Epilogue

I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay undiscovered before me.

—Isaac Newton[1]

The meaning of life is creative love. Not love as an inner feeling, as a private sentimental emotion, but love as a dynamic power moving out into the world and doing something original.

—Tom Morris, *If Aristotle Ran General Motors*

No exponential is forever . . . but we can delay "forever."

—Gordon E. Moore, 2004

How Singular? How singular is the Singularity? Will it happen in an instant? Let's consider again the derivation of the word. In mathematics a singularity is a value that is beyond any limit—in essence, infinity. (Formally the value of a function that contains such a singularity is said to be undefined at the singularity point, but we can show that the value of the function at nearby points exceeds any specific finite value).[2]

The Singularity, as we have discussed it in this book, does not achieve infinite levels of computation, memory, or any other measurable attribute. But it certainly achieves vast levels of all of these qualities, including intelligence. With the reverse engineering of the human brain we will be able to apply the parallel, self-organizing, chaotic algorithms of human intelligence to enormously powerful computational substrates. This intelligence will then be in a position to improve its own design, both hardware and software, in a rapidly accelerating iterative process.

But there still appears to be a limit. The capacity of the universe to support

intelligence appears to be only about 10^{90} calculations per second, as I discussed in chapter 6. There are theories such as the holographic universe that suggest the possibility of higher numbers (such as 10^{120}), but these levels are all decidedly finite.

Of course, the capabilities of such an intelligence may appear infinite for all practical purposes to our current level of intelligence. A universe saturated with intelligence at 10^{90} cps would be one trillion trillion trillion trillion trillion times more powerful than all biological human brains on Earth today.[3] Even a one-kilogram "cold" computer has a peak potential of 10^{42} cps, as I reviewed in chapter 3, which is ten thousand trillion (10^{16}) times more powerful than all biological human brains.[4]

Given the power of exponential notation, we can easily conjure up bigger numbers, even if we lack the imagination to contemplate all of their implications. We can imagine the possibility of our future intelligence spreading into other universes. Such a scenario is conceivable given our current understanding of cosmology, although speculative. This could potentially allow our future intelligence to go beyond any limits. If we gained the ability to create and colonize other universes (and if there is a way to do this, the vast intelligence of our future civilization is likely to be able to harness it), our intelligence would ultimately be capable of exceeding any specific finite level. That's exactly what we can say for singularities in mathematical functions.

How does our use of "singularity" in human history compare to its use in physics? The word was borrowed from mathematics by physics, which has always shown a penchant for anthropomorphic terms (such as "charm" and "strange" for names of quarks). In physics "singularity" theoretically refers to a point of zero size with infinite density of mass and therefore infinite gravity. But because of quantum uncertainty there is no actual point of infinite density, and indeed quantum mechanics disallows infinite values.

Just like the Singularity as I have discussed it in this book, a singularity in physics denotes unimaginably large values. And the area of interest in physics is not actually zero in size but rather is an event horizon around the theoretical singularity point inside a black hole (which is not even black). Inside the event horizon particles and energy, such as light, cannot escape because gravity is too strong. Thus from outside the event horizon, we cannot see easily inside the event horizon with certainty.

However, there does appear to be a way to see inside a black hole, because black holes give off a shower of particles. Particle-antiparticle pairs are created near the event horizon (as happens everywhere in space), and for some of these pairs, one of the pair is pulled into the black hole while the other manages to

escape. These escaping particles form a glow called Hawking radiation, named after its discoverer, Stephen Hawking. The current thinking is that this radiation does reflect (in a coded fashion, and as a result of a form of quantum entanglement with the particles inside) what is happening inside the black hole. Hawking initially resisted this explanation but now appears to agree.

So, we find our use of the term "Singularity" in this book to be no less appropriate than the deployment of this term by the physics community. Just as we find it hard to see beyond the event horizon of a black hole, we also find it difficult to see beyond the event horizon of the historical Singularity. How can we, with our brains each limited to 10^{16} to 10^{19} cps, imagine what our future civilization in 2099 with its 10^{60} cps will be capable of thinking and doing?

Nevertheless, just as we can draw conclusions about the nature of black holes through our conceptual thinking, despite never having actually been inside one, our thinking today is powerful enough to have meaningful insights into the implications of the Singularity. That's what I've tried to do in this book.

Human Centrality. A common view is that science has consistently been correcting our overly inflated view of our own significance. Stephen Jay Gould said, "The most important scientific revolutions all include, as their only common feature, the dethronement of human arrogance from one pedestal after another of previous convictions about our centrality in the cosmos."[5]

But it turns out that we are central, after all. Our ability to create models—virtual realities—in our brains, combined with our modest-looking thumbs, has been sufficient to usher in another form of evolution: technology. That development enabled the persistence of the accelerating pace that started with biological evolution. It will continue until the entire universe is at our fingertips.