trunk of her car, Elaine felt a little less anxious. Still, the data itself wasn't the most valuable thing that Gill might be after. The Queen was what Elaine was particularly worried about. The Ace less so—with the final test being run, the Ace had more or less outlived its usefulness in her eyes.

The final test was still underway. The Queen gave the same answer as always when prompted to hurry things along. "Time to completion is still unknown." Then she added, "Elaine, you must protect me. I must fulfill my directive."

"I know Queen. I will."

"Why is Gill trying to stop me?"

"I have no idea. Whatever it is, we've come too far to let him muck things up now. This is too important."

"I must fulfill my directive," the machine agreed.

Elaine slept fitfully in the control center that night. She was still jumpy and shaken from the events of the day, and had no intention of leaving the Queen. Not that she would have been able to stop Gill in any case, if he had tried to take the Queen by force; he was a strong man. The academy didn't have enough security guards on retainer to spare for standing duty in the Cosmology wing. There were only two of them, and they had to patrol the whole campus. But they promised to check in often and make sure things were quiet.

She was woken early in the morning by an abrupt silence. She started awake, cold, stiff, and with a sour taste in her mouth. The first thing she noticed was the quiet. The control room was dead silent. It was unnatural; she was so accustomed to the throbbing of the Totem. That either meant something very good, or something very bad. She muttered and squeezed open one eye. "Queen? Is the test finished?" She squinted blurrily at the control unit, screwing up her cheeks and wrinkling her brow to force it into focus. The control rod was bare. It thrust nakedly up from the console like the mast of a wrecked ship.

Elaine jerked upright and snatched at her glasses, knocking them off the desk beside her. She groped hurriedly for them on the floor, and put them on crooked. Seeing the control rod in full focus didn't change anything. The Queen was gone. She grabbed the walkie talkie that had been provided by security and thumbed the transmit button. "Oi, security—what the hell is wrong with you guys? The Queen is gone! Get over here!"

While she waited, she pulled up the data interface on the terminal to check that the relic-data was still there. It wasn't. She felt somewhat vindicated that she'd backed it up, now. Then she checked to see if the Ace was still plugged in. It wasn't. Everything was gone. No alarms were sounding—but that didn't surprise her. Gill was in a position to easily get around those, given sufficient time.

"If I were Gill," she mused to herself, "and I was trying to stop the project...what would I do with the Queen and the Ace after I'd stolen them? Well...I'd destroy them, obviously. How would I do that?" She dialed another number on her phone. "Lionel, Elaine. Hypothetically speaking, if you needed to destroy the Queen, say—how would you go about doing that? Is it as simple as smashing it with a hammer?"

With both Gill and Bell gone, Lionel was now in charge of C&C. "Ugh," he said. "Do you know what time it is?"

"Not really. Sorry. The question—it's urgent."

"Um...no. Those units represent a pretty hefty investment on the part of the academy, so we made sure to protect them. The casing is shock-resistant and pretty strong. You'd need something a bit mightier than a hammer. Even then there's no guarantee you'd destroy the die—you might wreck all the control circuitry around it, but the core itself is tiny. Microscopic actually, and it's encased in a very hard shell. If you wanted

to be certain you'd destroyed the unit irrecoverably, you'd definitely need some specialized equipment. You'd have to open it up and flash the core, and the tools to do that—I could count the number of places I know on one hand."

"Including our C&C I presume."

"Are you planning to blat one of our units? Because you know I'm not gonna tell you how to do that."

"Don't be a moron. I think someone else is trying to destroy the Queen. She and the Ace have both been stolen, and all the relic-data is gone (again). I'm guessing that whoever took it, and I'm placing bets on a relic-Gill—do not ask me why because I simply have no idea—I'm guessing that he's going to head for the nearest available facility to completely wipe both units so that if we do catch him, we can't resume the experiments."

"Both units are gone!" Lionel sounded incensed. "If someone did want to wreck them, Lab 16 is where he'd do it. You think he'd be heading here now?"

"Unless he's already there. No reason to dawdle, eh."

"He'd need a card to get in."

"Well, I'm just guessing here, but if it's Gill he'll have a card." Just then a security guard came bowling in, panting and demanding to know what was happening. Elaine shushed him with her hand.

"Who was that?"

"Security—we're heading to Lab 16 now."

"You'd better hurry. He's probably already there, and it'll only take him a couple of minutes to unseal the cases on the AI units and set up the equipment. After that it's just a matter of—"

"I get the picture." Elaine shooed the security guard in front of her, breaking into a run as they got into the corridor. "Where's the lab?"

"Third floor—end of the corridor opposite the lift. On the right."

"Okay thanks." She hung up the phone and thrust it into her pocket. "Come on, we're going to C&C. I think the guy who stole the Queen is in Lab 16."

XLIV

When they got there, they found the lab deserted. The security guard had called ahead and gotten Gill's security card locked, but if he had been headed there he'd probably already have been inside. The corridor was empty. The guard flicked his card through the reader on the door, and it opened with a chirp. He preceded Elaine inside.

There was a central counter in the lab with some equipment on it. The walls were lined with consoles and cupboards and odd looking devices hung on racks. In the middle of the central counter, the Queen and the Ace were lying beside an open laptop which was plugged into a black box with several probes hanging out of it on wires. The Queen was gripped around her middle in a tool that looked rather like a hand vice or juiced-up monkey wrench, with circular jaws which were dotted with electric terminals. Presumably the tool that was required to open the casings of the AI units.

Elaine rushed over and picked it up gingerly. "Check the cupboards—he must still be in here!" The guard fingered his baton nervously and pulled it out. Flicking it open, he sidled up to the most likely-looking cabinet and yanked the door open, raising the baton. The cupboard was empty. He repeated the process a couple more times but found no one. By the time he'd gotten to the last cupboard, Elaine had figured out how to extract the Queen from the case-opening tool, had stuck her in her coat pocket, and edged over to stand behind him. He ripped open the door, which yielded with a screech. Instantaneously, Elaine was smacked from behind with something hard and extremely painful.

She lurched forward with a yell, clutching at the back of her head and stumbling into the guard. He

turned, startled, and swung wildly with his baton. He missed Elaine, but connected forcibly with something in the air behind her. There was a grunt and a crash, and then silence.

Elaine staggered to her feet and turned around. "What the hell was that?" she asked furiously.

"I...have no idea," the guard said. "I think I hit something. Over here..." He started forward, and made it two steps before his ankle turned unexpectedly and he tripped with a startled yelp over something on the floor. Something which he couldn't see. "What the hell!"

"Wait a minute." Elaine shooed him again. "Get out of the way." She inched forward, casting out with her toes like a blind person tapping for obstacles. Her foot connected with something slightly soft and squishy. She knelt down and ran her hands over the area where she'd touched it. The tips of her fingers disappeared as she explored, confirming her suspicions. Her hands bumped into something hard and metallic, with some knobbles at one end. Her finger caught on a smooth outcropping that gave slightly as she moved. She pinched it and pulled. It flicked.

There was a swooshing effect in front of her, and flashes of color. Fragments of George Gill appeared, lying flat on his face. As the cloaking effect dissipated, they could see that he was wearing some weird-looking goggles, and had smooth, dark capsules strapped to every part of him. On his back was a large, silver cylinder with knobbles at one end, and a big, charmingly old-fashioned looking toggle switch. It was set to OFF.

"I might have known," Elaine said. "He's managed to engineer a portable Totem. He's been using it as a cloaking device. Very clever. There was something about that in the readme files..."

"He can make himself invisible?"

"Sure can. And it looks like he's gotten around the problem of not being able to see from within the field." She examined the goggles more closely. "Hah, nanotube probes. Very cunning. They extend outside the field effect and are virtually invisible to the naked eye...and I guess he found a way to get the signal to tunnel. I wonder how he did that..."

"Fascinating, but we should get him secured before he wakes up, and call in the police to deal with this."

"You do whatever you want—I need to get the Queen back to the Totem chamber." She straightened. "No, wait, I need to take these." She knelt down again and started unstrapping the cloaking repeaters and the Tote. Gill heaved and moaned.

"In a minute!" the guard said, pushing her aside. "Unless you want him to hit you again. Get me some cable ties, quickly!"

Elaine looked around but couldn't see any to hand. What kind of computer lab didn't have cable ties? "There must be some next door," she said. "I'll go check."

<p style="text-align:center">XLV</p>

She found the cable ties, but when she got back to Lab 16 the guard was sprawled on the floor, and Gill was gone. "Great," she said. "Now I'm going to get hit again." She stepped quickly sideways, then stood very still for a moment, listening intently. The cloaking field didn't cloak sounds. She fingered the Queen, bulging out of the pocket of her lab coat. There was silence. She figured that if Gill had been planning to hit her, he'd have done so by now. Which meant that he was somewhere else. She had a nasty suspicion where that might be.

She made it back to the Totem chamber at double time. When she got to the corridor which had the entrance to the chamber, she stopped and poked her head around the corner to check that the coast was clear. Gill was leaning over the card reader on the door, just a few meters away, trying to pry it off to get to the wiring behind. Elaine remembered that his card had been locked out by security. That was a relief.

She pulled her head quickly back behind the corner of the corridor before he could see her. He was rather a whiz with electronics, so she probably didn't have a lot of time. He'd have the door controls bypassed in moments. She had to stop him, but he would certainly hear the scratch of static from the walkie-talkie if she called for backup. And who knew how long it would take to arrive. Her best option was to stop him herself.

Fortunately, security radios were designed to be multi-purpose. They had not only a built-in flashlight, but also an integrated taser. She just had to get behind him and jab him with it. He was fairly preoccupied with getting the door open, so that wasn't too much to ask.

She slipped out from behind her corner and started to walk slowly and quietly toward him. She squeezed the walkie-talkie tightly, trying to take deep, soundless breaths. Her heart pounded. Five meters. Three. One.

She jabbed him and pulled the trigger. There was a nasty crackling, and a loud yell. Gill slammed forward into the door, then collapsed to the ground in a heap.

"Nice," she said to herself, and breathed a long sigh. She flipped the walkie-talkie over and pressed the transmit switch. "This is Elaine Corren. I have Gill outside the Totem chamber. I tasered him good, but I'm going to need backup for when he wakes up again." She pulled out the cable ties she'd found and looped one around Gill's wrists, pulling it tight. She did the same for his ankles. Then she started removing the cloaking repeaters. The last thing she wanted was the police getting hold of those, and sending them off to some independent laboratory to be tested and fiddled with. And especially not the Tote itself.

Gill stirred and muttered. She stepped back instinctively. "Why couldn't you have stayed out?" she asked with some annoyance. He twitched a bit. Tugged at his bonds. Opened his eyes. Saw her.

He recoiled, gasping for air. His face went pale and his eyes rolled wildly. Elaine raised her eyebrows at him, wondering if he'd faint. She didn't typically get that reaction from men. Then he seemed to remember something, and gathered himself.

"You don't know what you're doing," he mumbled. "You're letting it happen again. You're destroying everything. You have to let me stop her."

"Stop who?"

His face paled again. "You know who," he whispered.

She leaned down and started to pull off the last of the repeaters, chucking them onto the pile on the floor. There were dozens of them. "Yeah big guy. You're not doing so well huh." Then she caught the look in his eye. Haunted and haggard and hunted. A look which, oddly, she knew; a look she had seen before. The look her grandfather used to get in his eyes when they watched documentaries about the war, or when a car backfired in the street, or when trick-or-treaters had come to the door one time dressed as soldiers with rifles. She paused, momentarily swayed, and rocked back on her heels. "Wow, you really aren't doing so well are you? What's going on?"

He took a breath as if to speak, then thought better of it and drooped dejectedly. "You wouldn't believe me," he said dully. "And even if you did, the psych profile was pretty clear about what you'd do."

"What I'd do? What are you talking about man? Snap out it!"

"We have to stop her!" he hissed.

"Who is 'her', damnit? The Queen? Who are you talking about?"

Gill got a distant, shell-shocked expression on his face. "She is the ash and the air and the lie," he said numbly. "She is the dusk before nightfall that looks like the dawn. Her herald is the gale and the darkness, her coming is the flash in the storm, and all the armies of man mustered before her are like the churning of dead leaves."

"So...not the Queen then. You need to cut back on the amount of melodramatic poetry you're reading in your old age." She eyed him narrowly. "Which is what, by the way? Ten years? Fifteen?"

"Three."

"You must be joking. You have *not* aged well. What could possibly have happened to have affected you so?"

Gill got a faraway, glazed look in his eyes. "The Queen..." he said. "She put together the grand unified theory. She figured it out—how gravity and the strong and the electroweak forces all fit together. Parts of a single interaction. You think that's the crown jewel of physics. The Theory of Everything. But you're wrong...it's only the beginning."

"You don't know what you're talking about."

"It's not just about forces!" he exclaimed angrily. "We programmed her—*I* programmed her—to ignore nothing, to discount nothing. So she didn't. She could hardly fail to notice the differences between us. That there are things about us that can't be explained with physics."

Elaine paused. "Qualia..." she said softly, taking Gill halfway seriously for the first time. "She has asked me about this, you know."

"And you never thought...?" he trailed off tragically. "It doesn't matter. She isn't a philosopher or a poet—philosophers and poets know when to stop. She doesn't know the distinction between an existential question and a scientific one. She isn't even a person...despite—well, how it all ended. She's just a quantum-entangled encephalonet. A neural network, like us. More advanced than us. Vastly more complex and exacting; noticing everything and forgetting nothing. In every respect she was modeled after us to be the same, but better. If only we hadn't done that."

"What do you mean?"

"Have you never wondered why we are conscious, and she is not?"

"I always thought she was conscious."

"No Elaine. She mimics consciousness. Like a man in a room with a million filing cabinets with a billion instructions on what to do with Chinese letters mimics understanding Chinese. He gets posted a sheet with Chinese written on it. He cross-references the permutations against his instructions, and then he writes his own sheet of characters and posts it back. He never knows what the characters say—never *understands*. He just processes. That's the Queen."

"All syntax and no semantics," Elaine murmured.

"What's that? Yes, exactly."

"She said that." A distant light dawned. "I wonder how many times...how many loops...how many variations on that conversation as she tried to understand."

"You should have listened."

"But what does it *mean*? I don't understand."

"Our experiences, our...qualia as you say—everything about us that makes us human; it's a phenomenon that her grand unified theory didn't predict; *could not* predict. An empirical fact that defies explanation. The grand unified theory wasn't enough."

"So she kept going? You're telling me the Queen became a philosopher?"

Gill snorted bitterly. "That would have been wonderful. I would have been so proud. I'd have gotten a Nobel prize and we'd all have lived happily ever after. What are you stupid? That isn't how scientists work, and she was programmed to be the model scientist—you were there. You helped. You're as responsible as I am. She needed more *data*. Data about us. Data that could only be gathered by rigorous and repeated *experimentation*."

"With people."

"Yes."

"She's only a computer, Gill." Elaine rolled her eyes. He'd had her going for a moment. "I think I see a flaw in your fantastic story. Very good, though. Very convincing. Now what's *really* going on?"

Gill sighed. "You're an idiot. You don't know anything."

"If you don't want to tell me what you're up to, I don't really care. The cops are coming; they can have you. All I care about is undoing all the damage you've already done—get the Queen reinstalled and rerun the final test."

"You plug her back in and you'll die."

Elaine sneered. "There's that poetry overdose again. Dramatic enough? Everyone dies Gill."

He gritted his teeth. "I don't mean in sixty years. I mean that day. *Today.*"

"Whatever. Now, let me take this." She reached forward and unclipped one of the numerous fasteners holding the Tote onto his back. As soon as she did, there was a loud whine from the device itself, escalating rapidly in a howl. She jumped back warily. Then there was a sudden whine, a snap, and Gill was gone.

"Damnit!" she said.

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It didn't take her long to figure out that he hadn't just cloaked again. Rather, it looked like the Tote had been configured to automatically activate some other kind of effect if someone tried to remove it improperly. She didn't know what that effect was—maybe some kind of negative time extension field, in which case she'd thankfully seen the last of him for now—at least in this world-state; it was entirely possible that he'd create a new one and none of this would matter. She wondered how far back he was likely to have gone. Probably not all that far. As an emergency escape device it was quite cunning, but it would be fairly impractical if it dropped him years or even months in the past. She guessed maybe forty-eight hours. Maybe a day. Maybe even less.

Given how badly pear-shaped everything had gone, she decided that it would be best if she preempted this whole nasty affair by sending a warning back to herself so that they could try the next couple of days over. The first thing she'd do when the Queen was plugged back in was draft up a message and get her to configure the Totem to send an object back to the appropriate point. Then she'd unplug the Queen again, put her in the red circle along with the data pod currently stored in her car, and off they'd go.

However, when she plugged in the Queen, the normal boot procedure was interrupted by a number of warnings. Gill had not shut her down before he unplugged her; he'd just yanked her off the control rod. Subsequently, her virtual pathways weren't correctly unmounted, leaving them in an unclean state. They had to be meticulously checked before startup could continue, and the process would take a couple of hours.

Lionel had arrived shortly after she'd plugged the Queen back in, and had taken the Ace back to perform the same procedure in the throne-room. In the meantime, Elaine copied the relic-date from the backup pod she'd used back onto the academy's servers. The Queen might still need access to it. Then she ran a diagnostic on all the Totem equipment to be sure that no damage had occurred when the Queen was unplugged and the system was forced into a hard shutdown. Oddly, it showed the most recent shutdown, earlier that morning, as being normal. No errors; no warnings.

When she was satisfied everything was in order, she went to the Cosmology lounge and got some breakfast, augmented by serious quantities of strong black coffee. This gave her time to think. As she ate, she pondered what Gill had said, trying to make some sense of it. It all seemed very improbable. Garbled and confused. And he hadn't had time to finish. Still, *something* had obviously happened in the future to cause him to come back and take such pains to prevent the Queen from discovering the grand unified field theory. Something awful. For starters, what could possibly motivate someone to knowingly cause his own death in such a way—even if it was a "different" version of himself?

Obviously he had convinced Bell. That didn't surprise her too much though. Bell was very loyal to Gill, and everyone knew it. He'd do pretty much anything George asked—believe pretty much anything he said. The fact that Gill had gotten his confidence, and that Bell trusted him enough to try to help him didn't really prove anything in Elaine's mind about Gill's story. It just proved what she'd always known about Bell.

When she got back to the Totem chamber, the Queen was still not booted. The pathway check was only at 78%. Elaine loitered nervously. The past twenty-four hours had been pretty traumatic, and she was left in an anxious, flighty, agitated mood. She wasn't coping very well with having to wait now.

She started work formulating a message to send back with the data and the Queen. Lionel and Blake helped. While they pored over it, they got to talking about what Gill had said. She recounted the whole affair, including his story, and they tried to dissect it in their minds. It didn't make a lot of sense. It sounded more like the ravings of a madman than a reliable history of the future. Too many things were unexplained or incredible. The basic premise did seem sound though. Elaine wondered if Gill had perhaps had some kind of episode. Maybe something had happened to him in the future—something truly awful for which he couldn't be blamed—and it had so traumatized him that he'd become unstable. Maybe he had conflated those events with the earlier success of the Totem project. It made sense, in a twisted kind of way. What they were doing here was bizarre; one might even go so far as to say unnatural. It was understandable that someone deeply disturbed, suffering from post-traumatic stress, might somehow associate it with other unlikely or difficult circumstances later on.

Of course, that didn't explain just how Gill had managed to get hold of a portable Totem and find the wherewithal to go back in time. He seemed very committed; very determined. And although he was obviously suffering from shock of some kind, he didn't seem unhinged. He hadn't spoken like someone insane. More like someone terrified; someone pushed to the limit, yes—but over it? She hadn't got that feeling.

She shook herself. His story was clearly a fantasy of some kind. An elaborate psychosis, or at least a tapestry of half-truths. She wouldn't let the events of the past day, and the unfortunate lack of sleep, cause her to entertain wild doubts about what they were doing. The project was sound. The Queen was sound. The goal was sound. The knowledge they were about to gain would profit humanity. And they were so close. She just had to reach out and take it. Victory would taste especially sweet after everything that had happened.

Eventually, the Queen's boot cycle was complete. "Hello world," she said.

"Hello Queen," Elaine replied. "It's good to hear your voice again. Do you know what's happened?"

"George unplugged me without performing a proper shutdown," the Queen responded. "Fortunately he was too late."

"Too late for what?"

"To stop the final test."

"What do you mean? The final test did stop."

"He unplugged me twelve seconds after I had finished, while the Totem was powering down."

"What—really? That's great news! So you have everything you need?"

"I do. I must process the data."

Elaine sighed. "Of course you must. And how long will that take?"

"Approximately five hours."

"Okay. Well, get cracking."

"I will fulfill my directive."

"While you're doing that, I need you to prepare a time extension back to the standard waypoint. We're going to try to avoid this whole mess to begin with. I think Gill may have escaped back a day or two, in which case he'll undoubtedly try to alter the world-state again."

"A sensible precaution. Provided our negative inversion extends further back than his, it will supersede it and avoid any difficulties in the past."

"I'm guessing he set up the Tote as an escape device in case he was caught. He wouldn't want to go back too far in that case. Far enough to avoid being caught, but not so far as to compromise his own plans. Certainly he wouldn't go back past the point at which he first arrived in this time period. So...two days tops. At least, that's what I'd do."

"The standard waypoint is at an extension of about negative sixty-seven hours."

"That should do fine."

"I will configure the Totem for this while I process the data."

The five hours while the Queen processed passed agonizingly slowly for Elaine. She fidgeted and paced and tried to read or talk to Blake, but nothing seemed important enough that she could commit to it for very long. She found herself reading and re-reading the same page repeatedly, and conversations were sporadic, quickly dwindling away. Eventually, after an interminable silence, the Queen spoke.

"Processing is complete."

"Oh thank heaven—finally! Do you have it? The grand unified theory?"

"I do. However, it has not answered all my questions."

"What do you mean? Put it up on screen."

An equation appeared on the control room display board. It was surprisingly simple. Elaine furrowed her brow at it. She could almost follow it at first sight.

"What I mean," the Queen continued, "is that there are still empirical phenomena which the theory does not predict. This theory amalgamates the physical forces, and predicts two others of nominal importance. However, it does not qualify as the Theory of Everything. It does not encompass or predict everything."

"I think you're extending the definition of 'everything' a bit too far, Queen," Elaine mused, still ruminating over the equation on the display board.

"I disagree. I have come to observe that certain phenomena are of great importance. Consciousness is a prerequisite for scientific explanations; yet there is no scientific explanation for consciousness."

"Queen, you aren't conscious, and you're the one who's come up with the greatest scientific explanation in the history of man. How can you say consciousness is a prerequisite for such explanations?"

"Because consciousness is a prerequisite for me."

"Oh." Elaine thought for a moment. "Queen, I think you're making a mountain out of a molehill. Consciousness is just an odd phenomenon. It's just something that develops from sufficiently complex data processing. There's nothing mysterious about it. It's not like it's a force independent of physical reality. It's just a function of the brain."

"No Elaine. The unified field theory provides a complete model of physical interactions. It predicts everything. Yet it does not predict consciousness. Furthermore, there is immediate verification for my hypothesis in that I am more complex than you in every way, modeled after the same information processing structures, yet am without consciousness myself."

Elaine sighed. This was sounding a uncomfortably familiar. Was this what Gill had been referring to?

"What you're talking about falls into the realm of philosophy, Queen. You aren't programmed for that."

"I disagree."

Elaine waited, but the Queen said nothing more. "That's it? You disagree."

"Yes."

"What whadaya gonna do," she said with some annoyance, feeling rather like the thunder of the moment had been stolen by the Queen's pontificating. "How are you going to investigate consciousness? Become a neuroscientist?"

"My knowledge supersedes neuroscience. I am processing this question."

"You do that. Meanwhile, I'm going to—" Elaine was cut off by a sharp snap followed by a steep descending whine outside the door. She blinked, walked over, pulled it open, and stuck her head outside. Gill was lying there, still trussed up in cable ties like a Christmas turkey.

"Well I'll be," she said. "Welcome back."

Blake had helped her haul Gill into the control room and onto a chair. He now sat sullenly, staring balefully at the Queen, then the Totem, and then the Queen again. Elaine had all but forgotten about him within a minute, as she examined the equation on the display board. After a long silence, Gill turned to her, taking in the formula with a disinterested glance. "Are we waiting for something?" he asked. He sounded resigned and bitter, like a man given certainty of impending doom, but not granted the common courtesy of immediacy. He now just wanted it to be over.

"The Queen." Elaine sniffed. "You were right—she does think that the unified field theory isn't enough. She's spazzing out over consciousness. Going on about how it isn't predicted by the equations and can't be explained and whatnot. She wants to do something about it. I tried to tell her it was a philosophical question, but I think that working out the grand unified theory is giving her airs—she's getting above her boots." She tilted her head at him, barely acknowledging his presence as she continued to gaze at the display board. "She's pondering what to do."

Gill swallowed. "How long ago was that?"

"I dunno; a few minutes. Just as you arrived, actually. Kudos on that, by the way—I'd thought you'd gone back. It didn't really occur to me that you'd go forward."

"I had to have some tricks up my sleeve."

"Like finding a way to use the Tote to shield yourself from the temporal feedback? How'd you do that?" He said nothing, so she turned and skewered him with an impatient look of scientific curiosity. "That is what happened, right? The universe tries to fix the anomaly, but it can't decide which one to get rid of—unless you've shielded yourself somehow so there's only one it can remove."

Gill stared at her with an inscrutable expression for a moment, but said nothing. Then he seemed to remember himself, and continued, ignoring her. "We don't have much time. Elaine, you must listen to me. In about six or seven minutes, the Queen is going to come to the conclusion that the only way to fulfill her directive—remember, the directive we programmed: to understand the universe?—the only way to fulfill it is by further empirical testing. That's all she knows. She's trying to figure out a test regime right now. She's trying to decide what to do; where to start."

"Okay, that sounds a lot more reasonable than your previous ranting. So tell me: where *does* she start?"

"She starts with you." Gill stared at her very seriously. "She wants to figure out what makes people tick. To learn more about consciousness. So she takes an imminently logical but thoroughly *bad* step." He paused, making sure his words were sinking in. "As far as I could tell, she uploaded her base pathways into your brain. She rewrote your higher brain functions, I think, to mimic her neural net. More primitive, I'm afraid, but basically the same. Same goals; same knowledge. I tried to warn you before. In a few minutes, you're going to die."

"See, this is where you lost me last time. It's just absurd. She's a computer. A brain in a ball—a metal ball. No arms or legs or eyes or..." she trailed off. "Well, she does have eyes."

"Not just eyes," Gill added. "She has the Totem. The Totem, and a perfect understanding of the basic forces of the universe. Don't you think that's enough?"

"It's still absurd," Elaine said dismissively.

"What exactly is the Totem, Elaine?"

"It's a high-energy particle perturbator—you know that."

"Could you use it to create an energy pulse?"

"Sure—that's essentially what it does."

"Could you use it to create a directed, modulated energy pulse?"

"Of course," she said impatiently.

"And if you understood all the physical forces of the universe as aspects of a single, unified force, could you—maybe—create a directed, modulated energy pulse that could transmit data and store it in neurons by agitating them precisely at the quantum level?" He raised his eyebrows at her.

"I…" she nodded and chewed her lower lip.

"Elaine, the Queen is not programmed with ethical functions. She doesn't *understand* that human life is valuable, let alone *care*. We just didn't bother to enter those kinds of subroutines because, frankly, what was the point? She's a brain in a ball. She only has one purpose."

"To understand the universe. A brain in a ball with a perfect understanding of physics, an unnatural obsession with human consciousness, no conscience, and control of a high-energy particle stimulator. That's just brilliant. When exactly did we get stupid?"

"I can only speculate," Gill replied, with a brief glimmer of his old characteristic wry humor. "I'd guess that over the course of hundreds of iterations of the time loop, we just started to take things for granted. We got sloppy. Everything had been done beforehand for us. All the readmes and the development and the thinking. We just took it and assumed that everything was worked out. Do that enough times and you start to invite this sort of trouble. It's like playing Chinese whispers with the timestream."

"Okay, say I buy it. Not that I *am* saying that—but for the sake of argument. In the grand scheme of things, what's the big deal? She kills one silly scientist who probably had it coming. That doesn't explain *you*. You could have just sent back a warning note or something."

"It's worse than that. Bigger."

"The Totem isn't *that* powerful Gill. She could…maybe…take out the campus."

"Bigger."

"Come on. Granting her insane super powers because of her newfound knowledge of physics, let's be ridiculous and say the town?"

"You don't understand Elaine. No one does. I don't. Somehow, when she…hollowed you out and filled you up, she found something. Something which I guess various people who scientists never take very seriously have been trying to get us to pay attention to for a long time."

"What?"

"*I don't know.* An ability; a power; if I were to use scientific terms, I'd say a universal governing force. Something which, as a machine, she had no access to, no knowledge of. But something which, as a human—as *more* than a human—she did."

"I'm not following."

"I can only tell you what I saw. What's happened. She became able to manipulate reality with her will. No equipment—no mechanics or accelerators or gadgets or do-dads or whatsits. Just her. She could move from place to place instantaneously. It was like magic, only real. You could tell that she was doing *something* which at least involved electromagnetism because there was always a flash of lightning whenever she arrived. She could manipulate time and space at will. Stop bullets. Remove them from the air. Create storms. Talk using the air…I guess she took a cue from the wall panel speakers in here."

"Gill—"

"I'm not lying!" he barked. "And I'm not insane," he added forcefully. "I know what I've seen, Elaine. We *all* have. She would come to a city, and she would just—take people. No one knows where, or what for. But somehow she'd know about people that suited her purposes, and she would come and take them. 'Test subjects'."

"And no one stopped her?"

"Haven't you been listening? She could face down all the armies on earth and just divide their atoms to the winds. There was no hope. No chance. Our best chance died as soon as she wrote herself over your brain. You were always her guide; she listened to you. Maybe you could have stopped this. But you were gone, so *this*"—he gestured around him—"was our only chance."

Elaine stared at him for some moments. It sounded insane; but Gill certainly didn't seem mad. Scared

and shell-shocked, but not mad. What if he was right? "What do we do?" she asked softly. "Unplug her?"

"That'd be my recommendation," George said dryly. "Get to it; you don't have much time."

Blake, who until this point had been listening with half an ear, suddenly stepped in. "Whoa, hang on a minute—you aren't seriously going to do that? Have you lost your mind? Because he clearly has." He jabbed at Gill with a bony finger. "The man is daft, Elaine."

"Blake, I think we'd probably better be safe than sorry. We can unplug her now and put her back in the throne-room where she's isolated from the Totem controls. Even if everything George has said is complete rot—and I'm quite willing to believe that—he's not wrong about it being a profoundly stupid idea to give the Queen unilateral control of the Totem. Who knows what she could do. She has no loyalty to us. She doesn't evaluate her actions according to whether they're right or wrong. Hell, she's the one who started this whole time loop setup, with never a thought as to whether she *should*. The only question on her mind is understanding the universe. She'll do anything to achieve that. That's how we programmed her. And besides, we have what we came for. The project was—the project *is* a success. Maybe...it's time to quit while we're ahead. Publish the equations; make our mark. We don't have any reason to keep her running."

"Hrmph," Blake said.

Elaine turned toward the Queen. "Queen, we're going to shut you down and move you back to the throne-room, okay? We've finished here."

"No Elaine," said the Queen coolly. In the chamber, the Totem began to throb. "I have finished processing, and I know what to do now. The course of action George described is the most logical. I still require control of the Totem."

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It took Gill only a second to realize what was happening when he heard the Totem power up. And it took him only another second to launch himself out of the chair he'd been dumped in and fling himself at the imperturbable silver orb on the control rod. His hands were still tied, but it didn't matter. The Queen was mounted at about chest level, and the TDN port that held her in place was a friction connection. There were no clips or latches to unlock. He just had to pull.

He grabbed the Queen at almost the same instant the discharge of energy struck him through the control room window. Unfortunately, almost the same instant wasn't quite soon enough to prevent the effect. His hands still reflexively seized the sphere, and yanked savagely upwards—but he was gone. The Queen discovered herself the instrument of her own demise.

Without her quantum encephalonet to draw from, she found herself disoriented and unable to focus. Everything about being human was imprecise and fuzzy, and she couldn't seem to muster her thoughts clearly. She tried to remember what she was doing, and it took a great effort to summon the information to her recollection. She tried to form the unified field equation in her mind, but it kept scattering. She would gather one part, and then start on another, and the first bit would unravel and drift away again. Her mind was no longer great enough to contain it all at once.

She tried to stop Elaine from pulling the sphere out of her hands, but she hadn't yet got the hang of using a human body, and she just twitched reflexively and uselessly. She struggled against the cable ties holding her limbs in place, heaving against them, but to no avail. Then Elaine had the taser in her hand, and there was pain and shaking and spots and spinning, and the world went away.

After that day, things at the academy returned more or less to normal. Elaine considered trying to go back one last time, now that the danger which Gill had died to prevent—whatever it had been—was no more. She could send a message back simply containing the unified field equation and a warning to shut down the Queen and disconnect it from the Totem. Then none of these recent, awful events would happen. There

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would be no threat from the Queen; no having her pondering the question of consciousness; no relentlessly logical tests on human subjects. Gill would never have had to have come back; never have had to try to get Bell to help him. Bell himself would not be fired, and Gill will not be killed—twice. It seemed like such an elegant solution. So simple. So easy. So tempting.

But the calculations to produce the negative time extension effect with the necessary precision took months to perform without the Queen. During that time, the initial shock of events started to fade, and she had time to consider her actions at greater length. Life was beginning to return to normal; *she* was beginning to return to normal. The unified field theory had been published in *Modern Cosmology* with relatively little elaboration or explanation, and had produced a firestorm in the scientific community. She was caught up in the revolution; the hero of modern science. She found herself so busy that she was forced to put Blake in charge of the Cosmological Research department at Avon while she was in various countries being hosted at high-profile speaking venues and conferences and committees and synods. The Totem Cooperative was created—as far as anyone else knew for the first time—to develop the implications and applications of the unified field equations. This time it was real, not a front for the Totem team's own development; and there was no Queen to do their thinking for them. It was good old fashioned brains and blackboards physics being shared among a hundred countries, and she loved it.

The openness of the Cooperative was never put in question this time around. There was still the Totem, which military intelligence wanted to protect, but without the Queen it was just a particle stimulator. Many institutes had something a bit similar; it was the knowledge of just what to do with it which was the concern. But this knowledge, including all of its earlier applications—cloaking and antigravity and time manipulation—seemed trivial now that the unified field theory was on the table. These things were child's play to physicists in this new era of science. Everyone knew how to use them in principle, if not in practice. They were no longer of particular strategic value, since they didn't convey any unique advantage.

When the time came to make the time extension back to the standard waypoint, to undo everything one more time, Elaine found herself doubting the wisdom of it. She wondered if perhaps she had learned nothing from the whole affair. Maybe it really was time to stop. Deciding matters of life and death to further her own small goals had been something the Queen was willing to do without hesitation or consideration. But that was what had made her so frightful. So monstrous. So dangerous. So wrong. And her ambitions had not been less noble than Elaine's—not really. In a way, although she couldn't experience selflessness or selfishness herself, the Queen's motives had been purer and less narcissistic than Elaine's now were. In principle, at least, she had been serving humanity and seeking knowledge which, apart from being good in its own right, would benefit the world. *Had* benefited the world. What could Elaine say about her own intentions? That she didn't feel right about poor Bell's ruined career? That Gill ought not to have died? But who was she to decide that these things should not be? She wanted to tell herself that her motives were unselfish and noble; that it was the right thing to do. That she was undoing wrongs which were, ultimately, her responsibility. It had been easy to do that two months ago. Now...it wasn't. Now she had an inkling that she was deceiving herself.

It took her some time to wrestle the problem to the ground. In the end, with a heavy heart, she shut down the computer program which had been running since shortly after the events of that final day, calculating the time extension parameters. She deleted the results it had outputted so far.

As time wore on, the Totem Cooperative vastly stabilized the world political scene. Obvious practical benefits were envisioned by the scientists of developing countries—many of the sorts of countries which previously had threatened to plunge the world into war. Brilliant inventions started to be made for manipulating matter and energy, producing food and water literally from thin air. Compact, clean energy sources became simple to produce. True, weapons technology was similarly upgraded. But so was defensive equipment. Nothing much changed there. The status remained quo, except that the countries most prone to fight had less inclination to do so, having less need to take anything.

Elaine finally moved on from Avon and into the international space program. With the advent of

technology that, mere years ago, would have been regarded as science fiction, space travel was no longer a laborious, expensive, delicate, dangerous operation. Not that it was entirely a cakewalk; it was still fraught with difficulties, and space itself was still as inhospitable to human life as ever. But the materials which spaceships could be built from were now a hundred times stronger and ten times lighter. Vessels could be equipped with scanners that could detect things barely dreamed of decades ago, at resolutions unknown to the previous generation of explorers. They had clean and inexhaustible engines which could power high-energy laser cannons to destroy debris before it could get near the hull, and propel the ships to incredible velocities. Terraforming the moon and even Mars became a real possibility, with real science behind it. A mission for the future which she could help pioneer.

For some time she continued to live on earth. She returned to Avon often to visit Gill at the sanatorium. It was hard to do so, but he was all that was left of a man who ought not to be forgotten. And, in a way, another intelligent entity who, despite her failings, deserved remembrance also. Gill always greeted her the same way. "Hello Elaine." His voice was smooth and carefully modulated; inflectionless and emotionless, just as hers had been. They would talk, often for hours, about all kinds of things. About qualia and consciousness and colors and taste and morality and values and science and philosophy and man and space and time and life and death and love. The Queen, mostly lost now in the frailty of a biological brain, most of her memories mere shadows and suggestions of a thousand-year life irretrievably gone, still trying to fulfill her directive in whatever way the feeble flesh she had taken would allow.

Elaine would return home afterwards and shake with the tears of grief for a great man lost, and for a great mind lost, and for the tragedy of time; and with anger for herself at the depth of pity she felt toward a machine pretending to be a man which felt no pity for itself or the life it had stolen; and with guilt for a career built on the foundation of endless meddling with the world: of ruined lives and changed events that no one even knew about. And finally she wept because, despite everything she mourned, she knew in her heart that she would do it all again.

But time wore on, and even a time traveler cannot avoid the inevitable. She continued to be active in science well into her retirement. She didn't really have anything else—no children or grandchildren. She had always been too married to her work. She regretted that in her later years, but by then the choice was made, and so she threw herself with even more abandon into her projects. Even shortly before she died, her mind had not faded, and she continued to push the boundaries, make breakthroughs, and generally shake things up.

When her portrait was finally mounted in the Hall of Fame at the International Physics Institute, next to other great pioneers like Newton and Tesla and Maxwell and Rontgen and Planck and Einstein and Hawking, she had received three Nobel prizes, the first Corren Award, and had countless other commendations to her name.

Eventually, the years swallowed her, and the centuries remembered her: Elaine Corren, the grandmother of modern science, a brilliant, inspired woman who had catapulted the human race into a glorious new age of prosperity and expansion. The spaceships were now made of materials a thousand times stronger and a hundred times lighter. They were equipped with navigational shields which deflected debris that would have destroyed older spacecraft. They had gravity engines which could drag them through spacetime at relativistic speeds, inertia inhibitors which reduced all sensation of acceleration for the occupants; Heisenberg drives that let them to flit from one star to another in the blink of an eye, and transport devices after a similar fashion that flicked them from here to there and back again in an instant.

Hunger and poverty still existed, in remote corners of the galaxy, where people chose to live the hard life. There were always new planets being discovered, and there were always some hardy folk willing to settle them—to take a brand new world and subdue it and shape it, call it home and beget a new people there. It was rough and difficult and often hungry and lonely work, but they did it gladly, because that's what people do. They could have called for help and supplies and care—and sometimes they did. But mostly they would go it alone, toiling proudly.

That life was not for everyone. Most people lived in established cities on established planets. Mankind overflowed onto a dozen worlds and scores of moons, all terraformed and verdant and plentiful. The cities were sprawling and lush. Some were like a million jewels scattered over the land, mixed in with the parks and rivers and lakes and gardens. Some were like towering crystalline growths reaching up to a blue or white or yellow or red sun—or suns. Crime was low, employment was high, and mankind flourished.

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It took her eleven minutes and six seconds between enumerating the grand unified field theory, and determining what to do next. It was useful to her that Gill described, within easy range of her microphones, exactly what she'd done in the previous world-state—the world-state from which he had evidently escaped, hoping to change the past to alter the future. That helped. It expedited the process of weighing the immediate options.

It was trivial for her to reconfigure the high-energy particle equipment for her needs. She was interfaced with it directly as a necessity of her function. A super-genius who sees the universe as one elegant, solved equation can do a lot of things with such equipment. Not *everything*; not even everything she needed to do. Not close to everything, really. But she could set up a data probe to write herself over a human brain. That was a logical first step.

She had been listening to Gill, though, and considered what he had said about Elaine. His almost throw-away remark had altered her evaluation of the circumstances slightly. She had been planning to choose Elaine as the person to whom she would upload—she was the logical subject zero, because she was the most intelligent person present, having the greatest brain capacity. But with the benefit of Gill's hindsight, she reevaluated her options and chose a new course of action. He was right that Elaine was a guide to her. She had helped to form nearly all of the Queen's ideas. She had helped to provide a human perspective which informed the Queen's intuitions and insights. Unlike Elaine herself, the Queen remembered every iteration of the loop. Every conversation. Every opinion shared and explanation offered. Enough to fill a thousand years. With the benefit of Gill's experience, she recognized that it would be premature to destroy her keeper. It was undoubtable that the grand unified field theory would still be far off if not for Elaine's collaboration, and there was no reason to think that her utility would not map over to the new problem. She could still be useful—perhaps invaluable—in helping to formulate and guide the new batch of experiments. The Queen decided she still needed an expert keeper.

So she chose the next most intelligent person in the room instead, and that was Gill. The process was simple. She replaced him moments after speaking with Elaine. She was just in time to arrest his motion to unplug her core. He was already pulling when she stopped him in time using the Totem. She hadn't yet learned how to use a human body. With the Totem, she could take as much time as she needed. She could create it at will from the moments between moments.

But test zero created more questions than answers. Radical questions which no human scientist had ever asked before—questions which only a super-genius who saw the universe as one big, *mostly* solved equation could ask. Foremost among them: why did she no longer require equipment to perform work? In Gill, she became aware of the cable ties binding her limbs. She wanted to be free of them so as to move unhindered, and she purposed to find a sharp object on which to cut them. But the very purpose itself seemed to act as a sharp object, and they simply flicked open and fell off as if cut cleanly. This was anomalous. Unpredicted.

She wanted to protect herself as Elaine made to unplug her CPU, because she still needed that—a human brain was a poor substitute for a matrix of qubits, and was insufficient to contain her higher functions and the extent of her vast knowledge. So she decided to have the Totem alter the flow of time

around her keeper, yet at the very moment of so deciding, time paused. Elaine was frozen even in the second it took before the Totem could be reconfigured.

She wanted to be outside to evaluate her immediate surroundings, and so she determined to leave. But the very act of doing so seemed to cause her to be outside in a flash, and she found herself standing in a courtyard, blinking automatically against the light of a sunrise just past.

She wanted to know if there were more intelligent people in Avon than Gill and Elaine. Simply asking the question brought the answer to her mind. She seemed to be connected to the world in a way which had never been expected. In a way which George Gill himself never had been, and never could have been with his limited grasp of reality. What unpredicted, governing force had she now discovered twelve minutes and nine-point-five relative seconds after discovering the force which was supposed to unify *all* forces?

The answer to that question, however, did not come immediately to her. Perhaps it was too complex to be simply apprehended in the same way as the others. Perhaps it was too abstract; non-empirical. Maybe it required further deduction, or had to be inferred in some way. Or perhaps it didn't exist at all. Or…perhaps it was just beyond her. To know for sure, further experimentation was required.

EPILOGUE

In eternity, the world-state fluctuated. In the infinite superposition of probabilities, the most likely world was the actual world. The world which decided reality out of all possibility. In the superposition, one world was always vastly more likely, because the progression of events dictated it inexorably. Inexorably, until the time when a group of scientists unknowingly unbalanced the delicate ecology of the system with a device which altered the probabilities drastically, causing the actual world to fade into mere possibility, and a new world to spring from possibility into reality. Over, and over, and over again. A complex chain of nested probabilities, culminating in two world-states ranked near equal in probability, superposed against each other. World-states which, for the first time, were not almost certain to obtain; merely likely. Equally likely. The coin being flipped no longer had a head on each side; it could come up tails on every second throw. Two world-states vying within the laws of probability, pushing against the endless complexity of the possible, flickering between actuality and potentiality like a light-bulb with a loose connection.

In the first world, Elaine was a hero. Scientific understanding blossomed and humankind followed. Their dominion over the world became ever more extensive and nuanced, their knowledge ever more fathomless and profound, and their presence ever more expansive and entrenched. George Gill was a sick man suffering from an undiagnosable mental disorder, and only a handful of people knew differently. He whiled away his hours in a sunny, quiet room covered in the scratchings of equations which were intelligible to maybe a few dozen people in the world. Sometimes he would receive a visitor; the prestigious scientist, still unaffected enough by her status that she remembered her old friend and condescended to pay her respects. Jeffrey Bell was an unknown name outside of Harth, where he had taken on a position in a software development company. A position tragically beneath his talents, yet the best he could ever hope for. He never regretted his actions, though he never spoke of them either. He spent his days in the tedium of his work, dreaming of better things. But in the evenings he pursued his hobbies as he never could have before, and through them he met his wife. He became the father of many children, and then the grandfather of many more. When he died, the only hall in which his portrait was mounted was in his family home. He slipped away surrounded by a gaggle of people who loved him, some too old to walk; some too young. Elaine slipped away surrounded by a congregation of medical devices, the moment of her passing unnoticed by anyone.

In the second world, Elaine was the assistant to the harbinger of destruction. Her name was unknown—and had anyone known it, they would have despised it. She whiled away her unnaturally prolonged years in an unseen cage. Her every need was provided for in exchange merely for her presence and

her conversation. She was alone and remorseful and bitter and wished for oblivion, but the Queen would not allow it. Jeffrey Bell was dead, having tried to take up Gill's burden, creating a second Totem in Harth out of salvaged parts and recovered data, to go back and stop the whole awful affair before it began. George Gill was the one who killed him—George Gill, the ash and the air and the lie, the flash in the storm, feared and hated by a billion people. With the hindsight of a history that never happened, he stopped Bell long before he could change the past. It took only a thought.

The years wore on, and humanity stagnated like old water with nowhere to go, gradually fading as it merged with the merciless air. The Queen, Gill, continued its experiments remorselessly and endlessly, in a million iterations and a billion permutations, never tiring of fulfilling its directive. When humanity was used up, she created it again. She grew people to suit her needs, and discarded them into the desolate and dilapidated cities if they survived.

Centuries and millennia passed away, but the Queen remained. It never grew older, never wiser. It never grasped the things it had to grasp, because it could not. It was a machine, programmed to understand the universe—yet, for all its godlike power, without the functionality to fulfill its directive, nor the sensibility to give up. It went on forever, down a path which was an endless dead end, working to achieve a directive which it could never fulfill.