

# Singleton

## by Greg Egan

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2003

I was walking north along George Street towards Town Hall railway station, pondering the ways I might solve the tricky third question of my linear algebra assignment, when I encountered a small crowd blocking the footpath. I didn't give much thought to the reason they were standing there; I'd just passed a busy restaurant, and I often saw groups of people gathered outside. But once I'd started to make my way around them, moving into an alley rather than stepping out into the traffic, it became apparent that they were not just diners from a farewell lunch for a retiring colleague, putting off their return to the office for as long as possible. I could see for myself exactly what was holding their attention.

Twenty metres down the alley, a man was lying on his back on the ground, shielding his bloodied face with his hands, while two men stood over him, relentlessly swinging narrow sticks of some kind. At first I thought the sticks were pool cues, but then I noticed the metal hooks on the ends. I'd only ever seen these obscure weapons before in one other place: my primary school, where an appointed window monitor would use them at the start and end of each day. They were meant for opening and closing an old-fashioned kind of hinged pane when it was too high to reach with your hands.

I turned to the other spectators. “Has anyone called the police?” A woman nodded without looking at me, and said, “Someone used their mobile, a couple of minutes ago.”

The assailants must have realised that the police were on their way, but it seemed they were too committed to their task to abandon it until that was absolutely necessary. They were facing away from the crowd, so perhaps they weren't entirely reckless not to fear identification. The man on the ground was dressed like a kitchen hand. He was still moving, trying to protect himself, but he was making less noise than his attackers; the need, or the ability, to cry out in pain had been beaten right out of him.

As for calling for help, he could have saved his breath.

A chill passed through my body, a sick cold churning sensation that came a moment before the conscious realisation: *I'm going to watch someone murdered, and I'm going to do nothing*. But this wasn't a drunken brawl, where a few bystanders could step in and separate the combatants; the two assailants had to be serious criminals, settling a score. Keeping your distance from something like that was just common sense. I'd go to court, I'd be a witness, but no one could expect anything more of me. Not when thirty other people had behaved in exactly the same way.

The men in the alley did not have guns. If they'd had guns, they would have used them by now. They weren't going to mow down anyone who got in their way. It was one thing not to make a martyr of yourself, but how many people could these two grunting slobs fend off with sticks?

I unstrapped my backpack and put it on the ground. Absurdly, that made me feel more vulnerable; I was always worried about losing my textbooks. *Think about this. You don't know what you're doing*. I hadn't been in so much as a fist fight since I was thirteen. I glanced at the strangers around me, wondering

if anyone would join in if I implored them to rush forward together. But that wasn't going to happen. I was a willowy, unimposing eighteen-year-old, wearing a T-shirt adorned with Maxwell's Equations. I had no presence, no authority. No one would follow me into the fray.

Alone, I'd be as helpless as the guy on the ground. These men would crack my skull open in an instant. There were half a dozen solid-looking office workers in their twenties in the crowd; if these weekend rugby players hadn't felt competent to intervene, what chance did I have?

I reached down for my backpack. If I wasn't going to help, there was no point being here at all. I'd find out what had happened on the evening news.

I started to retrace my steps, sick with self-loathing. This wasn't *kristallnacht*. There'd be no embarrassing questions from my grandchildren. No one would ever reproach me.

As if that were the measure of everything.

“Fuck it.” I dropped my backpack and ran down the alley.

I was close enough to smell the three sweating bodies over the stench of rotting garbage before I was even noticed. The nearest of the attackers glanced over his shoulder, affronted, then amused. He didn't bother redeploying his weapon in mid-stroke; as I hooked an arm around his neck in the hope of overbalancing him, he thrust his elbow into my chest, winding me. I clung on desperately, maintaining the hold even though I couldn't tighten it. As he tried to prise himself loose, I managed to kick his feet out from under him. We both went down onto the asphalt; I ended up beneath him.

The man untangled himself and clambered to his feet. As I struggled to right myself, picturing a metal hook swinging into my face, someone whistled. I looked up to see the second man gesturing to his companion, and I followed his gaze. A dozen men and women were coming down the alley, advancing together at a brisk walk. It was not a particularly menacing sight — I'd seen angrier crowds with peace signs painted on their faces — but the sheer numbers were enough to guarantee some inconvenience. The first man hung back long enough to kick me in the ribs. Then the two of them fled.

I brought my knees up, then raised my head and got into a crouch. I was still winded, but for some reason it seemed vital not to remain flat on my back. One of the office workers grinned down at me. “You fuckwit. You could have got killed.”

The kitchen hand shuddered, and snorted bloody mucus. His eyes were swollen shut, and when he lay his hands down beside him, I could see the bones of his knuckles through the torn skin. My own skin turned icy, at this vision of the fate I'd courted for myself. But if it was a shock to realise how I might have ended up, it was just as sobering to think that I'd almost walked away and let them finish him off, when the intervention had actually cost me nothing.

I rose to my feet. People milled around the kitchen hand, asking each other about first aid. I remembered the basics from a course I'd done in high school, but the man was still breathing, and he wasn't losing vast amounts of blood, so I couldn't think of anything helpful that an amateur could do in the circumstances. I squeezed my way out of the gathering and walked back to the street. My backpack was exactly where I'd left it; no one had stolen my books. I heard sirens approaching; the police and the ambulance would be there soon.

My ribs were tender, but I wasn't in agony. I'd cracked a rib falling off a trail bike on the farm when I was twelve, and I was fairly sure that this was just bruising. For a while I walked bent over, but by the time I reached the station I found I could adopt a normal gait. I had some grazed skin on my arms, but I couldn't have appeared too battered, because no one on the train looked at me twice.

That night, I watched the news. The kitchen hand was described as being in a stable condition. I pictured him stepping out into the alley to empty a bucket of fish-heads into the garbage, to find the two of them waiting for him. I'd probably never learn what the attack had been about unless the case went to trial, and as yet the police hadn't even named any suspects. If the man had been in a fit state to talk in the alley, I might have asked him then, but any sense that I was entitled to an explanation was rapidly fading.

The reporter mentioned a student "leading the charge of angry citizens" who'd rescued the kitchen hand, and then she spoke to an eye witness, who described this young man as "a New Ager, wearing some kind of astrological symbols on his shirt." I snorted, then looked around nervously in case one of my housemates had made the improbable connection, but no one else was even in earshot.

Then the story was over.

I felt flat for a moment, cheated of the minor rush that fifteen seconds' fame might have delivered; it was like reaching into a biscuit tin when you thought there was one more chocolate chip left, to find that there actually wasn't. I considered phoning my parents in Orange, just to talk to them from within the strange afterglow, but I'd established a routine and it was not the right day. If I called unexpectedly, they'd think something was wrong.

So, that was it. In a week's time, when the bruises had faded, I'd look back and doubt that the incident had ever happened.

I went upstairs to finish my assignment.

Francine said, "There's a nicer way to think about this. If you do a change of variables, from  $x$  and  $y$  to  $z$  and  $z$ -conjugate, the Cauchy-Riemann equations correspond to the condition that the partial derivative of the function with respect to  $z$ -conjugate is equal to zero."

We were sitting in the coffee shop, discussing the complex analysis lecture we'd had half an hour before. Half a dozen of us from the same course had got into the habit of meeting at this time every week, but today the others had failed to turn up. Maybe there was a movie being screened, or a speaker appearing on campus that I hadn't heard about.

I worked through the transformation she'd described. "You're right," I said. "That's really elegant!"

Francine nodded slightly in assent, while retaining her characteristic jaded look. She had an undisguisable passion for mathematics, but she was probably bored out of her skull in class, waiting for the lecturers to catch up and teach her something she didn't already know.

I was nowhere near her level. In fact, I'd started the year poorly, distracted by my new surroundings: nothing so glamorous as the temptations of the night life, just the different sights and sounds and scale of the place, along with the bureaucratic demands of all the organisations that now impinged upon my life, from the university itself down to the shared house groceries subcommittee. In the last few weeks, though, I'd finally started hitting my stride. I'd got a part-time job, stacking shelves in a supermarket; the pay was lousy, but it was enough to take the edge off my financial anxieties, and the hours weren't so long that they left me with no time for anything but study.

I doodled harmonic contours on the notepaper in front of me. "So what do you do for fun?" I said. "Apart from complex analysis?"

Francine didn't reply immediately. This wasn't the first time we'd been alone together, but I'd never felt confident that I had the right words to make the most of the situation. At some point, though, I'd stopped fooling myself that there was ever going to be a perfect moment, with the perfect phrase falling from my

lips: something subtle but intriguing slipped deftly into the conversation, without disrupting the flow. So now I'd made my interest plain, with no attempt at artfulness or eloquence. She could judge me as she knew me from the last three months, and if she felt no desire to know me better, I would not be crushed.

"I write a lot of Perl scripts," she said. "Nothing complicated; just odds and ends that I give away as freeware. It's very relaxing."

I nodded understandingly. I didn't think she was being deliberately discouraging; she just expected me to be slightly more direct.

"Do you like Deborah Conway?" I'd only heard a couple of her songs on the radio myself, but a few days before I'd seen a poster in the city announcing a tour.

"Yeah. She's great."

I started thickening the conjugation bars over the variables I'd scrawled. "She's playing at a club in Surry Hills," I said. "On Friday. Would you like to go?"

Francine smiled, making no effort now to appear world-weary. "Sure. That would be nice."

I smiled back. I wasn't giddy, I wasn't moonstruck, but I felt as if I was standing on the shore of an ocean, contemplating its breadth. I felt the way I felt when I opened a sophisticated monograph in the library, and was reduced to savouring the scent of the print and the crisp symmetry of the notation, understanding only a fraction of what I read. Knowing there was something glorious ahead, but knowing too what a daunting task it would be to come to terms with it.

I said, "I'll get the tickets on my way home."

To celebrate the end of exams for the year, the household threw a party. It was a sultry November night, but the back yard wasn't much bigger than the largest room in the house, so we ended up opening all the doors and windows and distributing food and furniture throughout the ground floor and the exterior, front and back. Once the faint humid breeze off the river penetrated the depths of the house, it was equally sweltering and mosquito-ridden everywhere, indoors and out.

Francine and I stayed close for an hour or so, obeying the distinctive dynamics of a couple, until by some unspoken mutual understanding it became clear that we could wander apart for a while, and that neither of us was so insecure that we'd resent it.

I ended up in a corner of the crowded back yard, talking to Will, a biochemistry student who'd lived in the house for the last four years. On some level, he probably couldn't help feeling that his opinions about the way things were run should carry more weight than anyone else's, which had annoyed me greatly when I'd first moved in. We'd since become friends, though, and I was glad to have a chance to talk to him before he left to take up a scholarship in Germany.

In the middle of a conversation about the work he'd be doing, I caught sight of Francine, and he followed my gaze.

Will said, "It took me a while to figure out what finally cured you of your homesickness."

"I was never homesick."

"Yeah, right." He took a swig of his drink. "She's changed you, though. You have to admit that."

"I do. Happily. Everything's clicked, since we got together." Relationships were meant to screw up your

studies, but my marks were soaring. Francine didn't tutor me; she just drew me into a state of mind where everything was clearer.

“The amazing thing is that you got together at all.” I scowled, and Will raised a hand placatingly. “I just meant, when you first moved in, you were pretty reserved. And down on yourself. When we interviewed you for the room, you practically begged us to give it to someone more deserving.”

“Now you're taking the piss.”

He shook his head. “Ask any of the others.”

I fell silent. The truth was, if I took a step back and contemplated my situation, I was as astonished as he was. By the time I'd left my home town, it had become clear to me that good fortune had nothing much to do with luck. Some people were born with wealth, or talent, or charisma. They started with an edge, and the benefits snowballed. I'd always believed that I had, at best, just enough intelligence and persistence to stay afloat in my chosen field; I'd topped every class in high school, but in a town the size of Orange that meant nothing, and I'd had no illusions about my fate in Sydney.

I owed it to Francine that my visions of mediocrity had not been fulfilled; being with her had transformed my life. But where had I found the nerve to imagine that I had anything to offer her in return?

“Something happened,” I admitted. “Before I asked her out.”

“Yeah?”

I almost clammed up; I hadn't told anyone about the events in the alley, not even Francine. The incident had come to seem too personal, as if to recount it at all would be to lay my conscience bare. But Will was off to Munich in less than a week, and it was easier to confide in someone I didn't expect to see again.

When I finished, Will bore a satisfied grin, as if I'd explained everything. “Pure karma,” he announced. “I should have guessed.”

“Oh, very scientific.”

“I'm serious. Forget the Buddhist mystobabble; I'm talking about the real thing. If you stick to your principles, of course things go better for you — assuming you don't get killed in the process. That's elementary psychology. People have a highly developed sense of reciprocity, of the appropriateness of the treatment they receive from each other. If things work out too well for them, they can't help asking, ‘What did I do to deserve this?’ If you don't have a good answer, you'll sabotage yourself. Not all the time, but often enough. So if you do something that improves your self-esteem — ”

“Self-esteem is for the weak,” I quipped. Will rolled his eyes. “I don't think like that,” I protested.

“No? Why did you even bring it up, then?”

I shrugged. “Maybe it just made me less pessimistic. I could have had the crap beaten out of me, but I didn't. That makes asking someone to a concert seem a lot less dangerous.” I was beginning to cringe at all this unwanted analysis, and I had nothing to counter Will's pop psychology except an equally folksy version of my own.

He could see I was embarrassed, so he let the matter drop. As I watched Francine moving through the crowd, though, I couldn't shake off an unsettling sense of the tenuousness of the circumstances that had brought us together. There was no denying that if I'd walked away from the alley, and the kitchen hand

had died, I would have felt like shit for a long time afterwards. I would not have felt entitled to much out of my own life.

I hadn't walked away, though. And even if the decision had come down to the wire, why shouldn't I be proud that I'd made the right choice? That didn't mean everything that followed was tainted, like a reward from some sleazy, palm-greasing deity. I hadn't won Francine's affection in a medieval test of bravery; we'd chosen each other, and persisted with that choice, for a thousand complicated reasons.

We were together now; that was what mattered. I wasn't going to dwell on the path that had brought me to her, just to dredge up all the doubts and insecurities that had almost kept us apart.

## 2012

As we drove the last kilometre along the road south from Ar Rafidiyah, I could see the Wall of Foam glistening ahead of us in the morning sunlight. Insubstantial as a pile of soap bubbles, but still intact, after six weeks.

"I can't believe it's lasted this long," I told Sadiq.

"You didn't trust the models?"

"Fuck, no. Every week, I thought we'd come over the hill and there'd be nothing but a shrivelled-up cobweb."

Sadiq smiled. "So you had no faith in my calculations?"

"Don't take it personally. There were a lot of things we could have both got wrong."

Sadiq pulled off the road. His students, Hassan and Rashid, had climbed off the back of the truck and started towards the Wall before I'd even got my face mask on. Sadiq called them back, and made them put on plastic boots and paper suits over their clothes, while the two of us did the same. We didn't usually bother with this much protection, but today was different.

Close up, the Wall almost vanished: all you noticed were isolated, rainbow-fringed reflections, drifting at a leisurely pace across the otherwise invisible film as water redistributed itself, following waves induced in the membrane by the interplay of air pressure, thermal gradients, and surface tension. These images might easily have been separate objects, scraps of translucent plastic blowing around above the desert, held aloft by a breeze too faint to detect at ground level.

The further away you looked, though, the more crowded the hints of light became, and the less plausible any alternative hypothesis that denied the Wall its integrity. It stretched for a kilometre along the edge of the desert, and rose an uneven fifteen to twenty metres into the air. But it was merely the first, and smallest, of its kind, and the time had come to put it on the back of the truck and drive it all the way back to Basra.

Sadiq took a spray can of reagent from the cabin, and shook it as he walked down the embankment. I followed him, my heart in my mouth. The Wall had not dried out; it had not been torn apart or blown away, but there was still plenty of room for failure.

Sadiq reached up and sprayed what appeared from my vantage to be thin air, but I could see the fine mist of droplets strike the membrane. A breathy susurration rose up, like the sound from a steam iron, and I felt a faint warm dampness before the first silken threads appeared, crisscrossing the region where the polymer from which the Wall was built had begun to shift conformations. In one state, the polymer

was soluble, exposing hydrophilic groups of atoms that bound water into narrow sheets of feather-light gel. Now, triggered by the reagent and powered by sunlight, it was tucking these groups into slick, oily cages, and expelling every molecule of water, transforming the gel into a desiccated web.

I just hoped it wasn't expelling anything else.

As the lacy net began to fall in folds at his feet, Hassan said something in Arabic, disgusted and amused. My grasp of the language remained patchy; Sadiq translated for me, his voice muffled by his face mask: "He says probably most of the weight of the thing will be dead insects." He shooed the youths back towards the truck before following himself, as the wind blew a glistening curtain over our heads. It descended far too slowly to trap us, but I hastened up the slope.

We watched from the truck as the Wall came down, the wave of dehydration propagating along its length. If the gel had been an elusive sight close up, the residue was entirely invisible in the distance; there was less substance to it than a very long pantyhose — albeit, pantyhose clogged with gnats.

The smart polymer was the invention of Sonja Helvig, a Norwegian chemist; I'd tweaked her original design for this application. Sadiq and his students were civil engineers, responsible for scaling everything up to the point where it could have a practical benefit. On those terms, this experiment was still nothing but a minor field trial.

I turned to Sadiq. "You did some mine clearance once, didn't you?"

"Years ago." Before I could say anything more, he'd caught my drift. "You're thinking that might have been more satisfying? Bang, and it's gone, the proof is there in front of you?"

"One less mine, one less bomblet," I said. "However many thousands there were to deal with, at least you could tick each one off as a definite achievement."

"That's true. It was a good feeling." He shrugged. "But what should we do? Give up on this, because it's harder?"

He took the truck down the slope, then supervised the students as they attached the wisps of polymer to the specialised winch they'd built. Hassan and Rashid were in their twenties, but they could easily have passed for adolescents. After the war, the dictator and his former backers in the west had found it mutually expedient to have a generation of Iraqi children grow up malnourished and without medical care, if they grew up at all. More than a million people had died under the sanctions. My own sick joke of a nation had sent part of its navy to join the blockade, while the rest stayed home to fend off boatloads of refugees from this, and other, atrocities. General Moustache was long dead, but his comrades-in-genocide with more salubrious addresses were all still at large: doing lecture tours, running think tanks, lobbying for the Nobel peace prize.

As the strands of polymer wound around a core inside the winch's protective barrel, the alpha count rose steadily. It was a good sign: the fine particles of uranium oxide trapped by the Wall had remained bound to the polymer during dehydration, and the reeling in of the net. The radiation from the few grams of U-238 we'd collected was far too low to be a hazard in itself; the thing to avoid was ingesting the dust, and even then the unpleasant effects were as much chemical as radiological. Hopefully, the polymer had also bound its other targets: the organic carcinogens that had been strewn across Kuwait and southern Iraq by the apocalyptic oil well fires. There was no way to determine that until we did a full chemical analysis.

We were all in high spirits on the ride back. What we'd plucked from the wind in the last six weeks wouldn't spare a single person from leukaemia, but it now seemed possible that over the years, over the

decades, the technology would make a real difference.

I missed the connection in Singapore for a direct flight home to Sydney, so I had to go via Perth. There was a four-hour wait in Perth; I paced the transit lounge, restless and impatient. I hadn't set eyes on Francine since she'd left Basra three months earlier; she didn't approve of clogging up the limited bandwidth into Iraq with decadent video. When I'd called her from Singapore she'd been busy, and now I couldn't decide whether or not to try again.

Just when I'd resolved to call her, an email came through on my notepad, saying that she'd received my message and would meet me at the airport.

In Sydney, I stood by the baggage carousel, searching the crowd. When I finally saw Francine approaching, she was looking straight at me, smiling. I left the carousel and walked towards her; she stopped and let me close the gap, keeping her eyes fixed on mine. There was a mischievousness to her expression, as if she'd arranged some kind of prank, but I couldn't guess what it might be.

When I was almost in front of her, she turned slightly, and spread her arms. "Ta-da!"

I froze, speechless. *Why hadn't she told me?*

I walked up to her and embraced her, but she'd read my expression. "Don't be angry, Ben. I was afraid you'd come home early if you knew."

"You're right, I would have." My thoughts were piling up on top of each other; I had three months' worth of reactions to get through in fifteen seconds. *We hadn't planned this. We couldn't afford it. I wasn't ready.*

Suddenly I started weeping, too shocked to be self-conscious in the crowd. The knot of panic and confusion inside me dissolved. I held her more tightly, and felt the swelling in her body against my hip.

"Are you happy?" Francine asked.

I laughed and nodded, choking out the words: "This is wonderful!"

I meant it. I was still afraid, but it was an exuberant fear. Another ocean had opened up before us. We would find our bearings. We would cross it together.

It took me several days to come down to Earth. We didn't have a real chance to talk until the weekend; Francine had a teaching position at UNSW, and though she could have set her own research aside for a couple of days, marking could wait for no one. There were a thousand things to plan; the six-month UNESCO fellowship that had paid for me to take part in the project in Basra had expired, and I'd need to start earning money again soon, but the fact that I'd made no commitments yet gave me some welcome flexibility.

On Monday, alone in the flat again, I started catching up on all the journals I'd neglected. In Iraq I'd been obsessively single-minded, instructing my knowledge miner to keep me informed of work relevant to the Wall, to the exclusion of everything else.

Skimming through a summary of six months' worth of papers, a report in *Science* caught my eye: *An Experimental Model for Decoherence in the Many-Worlds Cosmology*. A group at Delft University in the Netherlands had arranged for a simple quantum computer to carry out a sequence of arithmetic operations on a register which had been prepared to contain an equal superposition of binary representations of two different numbers. This in itself was nothing new; superpositions representing up to



128 numbers were now manipulated daily, albeit only under laboratory conditions, at close to absolute zero.

Unusually, though, at each stage of the calculation the qubits containing the numbers in question had been deliberately entangled with other, spare qubits in the computer. The effect of this was that the section performing the calculation had ceased to be in a pure quantum state: it behaved, not as if it contained two numbers simultaneously, but as if there were merely an equal chance of it containing either one. This had undermined the quantum nature of the calculation, just as surely as if the whole machine had been imperfectly shielded and become entangled with objects in the environment.

There was one crucial difference, though: in this case, the experimenters had still had access to the spare qubits that had made the calculation behave classically. When they performed an appropriate measurement on the state of the computer *as a whole*, it was shown to have remained in a superposition all along. A single observation couldn't prove this, but the experiment had been repeated thousands of times, and within the margins of error, their prediction was confirmed: although the superposition had become undetectable when they ignored the spare qubits, it had never really gone away. *Both* classical calculations had always taken place simultaneously, even though they'd lost the ability to interact in a quantum-mechanical fashion.

I sat at my desk, pondering the result. On one level, it was just a scaling-up of the quantum eraser experiments of the '90s, but the image of a tiny computer program running through its paces, appearing "to itself" to be unique and alone, while in fact a second, equally oblivious version had been executing beside it all along, carried a lot more resonance than an interference experiment with photons. I'd become used to the idea of quantum computers performing several calculations at once, but that conjuring trick had always seemed abstract and ethereal, precisely because the parts continued to act as a complicated whole right to the end. What struck home *here* was the stark demonstration of the way each calculation could come to appear as a distinct classical history, as solid and mundane as the shuffling of beads on an abacus.

When Francine arrived home I was cooking dinner, but I grabbed my notepad and showed her the paper.

"Yeah, I've seen it," she said.

"What do you think?"

She raised her hands and recoiled in mock alarm.

"I'm serious."

"What do you want me to say? Does this prove the Many Worlds interpretation? No. Does it make it easier to understand, to have a toy model like this? Yes."

"But does it sway you at all?" I persisted. "Do you believe the results would still hold, if they could be scaled up indefinitely?" From a toy universe, a handful of qubits, to the real one.

She shrugged. "I don't really need to be swayed. I always thought the MWI was the most plausible interpretation anyway."

I left it at that, and went back to the kitchen while she pulled out a stack of assignments.

That night, as we lay in bed together, I couldn't get the Delft experiment out of my mind.

"Do you believe there are other versions of us?" I asked Francine.

“I suppose there must be.” She conceded the point as if it was something abstract and metaphysical, and I was being pedantic even to raise it. People who professed belief in the MWI never seemed to want to take it seriously, let alone personally.

“And that doesn't bother you?”

“No,” she said blithely. “Since I'm powerless to change the situation, what's the use in being upset about it?”

“That's very pragmatic,” I said. Francine reached over and thumped me on the shoulder. “That was a compliment!” I protested. “I envy you for having come to terms with it so easily.”

“I haven't, really,” she admitted. “I've just resolved not to let it worry me, which isn't quite the same thing.”

I turned to face her, though in the near-darkness we could barely see each other. I said, “What gives you the most satisfaction in life?”

“I take it you're not in the mood to be fobbed off with a sappy romantic answer?” She sighed. “I don't know. Solving problems. Getting things right.”

“What if for every problem you solve, there's someone just like you who fails, instead?”

“I cope with my failures,” she said. “Let them cope with theirs.”

“You know it doesn't work like that. Some of them simply *don't* cope. Whatever you find the strength to do, there'll be someone else who won't.”

Francine had no reply.

I said, “A couple of weeks ago, I asked Sadiq about the time he was doing mine clearance. He said it was more satisfying than mopping up DU; one little explosion, right before your eyes, and you know you've done something worthwhile. We all get moments in our lives like that, with that pure, unambiguous sense of achievement: whatever else we might screw up, at least there's one thing that we've done right.” I laughed uneasily. “I think I'd go mad, if I couldn't rely on that.”

Francine said, “You can. Nothing you've done will ever disappear from under your feet. No one's going to march up and take it away from you.”

“I know.” My skin crawled, at the image of some less favoured alter ego turning up on our doorstep, demanding his dues. “That seems so fucking selfish, though. I don't want everything that makes me happy to be at the expense of someone else. I don't want every choice to be like ... fighting other versions of myself for the prize in some zero-sum game.”

“No.” Francine hesitated. “But if the reality is like that, what can you do about it?”

Her words hung in the darkness. What could I do about it? Nothing. So did I really want to dwell on it, corroding the foundations of my own happiness, when there was absolutely nothing to be gained, for anyone?

“You're right. This is crazy.” I leant over and kissed her. “I'd better let you get to sleep.”

“It's not crazy,” she said. “But I don't have any answers.”

The next morning, after Francine had left for work, I picked up my notepad and saw that she'd mailed me an e-book: an anthology of cheesy "alternate (sic) history" stories from the '90s, entitled *My God, It's Full of Tsars!* "What if Gandhi had been a ruthless soldier of fortune? What if Theodore Roosevelt had faced a Martian invasion? What if the Nazis had had Janet Jackson's choreographer?"

I skimmed through the introduction, alternately cackling and groaning, then filed the book away and got down to work. I had a dozen minor administrative tasks to complete for UNESCO, before I could start searching in earnest for my next position.

By mid-afternoon, I was almost done, but the growing sense of achievement I felt at having buckled down and cleared away these tedious obligations brought with it the corollary: someone infinitesimally different from me — someone who had shared my entire history up until that morning — had procrastinated instead. The triviality of this observation only made it more unsettling; the Delft experiment was seeping into my daily life on the most mundane level.

I dug out the book Francine had sent and tried reading a few of the stories, but the authors' relentlessly camp take on the premise hardly amounted to a *reductio ad absurdum*, or even a comical existential balm. I didn't really care how hilarious it would have been if Marilyn Monroe had been involved in a bedroom farce with Richard Feynman and Richard Nixon. I just wanted to lose the suffocating conviction that everything I had become was a mirage; that my life had been nothing but a blinkered view of a kind of torture chamber, where every glorious reprieve I'd ever celebrated had in fact been an unwitting betrayal.

If fiction had no comfort to offer, what about fact? Even if the Many Worlds cosmology was correct, no one knew for certain what the consequences were. It was a fallacy that literally everything that was physically possible had to occur; most cosmologists I'd read believed that the universe as a whole possessed a single, definite quantum state, and while that state would appear from within as a multitude of distinct classical histories, there was no reason to assume that these histories amounted to some kind of exhaustive catalogue. The same thing held true on a smaller scale: every time two people sat down to a game of chess, there was no reason to believe that they played every possible game.

*And if I'd stood in an alley, nine years before, struggling with my conscience?* My subjective sense of indecision proved nothing, but even if I'd suffered no qualms and acted without hesitation, to find a human being in a quantum state of pure, unshakeable resolve would have been freakishly unlikely at best, and in fact was probably physically impossible.

"Fuck this." I didn't know when I'd set myself up for this bout of paranoia, but I wasn't going to indulge it for another second. I banged my head against the desk a few times, then picked up my notepad and went straight to an employment site.

The thoughts didn't vanish entirely; it was too much like trying not to think of a pink elephant. Each time they recurred, though, I found I could shout them down with threats of taking myself straight to a psychiatrist. The prospect of having to explain such a bizarre mental problem was enough to give me access to hitherto untapped reserves of self-discipline.

By the time I started cooking dinner, I was feeling merely foolish. If Francine mentioned the subject again, I'd make a joke of it. I didn't need a psychiatrist. I was a little insecure about my good fortune, and still somewhat rattled by the news of impending fatherhood, but it would hardly have been healthier to take everything for granted.

My notepad chimed. Francine had blocked the video again, as if bandwidth, even here, was as precious as water.

“Hello.”

“Ben? I've had some bleeding. I'm in a taxi. Can you meet me at St Vincent's?”

Her voice was steady, but my own mouth went dry. “Sure. I'll be there in fifteen minutes.” I couldn't add anything: *I love you, it will be all right, hold on*. She didn't need that, it would have jinxed everything.

Half an hour later, I was still caught in traffic, white-knuckled with rage and helplessness. I stared down at the dashboard, at the real-time map with every other gridlocked vehicle marked, and finally stopped deluding myself that at any moment I would turn into a magically deserted side-street and weave my way across the city in just a few more minutes.

In the ward, behind the curtains drawn around her bed, Francine lay curled and rigid, her back turned, refusing to look at me. All I could do was stand beside her. The gynaecologist was yet to explain everything properly, but the miscarriage had been accompanied by complications, and she'd had to perform surgery.

Before I'd applied for the UNESCO fellowship, we'd discussed the risks. For two prudent, well-informed, short-term visitors, the danger had seemed microscopic. Francine had never travelled out into the desert with me, and even for the locals in Basra the rates of birth defects and miscarriages had fallen a long way from their peaks. We were both taking contraceptives; condoms had seemed like overkill. *Had I brought it back to her, from the desert? A speck of dust, trapped beneath my foreskin? Had I poisoned her while we were making love?*

Francine turned towards me. The skin around her eyes was grey and swollen, and I could see how much effort it took for her to meet my gaze. She drew her hands out from under the bedclothes, and let me hold them; they were freezing.

After a while, she started sobbing, but she wouldn't release my hands. I stroked the back of her thumb with my own thumb, a tiny, gentle movement.

## 2020

“How do you feel now?” Olivia Maslin didn't quite make eye contact as she addressed me; the image of my brain activity painted on her retinas was clearly holding her attention.

“Fine,” I said. “Exactly the same as I did before you started the infusion.”

I was reclining on something like a dentist's couch, halfway between sitting and lying, wearing a tight-fitting cap studded with magnetic sensors and inducers. It was impossible to ignore the slight coolness of the liquid flowing into the vein in my forearm, but that sensation was no different than it had been on the previous occasion, a fortnight before.

“Could you count to ten for me, please.”

I obliged.

“Now close your eyes and picture the same familiar face as the last time.”

She'd told me I could choose anyone; I'd picked Francine. I brought back the image, then suddenly recalled that, the first time, after contemplating the detailed picture in my head for a few seconds — as if I was preparing to give a description to the police — I'd started thinking about Francine herself. On cue, the same transition occurred again: the frozen, forensic likeness became flesh and blood.

I was led through the whole sequence of activities once more: reading the same short story (“Two Old-Timers” by F. Scott Fitzgerald), listening to the same piece of music (from Rossini’s *The Thieving Magpie*), recounting the same childhood memory (my first day at school). At some point, I lost any trace of anxiety about repeating my earlier mental states with sufficient fidelity; after all, the experiment had been designed to cope with the inevitable variation between the two sessions. I was just one volunteer out of dozens, and half the subjects would be receiving nothing but saline on both occasions. For all I knew, I was one of them: a control, merely setting the baseline against which any real effect would be judged.

If I was receiving the coherence disruptors, though, then as far as I could tell they’d had no effect on me. My inner life hadn’t evaporated as the molecules bound to the microtubules in my neurons, guaranteeing that any kind of quantum coherence those structures might otherwise have maintained would be lost to the environment in a fraction of a picosecond.

Personally, I’d never subscribed to Penrose’s theory that quantum effects might play a role in consciousness; calculations dating back to a seminal paper by Max Tegmark, twenty years before, had already made sustained coherence in any neural structure extremely unlikely. Nevertheless, it had taken considerable ingenuity on the part of Olivia and her team to rule out the idea definitively, in a series of clear-cut experiments. Over the past two years, they’d chased the ghost away from each of the various structures that different factions of Penrose’s disciples had anointed as the essential quantum components of the brain. The earliest proposal — the microtubules, huge polymeric molecules that formed a kind of skeleton inside every cell — had turned out to be the hardest to target for disruption. But now it was entirely possible that the cytoskeletons of my very own neurons were dotted with molecules that coupled them strongly to a noisy microwave field in which my skull was, definitely, bathed. In which case, my microtubules had about as much chance of exploiting quantum effects as I had of playing a game of squash with a version of myself from a parallel universe.

When the experiment was over, Olivia thanked me, then became even more distant as she reviewed the data. Raj, one of her graduate students, slid out the needle and stuck a plaster over the tiny puncture wound, then helped me out of the cap.

“I know you don’t know yet if I was a control or not,” I said, “but have you noticed significant differences, with anyone?” I was almost the last subject in the microtubule trials; any effect should have shown up by now.

Olivia smiled enigmatically. “You’ll just have to wait for publication.” Raj leant down and whispered, “No, never.”

I climbed off the couch. “The zombie walks!” Raj declaimed. I lunged hungrily for his brain; he ducked away, laughing, while Olivia watched us with an expression of pained indulgence. Die-hard members of the Penrose camp claimed that Olivia’s experiments proved nothing, because even if people *behaved* identically while all quantum effects were ruled out, they could be doing this as mere automata, totally devoid of consciousness. When Olivia had offered to let her chief detractor experience coherence disruption for himself, he’d replied that this would be no more persuasive, because memories laid down while you were a zombie would be indistinguishable from ordinary memories, so that looking back on the experience, you’d notice nothing unusual.

This was sheer desperation; you might as well assert that everyone in the world but yourself was a zombie, and you were one, too, every second Tuesday. As the experiments were repeated by other groups around the world, those people who’d backed the Penrose theory as a scientific hypothesis, rather than adopting it as a kind of mystical dogma, would gradually accept that it had been refuted.

I left the neuroscience building and walked across the campus, back towards my office in the physics department. It was a mild, clear spring morning, with students out lying on the grass, dozing off with books balanced over their faces like tents. There were still some advantages to reading from old-fashioned sheaves of e-paper. I'd only had my own eyes chipped the year before, and though I'd adapted to the technology easily enough, I still found it disconcerting to wake on a Sunday morning to find Francine reading the *Herald* beside me with her eyes shut.

Olivia's results didn't surprise me, but it was satisfying to have the matter resolved once and for all: consciousness was a purely classical phenomenon. Among other things, this meant that there was no compelling reason to believe that software running on a classical computer could not be conscious. Of course, everything in the universe obeyed quantum mechanics at some level, but Paul Benioff, one of the pioneers of quantum computing, had shown back in the '80s that you could build a classical Turing machine from quantum mechanical parts, and over the last few years, in my spare time, I'd studied the branch of quantum computing theory that concerned itself with *avoiding* quantum effects.

Back in my office, I summoned up a schematic of the device I called the Qusp: the quantum singleton processor. The Qusp would employ all the techniques designed to shield the latest generation of quantum computers from entanglement with their environment, but it would use them to a very different end. A quantum computer was shielded so it could perform a multitude of parallel calculations, without each one spawning a separate history of its own, in which only one answer was accessible. The Qusp would perform just a single calculation at a time, but on its way to the unique result it would be able to pass safely through superpositions that included any number of alternatives, without those alternatives being made real. Cut off from the outside world during each computational step, it would keep its temporary quantum ambivalence as private and inconsequential as a daydream, never being forced to act out every possibility it dared to entertain.

The Qusp would still need to interact with its environment whenever it gathered data about the world, and that interaction would inevitably split it into different versions. If you attached a camera to the Qusp and pointed it at an ordinary object — a rock, a plant, a bird — that object could hardly be expected to possess a single classical history, and so neither would the combined system of Qusp plus rock, Qusp plus plant, Qusp plus bird.

*The Qusp itself*, though, would never initiate the split. In a given set of circumstances, it would only ever produce a single response. An AI running on the Qusp could make its decisions as whimsically, or with as much weighty deliberation as it liked, but for each distinct scenario it confronted, in the end it would only make one choice, only follow one course of action.

I closed the file, and the image vanished from my retinas. For all the work I'd put into the design, I'd made no effort to build the thing. I'd been using it as little more than a talisman: whenever I found myself picturing my life as a tranquil dwelling built over a slaughter house, I'd summon up the Qusp as a symbol of hope. It was proof of a possibility, and a possibility was all it took. Nothing in the laws of physics could prevent a small portion of humanity's descendants from escaping their ancestors' dissipation.

Yet I'd shied away from any attempt to see that promise fulfilled, firsthand. In part, I'd been afraid of delving too deeply and uncovering a flaw in the Qusp's design, robbing myself of the one crutch that kept me standing when the horror swept over me. It had also been a matter of guilt: I'd been the one granted happiness, so many times, that it had seemed unconscionable to aspire to that state yet again. I'd knocked so many of my hapless cousins out of the ring, it was time I threw a fight and let the prize go to my opponent instead.

That last excuse was idiotic. The stronger my determination to build the Qusp, the more branches there would be in which it was real. Weakening my resolve was *not* an act of charity, surrendering the benefits

to someone else; it merely impoverished every future version of me, and everyone they touched.

I did have a third excuse. It was time I dealt with that one, too.

I called Francine.

“Are you free for lunch?” I asked. She hesitated; there was always work she could be doing. “To discuss the Cauchy-Riemann equations?” I suggested.

She smiled. It was our code, when the request was a special one. “All right. One o'clock?”

I nodded. “I'll see you then.”

Francine was twenty minutes late, but that was less of a wait than I was used to. She'd been appointed deputy head of the mathematics department eighteen months before, and she still had some teaching duties as well as all the new administrative work. Over the last eight years, I'd had a dozen short-term contracts with various bodies — government departments, corporations, NGOs — before finally ending up as a very lowly member of the physics department at our *alma mater*. I did envy her the prestige and security of her job, but I'd been happy with most of the work I'd done, even if it had been too scattered between disciplines to contribute to anything like a traditional career path.

I'd bought Francine a plate of cheese-and-salad sandwiches, and she attacked them hungrily as soon as she sat down. I said, “I've got ten minutes at the most, haven't I?”

She covered her mouth with her hand and replied defensively, “It could have waited until tonight, couldn't it?”

“Sometimes I can't put things off. I have to act while I still have the courage.”

At this ominous prelude she chewed more slowly. “You did the second stage of Olivia's experiment this morning, didn't you?”

“Yeah.” I'd discussed the whole procedure with her before I volunteered.

“So I take it you didn't lose consciousness, when your neurons became marginally more classical than usual?” She sipped chocolate milk through a straw.

“No. Apparently no one ever loses anything. That's not official yet, but — ”

Francine nodded, unsurprised. We shared the same position on the Penrose theory; there was no need to discuss it again now.

I said, “I want to know if you're going to have the operation.”

She continued drinking for a few more seconds, then released the straw and wiped her upper lip with her thumb, unnecessarily. “You want me to make up my mind about that, here and now?”

“No.” The damage to her uterus from the miscarriage could be repaired; we'd been discussing the possibility for almost five years. We'd both had comprehensive chelation therapy to remove any trace of U-238. We could have children in the usual way with a reasonable degree of safety, if that was what we wanted. “But if you've already decided, I want you to tell me now.”

Francine looked wounded. “That's unfair.”

“What is? Implying that you might not have told me, the instant you decided?”

“No. Implying that it's all in my hands.”

I said, “I'm not washing my hands of the decision. You know how I feel. But you know I'd back you all the way, if you said you wanted to carry a child.” I believed I would have. Maybe it was a form of doublethink, but I couldn't treat the birth of one more ordinary child as some kind of atrocity, and refuse to be a part of it.

“Fine. But what will you do if I don't?” She examined my face calmly. I think she already knew, but she wanted me to spell it out.

“We could always adopt,” I observed casually.

“Yes, we could do that.” She smiled slightly; she knew that made me lose my ability to bluff, even faster than when she stared me down.

I stopped pretending that there was any mystery left; she'd seen right through me from the start. I said, “I just don't want to do this, then discover that it makes you feel that you've been cheated out of what you really wanted.”

“It wouldn't,” she insisted. “It wouldn't rule out anything. We could still have a natural child as well.”

“Not as easily.” This would not be like merely having workaholic parents, or an ordinary brother or sister to compete with for attention.

“You only want to do this if I can promise you that it's the only child we'd ever have?” Francine shook her head. “I'm not going to promise that. I don't intend having the operation any time soon, but I'm not going to swear that I won't change my mind. Nor am I going to swear that if we do this it will make no difference to what happens later. It will be a factor. How could it not be? But it won't be enough to rule anything in or out.”

I looked away, across the rows of tables, at all the students wrapped up in their own concerns. She was right; I was being unreasonable. I'd wanted this to be a choice with no possible downside, a way of making the best of our situation, but no one could guarantee that. It would be a gamble, like everything else.

I turned back to Francine.

“All right; I'll stop trying to pin you down. What I want to do right now is go ahead and build the Qusp. And when it's finished, if we're certain we can trust it . . . I want us to raise a child with it. I want us to raise an AI.”

## 2029

I met Francine at the airport, and we drove across São Paulo through curtains of wild, lashing rain. I was amazed that her plane hadn't been diverted; a tropical storm had just hit the coast, halfway between us and Rio.

“So much for giving you a tour of the city,” I lamented. Through the windscreen, our actual surroundings were all but invisible; the bright overlay we both perceived, surreally coloured and detailed, made the experience rather like perusing a 3D map while trapped in a car wash.

Francine was pensive, or tired from the flight. I found it hard to think of San Francisco as remote when the time difference was so small, and even when I'd made the journey north to visit her, it had been nothing compared to all the ocean-spanning marathons I'd sat through in the past.



We both had an early night. The next morning, Francine accompanied me to my cluttered workroom in the basement of the university's engineering department. I'd been chasing grants and collaborators around the world, like a child on a treasure hunt, slowly piecing together a device that few of my colleagues believed was worth creating for its own sake. Fortunately, I'd managed to find pretexts — or even genuine spin-offs — for almost every stage of the work. Quantum computing, *per se*, had become bogged down in recent years, stymied by both a shortage of practical algorithms and a limit to the complexity of superpositions that could be sustained. The Qusp had nudged the technological envelope in some promising directions, without making any truly exorbitant demands; the states it juggled were relatively simple, and they only needed to be kept isolated for milliseconds at a time.

I introduced Carlos, Maria and Jun, but then they made themselves scarce as I showed Francine around. We still had a demonstration of the “balanced decoupling” principle set up on a bench, for the tour by one of our corporate donors the week before. What caused an imperfectly shielded quantum computer to decohere was the fact that each possible state of the device affected its environment slightly differently. The shielding itself could always be improved, but Carlos's group had perfected a way to buy a little more protection by sheer deviousness. In the demonstration rig, the flow of energy through the device remained absolutely constant whatever state it was in, because any drop in power consumption by the main set of quantum gates was compensated for by a rise in a set of balancing gates, and *vice versa*. This gave the environment one less clue by which to discern internal differences in the processor, and to tear any superposition apart into mutually disconnected branches.

Francine knew all the theory backwards, but she'd never seen this hardware in action. When I invited her to twiddle the controls, she took to the rig like a child with a game console.

“You really should have joined the team,” I said.

“Maybe I did,” she countered. “In another branch.”

She'd moved from UNSW to Berkeley two years before, not long after I'd moved from Delft to São Paulo; it was the closest suitable position she could find. At the time, I'd resented the fact that she'd refused to compromise and work remotely; with only five hours' difference, teaching at Berkeley from São Paulo would not have been impossible. In the end, though, I'd accepted the fact that she'd wanted to keep on testing me, testing both of us. If we weren't strong enough to stay together through the trials of a prolonged physical separation — or if I was not sufficiently committed to the project to endure whatever sacrifices it entailed — she did not want us proceeding to the next stage.

I led her to the corner bench, where a nondescript grey box half a metre across sat, apparently inert. I gestured to it, and our retinal overlays transformed its appearance, “revealing” a maze with a transparent lid embedded in the top of the device. In one chamber of the maze, a slightly cartoonish mouse sat motionless. Not quite dead, not quite sleeping.

“This is the famous Zelda?” Francine asked.

“Yes.” Zelda was a neural network, a stripped-down, stylised mouse brain. There were newer, fancier versions available, much closer to the real thing, but the ten-year-old, public domain Zelda had been good enough for our purposes.

Three other chambers held cheese. “Right now, she has no experience of the maze,” I explained. “So let's start her up and watch her explore.” I gestured, and Zelda began scampering around, trying out different passages, deftly reversing each time she hit a *cul-de-sac*. “Her brain is running on a Qusp, but the maze is implemented on an ordinary classical computer, so in terms of coherence issues, it's really no different from a physical maze.”

“Which means that each time she takes in information, she gets entangled with the outside world,” Francine suggested.

“Absolutely. But she always holds off doing that until the Qusp has completed its current computational step, and every qubit contains a definite zero or a definite one. She's never in two minds when she lets the world in, so the entanglement process doesn't split her into separate branches.”

Francine continued to watch, in silence. Zelda finally found one of the chambers containing a reward; when she'd eaten it, a hand scooped her up and returned her to her starting point, then replaced the cheese.

“Here are ten thousand previous trials, superimposed.” I replayed the data. It looked as if a single mouse was running through the maze, moving just as we'd seen her move when I'd begun the latest experiment. Restored each time to exactly the same starting condition, and confronted with exactly the same environment, Zelda — like any computer program with no truly random influences — had simply repeated herself. All ten thousand trials had yielded identical results.

To a casual observer, unaware of the context, this would have been a singularly unimpressive performance. Faced with exactly one situation, Zelda the virtual mouse did exactly one thing. So what? If you'd been able to wind back a flesh-and-blood mouse's memory with the same degree of precision, wouldn't it have repeated itself too?

Francine said, “Can you cut off the shielding? And the balanced decoupling?”

“Yep.” I obliged her, and initiated a new trial.

Zelda took a different path this time, exploring the maze by a different route. Though the initial condition of the neural net was identical, the switching processes taking place within the Qusp were now opened up to the environment constantly, and superpositions of several different eigenstates — states in which the Qusp's qubits possessed definite binary values, which in turn led to Zelda making definite choices — were becoming entangled with the outside world. According to the Copenhagen interpretation of quantum mechanics, this interaction was randomly “collapsing” the superpositions into single eigenstates; Zelda was still doing just one thing at a time, but her behaviour had ceased to be deterministic. According to the MWI, the interaction was transforming the environment — Francine and me included — into a superposition with components that were coupled to each eigenstate; Zelda was actually running the maze in many different ways simultaneously, and other versions of us were seeing her take all those other routes.

Which scenario was correct?

I said, “I'll reconfigure everything now, to wrap the whole setup in a Delft cage.” A “Delft cage” was jargon for the situation I'd first read about seventeen years before: instead of opening up the Qusp to the environment, I'd connect it to a second quantum computer, and let *that* play the role of the outside world.

We could no longer watch Zelda moving about in real time, but after the trial was completed, it was possible to test the combined system of both computers against the hypothesis that it was in a pure quantum state in which Zelda had run the maze along hundreds of different routes, all at once. I displayed a representation of the conjectured state, built up by superimposing all the paths she'd taken in ten thousand unshielded trials.

The test result flashed up: CONSISTENT.

“One measurement proves nothing,” Francine pointed out.

“No.” I repeated the trial. Again, the hypothesis was not refuted. If Zelda had actually run the maze along just one path, the probability of the computers' joint state passing this imperfect test was about one percent. For passing it twice, the odds were about one in ten thousand.

I repeated it a third time, then a fourth.

Francine said, “That's enough.” She actually looked queasy. The image of the hundreds of blurred mouse trails on the display was not a literal photograph of anything, but if the old Delft experiment had been enough to give me a visceral sense of the reality of the multiverse, perhaps this demonstration had finally done the same for her.

“Can I show you one more thing?” I asked.

“Keep the Delft cage, but restore the Qusp's shielding?”

“Right.”

I did it. The Qusp was now fully protected once more whenever it was not in an eigenstate, but this time, it was the second quantum computer, not the outside world, to which it was intermittently exposed. If Zelda split into multiple branches again, then she'd only take that fake environment with her, and we'd still have our hands on all the evidence.

Tested against the hypothesis that no split had occurred, the verdict was: CONSISTENT. CONSISTENT. CONSISTENT.

We went out to dinner with the whole of the team, but Francine pleaded a headache and left early. She insisted that I stay and finish the meal, and I didn't argue; she was not the kind of person who expected you to assume that she was being politely selfless, while secretly hoping to be contradicted.

After Francine had left, Maria turned to me. “So you two are really going ahead with the Frankenchild?” She'd been teasing me about this for as long as I'd known her, but apparently she hadn't been game to raise the subject in Francine's presence.

“We still have to talk about it.” I felt uncomfortable myself, now, discussing the topic the moment Francine was absent. Confessing my ambition when I applied to join the team was one thing; it would have been dishonest to keep my collaborators in the dark about my ultimate intentions. Now that the enabling technology was more or less completed, though, the issue seemed far more personal.

Carlos said breezily, “Why not? There are so many others now. Sophie. Linus. Theo. Probably a hundred we don't even know about. It's not as if Ben's child won't have playmates.” Adai — Autonomously Developing Artificial Intelligences — had been appearing in a blaze of controversy every few months for the last four years. A Swiss researcher, Isabelle Schib, had taken the old models of morphogenesis that had led to software like Zelda, refined the technique by several orders of magnitude, and applied it to human genetic data. Wedded to sophisticated prosthetic bodies, Isabelle's creations inhabited the physical world and learnt from their experience, just like any other child.

Jun shook his head reprovingly. “I wouldn't raise a child with no legal rights. What happens when you die? For all you know, it could end up as someone's property.”

I'd been over this with Francine. “I can't believe that in ten or twenty years' time there won't be citizenship laws, somewhere in the world.”

Jun snorted. “Twenty years! How long did it take the U.S. to emancipate their slaves?”

Carlos interjected, “Who's going to create an adai just to use it as a slave? If you want something biddable, write ordinary software. If you need consciousness, humans are cheaper.”

Maria said, “It won't come down to economics. It's the nature of the things that will determine how they're treated.”

“You mean the xenophobia they'll face?” I suggested.

Maria shrugged. “You make it sound like racism, but we aren't talking about human beings. Once you have software with goals of its own, free to do whatever it likes, where will it end? The first generation makes the next one better, faster, smarter; the second generation even more so. Before we know it, we're like ants to them.”

Carlos groaned. “Not that hoary old fallacy! If you really believe that stating the analogy ‘ants are to humans, as humans are to  $x$ ’ is proof that it's possible to solve for  $x$ , then I'll meet you where the south pole is like the equator.”

I said, “The Qusp runs no faster than an organic brain; we need to keep the switching rate low, because that makes the shielding requirements less stringent. It might be possible to nudge those parameters, eventually, but there's no reason in the world why an adai would be better equipped to do that than you or I would. As for making their own offspring smarter ... even if Schib's group has been perfectly successful, they will have merely translated human neural development from one substrate to another. They won't have ‘improved’ on the process at all — whatever that might mean. So if the adai have any advantage over us, it will be no more than the advantage shared by flesh-and-blood children: cultural transmission of one more generation's worth of experience.”

Maria frowned, but she had no immediate comeback.

Jun said dryly, “Plus immortality.”

“Well, yes, there is that,” I conceded.

Francine was awake when I arrived home.

“Have you still got a headache?” I whispered.

“No.”

I undressed and climbed into bed beside her.

She said, “You know what I miss the most? When we're fucking on-line?”

“This had better not be complicated; I'm out of practice.”

“Kissing.”

I kissed her, slowly and tenderly, and she melted beneath me. “Three more months,” I promised, “and I'll move up to Berkeley.”

“To be my kept man.”

“I prefer the term ‘unpaid but highly valued caregiver.’” Francine stiffened. I said, “We can talk about that later.” I started kissing her again, but she turned her face away.

“I’m afraid,” she said.

“So am I,” I assured her. “That’s a good sign. Everything worth doing is terrifying.”

“But not everything terrifying is good.”

I rolled over and lay beside her. She said, “On one level, it’s easy. What greater gift could you give a child, than the power to make real decisions? What worse fate could you spare her from, than being forced to act against her better judgment, over and over? When you put it like that, it’s simple.

“But every fibre in my body still rebels against it. How will she feel, knowing what she is? How will she make friends? How will she belong? How will she not despise us for making her a freak? And what if we’re robbing her of something she’d value: living a billion lives, never being forced to choose between them? What if she sees the gift as a kind of impoverishment?”

“She can always drop the shielding on the Qusp,” I said. “Once she understands the issues, she can choose for herself.”

“That’s true.” Francine did not sound mollified at all; she would have thought of that long before I’d mentioned it, but she wasn’t looking for concrete answers. Every ordinary human instinct screamed at us that we were embarking on something *dangerous*, *unnatural*, *hubristic* — but those instincts were more about safeguarding our own reputations than protecting our child-to-be. No parent, save the most wilfully negligent, would be pilloried if their flesh-and-blood child turned out to be ungrateful for life; if I’d railed against my own mother and father because I’d found fault in the existential conditions with which I’d been lumbered, it wasn’t hard to guess which side would attract the most sympathy from the world at large. Anything that went wrong with *our* child would be grounds for lynching — however much love, sweat, and soul-searching had gone into her creation — because we’d had the temerity to be dissatisfied with the kind of fate that everyone else happily inflicted on their own.

I said, “You saw Zelda today, spread across the branches. You know, deep down now, that the same thing happens to all of us.”

“Yes.” Something tore inside me as Francine uttered that admission. I’d never really wanted her to feel it, the way I did.

I persisted. “Would you willingly sentence your own child to that condition? And your grandchildren? And your great-grandchildren?”

“No,” Francine replied. A part of her hated me now; I could hear it in her voice. It was *my* curse, *my* obsession; before she met me, she’d managed to believe and not believe, taking her acceptance of the multiverse lightly.

I said, “I can’t do this without you.”

“You can, actually. More easily than any of the alternatives. You wouldn’t even need a stranger to donate an egg.”

“I can’t do it unless you’re behind me. If you say the word, I’ll stop here. We’ve built the Qusp. We’ve shown that it can work. Even if we don’t do this last part ourselves, someone else will, in a decade or two.”

“If *we* don’t do this,” Francine observed acerbically, “we’ll simply do it in another branch.”

I said, “That’s true, but it’s no use thinking that way. In the end, I can’t function unless I pretend that my

choices are real. I doubt that anyone can.”

Francine was silent for a long time. I stared up into the darkness of the room, trying hard not to contemplate the near certainty that her decision would go both ways.

Finally, she spoke.

“Then let's make a child who doesn't need to pretend.”

## 2031

Isabelle Schib welcomed us into her office. In person, she was slightly less intimidating than she was on-line; it wasn't anything different in her appearance or manner, just the ordinariness of her surroundings. I'd envisaged her ensconced in some vast, pristine, high-tech building, not a couple of pokey rooms on a back-street in Basel.

Once the pleasantries were out of the way, Isabelle got straight to the point. “You've been accepted,” she announced. “I'll send you the contract later today.”

My throat constricted with panic; I should have been elated, but I just felt unprepared. Isabelle's group licensed only three new adai a year. The short-list had come down to about a hundred couples, winnowed from tens of thousands of applicants. We'd travelled to Switzerland for the final selection process, carried out by an agency that ordinarily handled adoptions. Through all the interviews and questionnaires, all the personality tests and scenario challenges, I'd managed to half-convince myself that our dedication would win through in the end, but that had been nothing but a prop to keep my spirits up.

Francine said calmly, “Thank you.”

I coughed. “You're happy with everything we've proposed?” If there was going to be a proviso thrown in that rendered this miracle worthless, better to hear it now, before the shock had worn off and I'd started taking things for granted.

Isabelle nodded. “I don't pretend to be an expert in the relevant fields, but I've had the Qusp's design assessed by several colleagues, and I see no reason why it wouldn't be an appropriate form of hardware for an adai. I'm entirely agnostic about the MWI, so I don't share your view that the Qusp is a necessity, but if you were worried that I might write you off as cranks because of it,” she smiled slightly, “you should meet some of the other people I've had to deal with.

“I believe you have the adai's welfare at heart, and you're not suffering from any of the superstitions — technophobic *or* technophilic — that would distort the relationship. And as you'll recall, I'll be entitled to visits and inspections throughout your period of guardianship. If you're found to be violating any of the terms of the contract, your licence will be revoked, and I'll take charge of the adai.”

Francine said, “What do you think the prospects are for a happier end to our guardianship?”

“I'm lobbying the European parliament, constantly,” Isabelle replied. “Of course, in a few years' time several adai will reach the stage where their personal testimony begins contributing to the debate, but none of us should wait until then. The ground has to be prepared.”

We spoke for almost an hour, on this and other issues. Isabelle had become quite an expert at fending off the attentions of the media; she promised to send us a handbook on this, along with the contract.

“Did you want to meet Sophie?” Isabelle asked, almost as an afterthought.

Francine said, "That would be wonderful." Francine and I had seen a video of Sophie at age four, undergoing a battery of psychological tests, but we'd never had a chance to converse with her, let alone meet her face to face.

The three of us left the office together, and Isabelle drove us to her home on the outskirts of the town.

In the car, the reality began sinking in anew. I felt the same mixture of exhilaration and claustrophobia that I'd experienced nineteen years before, when Francine had met me at the airport with news of her pregnancy. No digital conception had yet taken place, but if sex had ever felt half as loaded with risks and responsibilities as this, I would have remained celibate for life.

"No badgering, no interrogation," Isabelle warned us as she pulled into the driveway.

I said, "Of course not."

Isabelle called out, "Marco! Sophie!" as we followed her through the door. At the end of the hall, I heard childish giggling, and an adult male voice whispering in French. Then Isabelle's husband stepped out from behind the corner, a smiling, dark-haired young man, with Sophie riding on his shoulders. At first I couldn't look at her; I just smiled politely back at Marco, while noting glumly that he was at least fifteen years younger than I was. *How could I even think of doing this, at forty-six?* Then I glanced up, and caught Sophie's eye. She gazed straight back at me for a moment, appearing curious and composed, but then a fit of shyness struck her, and she buried her face in Marco's hair.

Isabelle introduced us, in English; Sophie was being raised to speak four languages, though in Switzerland that was hardly phenomenal. Sophie said, "Hello" but kept her eyes lowered. Isabelle said, "Come into the living room. Would you like something to drink?"

The five of us sipped lemonade, and the adults made polite, superficial conversation. Sophie sat on Marco's knees, squirming restlessly, sneaking glances at us. She looked exactly like an ordinary, slightly gawky, six-year-old girl. She had Isabelle's straw-coloured hair, and Marco's brown eyes; whether by fiat or rigorous genetic simulation, she could have passed for their biological daughter. I'd read technical specifications describing her body, and seen an earlier version in action on the video, but the fact that it looked so plausible was the least of its designers' achievements. Watching her drinking, wriggling and fidgeting, I had no doubt that she felt herself inhabiting this skin, as much as I did my own. She was not a puppeteer posing as a child, pulling electronic strings from some dark cavern in her skull.

"Do you like lemonade?" I asked her.

She stared at me for a moment, as if wondering whether she should be affronted by the presumptuousness of this question, then replied, "It tickles."

In the taxi to the hotel, Francine held my hand tightly.

"Are you OK?" I asked.

"Yes, of course."

In the elevator, she started crying. I wrapped my arms around her.

"She would have turned eighteen this year."

"I know."

"Do you think she's alive, somewhere?"

“I don't know. I don't know if that's a good way to think about it.”

Francine wiped her eyes. “No. This will be her. That's the way to see it. This will be my girl. Just a few years late.”

Before flying home, we visited a small pathology lab, and left samples of our blood.

Our daughter's first five bodies reached us a month before her birth. I unpacked all five, and laid them out in a row on the living room floor. With their muscles slack and their eyes rolled up, they looked more like tragic mummies than sleeping infants. I dismissed that grisly image; better to think of them as suits of clothes. The only difference was that we hadn't bought pyjamas quite so far ahead.

From wrinkled pink newborn to chubby eighteen-month-old, the progression made an eerie sight — even if an organic child's development, short of serious disease or malnourishment, would have been scarcely less predictable. A colleague of Francine's had lectured me a few weeks before about the terrible “mechanical determinism” we'd be imposing on our child, and though his arguments had been philosophically naive, this sequence of immutable snapshots from the future still gave me goose bumps.

The truth was, reality as a whole was deterministic, whether you had a Qusp for a brain or not; the quantum state of the multiverse at any moment determined the entire future. Personal experience — confined to one branch at a time — certainly *appeared* probabilistic, because there was no way to predict which local future you'd experience when a branch split, but the reason it was impossible to know that in advance was because the real answer was “all of them”.

For a singleton, the only difference was that branches never split on the basis of your personal decisions. The world at large would continue to look probabilistic, but every choice you made was entirely determined by *who you were* and *the situation you faced*.

What more could anyone hope for? It was not as if *who you were* could be boiled down to some crude genetic or sociological profile; every shadow you'd seen on the ceiling at night, every cloud you'd watched drift across the sky, would have left some small imprint on the shape of your mind. Those events were fully determined too, when viewed across the multiverse — with different versions of you witnessing every possibility — but in practical terms, the bottom line was that no private investigator armed with your genome and a potted biography could plot your every move in advance.

Our daughter's choices — like everything else — had been written in stone at the birth of the universe, but that information could only be decoded by *becoming her* along the way. Her actions would flow from her temperament, her principles, her desires, and the fact that all of these qualities would themselves have prior causes did nothing to diminish their value. *Free will* was a slippery notion, but to me it simply meant that your choices were more or less consistent with your nature — which in turn was a provisional, constantly-evolving consensus between a thousand different influences. Our daughter would not be robbed of the chance to act capriciously, or even perversely, but at least it would not be impossible for her ever to act wholly in accordance with her ideals.

I packed the bodies away before Francine got home. I wasn't sure if the sight would unsettle her, but I didn't want her measuring them up for more clothes.

The delivery began in the early hours of the morning of Sunday, December 14, and was expected to last about four hours, depending on traffic. I sat in the nursery while Francine paced the hallway outside, both of us watching the data coming through over the fibre from Basel.

Isabelle had used our genetic information as the starting point for a simulation of the development *in*



*utero* of a complete embryo, employing an “adaptive hierarchy” model, with the highest resolution reserved for the central nervous system. The Qusp would take over this task, not only for the newborn child's brain, but also for the thousands of biochemical processes occurring outside the skull that the artificial bodies were not designed to perform. Apart from their sophisticated sensory and motor functions, the bodies could take in food and excrete wastes — for psychological and social reasons, as well as for the chemical energy this provided — and they breathed air, both in order to oxidise this fuel, and for vocalisation, but they had no blood, no endocrine system, no immune response.

The Qusp I'd built in Berkeley was smaller than the São Paulo version, but it was still six times as wide as an infant's skull. Until it was further miniaturised, our daughter's mind would sit in a box in a corner of the nursery, joined to the rest of her by a wireless data link. Bandwidth and time lag would not be an issue within the Bay Area, and if we needed to take her further afield before everything was combined, the Qusp wasn't too large or delicate to move.

As the progress bar I was overlaying on the side of the Qusp nudged 98 per cent, Francine came into the nursery, looking agitated.

“We have to put it off, Ben. Just for a day. I need more time to prepare myself.”

I shook my head. “You made me promise to say no, if you asked me to do that.” She'd even refused to let me tell her how to halt the Qusp herself.

“Just a few hours,” she pleaded.

Francine seemed genuinely distressed, but I hardened my heart by telling myself that she was acting: testing me, seeing if I'd keep my word. “No. No slowing down or speeding up, no pauses, no tinkering at all. This child has to hit us like a freight train, just like any other child would.”

“You want me to go into labour now?” she said sarcastically. When I'd raised the possibility, half-jokingly, of putting her on a course of hormones that would have mimicked some of the effects of pregnancy in order to make bonding with the child easier — for myself as well, indirectly — she'd almost bit my head off. I hadn't been serious, because I knew it wasn't necessary. Adoption was the ultimate proof of that, but what we were doing was closer to claiming a child of our own from a surrogate.

“No. Just pick her up.”

Francine peered down at the inert form in the cot.

“I can't do it!” she wailed. “When I hold her, she should feel as if she's the most precious thing in the world to me. How can I make her believe that, when I know I could bounce her off the walls without harming her?”

We had two minutes left. I felt my breathing grow ragged. I could send the Qusp a halt code, but what if that set the pattern? If one of us had had too little sleep, if Francine was late for work, if we talked ourselves into believing that our special child was so unique that we deserved a short holiday from her needs, what would stop us from doing the same thing again?

I opened my mouth to threaten her: *Either you pick her up, now, or I do it.* I stopped myself, and said, “You know how much it would harm her psychologically, if you dropped her. The very fact that you're afraid that you won't convey as much protectiveness as you need to will be just as strong a signal to her as anything else. *You care about her.* She'll sense that.”

Francine stared back at me dubiously.

I said, “She’ll know. I’m sure she will.”

Francine reached into the cot and lifted the slack body into her arms. Seeing her cradle the lifeless form, I felt an anxious twisting in my gut; I’d experienced nothing like this when I’d laid the five plastic shells out for inspection.

I banished the progress bar and let myself free-fall through the final seconds: watching my daughter, willing her to move.

Her thumb twitched, then her legs scissored weakly. I couldn’t see her face, so I watched Francine’s expression. For an instant, I thought I could detect a horrified tightening at the corners of her mouth, as if she was about to recoil from this golem. Then the child began to bawl and kick, and Francine started weeping with undisguised joy.

As she raised the child to her face and planted a kiss on its wrinkled forehead, I suffered my own moment of disquiet. How easily that tender response had been summoned, when the body could as well have been brought to life by the kind of software used to animate the characters in games and films.

It hadn’t, though. There’d been nothing false or easy about the road that had brought us to this moment — let alone the one that Isabelle had followed — and we hadn’t even tried to fashion life from clay, from nothing. We’d merely diverted one small trickle from a river already four billion years old.

Francine held our daughter against her shoulder, and rocked back and forth. “Have you got the bottle? Ben?” I walked to the kitchen in a daze; the microwave had anticipated the happy event, and the formula was ready.

I returned to the nursery and offered Francine the bottle. “Can I hold her, before you start feeding?”

“Of course.” She leant forward to kiss me, then held out the child, and I took her the way I’d learnt to accept the babies of relatives and friends, cradling the back of her head beneath my hand. The distribution of weight, the heavy head, the play of the neck, felt the same as it did for any other infant. Her eyes were still screwed shut, as she screamed and swung her arms.

“What’s your name, my beautiful girl?” We’d narrowed the list down to about a dozen possibilities, but Francine had refused to settle on one until she’d seen her daughter take her first breath. “Have you decided?”

“I want to call her Helen.”

Gazing down at her, that sounded too old to me. Old-fashioned, at least. Great-Aunt Helen. Helena Bonham-Carter. I laughed inanely, and she opened her eyes.

Hairs rose on my arms. The dark eyes couldn’t quite search my face, but she was not oblivious to me. Love and fear coursed through my veins. *How could I hope to give her what she needed?* Even if my judgment had been faultless, my power to act upon it was crude beyond measure.

We were all she had, though. We would make mistakes, we would lose our way, but I had to believe that something would hold fast. Some portion of the overwhelming love and resolve that I felt right now would have to remain with every version of me who could trace his ancestry to this moment.

I said, “I name you Helen.”

“Sophie! *Sophie!*” Helen ran ahead of us towards the arrivals gate, where Isabelle and Sophie were emerging. Sophie, almost sixteen now, was much less demonstrative, but she smiled and waved.

Francine said, “Do you ever think of moving?”

“Maybe if the laws change first in Europe,” I replied.

“I saw a job in Zürich I could apply for.”

“I don't think we should bend over backwards to bring them together. They probably get on better with just occasional visits, and the net. It's not as if they don't have other friends.”

Isabelle approached, and greeted us both with kisses on the cheek. I'd dreaded her arrival the first few times, but by now she seemed more like a slightly overbearing cousin than a child protection officer whose very presence implied misdeeds.

Sophie and Helen caught up with us. Helen tugged at Francine's sleeve. “Sophie's got a boyfriend! Daniel. She showed me his picture.” She swooned mockingly, one hand on her forehead.

I glanced at Isabelle, who said, “He goes to her school. He's really very sweet.”

Sophie grimaced with embarrassment. “Three-year-old *boys* are *sweet*.” She turned to me and said, “Daniel is charming, and sophisticated, and *very* mature.”

I felt as if an anvil had been dropped on my chest. As we crossed the car park, Francine whispered, “Don't have a heart attack yet. You've got a while to get used to the idea.”

The waters of the bay sparkled in the sunlight as we drove across the bridge to Oakland. Isabelle described the latest session of the European parliamentary committee into adai rights. A draft proposal granting personhood to any system containing and acting upon a significant amount of the information content of human DNA had been gaining support; it was a tricky concept to define rigorously, but most of the objections were Pythonesque rather than practical. “Is the Human Proteomic Database a person? Is the Harvard Reference Physiological Simulation a person?” The HRPS modelled the brain solely in terms of what it removed from, and released into, the bloodstream; there was nobody home inside the simulation, quietly going mad.

Late in the evening, when the girls were upstairs, Isabelle began gently grilling us. I tried not to grit my teeth too much. I certainly didn't blame her for taking her responsibilities seriously; if, in spite of the selection process, we had turned out to be monsters, criminal law would have offered no remedies. Our obligations under the licensing contract were Helen's sole guarantee of humane treatment.

“She's getting good marks this year,” Isabelle noted. “She must be settling in.”

“She is,” Francine replied. Helen was not entitled to a government-funded education, and most private schools had either been openly hostile, or had come up with such excuses as insurance policies that would have classified her as hazardous machinery. (Isabelle had reached a compromise with the airlines: Sophie had to be powered down, appearing to sleep during flights, but was not required to be shackled or stowed in the cargo hold.) The first community school we'd tried had not worked out, but we'd eventually found one close to the Berkeley campus where every parent involved was happy with the idea of Helen's presence. This had saved her from the prospect of joining a net-based school; they weren't so bad, but they were intended for children isolated by geography or illness, circumstances that could not be overcome by other means.

Isabelle bid us good night with no complaints or advice; Francine and I sat by the fire for a while, just

smiling at each other. It was nice to have a blemish-free report for once.

The next morning, my alarm went off an hour early. I lay motionless for a while, waiting for my head to clear, before asking my knowledge miner why it had woken me.

It seemed Isabelle's visit had been beaten up into a major story in some east coast news bulletins. A number of vocal members of Congress had been following the debate in Europe, and they didn't like the way it was heading. Isabelle, they declared, had sneaked into the country as an agitator. In fact, she'd offered to testify to Congress any time they wanted to hear about her work, but they'd never taken her up on it.

It wasn't clear whether it was reporters or anti-adai activists who'd obtained her itinerary and done some digging, but all the details had now been splashed around the country, and protesters were already gathering outside Helen's school. We'd faced media packs, cranks, and activists before, but the images the knowledge miner showed me were disturbing; it was five a.m. and the crowd had already encircled the school. I had a flashback to some news footage I'd seen in my teens, of young schoolgirls in Northern Ireland running the gauntlet of a protest by the opposing political faction; I could no longer remember who had been Catholic and who had been Protestant.

I woke Francine and explained the situation.

"We could just keep her home," I suggested.

Francine looked torn, but she finally agreed. "It will probably all blow over when Isabelle flies out on Sunday. One day off school isn't exactly capitulating to the mob."

At breakfast, I broke the news to Helen.

"I'm not staying home," she said.

"Why not? Don't you want to hang out with Sophie?"

Helen was amused. "'Hang out'? Is that what the hippies used to say?" In her personal chronology of San Francisco, anything from before her birth belonged to the world portrayed in the tourist museums of Haight-Ashbury.

"Gossip. Listen to music. Interact socially in whatever manner you find agreeable."

She contemplated this last, open-ended definition. "Shop?"

"I don't see why not." There was no crowd outside the house, and though we were probably being watched, the protest was too large to be a moveable feast. Perhaps all the other parents would keep their children home, leaving the various placard wavers to fight among themselves.

Helen reconsidered. "No. We're doing that on Saturday. I want to go to school."

I glanced at Francine. Helen added, "It's not as if they can hurt me. I'm backed up."

Francine said, "It's not pleasant being shouted at. Insulted. Pushed around."

"I don't think it's going to be *pleasant*," Helen replied scornfully. "But I'm not going to let them tell me what to do."

To date, a handful of strangers had got close enough to yell abuse at her, and some of the children at her first school had been about as violent as (ordinary, drug-free, non-psychotic) nine-year-old bullies could

be, but she'd never faced anything like this. I showed her the live news feed. She was not swayed. Francine and I retreated to the living room to confer.

I said, "I don't think it's a good idea." On top of everything else, I was beginning to suffer from a paranoid fear that Isabelle would blame us for the whole situation. Less fancifully, she could easily disapprove of us exposing Helen to the protesters. Even if that was not enough for her to terminate the licence immediately, eroding her confidence in us could lead to that fate, eventually.

Francine thought for a while. "If we both go with her, both walk beside her, what are they going to do? If they lay a finger on us, it's assault. If they try to drag her away from us, it's theft."

"Yes, but whatever they do, she gets to hear all the poison they spew out."

"She watches the news, Ben. She's heard it all before."

"Oh, shit." Isabelle and Sophie had come down to breakfast; I could hear Helen calmly filling them in about her plans.

Francine said, "Forget about pleasing Isabelle. If Helen wants to do this, knowing what it entails, and we can keep her safe, then we should respect her decision."

I felt a sting of anger at the unspoken implication: having gone to such lengths to enable her to make meaningful choices, I'd be a hypocrite to stand in her way. *Knowing what it entails?* She was nine-and-a-half years old.

I admired her courage, though, and I did believe that we could protect her.

I said, "All right. You call the other parents. I'll inform the police."

The moment we left the car, we were spotted. Shouts rang out, and a tide of angry people flowed towards us.

I glanced down at Helen and tightened my grip on her. "Don't let go of our hands."

She smiled at me indulgently, as if I was warning her about something trivial, like broken glass on the beach. "I'll be all right, Dad." She flinched as the crowd closed in, and then there were bodies pushing against us from every side, people jabbering in our faces, spittle flying. Francine and I turned to face each other, making something of a protective cage and a wedge through the adult legs. Frightening as it was to be submerged, I was glad my daughter wasn't at eye level with these people.

"Satan moves her! Satan is inside her! Out, Jezebel spirit!" A young woman in a high-collared lilac dress pressed her body against me and started praying in tongues.

"Gödel's theorem proves that the non-computible, non-linear world behind the quantum collapse is a manifest expression of Buddha-nature," a neatly-dressed youth intoned earnestly, establishing with admirable economy that he had no idea what any of these terms meant. "Ergo, there can be no soul in the machine."

"Cyber nano quantum. Cyber nano quantum. Cyber nano quantum." That chant came from one of our would-be "supporters", a middle-aged man in lycra cycling shorts who was forcefully groping down between us, trying to lay his hand on Helen's head and leave a few flakes of dead skin behind; according to cult doctrine, this would enable her to resurrect him when she got around to establishing the Omega Point. I blocked his way as firmly as I could without actually assaulting him, and he wailed like a pilgrim denied admission to Lourdes.

“Think you're going to live forever, Tinkerbell?” A leering old man with a matted beard poked his head out in front of us, and spat straight into Helen's face.

“Arsehole!” Francine shouted. She pulled out a handkerchief and started mopping the phlegm away. I crouched down and stretched my free arm around them. Helen was grimacing with disgust as Francine dabbed at her, but she wasn't crying.

I said, “Do you want to go back to the car?”

“No.”

“Are you sure?”

Helen screwed up her face in an expression of irritation. “Why do you always ask me that? *Am I sure? Am I sure?* You're the one who sounds like a computer.”

“I'm sorry.” I squeezed her hand.

We ploughed on through the crowd. The core of the protesters turned out to be both saner and more civilised than the lunatics who'd got to us first; as we neared the school gates, people struggled to make room to let us through uninjured, at the same time as they shouted slogans for the cameras. “Healthcare for all, not just the rich!” I couldn't argue with that sentiment, though adai were just one of a thousand ways the wealthy could spare their children from disease, and in fact they were among the cheapest: the total cost in prosthetic bodies up to adult size came to less than the median lifetime expenditure on healthcare in the U.S. Banning adai wouldn't end the disparity between rich and poor, but I could understand why some people considered it the ultimate act of selfishness to create a child who could live forever. They probably never wondered about the fertility rates and resource use of their own descendants over the next few thousand years.

We passed through the gates, into a world of space and silence; any protester who trespassed here could be arrested immediately, and apparently none of them were sufficiently dedicated to Gandhian principles to seek out that fate.

Inside the entrance hall, I squatted down and put my arms around Helen. “Are you OK?”

“Yes.”

“I'm really proud of you.”

“You're shaking.” She was right; my whole body was trembling slightly. It was more than the crush and the confrontation, and the sense of relief that we'd come through unscathed. Relief was never absolute for me; I could never quite erase the images of other possibilities at the back of my mind.

One of the teachers, Carmela Peña, approached us, looking stoical; when they'd agreed to take Helen, all the staff and parents had known that a day like this would come.

Helen said, “I'll be OK now.” She kissed me on the cheek, then did the same to Francine. “I'm all right,” she insisted. “You can go.”

Carmela said, “We've got sixty per cent of the kids coming. Not bad, considering.”

Helen walked down the corridor, turning once to wave at us impatiently.

I said, “No, not bad.”

A group of journalists cornered the five of us during the girls' shopping trip the next day, but media organisations had grown wary of lawsuits, and after Isabelle reminded them that she was presently enjoying “the ordinary liberties of every private citizen” — a quote from a recent eight-figure judgment against *Celebrity Stalker* — they left us in peace.

The night after Isabelle and Sophie flew out, I went in to Helen's room to kiss her good night. As I turned to leave, she said, “What's a Qusp?”

“It's a kind of computer. Where did you hear about that?”

“On the net. It said I had a Qusp, but Sophie didn't.”

Francine and I had made no firm decision as to what we'd tell her, and when. I said, “That's right, but it's nothing to worry about. It just means you're a little bit different from her.”

Helen scowled. “I don't want to be different from Sophie.”

“Everyone's different from everyone else,” I said glibly. “Having a Qusp is just like ... a car having a different kind of engine. It can still go to all the same places.” *Just not all of them at once.* “You can both still do whatever you like. You can be as much like Sophie as you want.” That wasn't entirely dishonest; the crucial difference could always be erased, simply by disabling the Qusp's shielding.

“I want to be the same,” Helen insisted. “Next time I grow, why can't you give me what Sophie's got, instead?”

“What you have is newer. It's better.”

“No one else has got it. Not just Sophie; none of the others.” Helen knew she'd nailed me: if it was newer and better, why didn't the younger adai have it too?

I said, “It's complicated. You'd better go to sleep now; we'll talk about it later.” I fussed with the blankets, and she stared at me resentfully.

I went downstairs and recounted the conversation to Francine. “What do you think?” I asked her. “Is it time?”

“Maybe it is,” she said.

“I wanted to wait until she was old enough to understand the MWI.”

Francine considered this. “Understand it how well, though? She's not going to be juggling density matrices any time soon. And if we make it a big secret, she's just going to get half-baked versions from other sources.”

I flopped onto the couch. “This is going to be hard.” I'd rehearsed the moment a thousand times, but in my imagination Helen had always been older, and there'd been hundreds of other adai with Qusps. In reality, no one had followed the trail we'd blazed. The evidence for the MWI had grown steadily stronger, but for most people it was still easy to ignore. Ever more sophisticated versions of rats running mazes just looked like elaborate computer games. You couldn't travel from branch to branch yourself, you couldn't spy on your parallel alter egos — and such feats would probably never be possible. “How do you tell a nine-year-old girl that she's the only sentient being on the planet who can make a decision, and stick to it?”

Francine smiled. “Not in those words, for a start.”

“No.” I put my arm around her. We were about to enter a minefield — and we couldn't help diffusing out across the perilous ground — but at least we had each other's judgment to keep us in check, to rein us in a little.

I said, “We'll work it out. We'll find the right way.”

## 2050

Around four in the morning, I gave in to the cravings and lit my first cigarette in a month.

As I drew the warm smoke into my lungs, my teeth started chattering, as if the contrast had forced me to notice how cold the rest of my body had become. The red glow of the tip was the brightest thing in sight, but if there was a camera trained on me it would be infrared, so I'd been blazing away like a bonfire, anyway. As the smoke came back up I spluttered like a cat choking on a fur ball; the first one was always like that. I'd taken up the habit at the surreal age of sixty, and even after five years on and off, my respiratory tract couldn't quite believe its bad luck.

For five hours, I'd been crouched in the mud at the edge of Lake Pontchartrain, a couple of kilometres west of the soggy ruins of New Orleans. Watching the barge, waiting for someone to come home. I'd been tempted to swim out and take a look around, but my aide sketched a bright red moat of domestic radar on the surface of the water, and offered no guarantee that I'd remain undetected even if I stayed outside the perimeter.

I'd called Francine the night before. It had been a short, tense conversation.

“I'm in Louisiana. I think I've got a lead.”

“Yeah?”

“I'll let you know how it turns out.”

“You do that.”

I hadn't seen her in the flesh for almost two years. After facing too many dead ends together, we'd split up to cover more ground: Francine had searched from New York to Seattle; I'd taken the south. As the months had slipped away, her determination to put every emotional reaction aside for the sake of the task had gradually eroded. One night, I was sure, grief had overtaken her, alone in some soulless motel room — and it made no difference that the same thing had happened to me, a months later or a week before. Because we had not experienced it together, it was not a shared pain, a burden made lighter. After forty-seven years, though we now had a single purpose as never before, we were starting to come adrift.

I'd learnt about Jake Holder in Baton Rouge, triangulating on rumours and fifth-hand reports of bar-room boasts. The boasts were usually empty; a prosthetic body equipped with software dumber than a microwave could make an infinitely pliable slave, but if the only way to salvage any trace of dignity when your buddies discovered that you owned the high-tech equivalent of a blow-up doll was to imply that there was somebody home inside, apparently a lot of men leapt at the chance.

Holder looked like something worse. I'd bought his lifetime purchasing records, and there'd been a steady stream of cyber-fetish porn over a period of two decades. Hardcore and pretentious; half the titles contained the word “manifesto”. But the flow had stopped, about three months ago. The rumours were, he'd found something better.

I finished the cigarette, and slapped my arms to get the circulation going. *She would not be on the*



*barge*. For all I knew, she'd heard the news from Brussels and was already halfway to Europe. That would be a difficult journey to make on her own, but there was no reason to believe that she didn't have loyal, trustworthy friends to assist her. I had too many out-of-date memories burnt into my skull: all the blazing, pointless rows, all the petty crimes, all the self-mutilation. Whatever had happened, whatever she'd been through, she was no longer the angry fifteen-year-old who'd left for school one Friday and never come back.

By the time she'd hit thirteen, we were arguing about everything. Her body had no need for the hormonal flood of puberty, but the software had ground on relentlessly, simulating all the neuroendocrine effects. Sometimes it had seemed like an act of torture to put her through that — instead of hunting for some magic short-cut to maturity — but the cardinal rule had been never to tinker, never to intervene, just to aim for the most faithful simulation possible of ordinary human development.

Whatever we'd fought about, she'd always known how to shut me up. “I'm just a thing to you! An instrument! Daddy's little silver bullet!” I didn't care who she was, or what she wanted; I'd fashioned her solely to slay my own fears. (I'd lie awake afterwards, rehearsing lame counter-arguments. Other children were born for infinitely baser motives: to work the fields, to sit in boardrooms, to banish ennui, to save failing marriages.) In her eyes, the Qusp itself wasn't good or bad — and she turned down all my offers to disable the shielding; that would have let me off the hook too easily. But I'd made her a freak for my own selfish reasons; I'd set her apart even from the other adai, purely to grant myself a certain kind of comfort. “You wanted to give birth to a singleton? Why didn't you just shoot yourself in the head every time you made a bad decision?”

When she went missing, we were afraid she'd been snatched from the street. But in her room, we'd found an envelope with the locator beacon she'd dug out of her body, and a note that read: *Don't look for me. I'm never coming back.*

I heard the tyres of a heavy vehicle squelching along the muddy track to my left. I hunkered lower, making sure I was hidden in the undergrowth. As the truck came to a halt with a faint metallic shudder, the barge disgorged an unmanned motorboat. My aide had captured the data streams exchanged, one specific challenge and response, but it had no clue how to crack the general case and mimic the barge's owner.

Two men climbed out of the truck. One was Jake Holder; I couldn't make out his face in the starlight, but I'd sat within a few metres of him in diners and bars in Baton Rouge, and my aide knew his somatic signature: the electromagnetic radiation from his nervous system and implants; his body's capacitative and inductive responses to small shifts in the ambient fields; the faint gamma-ray spectrum of his unavoidable, idiosyncratic load of radioisotopes, natural and Chernobyl-esque.

I did not know who his companion was, but I soon got the general idea.

“One thousand now,” Holder said. “One thousand when you get back.” His silhouette gestured at the waiting motorboat.

The other man was suspicious. “How do I know it will be what you say it is?”

“Don't call her ‘it’,” Holder complained. “She's not an object. She's my Lilith, my Lo-li-ta, my luscious clockwork succubus.” For one hopeful moment, I pictured the customer snickering at this overheated sales pitch and coming to his senses; brothels in Baton Rouge openly advertised machine sex, with skilled human puppeteers, for a fraction of the price. Whatever he imagined the special thrill of a genuine adai to be, he had no way of knowing that Holder didn't have an accomplice controlling the body on the barge in exactly the same fashion. He might even be paying two thousand dollars for a puppet job from Holder

himself.

“OK. But if she's not genuine ...”

My aide overheard money changing hands, and it had modelled the situation well enough to know how I'd wish, always, to respond. “Move now,” it whispered in my ear. I complied without hesitation; eighteen months before, I'd pavloved myself into swift obedience, with all the pain and nausea modern chemistry could induce. The aide couldn't puppet my limbs — I couldn't afford the elaborate surgery — but it overlaid movement cues on my vision, a system I'd adapted from off-the-shelf choreography software, and I strode out of the bushes, right up to the motorboat.

The customer was outraged. “What is this?”

I turned to Holder. “You want to fuck him first, Jake? I'll hold him down.” There were things I didn't trust the aide to control; it set the boundaries, but it was better to let me improvise a little, and then treat my actions as one more part of the environment.

After a moment of stunned silence, Holder said icily, “I've never seen this prick before in my life.” He'd been speechless for a little too long, though, to inspire any loyalty from a stranger; as he reached for his weapon, the customer backed away, then turned and fled.

Holder walked towards me slowly, gun outstretched. “What's your game? Are you after her? Is that it?” His implants were mapping my body — actively, since there was no need for stealth — but I'd tailed him for hours in Baton Rouge, and my aide knew him like an architectural plan. Over the starlit grey of his form, it overlaid a schematic, flaying him down to brain, nerves, and implants. A swarm of blue fireflies flickered into life in his motor cortex, prefiguring a peculiar shrug of the shoulders with no obvious connection to his trigger finger; before they'd reached the intensity that would signal his implants to radio the gun, my aide said “Duck.”

The shot was silent, but as I straightened up again I could smell the propellant. I gave up thinking and followed the dance steps. As Holder strode forward and swung the gun towards me, I turned sideways, grabbed his right hand, then punched him hard, repeatedly, in the implant on the side of his neck. He was a fetishist, so he'd chosen bulky packages, intentionally visible through the skin. They were not hard-edged, and they were not inflexible — he wasn't that masochistic — but once you sufficiently compressed even the softest biocompatible foam, it might as well have been a lump of wood. While I hammered the wood into the muscles of his neck, I twisted his forearm upwards. He dropped the gun; I put my foot on it and slid it back towards the bushes.

In ultrasound, I saw blood pooling around his implant. I paused while the pressure built up, then I hit him again and the swelling burst like a giant blister. He sagged to his knees, bellowing with pain. I took the knife from my back pocket and held it to his throat.

I made Holder take off his belt, and I used it to bind his hands behind his back. I led him to the motorboat, and when the two of us were on board, I suggested that he give it the necessary instructions. He was sullen but cooperative. I didn't feel anything; part of me still insisted that the transaction I'd caught him in was a hoax, and that there'd be nothing on the barge that couldn't be found in Baton Rouge.

The barge was old, wooden, smelling of preservatives and unvanquished rot. There were dirty plastic panes in the cabin windows, but all I could see in them was a reflected sheen. As we crossed the deck, I kept Holder intimately close, hoping that if there was an armed security system it wouldn't risk putting the bullet through both of us.

At the cabin door, he said resignedly, “Don't treat her badly.” My blood went cold, and I pressed my

forearm to my mouth to stifle an involuntary sob.

I kicked open the door, and saw nothing but shadows. I called out “Lights!” and two responded, in the ceiling and by the bed. Helen was naked, chained by the wrists and ankles. She looked up and saw me, then began to emit a horrified keening noise.

I pressed the blade against Holder's throat. “Open those things!”

“The shackles?”

“Yes!”

“I can't. They're not smart; they're just welded shut.”

“Where are your tools?”

He hesitated. “I've got some wrenches in the truck. All the rest is back in town.”

I looked around the cabin, then I lead him into a corner and told him to stand there, facing the wall. I knelt by the bed.

“Ssh. We'll get you out of here.” Helen fell silent. I touched her cheek with the back of my hand; she didn't flinch, but she stared back at me, disbelieving. “We'll get you out.” The timber bedposts were thicker than my arms, the links of the chains wide as my thumb. I wasn't going to snap any part of this with my bare hands.

Helen's expression changed: I was real, she was not hallucinating. She said dully, “I thought you'd given up on me. Woke one of the backups. Started again.”

I said, “I'd never give up on you.”

“Are you sure?” She searched my face. “Is this the edge of what's possible? Is this the worst it can get?”

I didn't have an answer to that.

I said, “You remember how to go numb, for a shedding?”

She gave me a faint, triumphant smile. “Absolutely.” She'd had to endure imprisonment and humiliation, but she'd always had the power to cut herself off from her body's senses.

“Do you want to do it now? Leave all this behind?”

“Yes.”

“You'll be safe soon. I promise you.”

“I believe you.” Her eyes rolled up.

I cut open her chest and took out the Qusp.

Francine and I had both carried spare bodies, and clothes, in the trunks of our cars. Adai were banned from domestic flights, so Helen and I drove along the interstate, up towards Washington D.C., where Francine would meet us. We could claim asylum at the Swiss embassy; Isabelle had already set the machinery in motion.

Helen was quiet at first, almost shy with me as if with a stranger, but on the second day, as we crossed from Alabama into Georgia, she began to open up. She told me a little of how she'd hitchhiked from state to state, finding casual jobs that paid e-cash and needed no social security number, let alone biometric ID. "Fruit picking was the best."

She'd made friends along the way, and confided her nature to those she thought she could trust. She still wasn't sure whether or not she'd been betrayed. Holder had found her in a transient's camp under a bridge, and someone must have told him exactly where to look, but it was always possible that she'd been recognised by a casual acquaintance who'd seen her face in the media years before. Francine and I had never publicised her disappearance, never put up flyers or web pages, out of fear that it would only make the danger worse.

On the third day, as we crossed the Carolinas, we drove in near silence again. The landscape was stunning, the fields strewn with flowers, and Helen seemed calm. Maybe this was what she needed the most: just safety, and peace.

As dusk approached, though, I felt I had to speak.

"There's something I've never told you," I said. "Something that happened to me when I was young."

Helen smiled. "Don't tell me you ran away from the farm? Got tired of milking, and joined the circus?"

I shook my head. "I was never adventurous. It was just a little thing." I told her about the kitchen hand.

She pondered the story for a while. "And that's why you built the Qusp? That's why you made me? In the end, it all comes down to that man in the alley?" She sounded more bewildered than angry.

I bowed my head. "I'm sorry."

"For what?" she demanded. "Are you sorry that I was ever born?"

"No, but —"

"You didn't put me on that boat. Holder did that."

I said, "I brought you into a world with people like him. What I made you, made you a target."

"And if I'd been flesh and blood?" she said. "Do you think there aren't people like him, for flesh and blood? Or do you honestly believe that if you'd had an organic child, there would have been *no chance at all* that she'd have run away?"

I started weeping. "I don't know. I'm just sorry I hurt you."

Helen said, "I don't blame you for what you did. And I understand it better now. You saw a spark of good in yourself, and you wanted to cup your hands around it, protect it, make it stronger. I understand that. I'm not that spark, but that doesn't matter. I know who I am, I know what my choices are, and I'm glad of that. I'm glad you gave me that." She reached over and squeezed my hand. "Do you think I'd feel *better*, here and now, just because some other version of me handled the same situations better?" She smiled. "Knowing that other people are having a good time isn't much of a consolation to anyone."

I composed myself. The car beeped to bring my attention to a booking it had made in a motel a few kilometres ahead.

Helen said, "I've had time to think about a lot of things. Whatever the laws say, whatever the bigots say,

all adai are part of the human race. And what *I* have is something almost every person who's ever lived thought they possessed. Human psychology, human culture, human morality, all evolved with the illusion that we lived in a single history. But we don't — so in the long run, something has to give. Call me old-fashioned, but I'd rather we tinker with our physical nature than abandon our whole identities.”

I was silent for a while. “So what are your plans, now?”

“I need an education.”

“What do you want to study?”

“I'm not sure yet. A million different things. But in the long run, I know what I want to do.”

“Yeah?” The car turned off the highway, heading for the motel.

“You made a start,” she said, “but it's not enough. There are people in billions of other branches where the Qusp hasn't been invented yet — and the way things stand, there'll always be branches without it. What's the point in us having this thing, if we don't share it? All those people deserve to have the power to make their own choices.”

“Travel between the branches isn't a simple problem,” I explained gently. “That would be orders of magnitude harder than the Qusp.”

Helen smiled, conceding this, but the corners of her mouth took on the stubborn set I recognised as the precursor to a thousand smaller victories.

She said, “Give me time, Dad. Give me time.”

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*Miscellaneous Fiction / Singleton / revised Thursday, 8 August 2002*

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