TURING'S APPLES

Stephen Baxter

Near the centre of the Moon's far side there is a neat, round, well-defined crater called Daedalus. No human knew this existed before the middle of the twentieth century. It's a bit of lunar territory as far as you can get from Earth, and about the quietest.

That's why the teams of astronauts from Europe, America, Russia and China went there. They smoothed over the floor of a crater ninety kilometres wide, laid sheets of metal mesh over the natural dish, and suspended feed horns and receiver systems on spidery scaffolding. And there you had it, an instant radio telescope, by far the most powerful ever built: a super-Arecibo, dwarfing its mother in Puerto Rico. Before the astronauts left they christened their telescope Clarke.

Now the telescope is a ruin, and much of the floor of Daedalus is covered by glass, Moon dust melted by multiple nuclear strikes. But, I'm told, if you were to look down from some slow lunar orbit you would see a single point of light glowing there, a star fallen to the Moon. One day the Moon will be gone, but that point will remain, silently orbiting Earth, a lunar memory. And in the further future, when the Earth has gone too, when the stars have burned out and the galaxies fled from the sky, still that point of light will shine.

My brother Wilson never left the Earth. In fact he rarely left England. He was buried, what was left of him, in a grave next to our father's, just outside Milton Keynes. But he made that point of light on the Moon, which will be the last legacy of all mankind.

Talk about sibling rivalry.

2020

It was at my father's funeral, actually, before Wilson had even begun his SETI searches, that the Clarke first came between us.

There was a good turnout at the funeral, at an old church on the outskirts of Milton Keynes proper. Wilson and I were my father's only children, but as well as his old friends there were a couple of surviving aunts and a gaggle of cousins mostly around our age, mid-twenties to mid-thirties, so there was a good crop of children, like little flowers.

I don't know if I'd say Milton Keynes is a good place to live. It certainly isn't a good place to die. The city is a monument to planning, a concrete grid of avenues with very English names like Midsummer, now overlaid by the new monorail. It's so clean it makes death seem a social embarrassment, like a fart in a shopping mall. Maybe we need to be buried in ground dirty with bones.

Our father had remembered, just, how the area was all villages and farmland before the Second World War. He had stayed on even after our mother died twenty years before he did, him and his memories made invalid by all the architecture. At the service I spoke of those memories—for

instance how during the war a tough Home Guard had caught him sneaking into the grounds of Bletchley Park, not far away, scrumping apples while Alan Turing and the other geniuses were labouring over the Nazi codes inside the house. "Dad always said he wondered if he picked up a mathematical bug from Turing's apples," I concluded, "because, he would say, for sure Wilson's brain didn't come from him."

"Your brain too," Wilson said when he collared me later outside the church. He hadn't spoken at the service; that wasn't his style. "You should have mentioned that. I'm not the only mathematical nerd in the family."

It was a difficult moment. My wife and I had just been introduced to Hannah, the two-year-old daughter of a cousin. Hannah had been born profoundly deaf, and we adults in our black suits and dresses were awkwardly copying her parents' bits of sign language. Wilson just walked through this lot to get to me, barely glancing at the little girl with the wide smile who was the centre of attention. I led him away to avoid any offence.

He was thirty then, a year older than me, taller, thinner, edgier. Others have said we were more similar than I wanted to believe. He had brought nobody with him to the funeral, and that was a relief. His partners could be male or female, his relationships usually destructive; his companions were like unexploded bombs walking into the room.

"Sorry if I got the story wrong," I said, a bit caustically.

"Dad and his memories, all those stories he told over and over. Well, it's the last time I'll hear about Turing's apples!"

That thought hurt me. "We'll remember. I suppose I'll tell it to Eddie and Sam someday." My own little boys.

"They won't listen. Why should they? Dad will fade away. Everybody fades away. The dead get deader." He was talking about his own father, whom we had just buried. "Listen, have you heard they're putting the Clarke through its acceptance test run?. . ." And, there in the churchyard, he actually pulled a handheld computer out of his inside jacket pocket and brought up a specification. "Of course you understand the importance of it being on Farside." For the millionth time in my life he had set his little brother a pop quiz, and he looked at me as if I was catastrophically dumb.

"Radio shadow," I said. To be shielded from Earth's noisy chatter was particularly important for SETI, the search for extraterrestrial intelligence to which my brother was devoting his career. SETI searches for faint signals from remote civilisations, a task made orders of magnitude harder if you're drowned out by very loud signals from a nearby civilisation.

He actually applauded my guess, sarcastically. He often reminded me of what had always repelled me about academia—the barely repressed bullying, the intense rivalry. A university is a chimp pack. That was why I was never tempted to go down that route. That, and maybe the fact that Wilson had gone that way ahead of me.

I was faintly relieved when people started to move out of the churchyard.

There was going to be a reception at my father's home, and we had to go.

"So are you coming for the cakes and sherry?"

He glanced at the time on his handheld. "Actually I've somebody to meet."

"He or she?"

He didn't reply. For one brief moment he looked at me with honesty. "You're better at this stuff than me."

"What stuff? Being human?"

"Listen, the Clarke should be open for business in a month. Come on down to London; we can watch the first results."

"I'd like that."

I was lying, and his invitation probably wasn't sincere either. In the end it was over two years before I saw him again.

By then he'd found the Eagle signal, and everything had changed.

2022

Wilson and his team quickly established that their brief signal, first detected just months after Clarke went operational, was coming from a source six thousand five hundred light years from Earth, somewhere beyond a starbirth cloud called the Eagle Nebula. That's a long way away, on the other side of the Galaxy's next spiral arm in, the Sagittarius.

And to call the signal "brief" understates it. It was a second-long pulse, faint and hissy, and it repeated just once a year, roughly. It was a monument to robotic patience that the big lunar ear had picked up the damn thing at all.

Still it was a genuine signal from ET, the scientists were jumping up and down, and for a while it was a public sensation. Within days somebody had rushed out a pop single inspired by the message: called "Eagle Song," slow, dreamlike, littered with what sounded like sitars, and very beautiful. It was supposedly based on a Beatles master lost for five decades. It made number two.

But the signal was just a squirt of noise from a long way off. When there was no follow-up, when no mother ship materialised in the sky, interest moved on. That song vanished from the charts.

The whole business of the signal turned out to be your classic nine-day wonder. Wilson invited me in on the tenth day. That was why I was resentful, I guess, as I drove into town that morning to visit him.

The Clarke Institute's ground station was in one of the huge glass follies thrown up along the banks of the Thames in the profligate boom-capitalism days of the noughties. Now office space was cheap enough even for academics to rent, but central London was a fortress, with mandatory crawl lanes so your face could be captured by the surveillance cameras. I was in

the counter-terror business myself, and I could see the necessity as I edged past St. Paul's, whose dome had been smashed like an egg by the Carbon Cowboys' bomb of 2018. But the slow ride left me plenty of time to brood on how many more important people Wilson had shown off to before he got around to his brother. Wilson never was loyal that way.

Wilson's office could have been any modern data-processing installation, save for the all-sky projection of the cosmic background radiation painted on the ceiling. Wilson sat me down and offered me a can of warm Coke. An audio transposition of the signal was playing on an open laptop, over and over. It sounded like waves lapping at a beach. Wilson looked like he hadn't shaved for three days, slept for five, or changed his shirt in ten. He listened, rapt.

Even Wilson and his team hadn't known about the detection of the signal for a year. The Clarke ran autonomously; the astronauts who built it had long since packed up and come home. A year earlier the telescope's signal processors had spotted the pulse, a whisper of microwaves. There was structure in there, and evidence that the beam was collimated—it looked artificial. But the signal faded after just a second.

Most previous SETI searchers had listened for strong, continuous signals, and would have given up at that point. But what about a lighthouse, sweeping a microwave beam around the Galaxy like a searchlight? That, so Wilson had explained to me, would be a much cheaper way for a transmitting civilisation to send to a lot more stars. So, based on that economic argument, the Clarke was designed for patience. It had waited a whole year. It had even sent requests to other installations, asking them to keep an electronic eye out in case the Clarke, stuck in its crater, happened to be looking the other way when the signal recurred. In the end it struck lucky and found the repeat pulse itself, and at last alerted its human masters.

"We're hot favourites for the Nobel," Wilson said, matter of fact.

I felt like having a go at him. "Probably everybody out there has forgotten about your signal already." I waved a hand at the huge glass windows; the office, meant for fat-cat hedge fund managers, had terrific views of the river, the Houses of Parliament, the tangled wreck of the London Eye. "Okay, it's proof of existence, but that's all."

He frowned at that. "Well, that's not true. Actually we're looking for more data in the signal. It is very faint, and there's a lot of scintillation from the interstellar medium. We're probably going to have to wait for a few more passes to get a better resolution."

"A few more passes? A few more years!"

"But even without that there's a lot we can tell just from the signal itself." He pulled up charts on his laptop. "For a start we can deduce the Eaglets' technical capabilities and power availability, given that we believe they'd do it as cheaply as possible. This analysis is related to an old model called Benford beacons." He pointed to a curve minimum. "Look—we figure they are pumping a few hundred megawatts through an array kilometres across,

probably comparable to the one we've got listening on the Moon. Sending out pulses around the plane of the Galaxy, where most of the stars lie. We can make other guesses." He leaned back and took a slug of his Coke, dribbling a few drops to add to the collection of stains on his shirt. "The search for ET was always guided by philosophical principles and logic. Now we have this one data point, the Eaglets six thousand light years away, we can test those principles."

"Such as?"

"The principle of plenitude. We believed that because life and intelligence arose on this Earth, they ought to arise everywhere they can. Here's one validation of that principle. Then there's the principle of mediocrity."

I remembered enough of my studies to recall that. "We aren't at any special place in space and time."

"Right. Turns out, given this one data point, it's not likely to hold too well."

"Why do you say that?"

"Because we found these guys in the direction of the centre of the Galaxy. . ."

When the Galaxy was young, star formation was most intense at its core. Later a wave of starbirth swept out through the disc, with the heavy elements necessary for life baked in the hearts of dead stars and driven on a wind of supernovas. So the stars inward of us are older than the sun, and are therefore likely to have been harbours for life much longer.

"We would expect to see a concentration of old civilisations towards the centre of the Galaxy. This one example validates that." He eyed me, challenging. "We can even guess how many technological, transmitting civilisations there are in the Galaxy."

"From this one instance?" I was practiced at this kind of contest between us. "Well, let's see. The Galaxy is a disc a hundred thousand light years across, roughly. If all the civilisations are an average of six thousand light years apart—divide the area of the Galaxy by the area of a disc of diameter six thousand light years—around three hundred?"

He smiled. "Very good."

"So we're not typical," I said. "We're young, and out in the suburbs. All that from a single microwave pulse."

"Of course most ordinary people are too dumb to be able to appreciate logic like that. That's why they aren't rioting in the streets." He said this casually. Language like that always made me wince, even when we were undergraduates.

But he had a point. Besides, I had the feeling that most people had already believed in their gut that ET existed; this was a confirmation, not a shock. You might blame Hollywood for that, but Wilson sometimes speculated that we were looking for our lost brothers. All those other hominid species, those other kinds of mind, that we killed off one by one, just as in my

lifetime we had destroyed the chimps in the wild—sentient tool-using beings, hunted down for bushmeat. We evolved on a crowded planet, and we missed them all.

"A lot of people are speculating about whether the Eaglets have souls," I said. "According to Saint Thomas Aquinas—"

He waved away Saint Thomas Aquinas. "You know, in a way our feelings behind SETI were always theological, explicitly or not. We were looking for God in the sky, or some technological equivalent. Somebody who would care about us. But we were never going to find Him. We were going to find either emptiness, or a new category of being, between us and the angels. The Eaglets have got nothing to do with us, or our dreams of God. That's what people don't see. And that's what people will have to deal with, ultimately."

He glanced at the ceiling, and I guessed he was looking towards the Eagle nebula. "And they won't be much like us. Hell of a place they live. Not like here. The Sagittarius arm wraps a whole turn around the Galaxy's core, full of dust and clouds and young stars. Why, the Eagle nebula itself is lit up by stars only a few million years old. Must be a tremendous sky, like a slow explosion—not like our sky of orderly wheeling pinpoints, which is like the inside of a computer. No wonder we began with astrology and astronomy. How do you imagine their thinking will be different, having evolved under such a different sky?"

I grunted. "We'll never know. Not for six thousand years at least."

"Maybe. Depends what data we find in the signal. You want another Coke?"

But I hadn't opened the first.

That was how that day went. We talked of nothing but the signal, not how he was, who he was dating, not about my family, my wife and the boys—all of us learning sign, incidentally, to talk to little Hannah. The Eagle signal was inhuman, abstract. Nothing you could see or touch; you couldn't even hear it without fancy signal processing. But it was all that filled his head. That was Wilson all over.

This was, in retrospect, the happiest time of his life. God help him.

2026

"You want my help, don't you?"

Wilson stood on my doorstep, wearing a jacket and shambolic tie, every inch the academic. He looked shifty. "How do you know?"

"Why else would you come here? You never visit." Well, it was true. He hardly ever even mailed or called. I didn't think my wife and kids had seen him since our father's funeral six years earlier.

He thought that over, then grinned. "A reasonable deduction, given past observation. Can I come in?"

I took him through the living room on the way to my home study. The boys,

then twelve and thirteen, were playing a hologram boxing game, with two wavering foot-tall prize fighters mimicking the kids' actions in the middle of the carpet. I introduced Wilson. They barely remembered him and I wasn't sure if he remembered them. I hurried him on. The boys signed to each other: What a dork, roughly translated.

Wilson noticed the signing. "What are they doing? Some kind of private game?"

I wasn't surprised he wouldn't know. "That's British Sign Language. We've been learning it for years—actually since Dad's funeral, when we hooked up with Barry and his wife, and we found out they had a little deaf girl. Hannah, do you remember? She's eight now. We've all been learning to talk to her. The kids find it fun, I think. You know, it's an irony that you're involved in a billion-pound project to talk to aliens six thousand light years away, yet it doesn't trouble you that you can't speak to a little girl in your own family."

He looked at me blankly. I was mouthing words that obviously meant nothing to him, intellectually or emotionally. That was Wilson.

He just started talking about work. "We've got six years' worth of data now—six pulses, each a second long. There's a lot of information in there. They use a technique like our own wave-length division multiplexing, with the signal divided into sections each a kilohertz or so wide. We've extracted gigabytes. . ."

I gave up. I went and made a pot of coffee, and brought it back to the study. When I returned he was still standing where I'd left him, like a switched-off robot. He took a coffee and sat down.

I prompted, "Gigabytes?"

"Gigabytes. By comparison the whole Encyclopaedia Britannica is just one gigabyte. The problem is we can't make sense of it."

"How do you know it's not just noise?"

"We have techniques to test for that. Information theory. Based on experiments to do with talking to dolphins, actually." He dug a handheld out of his pocket and showed me some of the results.

The first was simple enough, called a "Zipf graph." You break your message up into what look like components—maybe words, letters, phonemes in English. Then you do a frequency count: how many letter As, how many Es, how many Rs. If you have random noise you'd expect roughly equal numbers of the letters, so you'd get a flat distribution. If you have a clean signal without information content, a string of identical letters, A, A, A, you'd get a graph with a spike. Meaningful information gives you a slope, somewhere in between those horizontal and vertical extremes.

"And we get a beautiful log-scale minus one power law," he said, showing me. "There's information in there all right. But there is a lot of controversy over identifying the elements themselves. The Eaglets did not send down neat binary code. The data is frequency modulated, their language full of

growths and decays. More like a garden growing on fast-forward than any human data stream. I wonder if it has something to do with that young sky of theirs. Anyhow, after the Zipf, we tried a Shannon entropy analysis."

This is about looking for relationships between the signal elements. You work out conditional probabilities: Given pairs of elements, how likely is it that you'll see U following Q? Then you go on to higher-order "entropy levels," in the jargon, starting with triples: How likely is it to find G following I and N?

"As a comparison, dolphin languages get to third- or fourth-order entropy. We humans get to eighth or ninth."

"And the Eaglets?"

"The entropy level breaks our assessment routines. We think it's around order thirty." He regarded me, seeing if I understood. "It is information, but much more complex than any human language. It might be like English sentences with a fantastically convoluted structure—triple or quadruple negatives, overlapping clauses, tense changes." He grinned. "Or triple entendres. Or quadruples."

"They're smarter than us."

"Oh, yes. And this is proof, if we needed it, that the message isn't meant specifically for us."

"Because if it were, they'd have dumbed it down. How smart do you think they are? Smarter than us, certainly, but—"

"Are there limits? Well, maybe. You might imagine that an older culture would plateau, once they've figured out the essential truths of the universe, and a technology optimal for their needs. . . There's no reason to think progress need be onward and upward forever. Then again perhaps there are fundamental limits to information processing. Perhaps a brain that gets too complex is prone to crashes and overloads. There may be a trade-off between complexity and stability."

I poured him more coffee. "I went to Cambridge. I'm used to being with entities smarter than I am. Am I supposed to feel demoralised?"

He grinned. "That's up to you. But the Eaglets are a new category of being for us. This isn't like the Incas meeting the Spaniards, a mere technological gap. They had a basic humanity in common. We may find the gulf between us and the Eaglets is forever unbridgeable. Remember how Dad used to read Gulliver's Travels to us?"

The memory made me smile.

"Those talking horses used to scare the wits out of me. They were genuinely smarter than us. And how did Gulliver react to them? He was totally overawed. He tried to imitate them, and even after they kicked him out he always despised his own kind, because they weren't as good as the horses."

"The revenge of Mister Ed," I said.

But he never was much good at that kind of humour. "Maybe that will be the way for us—we'll ape the Eaglets or defy them. Maybe the mere knowledge that a race smarter than your own exists is death."

"Is all this being released to the public?"

"Oh, yes. We're affiliated to NASA, and they have an explicit open-book policy. Besides the Institute is as leaky as hell. There's no point even trying to keep it quiet. But we're releasing the news gradually and soberly. Nobody's noticing much. You hadn't, had you?"

"So what do you think the signal is? Some kind of super-encyclopaedia?"

He snorted. "Maybe. That's the fond hope among the contact optimists. But when the European colonists turned up on foreign shores, their first impulse wasn't to hand over encyclopaedias or histories, but—"

"Bibles."

"Yes. It could be something less disruptive than that. A vast work of art, for instance. Why would they send such a thing? Maybe it's a funeral pyre. Or a pharaoh's tomb, full of treasure. Look: we were here, this is how good we became."

"So what do you want of me?"

He faced me. I thought it was clear he was trying to figure out, in his clumsy way, how to get me to do whatever it was he wanted. "Well, what do you think? This makes translating the most obscure human language a cakewalk, and we've got nothing like a Rosetta stone. Look, Jack, our information processing suites at the Institute are pretty smart theoretically, but they are limited. Running off processors and memory store not much beefier than this." He waved his handheld. "Whereas the software brutes that do your data mining are an order of magnitude more powerful."

The software I developed and maintained mined the endless torrents of data culled on every individual in the country, from your minute-to-minute movements on private or public transport to the porn you accessed and how you hid it from your partner. We tracked your patterns of behaviour, and deviations from those patterns. "Terrorist" is a broad label, but it suited to describe the modern phenomenon we were looking for. The terrorists were needles in a haystack, of which the rest of us were the millions of straws.

This continual live data mining took up monstrous memory storage and processing power. A few times I'd visited the big Home Office computers in their hardened bunkers under New Scotland Yard: giant superconducting neural nets suspended in rooms so cold your breath crackled. There was nothing like it in the private sector, or in academia.

Which, I realised, was why Wilson had come to me today.

"You want me to run your ET signal through my data mining suites, don't you?" He immediately had me hooked, but I wasn't about to admit it. I might have rejected the academic life, but I think curiosity burned in me as strongly as it ever did in Wilson. "How do you imagine I'd get permission

for that?"

He waved that away as a technicality of no interest. "What we're looking for is patterns embedded deep in the data, layers down, any kind of recognisable starter for us in decoding the whole thing. . . Obviously software designed to look for patterns in the way I use my travel cards is going to have to be adapted to seek useful correlations in the Eaglet data. It will be an unprecedented challenge.

"In a way that's a good thing. It will likely take generations to decode this stuff, if we ever do, the way it took the Renaissance Europeans generations to make sense of the legacy of antiquity. The sheer time factor is a culture-shock prophylactic.

"So are you going to bend the rules for me, Jack? Come on, man. Remember what Dad said. Solving puzzles like this is what we do. We both ate Turing's apples. . ."

He wasn't entirely without guile. He knew how to entice me. He turned out to be wrong about the culture shock, however.

2029

Two armed coppers escorted me through the Institute building. The big glass box was entirely empty save for me and the coppers and a sniffer dog. The morning outside was bright, a cold spring day, the sky a serene blue, elevated from Wilson's latest madness.

Wilson was sitting in the Clarke project office, beside a screen across which data displays flickered. He had big slabs of Semtex strapped around his waist, and some kind of dead man's trigger in his hand. My brother, reduced at last to a cliché suicide bomber. The coppers stayed safely outside.

"We're secure." Wilson glanced around. "They can see us but they can't hear us. I'm confident of that. My firewalls—" When I walked towards him he held up his hands. "No closer. I'll blow it, I swear."

"Christ, Wilson." I stood still, shut up, and deliberately calmed down.

I knew that my boys, now in their teens, would be watching every move on the spy-hack news channels. Maybe nobody could hear us, but Hannah, now a beautiful eleven-year-old, had plenty of friends who could read lips. That would never occur to Wilson. If I was to die today, here with my lunatic of a brother, I wasn't going to let my boys remember their father broken by fear.

I sat down, as close to Wilson as I could get. I tried to keep my head down, my lips barely moving when I spoke. There was a six-pack of warm soda on the bench. I think I'll always associate warm soda with Wilson. I took one, popped the tab and sipped; I could taste nothing. "You want one?"

"No," he said bitterly. "Make yourself at home."

"What a fucking idiot you are, Wilson. How did it ever come to this?"

"You should know. You helped me."

"And by God I've regretted it ever since," I snarled back at him. "You got me sacked, you moron. And since France, every nut job on the planet has me targeted, and my kids. We have police protection."

"Don't blame me. You chose to help me."

I stared at him. "That's called loyalty. A quality which you, entirely lacking it yourself, see only as a weakness to exploit."

"Well, whatever. What does it matter now? Look, Jack, I need your help."

"This is turning into a pattern."

He glanced at his screen. "I need you to buy me time, to give me a chance to complete this project."

"Why should I care about your project?"

"It's not my project. It never has been. Surely you understand that much. It's the Eaglets'. . ."

Everything had changed in the three years since I had begun to run Wilson's message through the big Home Office computers under New Scotland Yard—all under the radar of my bosses; they'd never have dared risk exposing their precious supercooled brains to such unknowns. Well, Wilson had been right. My data mining had quickly turned up recurring segments, chunks of organised data differing only in detail.

And it was Wilson's intuition that these things were bits of executable code: programs you could run. Even as expressed in the Eaglets' odd flowing language, he thought he recognised logical loops, start and stop statements. Mathematics may or may not be universal, but computing seems to be—my brother had found Turing machines, buried deep in an alien database.

Wilson translated the segments into a human mathematical programming language, and set them to run on a dedicated processor. They turned out to be like viruses. Once downloaded on almost any computer substrate they organised themselves, investigated their environment, started to multiply, and quickly grew, accessing the data banks that had been downloaded from the stars with them. Then they started asking questions of the operators: simple yes-no, true-false exchanges that soon built up a common language.

"The Eaglets didn't send us a message," Wilson had whispered to me on the phone in the small hours; at the height of it he worked twenty-four seven. "They downloaded an AI. And now the AI is learning to speak to us."

It was a way to resolve a ferocious communications challenge. The Eaglets were sending their message to the whole Galaxy; they knew nothing about the intelligence, cultural development, or even the physical form of their audiences. So they sent an all-purpose artificial mind embedded in the information stream itself, able to learn and start a local dialogue with the receivers.

This above all else proved to me how smart the Eaglets must be. It didn't comfort me at all that some commentators pointed out that this "Hoyle strategy" had been anticipated by some human thinkers; it's one thing to anticipate, another to build. I wondered if those viruses found it a challenge to dumb down their message for creatures capable of only ninth-order Shannon entropy, as we were.

We were soon betrayed. For running the Eaglet data through the Home Office mining suites I was sacked, arrested, and bailed on condition I went back to work on the Eaglet stuff under police supervision.

And of course the news that there was information in the Eaglets' beeps leaked almost immediately. A new era of popular engagement with the signal began; the chatter became intense. But because only the Clarke telescope could pick up the signal, the scientists at the Clarke Institute and the consortium of governments they answered to were able to keep control of the information itself. And that information looked as if it would become extremely valuable.

The Eaglets' programming and data compression techniques, what we could make of them, had immediate commercial value. When patented by the UK government and licensed, an information revolution began that added a billion euros to Britain's balance of payments in the first year. Governments and corporations outside the loop of control jumped up and down with fury.

And then Wilson and his team started to publish what they were learning of the Eaglets themselves.

We don't know anything about what they look like, how they live—or even if they're corporeal or not. But they are old, vastly old compared to us. Their cultural records go back a million years, maybe ten times as long as we've been human, and even then they built their civilisation on the ruins of others. But they regard themselves as a young species. They live in awe of older ones, whose presence they have glimpsed deep in the turbulent core of the Galaxy.

Not surprisingly, the Eaglets are fascinated by time and its processes. One of Wilson's team foolishly speculated that the Eaglets actually made a religion of time, deifying the one universal that will erode us all in the end. That caused a lot of trouble. Some people took up the time creed with enthusiasm. They looked for parallels in human philosophies, the Hindu and the Mayan. If the Eaglets really were smarter than us, they said, they must be closer to the true god, and we should follow them. Others, led by the conventional religions, moved sharply in the opposite direction. Minor wars broke out over a creed that was entirely unknown to humanity five years before, and which nobody on Earth understood fully.

Then the economic dislocations began, as those new techniques for data handling made whole industries obsolescent. That was predictable; it was as if the aliens had invaded cyberspace, which was economically dominant over the physical world. Luddite types began sabotaging the software houses turning out the new-generation systems, and battles broke out in the corporate universe, themselves on the economic scale of small wars.

"This is the danger of speed," Wilson had said to me, just weeks before he wired himself up with Semtex. "If we'd been able to take it slow, unwrapping the message would have been more like an exercise in normal science, and we could have absorbed it. Grown with it. Instead, thanks to the viruses, it's been like a revelation, a pouring of holy knowledge into our heads. Revelations tend to be destabilising. Look at Jesus. Three centuries after the Crucifixion Christianity had taken over the whole Roman empire."

Amid all the economic, political, religious and philosophical turbulence, if anybody had dreamed that knowing the alien would unite us around our common humanity, they were dead wrong.

Then a bunch of Algerian patriots used pirated copies of the Eaglet viruses to hammer the electronic infrastructure of France's major cities. As everything from sewage to air traffic control crashed, the country was simultaneously assaulted with train bombs, bugs in the water supply, a dirty nuke in Orleans. It was a force-multiplier attack, in the jargon; the toll of death and injury was a shock, even by the standards of the third decade of the bloody twenty-first century. And our counter-measures were useless in the face of the Eaglet viruses.

That was when the governments decided the Eaglet project had to be shut down, or at the very least put under tight control. But Wilson, my brother, wasn't having any of that.

"None of this is the fault of the Eaglets, Jack," he said now, an alien apologist with Semtex strapped to his waist. "They didn't mean to harm us in any way."

"Then what do they want?"

"Our help. . ."

And he was going to provide it. With, in turn, my help.

"Why me? I was sacked, remember."

"They'll listen to you. The police. Because you're my brother. You're useful."

"Useful?. . ." At times Wilson seemed unable to see people as anything other than useful robots, even his own family. I sighed. "Tell me what you want."

"Time," he said, glancing at his screen, the data and status summaries scrolling across it. "The great god of the Eaglets, remember? Just a little more time."

"How much?"

He checked. "Twenty-four hours would let me complete this download. That's an outside estimate. Just stall them. Keep them talking, stay here with me. Make them think you're making progress in talking me out of it."

"While the actual progress is being made by that." I nodded at the screen. "What are you doing here, Wilson? What's it about?"

"I don't know all of it. There are hints in the data. Subtexts sometimes. . ." He was whispering.

"Subtexts about what?"

"About what concerns the Eaglets. Jack, what do you imagine a long-lived civilisation wants? If you could think on very long timescales you would be concerned about threats that seem remote to us."

"An asteroid impact due in a thousand years, maybe? If I expected to live that long, or my kids—"

"That kind of thing. But that's not long enough, Jack, not nearly. In the data there are passages—poetry, maybe—that speak of the deep past and furthest future, the Big Bang that is echoed in the microwave background, the future that will be dominated by the dark energy expansion that will ultimately throw all the other galaxies over the cosmological horizon. . . The Eaglets think about these things, and not just as scientific hypotheses. They care about them. The dominance of their great god time. 'The universe has no memory.'"

"What does that mean?"

"I'm not sure. A phrase in the message."

"So what are you downloading? And to where?"

"The Moon," he said frankly. "The Clarke telescope, on Farside. They want us to build something, Jack. Something physical, I mean. And with the fabricators and other maintenance gear at Clarke there's a chance we could do it. I mean, it's not the most advanced offworld robot facility; it's only designed for maintenance and upgrade of the radio telescope—"

"But it's the facility you can get your hands on. You're letting these Eaglet agents out of their virtual world and giving them a way to build something real. Don't you think that's dangerous?"

"Dangerous how?" And he laughed at me and turned away.

I grabbed his shoulders and swivelled him around in his chair. "Don't you turn away from me, you fucker. You've been doing that all our lives. You know what I mean. Why, the Eaglets' software alone is making a mess of the world. What if this is some kind of Trojan horse—a Doomsday weapon they're getting us suckers to build ourselves?"

"It's hardly likely that an advanced culture—"

"Don't give me that contact-optimist bullshit. You don't believe it yourself. And even if you did, you don't know for sure. You can't."

"No. All right." He pulled away from me. "I can't know. Which is one reason why I set the thing going up on the Moon, not Earth. Call it a quarantine. If we don't like whatever it is, there's at least a chance we could contain it up there. Yes, there's a risk. But the rewards are unknowable, and huge." He looked at me, almost pleading for me to understand. "We have to go on. This is the Eaglets' project, not ours. Ever since we unpacked the message,

this story has been about them, not us. That's what dealing with a superior intelligence means. It's like those religious nuts say. We know the Eaglets are orders of magnitude smarter than us. Shouldn't we trust them? Shouldn't we help them achieve their goal, even if we don't understand precisely what it is?"

"This ends now." I reached for the keyboard beside me. "Tell me how to stop the download."

"No." He sat firm, that trigger clutched in his right hand.

"You won't use that. You wouldn't kill us both. Not for something so abstract, inhuman—"

"Superhuman," he breathed. "Not inhuman. Superhuman. Oh, I would. You've known me all your life, Jack. Look into my eyes. I'm not like you. Do you really doubt me?"

And, looking at him, I didn't.

So we sat there, the two of us, a face-off. I stayed close enough to overpower him if he gave me the slightest chance. And he kept his trigger before my face.

Hour after hour.

In the end it was time that defeated him, I think, the Eaglets' invisible god. That and fatigue. I'm convinced he didn't mean to release the trigger. Only seventeen hours had elapsed, of the twenty-four he asked for, when his thumb slipped.

I tried to turn away. That small, instinctive gesture was why I lost a leg, a hand, an eye, all on my right side.

And I lost a brother.

But when the forensics guys had finished combing through the wreckage, they were able to prove that the seventeen hours had been enough for Wilson's download.

2033

It took a month for NASA, ESA and the Chinese to send up a lunar orbiter to see what was going on. The probe found that Wilson's download had caused the Clarke fabricators to start making stuff. At first they made other machines, more specialised, from what was lying around in the workshops and sheds. These in turn made increasingly tiny versions of themselves, heading steadily down to the nano scale. In the end the work was so fine only an astronaut on the ground might have had a chance of even seeing it. Nobody dared send in a human.

Meanwhile the machines banked up Moon dust and scrap to make a high-energy facility—something like a particle accelerator or a fusion torus, but not.

Then the real work started.

The Eaglet machines took a chunk of Moon rock and crushed it, turning its mass-energy into a spacetime artefact—something like a black hole, but not. They dropped it into the body of the Moon, where it started accreting, sucking in material, like a black hole, and budding off copies of itself, unlike a black hole.

Gradually these objects began converting the substance of the Moon into copies of themselves. The glowing point of light we see at the centre of Clarke is leaked radiation from this process.

The governments panicked. A nuclear warhead was dug out of cold store and dropped plumb into Daedalus Crater. The explosion was spectacular. But when the dust subsided that pale, unearthly spark was still there, unperturbed.

As the cluster of nano artefacts grows, the Moon's substance will be consumed at an exponential rate. Centuries, a millennium tops, will be enough to consume it all. And Earth will be orbited, not by its ancient companion, but by a spacetime artefact, like a black hole, but not. That much seems well established by the physicists.

There is less consensus as to the purpose of the artefact. Here's my guess.

The Moon artefact will be a recorder.

Wilson said the Eaglets feared the universe has no memory. I think he meant that, right now, in our cosmic epoch, we can still see relics of the universe's birth, echoes of the Big Bang, in the microwave background glow. And we also see evidence of the expansion to come, in the recession of the distant galaxies. We discovered both these basic features of the universe, its past and its future, in the twentieth century.

There will come a time—the cosmologists quote hundreds of billions of years—when the accelerating recession will have taken all those distant galaxies over our horizon. So we will be left with just the local group, the Milky Way and Andromeda and bits and pieces, bound together by gravity. The cosmic expansion will be invisible. And meanwhile the background glow will have become so attenuated you won't be able to pick it out of the faint glow of the interstellar medium.

So in that remote epoch you wouldn't be able to repeat the twentieth-century discoveries; you couldn't glimpse past or future. That's what the Eaglets mean when they say the universe has no memory.

And I believe they are countering it. They, and those like Wilson that they co-opt into helping them, are carving time capsules out of folded spacetime. At some future epoch these will evaporate, maybe through something like Hawking radiation, and will reveal the truth of the universe to whatever eyes are there to see it.

Of course it occurs to me—this is Wilson's principle of mediocrity—that ours might not be the only epoch with a privileged view of the cosmos. Just after the Big Bang there was a pulse of "inflation," superfast expansion that homogenised the universe and erased details of whatever came before.

Maybe we should be looking for other time boxes, left for our benefit by the inhabitants of those early realms.

The Eaglets are conscious entities trying to give the universe a memory. Perhaps there is even a deeper purpose: it may be intelligence's role to shape the ultimate evolution of the universe, but you can't do that if you've forgotten what went before.

Not every commentator agrees with my analysis, as above. The interpretation of the Eaglet data has always been uncertain. Maybe even Wilson wouldn't agree. Well, since it's my suggestion he would probably argue with me by sheer reflex.

I suppose it's possible to care deeply about the plight of hypothetical beings a hundred billion years hence. In one sense we ought to; their epoch is our inevitable destiny. Wilson certainly did care, enough to kill himself for it. But this is a project so vast and cold that it can engage only a semi-immortal supermind like an Eaglet's—or a modern human who is functionally insane.

What matters most to me is the now. The sons who haven't yet aged and crumbled to dust, playing football under a sun that hasn't yet burned to a cinder. The fact that all this is transient makes it more precious, not less. Maybe our remote descendants in a hundred billion years will find similar brief happiness under their black and unchanging sky.

If I could wish one thing for my lost brother it would be that I could be sure he felt this way, this alive, just for one day. Just for one minute. Because, in the end, that's all we've got.