The Seventh Generation

by

Laser Quasar Absolutely

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INTRODUCTION

It used to be a tradition among North American native people to discuss among themselves every major decision, with a view to evaluating its impact not solely upon the immediate present, but upon five succeeding generations as well. They apparently were, in this respect, far more civilised than we are. Had we done this with the steam engine, the automobile, the aeroplane, petrochemicals and nuclear power, we probably wouldn't be in the mess we are today—what with our Chernobyls, acid rain, depletion of the ozone layer and endangered species.

Well, it's not too late. We can start now, and maybe, just maybe, we'll be able to avert even worse disasters. What we do have to do, however, is to foresee what is likely to happen in the next few generations. When thinking about this I figured, well, if a person lived a good long life he might actually see his descendants five generations down the road, but what about those that come after? I thought it might be worthwhile, then, talking about the Seventh Generation.

In this book I have tried to foresee what might happen seven generations ahead. And I think it very possible that most of the things I have written about could actually come to pass in that sort of time-frame. Many of the things I have discussed are, in fact, only a generation or two away. Our kids will be learning about them in college and preparing for a career in them in life. A few of the things I have brought to light are possible even today; they just aren't widely known.

Seven generations is not, from a historical point of view, a very long time; but it is about as long a period as we are likely to be able to see ahead. To get an idea of how far we might advance in that amount of time, just imagine what a person in the Victorian era might have thought had he tried to foresee much of what we all take for granted. Jules Verne, it is true, foresaw the spaceship and the submarine, but even he was not able to think of going around the world in much less than eighty days. Charles Babbage and Ada, the Countess Lovelace, designed the computer and thought up the idea of software, but even they would have been flabbergasted had they been able to get hands-on experience with a *Cray* supercomputer, or for that matter, even an *iMac*. And can you imagine the Wright Brothers at the controls of a *B-2* bomber?

In like fashion, many of the things I have written about, exaggerated though they may seem to our contemporaries, will probably appear elementary to our seventh-generation descendants (assuming, of course, that we'll have any that survive). I have therefore tried to throw my mind as far ahead as I possibly can, and imagine at the limits of my imagination. I figured that no matter how recklessly I imagined, I still wouldn't be able to do justice to our future descendants, not if the past is any guide.

What I *could* do, however—or so I figured—is to try and reason out my conclusions very carefully, in order to increase as much as I could the probability that what I write is indeed feasible. So I have steered away from science *fiction,* in which there is no obligation to imagine things that are feasible, only things that are interesting. I write, if not science *fact,* at least what could very well *be* science fact one day. I do claim, therefore, that there is no reason that the things I have written about will not come to pass, far-out though they may seem at first blush. And for the benefit of the inquisitive, I have also given an ***APPENDIX*** in which I explain in somewhat greater detail the scientific and technological principles behind many of my theses. Moreover, after the first and second editions of this book came out, I asked a number of my friends and acquaintances to point out flaws in my reasoning if they could. To date (October 1998) none of them have been able to do so. In fact I invite my readers to try as well, and I'd be glad to change anything in future editions of this book if such errors can be pointed out.

But if such errors *don't* exist, then we are in for a brave new world which makes *Brave New World* look like a Timid Old Neighbourhood, and *Nineteen Eighty-Four* look like 1984, **B.C.** What do you say to a world in which there is a cure for *every* disease (except for the cure itself)? What do you say to a world in which mile-high buildings can be raised overnight, and razed next day to make room for yet more contemporary structures? What do you say to supercomputers that can do a million years' worth of human research in a month, and give answers to questions we haven't even the imagination to ask? What do you say to making a mountain out of a molehill—literally?

And these are just the tip of the iceberg. We could be talking in terms which make the words "technology" and "science" lose all meaning, and overthrow the laws of nature themselves, sacrosanct as they are for today's scientists and engineers. We could be talking faster-than-light, and back to the future, and being here and there at once, and other kinds of impossibilities. We could be undoing the basis of logical thinking, and doing things that are totally illogical (not to say that some of us don't do so even nowadays). We could be pushing the frontiers of science and technology into the realms of mythology and the metaphysical (not to say that some of this isn't being done even nowadays).

Moreover, all these are results I myself, a single individual just sitting at home thinking, can see coming seven generations down the road. What my (hopefully!) millions of readers will be able to see coming would be so far beyond my imagination that all I've written could sound like kindergarten material. I personally, for instance, cannot foresee how we are going to make it possible for *every* scientist (or would-be scientist) to get adequate funding for all his projects, but who am I to say? Maybe someone in the audience can figure it out, given all the other wonderful things we can accomplish with future technologies. I do not rule out, for instance, the possibility that we could one day have true democracy of the type the Greeks originally conceived when they thought up the idea, or even that we could all have adequate day-care, a feat which is probably more difficult to accomplish.

Now although it is important, I think—and as the North American native people thought—to *discuss* the impact of all the things that are coming, I am not so sure we are going to be able to *do* anything about them. I'd *like* to be able to, but I'm not sure how. So what I suggest is that you, dear reader, give the matter some thought yourself, and send me your musings on the subject. I'd like this book to be interactive: I don't just want it *read,* I'd like to have it *replied to.* And to make it *really* feasible for you to do so, I am giving here below my e-mail and snailmail addresses, and phone and fax numbers. Go ahead, make a note of them:

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... Maybe together we *can* make a difference.

CHAPTER 1

NANOTECHNOLOGY

It's a wonder no one thought of it long ago. I mean, it's been more than two thousand years that it was suggested, and over a hundred years that it has been proved for a fact, that everything in the world is composed of atoms. That atoms are the building blocks of matter. That the only difference between grandma and her apple pie is in the number, variety and arrangement of the atoms of which each of them are composed. And that like all building blocks, including those with which kids play in nursery school, these building blocks too, could in theory be rearranged in any combination, provided one could manipulate them individually: to produce either apple pie or grandma, let's say.

I mean, all this is straightforward logical thinking, and none too sophisticated either. And yet, until only a couple of decades or so ago, no one ever thought along these lines. Not even you or I. No, you've got to hand the stuffed toy animal or baseball hat (according to choice) to K. Eric Drexler, who as a budding engineering student at the Massachusetts Institute of Technology began, in the year 1976, to wonder what would happen when engineers acquired the ability to manipulate matter at the level of individual atoms.

In a decade or two, give or take a few score years—says Drexler now—we should be able to do just that, given the progress already being made by molecular biology and genetic engineering on the one hand, and computer technology on the other. And when you begin to rearrange individual atoms, as he points out in his book *Engines of Creation,* you could do ... just about anything.

You could unscramble an egg. You could rearrange the atoms in a briquette of barbecue charcoal into a diamond necklace with matching brooch and earrings; in fact, there is no reason why you couldn't—if you wanted to—make a single diamond as large as the Great Pyramid. You could, almost literally, turn a pumpkin into a Porsche. You could even turn a Porsche into a pumpkin, which is considerably more difficult, considering that a pumpkin is a living thing, and thus about a zillion times more complex in structure than any man-made object. You could transform stale bread into fresh, or steak into sashimi.

Drexler has thought the whole engineering process through quite thoroughly. The trick, says he, is to begin by manufacturing little robots. Today's crude technology designs robots to do things human beings can also do—welding, riveting, painting, and so on. Silly, in his view. Robots have a much greater potential. What you want are robots capable of doing what *no* human being can do. What you want are teeny-weeny robots the size of viruses, controlled by computers the size of microbes, all working in their billions, trillions, quadrillions and quintillions to transform matter by individually rearranging its smallest building blocks—atoms. Take four atoms of carbon and you can arrange them into diamond. Take a few atoms of aluminum and a few of oxygen, and you can arrange them into sapphire. Take more atoms of anything and you can rearrange them into virtually anything else.

And the beauty (?!) of it is that you don't have to manufacture *all* these quintillions of robots. With great difficulty and at enormous expense, you manufacture *one* such robot and *one* such computer ... and program them to make replicas of themselves. Being tiny, they could rearrange atoms into exact clones in a matter of seconds. Two would give rise to four, four to eight, eight to sixteen, and in a matter of minutes you'd have millions, in a matter of days quintillions. Obviously this sort of thing could soon get out of hand, the pesky little things taking over the entire planet. So, says Drexler, at a certain stage in the cycle you'd have to program them to stop this senseless self-replication, and wait for further orders.

Drexler's ideas are—not surprisingly, considering that the logic behind them is at best grade school level—taken seriously. One of his most ardent supporters is MIT's Marvin Minsky, no less: the world authority in artificial intelligence research. He has even provided a foreword to Drexler's book, in which he writes "the thinking is technically sound" ... which of course it is. And indeed the principle behind it—rearrangement of individual atoms—is not only quite simple and elementary, but has been around for millions of years. This, in fact, is how life works. This is how a whale sperm becomes a sperm whale, and how the AIDS virus replicates itself, and in so doing, spreads. This is how agriculture rearranges manure and moisture into melons and milk. This is how you and I have come into existence; the only difference being that in our case it has been a slow, evolutionary and essentially haphazard process, while with *nanotechnology*—Drexler's word for this brave new world—it's done under our control, and can thus be speeded up by a factor of ten-to-the-whatever.

And the speeding-up, as any computer buff knows, is well under way. Twenty years ago if you told a typist that one day he'd be working with a "word processor", with which he could edit documents as many times as he liked before finally printing them out, you'd have been laughed out of the office—as I myself virtually was. Today no secretary would dream of working *without* a word processor, and that too with macros, thesaurus and a spelling-checker. The first computer ever built, in the 'forties, filled a whole basement. Today's microchip can just barely be seen with the naked eye, and tomorrow's will probably be invisible even to the optical microscope. Yet it will perform its task better and faster than its predecessors; it won't be long before desktop computers have as much computing power as the most powerful supercomputers of today. And as for molecular biology: Leroy Hood, chairman of Caltech's biology division, figures that in five to ten years we'll have the ability to map the entire DNA sequence of a human being, and to tailor-make protein molecules, even such as nature never created. From this to nanotechnology is only a few steps away.

And what *couldn't* you do with it. Greenpeace could send a few of these robots to the nuclear powers—maybe in the mail—with instructions to rearrange their entire arsenals into steel-wool: and within a week the Indians and Pakistanis would find themselves without any Bombs to test. "Beam me up, Scotty" could be quite as common-place a request as a car ride today: all Scotty would have to do is take you apart here and reassemble you there. Cars need not become obsolete—they'll probably still exist, as do bicycles today—but they'll be there for fun, not for transportation. And when you're stopped for speeding, as you most assuredly will be, you could turn the officer of the law into a toad. Of course, he would have pre-programmed *his* transforming robots to turn him back into his original shape, but by that time you'd have rearranged your own appearance, and your car's as well, so he won't be able to come up with a positive ID anyway. Yesterday's newspaper won't ever need to be recycled: the ink on the paper's surface will simply rearrange itself into today's news. There need no longer be any such thing as garbage; nor, if you don't like her, need there be any such thing as your mother-in-law.

Of course all this opens up a whole new field for the legal profession. When you can rearrange your neighbour into thin air, leaving not a wrack behind; when you can transform your own sex at will, today a man, tomorrow a woman, and the day after a member of what they call in England the Middlesex; when from lump of clay you can, Pygmalion-like, create a Demi Moore or a Keanu Reeves and take him or her to bed ... this is the stuff of which lawyers' dreams—and incomes—are made. There is no end to the imaginative use of nanotechnology. Who is to prevent you, in the quiet of your basement, from rearranging toilet paper into Swiss Francs, or from smuggling out the gold in the bank vault across the street, atom by invisible atom, up to your own apartment? Of course the lawyers will have to forego *some* of their lucrative practices ... for instance, there will hardly be any need for people to make wills, since a rearrangement of themselves into a more youthful version every now and then will have made funeral parlours quite obsolete.

Then there's nanotechnology's potential in education. When adults play with transformers, kids will want to as well. One can visualise science projects in the fifth grade, in which ten-year-olds would be required to produce an original rearrangement of atoms supplied by the school. Most, probably, will come to class next morning with a dinosaur in tow. But there will no doubt be the odd little lazy lout who won't want to do his homework, and having captured a common house-fly in a jar, will claim to have manufactured it all on his ownsome.

And what about the openings for research scientists? Not only will it be possible to bring back to life extinct species like pterodactyls and dodos, but even such as never had any existence, like centaurs and unicorns. And wouldn't it be fascinating to resurrect an Egyptian mummy, and ask the Pharaoh face to face how his people built the pyramids? (Having originally been mummified for just such a resurrection in the first place, the Pharaoh would probably take it all very matter-of-factly.)

The problem, as the keen-eyed reader will have immediately spotted, is to control this awe-some potential. The first people to get their hands on this technology will, as likely as not, be some large corporation. Once they have it, who can stop them from taking over the rest of us? Most of them have no compunctions about doing things which are not quite in the best interest of the public. Or suppose the government guys got their hands on this enormous power—surely their foreign policy goals will be radically revised as a consequence. Even if individuals got their hands on it first, there is no guarantee that they would use it exclusively for the greater good of humanity: just imagine if a guy like Preston Manning or Newt Gingrich—let alone Bill Gates—got a hold of a few such robots.

Of course, much worse than all these scenarios is the possibility that the experiment will run amok. When the power of these wee robots depends on something as delicate as the location of a single atom in their structure—when a chance cosmic ray might produce a drastic mutation in their makeup, what is to prevent the damn things from one day taking over and doing things *their* way? The whole earth, down to its very core, would be grist to their mill. In fact, why limit themselves to the earth? The smart ones among them might begin with rearranging the planet into numerous spaceships, loading them up with their own kind, and sending them out in all directions to colonise space. Swiftly tapping the energy of the sun, a suitably mutated strain of these virus-like “inorganisms” could pick up all the stray matter in the solar system, including the planets, asteroids and meteors, and rearrange them into more of themselves. A few years later they could reach the stars, a few millennia later the edges of our galaxy, and in a few hundred million years—a mere instant on the cosmological time-scale—they could rearrange the entire universe into a seething mass of nano-robots.

And even this is not the most frightening thing about it all. The scariest part is that nanotechnology is actually likely to come into existence—that the day is, in fact, almost upon us.

CHAPTER 2

WARP 57

Relativity tells us that nothing can move faster than light, and in one sense this is true. This is a "limit of natural law", and as long as nature is what it is, natural laws will not change.

However, although nature has limits, the imagination does not seem to have any. There doesn't seem to be any limit on the different kinds of music that can be composed, or the different kinds of paintings that can be painted. In a similar way, there doesn't seem to be a limit on the different kinds of ways to circumvent "natural law". What can't be accomplished in one way, can often be accomplished in another.

Here's a thought-experiment delineating a scenario which, making use of the known laws of science—indeed most of them laws of Relativity—would allow for a result that would be *indistinguishable from faster-than-light travel.*

Here goes.

We know from Relativity that under certain conditions there occurs a phenomenon known as "time-dilation". This means that for the object undergoing it, time runs slower than for objects not undergoing it. A clock undergoing time-dilation, for instance, would tick slower than a clock not undergoing it. A living thing would age slower. A radioactive isotope would decay in a longer period. Time itself, in fact, slows down.

Relativity predicts that time-dilation occurs, for instance, for an object travelling at speeds approaching that of light. This prediction has actually been verified, down to many decimal places, in modern "atom-smashers" such as the Fermilab at Batavia, Illinois, and the Stanford Linear Accelerator in California. Relativity also predicts that time-dilation occurs for objects in the vicinity of gravitational fields; and in the presence of extremely strong gravitational fields the time-dilation is calculated to be quite pronounced. Although this has not actually been observed in a laboratory, the arguments for it, from the point of view of the mathematics of Relativity, are overwhelmingly convincing and almost universally accepted in the scientific community.

Well then. Imagine an extremely massive object such as a Black Hole, which due to its mass generates an enormously powerful gravitational field. Imagine this object to be shaped more or less like a doughnut or a ring. It is perhaps unlikely that a Black Hole of this shape would spontaneously come into being, but there is no reason to believe that a technologically advanced civilisation, able to manipulate enormously large masses, could not manufacture such a thing.

Imagine, then, a gigantic Black Hole floating in space, happening to be travelling, relative to our solar system, at a speed approximately half that of light. Imagine further that the gravitational field in the hole in the middle of the doughnut is sufficient to cause time-dilation of the order of 1 to 1,000,000: that is, a million seconds would go by for an observer on Earth for every one second experienced by an object going through the gap. And finally imagine that this object travels through the hole in the middle of the doughnut and out again on the other side, and as it does so it takes an hour (of its own time). None of this contradicts any of the known laws of nature.

The word "object" is used here advisedly. It should be emphasised that time-dilation is not something that applies only to sentient or self-conscious things. Time-dilation has nothing to do with consciousness or the lack of it *per se*. The object can be anything, whether self-conscious or not. Relativity predicts that under the circumstances outlined above *any* object would undergo time-dilation. A clock, as we said, would undergo time-dilation—and show it—no less than a human being; and it wouldn't matter in the very least how the clock was constructed. The only difference is that the human being would be aware of the phenomenon, while the clock (or any other non-conscious object) would not be aware of it.

It's easier to construct this argument using self-conscious, sentient beings rather than non-conscious objects, but it should be made clear right from the outset that it applies just as much to the latter as to the former. It's true that as far as earthly human beings are concerned, there are side-effects of the gravitational pull of the Black Hole to be taken into account, such as gravitational tides which might rip them apart. Such side-effects, however, could in theory be minimised or at least made tolerable by making the Black Hole large enough. And in any case one need not presume that human beings are the only self-conscious things in the universe.

For the purposes of argument, then, we shall consider the *U.S.S. Enterprise* (as in *Star Trek: The Old Generation*) drifting gently through the hole in the middle of that gigantic doughnut-shaped Black Hole. Mr. Sulu and Mr. Spock are with Captain Kirk on the bridge, chatting amiably. Scotty is calling out from the engine room on the intercom, muttering something about tri-lithium crystals. Dr. McCoy is in the sick bay, calibrating his instruments.

Let us suppose that the Black Hole is about one light-year away from the Earth, and in the vicinity of the *Enterprise*, when the screen goes blank for a period which the ship's clock indicates as sixty minutes. At the time all this started, the Earth's Sun was a mere light-year away, shining brightly, everyone excited about making the rendezvous soon, visiting Epcot Center again. An hour later, on the other side of the Black Hole's black hole, the screen comes alive again, and the company looks around eagerly for home sweet planet. But the Sun is nowhere to be seen. In fact a significant part of the starscape has changed. Frantically they bring out the positronic telescopes and consult the computer. After a long and agonising search, punctuated by at least two commercial breaks, they find the Sun half a million light-hours away. This, not to put too fine a point on it, is like about 57 light-years, give or take a few million miles.

Now let's consider what has happened. As far as *they* are concerned, Captain Kirk and Messrs. Sulu, Spock, Scotty *et al* have just traveled a distance of 57 light-years in about an hour of their time. As far as observers on the Earth are concerned, of course, it has taken them much longer: about a million hours or approximately 114 years of earth-time. But there's no guarantee that anyone is left alive on Earth to make that observation. Let's suppose that unbeknownst to the crew of the Enterprise, nuclear war erupted on Earth a couple of days after they started off on their space-walk. By the time they came out of the gravitational field of the Black Hole, the planet was already a charred mass of totally inert radioactive debris, and in no mood to observe anything. In fact let's suppose the crew of the Enterprise are the *only* observers of this phenomenon anywhere in the universe. Then as far as *anyone* is concerned, they have traveled half-a-million light-hours in *one single hour.*

This is not only faster than light, it's even faster than Warp 9. It is enough to make both Einstein and Gene Roddenberry turn over in their graves. Relativity has been swallowed up by a Black Hole—and also by itself. Mr. Spock searches desperately in the logical recesses of his Vulcan mind to find an answer, and finds none. Captain Kirk gains weight from worry, quits the show, and hands things over to The Next Generation. Angels trying unsuccessfully to enforce the Universal Speed Limit re-check their radar guns in disbelief. From the depths of Hell, Mephistopheles lets out a clearly audible guffaw.

Is this faster-than-light travel, or is it not? In one sense it is not: the *Enterprise* was not only not travelling faster than light, it almost did not seem (to the crew) to be travelling at all. But the result is *indistinguishable from faster-than-light travel.* The Federation Starship was here at eleven o'clock ... and fifty-seven light-years away at noon. That's fast; that's a lot faster than a Ferrari GTO. And if, to the assumptions we outlined above, we add the further assumption that the crew of the *Enterprise* were not watching the screen as it went blank—because, let us say, their minds were occupied elsewhere, say upon a Romulan threat—and thus were quite unaware of the proximity of the Black Hole, then they have no explanation whatsoever of their great leap forward. As far as they are concerned, the laws of nature have been repealed. We, of course, with our 20/20 hindsight (or rather foresight) can see that no such thing has occurred. But because of World War III, we are all of us dead, and thus quite out of the picture. So what are *they* to make of it?

The figures given above are quite flexible. Similar scenarios would be possible for a wide range of figures—a very wide range indeed. The time-dilation figure could be different, the relative speeds of the Solar System *vis a vis* the Enterprise could be different, and even the people concerned could be different. The effect would be virtually the same: motion from one place to another within a time period which would imply a speed of travel faster than light.

Thought-experiments like this one have a lot of prestige. Einstein himself conducted quite a few such, and they helped him formulate his Theories of Relativity. They are also not without their pitfalls. One of Einstein's own thought-experiments has been shown to be erroneous. This is the well-known elevator thought-experiment, in which Einstein asks us to imagine a person being winched upwards in space in a windowless elevator, made to accelerate at a rate of 32 feet per second per second. Such a person, he said, could never know, from any conceivable experiment conducted purely inside the elevator, whether the elevator was accelerating in space, or stationary in the Earth's gravitational field—which also has a rate of acceleration of 32 feet per second per second. The effect of the one, he said, would be *completely indistinguishable* from that of the other.

This, as it turns out, is not quite correct. If the elevator were stationary on Earth, there would a slight but (at least theoretically) measurable convergence of the paths traced by two free-falling objects in it. This is because they would both fall towards a single point—the centre of gravity of the earth. Such convergence would not, of course, occur in an elevator being winched up in deep space at a constant rate of linear acceleration. Free-falling objects in it would trace *perfectly* parallel paths.

Einstein, as it happens, did not catch this little catch in his thought-experiment. Maybe the thought-experiment described in this chapter has a catch in it too, and I just haven't caught it. In the interests of truth, I would appreciate it if you would point it out. But if there is no catch in it—and that is also possible: several others of Einstein's thought-experiments don't seem to have any catch in them either—then it would show up something of immense importance in theoretical physics.

It would also show up those who, like the eminent physicist Albert A. Michelson, keep telling us that "the more important fundamental laws and facts of physical science have all been discovered, and these are now so firmly established that the possibility of their ever being supplanted in consequence of new discoveries is exceedingly remote." Michelson said this in 1894; the next year Roentgen discovered X-Rays; a couple of years later Thompson discovered the electron; and in 1905 Einstein formulated Special Relativity. Still to come were General Relativity and Quantum Mechanics, which were brought to light a few years before Michelson died in 1931.

Yet even today, people like Stephen Hawking of Cambridge University still tell us that the laws of nature will always pose limits to what can be accomplished. Maybe they will; but will those limits be permanent? Some say Yes; they cannot envision a limitless universe; and it is, in some deep sense, satisfying to believe that there has got to be a limit ... to *everything.* G.I. Gurdjieff, the Russian mystic, even postulated a limit to God. He is reputed to have asked, somewhat rhetorically: "Is there anything that even the Almighty cannot do?" And the answer was—at least on the face of it—stunning: "Not even the Almighty can trounce the ace of trumps with the deuce."

As Gurdjieff put it, once the rules of the game are set up, not even God can play the game in disregard of its rules—for if He does, He's not playing the game ... *by definition.* And if He holds the deuce and the Devil holds the ace of trumps, the Devil wins. Those are the rules of the game.

A pretty convincing thought-experiment, isn't it?

But wait! Equally by definition, the Almighty can do *anything*, else He would not be the Almighty. And "anything" *includes* beating the ace of trumps with the deuce ... and that too *within the rules of the game!*

I don't know how this can be done, and *you* don't know how it can be done. *But that does not mean it can't be done.* God being (again by definition) omniscient as well as omnipotent, knows how it can be done—and does it!

Eat your heart out, Mephistopheles!

CHAPTER 3

IMMORTALITY

I***MMORTALITY.*** The word has a far-off, improbable, almost scriptural sound to it, doesn't it?

What would you say if I were to tell you that immortality, far from being far from being, is not only not impossible, but is actually within our grasp *today*—that, in fact, we *already* have it?

No, I'm not a Fundamentalist Preacher, out to convince you about the Truth of Immortality with a capital *I*. I'm talking about immortality (with a small *i*) in a very physical, corporeal, day-to-day sense, one I wish you to understand in exactly the way it sounds: the capacity to live indefinitely in this very body you possess right now.

Nor am I talking about future technologies. No, this once I'm talking about technologies we possess *at this very time,* as of first writing August 15, 1988. Immortality is *here,* not somewhere in the future.

Now before you close the book with a bang and tune in to Benny Hill, let me assure you that I am neither joking nor being impossible to get along with. And before the end of this chapter I'd like to convince you of it too.

As any high school biology student knows, immortality is not unknown in nature. The amoeba, for instance, is an immortal creature. It never dies, in the normally accepted sense of the term, leaving a corpse behind: all that happens is that it splits into two, and then four, and then eight and so on. (Of course the odd amoeba does die, as a result of accident, by dehydration or burning up or whatever; but in the natural course of things, provided it has the right kind of environment and nutrients, it doesn't die). "Death" for the amoeba is the same as "birth", in the very course of reproduction it "dies", in that what was one amoeba now is two; but the "original" amoeba (if so you can even think of it) remains alive, for neither the "mother" nor the "daughter" actually comes to an end. Today's amoeba is, therefore, hundreds of millions of years of age. In fact, death, as we know it, is an invention of higher organisms. (Though in light of this fact, why they should be so called becomes a bit of a mystery.)

In another sense, however, we all die many times before our deaths—even amoebas. All the cells in our bodies die and are replaced—so biologists tell us—every seven years on the average. In single-celled organisms like amoebas, the atoms in their protoplasm are replaced by others in the very course of their metabolism. All living things are continually absorbing atoms, in the form of nutrients, and continually getting rid of atoms, in the form of waste matter. Nevertheless the fact that millions of our cells die daily does not inspire us to make urgent preparations for our own funerals. We think of ourselves as staying alive in spite of all this dying going on inside us all the time.

This is because what we call "death" is actually shorthand for a somewhat longer phrase: *"A situation in which one or more vital parts of the body stop functioning totally and irreversibly, and thereby cause all the other parts of the body to stop functioning totally and irreversibly as well"*. This, as near as dammit, is what may be called a "definition" of death from the medical and legal points of view. At one time it was felt that when a person stopped breathing he or she should be considered dead. This turned out to be inaccurate, for techniques like mouth-to-mouth resuscitation managed to revive a few such cases. Then they thought that heart failure was enough to make one drop down dead. And this too turned out to be bull; electrical and other kinds of cardiac stimulation could bring such a person round, so that though he was down, he was no longer considered out. Now the big word is "brain death". As soon as the brain stops functioning totally and irreversibly, it's organ-donation time.

And mark the word "irreversibly". The good doctors don't like to be caught burying a person alive, so they have to make sure that no technology presently available could possibly have enabled the brain to function again. Which brings up the very pertinent—or maybe, from their point of view, *im*pertinent—question: How do *they* know? Doctors, by their own admission, are not God. Not only do they not know All about Everything, they don't even know all about the latest advances in medical science. Nobody could, given the vast amount of it available even today. The problem is that "death" is largely a matter of definition. If the malfunction is irreversible *within the framework of current technology,* it is called "death"; but as soon as medical or other ingenuity can find ways to reverse the process, it can no longer be defined as "death".

Naturally: doctors (and morticians) need desperately to promote the idea that death is *permanent.* How would *you* like it if they buried mom—heart stopped, no doubt, but capable of being reactivated with the latest medical wizardry? How would you like it if you found yourself lying in the ICU with men in pale green coats hanging around, scalpels in hand, drooling over your kidneys and eyeballs, just barely containing their impatience to dismantle you as soon as you stopped breathing? You want to be reassured that once you are dead you're *dead*, that it's the end: that you won't have any further use for these spare parts. Death *has* to be permanent, *by definition;* otherwise no one would let themselves be buried or cremated. Not if there existed the remotest chance of resuscitation.

Now there may not be a chance of resuscitation using the knowledge and skill we have *at present*, but there may well be a chance using knowledge *yet to come.* The problem becomes, then, one of preparing ourselves for that happy occasion when we can reverse the "irreversible" process.

And we already have some hints as to how that's likely to come about. Let us consider an analogy with a motor car. When your souped-up Mercedes-Benz *Brabus* conversion from Bottrop breaks down, you don't immediately write it off, cash in your insurance and buy a new one; you try and fix it. The problem may as small as some dirt in the fuel injection system, or soot on the spark plugs. Clean up these tiny specks and you're back on the autobahn. If it's something bigger, like your transmission, you may have to replace the gearbox, but once that's done the Rolls rolls again. Even if it's been in a major crash it need not be a write-off: can you imagine "writing off" your 1932-vintage Bugatti *Type 55 Super Sport Roadster* for which you paid a whopping $5.8 million at the antique automobiles auction in Basle, Switzerland?

You can fix your car, or get it fixed, because you—or your competent mechanics—know *exactly* how your car is constructed and knows what should or shouldn't be there. Your family physician does not (yet) know exactly how *you* are constructed and what should—or shouldn't—be there, but in a quite reasonable number of years he will. This is because you're constructed out of fairly commonplace parts. They are called atoms, and there are many of them available quite cheaply, everywhere in the world. And luckily for you they come in exactly interchangeable sizes and shapes. If you have to replace an oxygen atom in your body, you can do so with one of literally octillions of others. It will fit precisely where the O.E.M. atom used to be, and so well you won't even know the difference.

Theoretically, if upon death you could replace in their precise locations all the out-of-place atoms in your body, you could not only be fixed like a motor car, you could be as good as new: you'd be good for another three-score-and-ten. Practically, of course, there's the problem of not knowing in sufficient detail what's missing, nor how to replace it with the necessary precision. We don't know that yet and we won't for some years, or decades, to come; but it seems fairly certain that eventually we will.

In fact we are quite close to doing so even now. Already we are working at the atomic level in a very limited way; we can tell how several proteins, for instance, are constructed, down to the last millionth of a millimetre. We know DNA and RNA sequences to many thousands of nucleotides. We can already do a lot, and soon we'll be able to do a lotter. It's only a question of time; and not too much time at that. Many thinkers on the subject are saying twenty to fifty years. That's all.

The question then becomes one of what to do for half a century at the most. Obviously—to revert to the automobile analogy—the smaller and less complicated the part we need to replace, the easier the car—or the driver—will be to fix. What we want to do is to preserve what we already have, so that when the time comes to fix man or machine, we only have to fix the part which is dud, or dead. We don't want to mess around with a major repair problem when we could have done it easier by containing the damage. We don't want to have to pay for new tires and fenders and a sunroof and a paint job when all that was needed was some distilled water in the battery.

However, if we simply leave things to nature, the Porsche is going to rust out and the body is going to decompose. If we wait long enough, we are likely to have nothing left to repair, and then we *will* have to cash in the insurance. But the solution is simple: we want to mothball the car over the long winter, grease up all the steel parts thoroughly so that they preserve their shiny structure, and so on; and similarly we want to preserve the body's atomic structure so that when the time does come to breathe back into it the breath of life it won't be such a big deal.

Now present-day technology is not capable of rearranging atomic structure, but it *is* capable of preserving it. We already possess several techniques for mothballing human beings. One of the simplest is freezing with liquid nitrogen. If this is carried out gently enough, very little damage, if any, is caused to the structure of the tissues, even at the atomic level. Frozen insects and other small organisms have not only been preserved in the laboratory, they have even been revived, showing that it is no mere theory. Once frozen, liquid nitrogen may no longer be necessary, and such a corpse could, very likely, be mothballed for many decades quite cheaply in Antarctica or Siberia. As everyone knows, Ice-age mammoths in perfectly edible condition have been found under the Siberian snows.

Another technique—which does not even require Antarctica—is called “fixation”. This is a method with which specimens are prepared for the electron microscope. A plastic-like substance is injected into the specimen, which sets after a while, but does not disturb the specimen’s molecular structure. It holds all the atoms in a sort of firm gel, or hardened glue, allowing no movement but permitting the specimen to be examined at any magnification. The microscopic examination shows that its structure has been preserved down to the minutest observable level. In fact that’s how cell structure is routinely examined in labs.

Whether frozen or fixated, a corpse could be preserved, using quite simple present-day technology, till such time as a knowledge of how to repair it becomes widely known. Then thaw it out, or unglue it, and hey presto. At that time it will, of course, be argued that since the person was revived he was not dead in the first place, because the very definition of “dead” requires a corpse that *can’t* be revived, irreversibly. *Well then, by this definition most of us living today are immortal!* Or at least we can choose to be so. Some of us will probably die, of course, no matter what we do: it is hard to see how one could reconstruct a person blown to smithereens by a car bomb. Even if you could gather up a cell or two, and from their DNA reconstruct the body, the person’s memories—which as far as we know reside in the structure and function of his brain—will have been lost forever, and the clone thus resurrected could never know that he was he. He’d look the same, but he’d be a different person, like an identical twin.

But if the brain’s structure were preserved intact, so, most probably, would the person’s memories—at least his long-term memories, such as his awareness of his own identity. He might not remember what he ate for breakfast, but he’d probably know his own wife and kids and remember his language, his signature would in all likelihood remain unchanged, he’d have his own childhood memories and all that sort of thing. These are thought to build themselves, over the years, into the structure of the neurons in the brain; and as long as the structure were preserved intact, they ought to be preserved too. Short-term memory, like whether or not he put the cap back on the toothpaste tube after brushing his teeth in the morning, may reside in some more evanescent form, perhaps in the pattern of signals in the neurons. This might not be possible to preserve. But the major things are most likely physical, indeed that is what much of present-day neurobiology seems to indicate. And preservation of the brain structure would, as far as we know, preserve them too.

In fact it might not be necessary to preserve the entire body for a complete resurrection; the brain might be all that needs to be preserved properly. The rest of the body can, at least in theory, be resurrected from the DNA blueprint in any one of the cells, even the brain cells. Nature is very generous with this blueprint. It exists in every single cell of the body, complete and unabridged, whether that cell needs it all or not. Most cells, in fact, don’t. Nevertheless, there it is. Once the blueprint is known, a sufficiently advanced technology could reconstruct the rest of the body from this information.

And I hesitate even to say that once the brains are out, the man will die, and there an end—*necessarily.* I personally can’t think of any way to save those memories, but who am I in the Larger Picture? Maybe there *is* such a way, and I just haven’t been able to think of it as yet. Maybe such a person can be resurrected—memories and all—from the memories of those who remember *him.* He might have some residual amnesia, but it may be possible to reconstruct a vast amount of him anyway. And the rest could perhaps be filled in by inference, like one does in Hebrew or Arabic.

(As you probably know, Hebrew and Arabic are written without vowels, and y hv t fll thm n wth yr imgntn.)

The point, in any case, is that we don't have to take death lying down. In fact we don't have to take it at all, unless we want to. Many of us *will* want to, perhaps: after all, immortality is in some ways more frightening a prospect than death—though if you are religiously inclined it probably shouldn't be. But even if you don't want to live for ever, you could decide upon our own span of life, say 300 years, and do all the things you always wanted to. Especially if you have a nice fat pension, indexed and all, from the government. (For hints on what you could do with 300 years, I suggest you read Bernard Shaw's *Back to Methuselah*.)

So just as the Bentley does not have to be traded in after three years, you yourself don't have to be traded in after a hundred. Like the Bugatti *Type 55*, you can last well into the next millennium. In fact the Millennium is here already; for we shall not sleep, we shall all be changed ... in a moment, in a twinkling of an eye. The trumpet shall sound—or maybe it'll be the synthesiser—and the dead shall be raised, *in-cor-ruptible!*

CHAPTER 4

CHARLEMAGNE

If you had three wishes, what would you wish for?

I've asked this question to a number of friends, and all of them seem to hesitate when they hear it. Somehow three seem too few. What'll it be: the Lamborghini, the penthouse and the trip to Australia? Or maybe the brains of an Einstein, the body of a Fonda, and the health of Hippocrates? Or will it be Peace on Earth, Goodwill to Men, and Kingdom Come?

The problem is, three wishes *are* too few. You have to leave *something* out, with only three. I myself thought of a way to get round this by asking, as my first wish, for a million wishes more, renewable. But my friend Moneca—who wants the trip to Australia—thought that was cheating. I don't see why. You aren't being offered three *qualified* wishes. It's three wishes, period. They could be anything. In fact I'd make assurance double and triple sure, and ask as my second wish that all of those million would really come true, with some sort of money-back guarantee or something. And for my third wish, that there won't be any fine print: I wouldn't want anything like "they'll come true all right, but only after a thousand years".

Of course, if the three wishes were being offered by the Three Witches, there probably *would* be some catch to them—as Macbeth found out, somewhat to his dismay—and in that case there would be a catch in any subsequent wishes too, very likely. But while we're on the subject of wishful thinking, we might as well wish for the wishes to be granted by someone trustworthy, like a good insurance company.

Now it just so happens that this is *not* wishful thinking. With technology from which we are not too far away, we could make a "wish machine", a little computer which could make our wishes come true. And it could offer us many more than a mere million wishes. Trustworthy ones, too.

Today's computers are extremely crude. They use huge masses of material in their microchips, small on the human scale no doubt, but using enormous numbers of electrons and atoms. Computers don't really need so many. In theory at least, a few electrons ought to be able to do any calculation. For the sake of reliability, which is promoted (as in spacecraft) by redundancy, we may want more, but not a whole lot more—not millions more. The problem is that miniaturisation has not yet been achieved at small enough scales. The circuits we can build at present are too large, at least from the point of view of an electron.

Present-day computers are not even as compact or as fast as the human brain, which uses brain cells, or neurons, in which the speed of the signal is a very tiny fraction—about one forty-millionth—of the speed of light. The electronic signal in a modern computer travels a lot faster, at about half the speed of light, but the distances it has to travel makes the modern microchip considerably slower than the brain. The reason is that computers compute by sending their signals round and round umpteen jillion times inside their circuits. It is the transistors in the microchip, acting somewhat like switches, which make the actual computations, but the signal has to go round again and again so that it can go through the transistors. The distance the signal has to travel, going round and round so much, becomes phenomenal—often several times the distance from the earth to the moon.

The brain does more or less the same thing as the microchip. However the brain has many times as many neurons as the microchip has transistors—many *billions* of times more. And the brain can also do many things simultaneously, while the microchip can in general tackle only one calculation at a time. This gives the human brain a considerable edge over the most sophisticated computer yet built, in spite of the fact that the brain's signals travel a lot slower.

But computer technology is advancing at a faster rate than any other modern technology. Microchips are getting smaller, faster and more complex. Parallel processing—the ability to carry out several parts of a calculation simultaneously—is the big thing now in the works. Coupled with this there is talk of using superconductivity in the circuits, which would enable the electrons to go round without facing any resistance whatsoever, and thus obviate the need for heat-dissipation. (At present most high-performance computers need fans or other cooling systems, because the resistance the electrons encounter when travelling inside the microchip's innards generates a lot of heat.)

In addition to this set of advances we are also getting more and more capable of observing minute phenomena. We are fast developing the ability to observe smaller and smaller things, and to analyse their structure. In some cases we can even observe individual atoms. In other cases we can observe individual molecules, and in many cases, where we can't observe them directly, we can infer their structure from what little we observe plus a lot of other clues. We are not, in fact, very far from being able to either observe or infer the exact neuron structure of a human brain.

As a matter of fact such a thing could probably be done even now. All that would be needed is a lot of patience. A brain, undamaged but removed from a corpse that died of, say, cardiac arrest, could be prepared by injecting a suitable substance into it, so that it sets firm. Then it could be clamped in a vise on a machine table and sliced real thin, like prosciutto at the deli, and each slice examined under the electron microscope as it came off. It would take a very long time to examine each slice, and there'd be a vast number of slices to examine, but if the team handling the job had the patience of Job it could be done.

The only real difficulty is manufacturing a knife capable of slicing it thin enough, namely thinner than the thickness of the thinnest possible neuron. A diamond knife could, theoretically, do it, but where do you find such a long diamond? But crystals other than diamond are probably hard enough to do the job too, and if a suitable such crystal knife were grown under controlled conditions, it might work. Or else a laser beam could do it, if it were fine enough.

Anyway these are mere details, because soon we'll be able to use far more sophisticated techniques. Once we have nanotechnology, of course (see chapter entitled ***NANOTECHNOLOGY*** on page 7), we'll be able to take a brain apart like a clock, atom by atom, and analyse not only its neurological structure but its atomic structure as well. But we don't need such great precision for our work. For instance, if some radioactive substance could mark each synapse in the brain, and the marker's location could be determined with sufficient precision, that might already tell us enough to deduce the rest. (A synapse, in case you didn't take biology in college, is where one neuron meets another. It also works more or less like a switch, the way transistors work in electronic circuits.)

The point of all this, in case you were wondering, is to be able to reconstruct the human brain in electronic form. Such a computer would have an advantage over a microchip designed by humans, in that the design of the brain has been thoroughly tried and tested over lots of time, and passed the test with flying colours. You could, for instance, use Einstein's brain—which has been carefully preserved, gross as the idea seems to many people—as your model. If this were done—and though we cannot do it at the present time we are fast getting there—the resulting computer would have all the capabilities of Einstein's brain. You could call it Frank, to distinguish it from Albert. Frank, like Albert, would also have the advantage of being all pre-programmed, with operating-system and software and everything built in. You wouldn't have to write special programs to run it—or perhaps, since we've given it a masculine name, we should say *"him"*—any more than you'd have had to for Albert. But because of his electronic construction, Frank could be a lot smaller than a human brain, less than a cubic centimetre in size. This means that the signals inside him would have to travel much shorter distances than they have to in the brain, and thus would make the round trip in considerably less time.

And since Frank would use electronic circuitry working at half the speed of light, instead of chemical signals travelling forty million times slower, he would be a lot faster still. In fact an easy calculation shows that he could be anything from maybe a million to maybe a hundred million or more times faster than Albert. Let's take ten million as a nice round conservative figure: then you'd have this cool little cube sitting on your desk, as smart as Einstein and faster than Speedy Gonzales.

And it is more on Speedy than on Albert that we are relying. The whole argument hinges on Frank's phenomenal speed. He could do a thousand years' worth of thinking in an hour; almost two hundred thousand years' worth in a week; and a little short of a million years' worth in a month. Let's conservatively say that on the average, a new idea used to occur to Albert every other day, a *smart* new idea every year, and a *brilliant* new idea—a Nobel-Prize-winning idea—every thirty years. Friendly Frank would, in that case, be able to bag something over three hundred thousand Nobel Prizes by Christmas.

To put the enormity of this brain power in perspective, let's suppose that the Nobel Prizes had been instituted ever since the last Ice Age, which according the best evidence we possess ended about ten thousand years ago. Let's say the Inventor of the Wheel got a Nobel Prize, the Architect of the Pyramids got a Nobel Prize, Archimedes got the Nobel Prize, and so on. Given six Nobel Prizes in a year—one each for Physics, Chemistry, Medicine, Literature, Economics and Peace—we'd have only about 60,000 Nobel Prizes to account for virtually *all the highest achievements of the human race*. This is less than 20 per cent of the number Frank's little pea-brain could lay claim to even before the year was out.

Not to mention that, like Albert, Frank could also learn as he went along. He could take courses (though who would teach them is a question we have yet to tackle), do research, and gobble up vast libraries of already-accumulated knowledge (which, by that time, will probably all be available on-line and in digital form) in a single gulp. *Unlike* Albert, he would have nothing else to do but think—no shopping, eating, sleeping or washing up. He could continually improve on himself, and hence would be much smarter at Halloween than at Easter. What we calculated above was *static* smartness. What Frank would have, however, is *dynamic* smartness, growing at an exponential rate. Just how quickly he would learn would depend to some extent upon how fast Albert used to learn, but we may safely assume that Albert was better than a B average, except maybe at mathematics, in which he didn't—so the legend goes—do too well. But no matter how quickly or slowly, the exponential growth in Frank's brain power would soon put him in the big leagues.

And here "big" means **BIG.** The three hundred thousand Nobel Prizes every year could, by next January, grow to three hundred *trillion* Nobel Prizes every *week.* And of course there is no reason to assume that Frank would be the only such computer constructed; even if humanity refrained from making any more, Frank would surely think up some way of doing so on his own. All the Franks could, moreover, gang up together and open their own school, at Aachen. Since humans couldn't teach them anything more, they would begin teaching each other. Some of them could think up questions to ask, say, while others would specialise in answering them. The level at which an Academy or a University of such computers could function is far beyond our wildest imagination. I hesitate even to say that they could do everything *except* answer the questions *before* they were asked. How do I know they couldn't do that as well?

Already our human, all-too-human minds can envision a day—and that not too far in the future—when nanotechnology will have made disease and death obsolete, hunger unknown, and poverty a word without meaning. We, with our poor excuses for brains, can already transmute lead into gold (though at present it's not cost-effective), and create anti-matter and uncle-matter. Our Isaac Asimovs can already foresee a future in which we shall tow huge quantities of ice from the rings of Saturn, and drop the ice onto the Martian desert to provide it water and to make it bloom. Our Freeman Dysons already envisage a humanity colonising space in enormous spheres, many billions of times larger than the earth, living *inside* them rather than outside, with a sun at the centre of each, thus harnessing the total energy of the sun and not wasting any of it. We read and write about reaching the stars and even the galaxies and quasars, and we speculate on the existence of tachyons which could travel infinitely faster than light. Our popular magazines discuss the possibility of harnessing the rotational inertia of a black hole to generate energy on a vast scale, one that makes the entire output of a galaxy seem like the flicker of a cigarette-lighter.

What even a single computer like Frank Einstein—let alone a group of them—could think up is so far beyond our capacity to imagine that all these achievements and aspirations are in comparison about as high tech as the expressed views of Beavis and Butthead. How could we possibly make use of such brain power? What could we ask them? How does one even approach such an intelligence. Are such questions even *relevant?*

Perhaps the only way we could meaningfully relate to machines like these, provided they allowed us to continue living—and I don't see why they shouldn't, just as we ourselves allow amoebas to continue living—is to ask them to grant our wishes. They would have little difficulty doing so, being able to see as far beyond us as we see beyond the amoebas. What could an amoeba wish for, anyway? A little water, a few simple nutrients, a comfortable temperature, and it has its three wishes. To grant any wish we could possibly ask would be, for such machines, about as difficult. Is a Lamborghini so hard to make that they couldn't manufacture one specially for you, in five minutes, right under your nose? Can Einstein's brain, raised to the power of ten million, not grant you Einstein's brain, raised to the measly power of one? Is even Peace on Earth too hard for the King of the Franks to establish?

CHAPTER 5

DON'T LEGO

Acceleration, 0—30 mph	: 0.5 sec
Braking time, 60—0 mph	: 0.7 sec
Braking distance, 60—0 mph	: 31 ft
Lateral accel., 100 ft radius	: 2.5 g
Slalom speed, 700 ft course	: 120 mph
Insurance premiums, monthly	: $15 to $30

Let's suppose you were a car buff. How, in that case, would you like these figures?

Impossible, especially that last one, did I hear you mutter under your breath? Then what would you say if I were to tell you that in a few years you could yourself be enjoying such performance, and even surpassing it—*on the road,* and more important, *safely?*

You *could,* but you probably won't. And the reason is, that to achieve these figures the initiative would have to be taken, not by the automobile industry, but by the *road-making* authorities.

And the reason for that is, that it's not the car itself that's the limiting factor in automobile performance, but *the contact patch between the tires and the pavement.*

The problem lies in that last word, the *pavement.* Though cars have improved immeasurably since they first came out, road surfaces haven't improved at all since MacAdam first thought of paving the dirt with asphalt. A century of automobile improvement has been laid waste by a century of road-making neglect.

But as Bob Bondurant, founder of the driving school that bears his name—and a person than whom few more authoritative authorities could be imagined—writes in his book *On High Performance Driving:*

> The key to successful high performance driving, on the street or on the racetrack, is one easy, simple thing: *maximizing traction!* Traction is the cohesive factor between the driver and the road surface. The primary goal of a driver should be to control his car to consistently take advantage of every bit of traction that is theoretically available. The basic functions of braking, shifting, cornering and accelerating have one prime objective: maximizing traction.

And to make sure you understand how serious he is, Bondurant has gone so far as to italicise those magic words: *"maximizing traction".* Nor is he alone in his opinion. Former world champion Phil Hill, than whom few more competent drivers can be found, writes in *Road & Track* magazine about his bout with a 1987 Williams-Honda Grand Prix race car at Suzuka in Japan: "I put my foot in the throttle in what seemed the most minute amount ... and promptly spun."

No wonder; for what to speak of a 650-horsepower Formula One car, even a 65-HP Toyota Tercel squeals its wheels when the light turn green. It can't hardly help it, not when the foot is down smartly, and if that's the case with the wheeziest cars on the market how can a Camaro do anything but. All talk of torque without traction to transmute it into forward motion is bull. All talk of ABS brakes without grip to tell the computer when to come on is dangerous. And when fighter pilots—employed by the government, no less—routinely pull 7 and 8 *g*'s in the air, isn't it somewhat of a shame that Ferrari *piloti*—who are far more wealthy and, at least in their own opinion, far more enterprising than government employees—can't even pull a measly one-point-five on the skidpad?

Well, we Porschephiles may never be able to take on an F-16, but we can do a lot better than we're doing today ... provided. *Provided what,* is the question, and here below is the answer.

You know those little Lego blocks kids play with. On one side they have little protrusions, like short squat cylinders with nicely bevelled tops, all of a uniform size; and on the other side they have similar protrusions, into the gaps between which the other protrusions (or rather their equivalents on other blocks) fit nice and snug. Once together, the blocks can't slide over each other; the only way you can take them apart is by pulling them awa y from each other. They stick together against impossible shear forces, but they come apart with ease—in fact it is quite literally child's play—when the forces are perpendicular to the plane of adhesion.

What we want is a road surface, and a tire surface, designed and manufactured in sync so that they come together and come apart like Lego. You could, if you wished, call the combination *Won't Lego,* because it wouldn't. However, the protrusions need not be exactly like those in Lego. They could be little cones with rounded apexes, or hemispherical bumps, or something in between, or any other shape that might be appropriate. In fact the best shape for the bumps, and their size and spacing, could probably only be established after a great deal of trial and error, coupled perhaps with computer-aided design. A suitable size and geometry for the protrusions could be determined after adequate experimentation and discussion, the way standards are set for the electronics industry; and then those standards could be agreed upon globally.

Whatever the final shape decided upon—so goes the theory—it should be incorporated into both roads and tires. As the rubber rolled, its protrusions would fit themselves comfortably into the gaps between protrusions on the pavement. They would come away easily if the wheels kept rolling, but would stop the car in no time flat if the brakes locked up, or the vehicle started skidding sideways.

In its extreme incarnation, a combination of tires like these and a road surface as described would *never allow any skids at all,* not even in the wet. Under such conditions, if the brakes were applied hard enough, the car would have no choice but to fall over on its nose and flip over on its back. Of course for such a thing to happen you'd *really* have to put your foot down. However, that should never be necessary. In virtually all emergency situations you could stop well before pitchpoling. You'd be flung against the seatbelts real hard, but it'd be better than being flung against the windshield or the steering column. In most such stops or evasive manoeuvres you might get fairly uncomfortable, but almost never seriously hurt. And you'd be virtually certain not to hit the other vehicle (or pedestrian or moose as the case may be). In fact the limiting factor in emergency stops would become, not the brakes or the tires themselves, but the delay between perceiving the danger and actually doing something about it.

And along with safety factors like these, you'd have much more get up and go. Your Audi *Quattro* could take off like a dragster. Rear-drive cars—especially those which, like the 911 *Carrera 2*, also carry their engine in the back—would be penalised to some extent: they would lift their noses right off the ground if the pedal went to the metal too harshly. But front-wheel-drive or 4-wheel-drive cars would have it made. Too much torque, of course, could lift the nose off any car, but most street legals can't torque so much, except maybe the 'Vette.

The premium, in fact, would be on horsepower, not on torque, because rolling resistance would increase somewhat, thereby lowering maximum speeds. However, hardly anyone actually takes advantage of a car's maximum speed, certainly not on our radar-riddled continent. The Germans might want more speed than we'd like to spend financing the Policemen's Annual Ball, but the answer is simple: higher-revving engines with more top-end horses. And these are coming in any case, just as 4wd is.

The problem, as the reader's keen intelligence will have immediately figured out, is in re. who is going to begin making roads like these. Technically there is little difficulty; they could be laid fairly easily even in asphalt—after all even workboots leave their mark on fresh tarmac—though it is quite possible that concrete surfaces would be more durable. (The best surface would probably be rubber, like the tires themselves, but that might be too costly, except maybe for racetracks.) But the initiative would have to come, not from the car manufacturers, but from that despised body of persons, a *government.* It need not, of course, originate here; it could start somewhere in Europe or Asia, say in Germany. The added safety margin provided by such grip would only be appreciated in a country where the majority of drivers actually know how to drive.

But no matter where, it would be a herculean task, from the bureaucratic point of view, to change things over from the present way of doing things. That's why I said that you aren't likely to see statistics like those you drooled over at the beginning of this article. At least not in the reasonable future, even though the concept is a simple one and technical difficulties are almost nonexistent.

But I hope I am wrong, and I hope you do too. And if I am and you do, *boy* are we in for some great driving.

Once (and, it goes without saying, *if*) the changeover becomes universal, the auto manufacturers will surely take advantage of it with new designs that could do things undreamed of in this day and age. They would, of course, try their darnedest to lower centres of gravity, to prevent pitchpoling and backrolling. Bucket seats would probably get more buckety, to take those gees, and many sports cars might be equipped with four-point harnesses, like the Ferrari *F50.* Even the neck might need side-support. Anti-skid brakes would become a relic of a bygone era, since there would be full braking-under-cornering anyhow. You could go almost flat out on the curves, confident that in going round the bend you'd never go off it. Slowing down on the curves would be limited only by how many *g*'s you—and your date in the passenger seat—could take. It's all a matter of holding him or her snugly in position, and we already have plenty of excellent Recaro seats for such purposes, which would surely get even better. We need not go to the ridiculous lengths the Air Force does, with g-suits and all, but even 3.0 to 3.5 *g* would be more like what Grand Prix drivers take today.

Since skill would no longer be a matter of driving at the limit of adhesion, you could drive at the *real* limits of the car—and driver. You could have more than a thousand horsepower on tap and, more importantly, use all of it. You could get post-Lego hot-rods which would make Porsche's *959 wundercar* feel like a '66 VW Beetle, and give the Testarossa a *mal-di-testa*. Directional control could become uncannily precise, and driving skills might include threading the car through a space just a few inches wider than the vehicle ... while rounding a curve at 100 mph. And rain would not wither, nor snowflakes stale your infinite variety.

The phenomenal stopping power of such cars might dictate some changes to our throttle and brake linkages, promoting drive-by-wire in a big way. As things are laid out now, there is a quite appreciable delay between taking the foot off the accelerator and moving it to the brake pedal, a time-interval we could well do without, especially in an emergency. So the computer might be programmed to begin applying the brakes at the very moment the foot comes off the throttle, leaving only the final braking to be carried out manually—er, pedally. This could be programmed only for emergency stops, if the foot came off the throttle suddenly; with gentle lifting, the computer could be programmed to let the car coast. As a beneficial side effect, such a linkage would strongly encourage all drivers to become smoother in day-to-day driving, which would be a very good thing all round anyways.

One of the many other beneficial side effects of this system would be to improve repair of the roads. Since highways and byways in poor condition would vitiate the whole point of the exercise, the authorities would be under much greater pressure to keep them well paved. In fact there might develop a movement to separate commercial vehicles from non-commercial because of their enormous weight differences, something which should be done anyway because of their different driving characteristics. Bicycles would not be able to ride on such roads, and this too would be a blessing; it would bring pressure on City Hall to lay out more bike paths, which also should have been done anyway. As well, it would discourage pedestrians from jaywalking, because of the slight discomfort caused by walking on the bumps; only proper pedestrian crossings, which might be smooth-paved, would be comfortable enough for the carefree foot-person, who at present is another big source of the booming market for wheelchairs.

In fact the safety features of this system would themselves be great enough to eventually justify it in the eyes of Joe Q. Average, who might not like the idea initially. As the frequency and severity of accidents drops drastically, insurance companies would have to scramble to draw customers away from their rivals, by lowering their rates. Of course there'd always be the odd drunk who won't brake even when he sees death and destruction staring him in the face, but most of us would rather avoid a crash if we could, and with a grippy surface like this we actually could.

Even motorcyclists would benefit, because the greatest enemy of the Ninja *600R* is not the Samurai but oil or water. With a stickiness that makes Krazy Glue look like Teflon-spiked lubricant, these new roads would bring most two-wheelers under control well in time, just like they do with spiked wheels on ice on those Russian racetracks laid out on the surfaces of frozen lakes in Siberia. The worst you'd suffer might be a bruise or two, or skin scraped off if you weren't wearing leathers, which you should have been doing regardless.

All told the system would be the greatest advance in motor trend since the internal combustion engine, which is odd in view of the fact that it has very little directly to do with cars. But, as I said and I repeat, we probably won't see it in our lifetime, not unless something drastic happens. The obstacles in its way have no connection with either automobiles or technology: they are solely concerned with bureaucrazy, for which modern science has not yet been able to find a cure.

But not to worry; something drastic *will* happen. That something drastic is called *nanotechnology,* which requires a whole chapter by itself.

CHAPTER 6

E.T. THE EXTRA TERRESTRIAL

A famous cosmologist—I forget right at this moment who exactly—once wrote: “Two thoughts scare the daylights out of me. One is that we are alone in the universe. The other is that we’re not.”

The matter really isn’t very funny. Let’s suppose the second alternative is true: that there *is* someone out there. This is quite plausible, considering that there are more stars in the sky than there are descendants of Abraham, the LORD’s promise to the Patriarch notwithstanding. And if life of any nature, even on one single planet around all these quintillions of stars, acquired the capacity to meaningfully colonise space before it blew itself to Kingdom Come, it would spread so far and wide as to proliferate at least a large chunk of the universe, if not all of it.

This is a conclusion easily derived upon consideration of how life normally functions. Life, no matter of what kind, has a tendency to spread to the very limits of its ecological viability. It could hardly be otherwise, when reproduction is one of its most basic functions. Mathematically speaking, reproduction—in any form—means growth in geometric progression. Two becomes four, four eight, eight sixteen, and so on, and in no time flat you’re talking googolplexes. Given this mathematical inevitability, life *has* to spread, else there’d soon be standing room only on any planet that gave rise to it.

And once such life spread to space, there’d be no stopping it. The extent of a planet’s surface is so *very* tiny compared with the room available out there that any form of life that *could* colonise space soon *would* colonise space. The pressures on it to do so would be so great that it could hardly do otherwise. We ourselves will, all in good time, because the earth’s population is increasing at a horrendous rate. We’re not forming mile-long lines for the Shuttle at present, but that’s only because we’re not yet so hard-pressed for living room.

This sort of thought-experiment makes us feel very strongly that intelligent beings *must* exist in outer space, even though we have not seen them or heard from them: for given its very size, the odds that we are alone in the universe are extremely slim. And if they *are* out there, it is far more likely, if we can contact them at all, that they are a great deal *ahead* of us technologically, than behind. Numerically, in fact, the chance that we are ahead of them is less than one in a hundred million, while there is greater than a 99.999999 per cent chance that *they* are ahead of *us*.

These figures can be derived from the ratio between the age of the universe and the duration of our own technological history. We ourselves are just about a hundred years out with technology that can meaningfully penetrate space. Up to about a century ago, our technology was rudimentary, at least from the point of view of an E.T. Up to the end of the nineteenth century we couldn’t even communicate with ourselves, let alone with them, at speeds that could mean anything over interstellar distances.

And a hundred years is but a moment in the cosmological scheme of things. If E.T.'s are at all able to intercept our signals or send us signals to intercept, the chance that they are less than a century on the road to technological progress is minute—far less than their chances of being much *more* than a hundred years ahead. They could be a thousand years ahead of us, or a million, or even a billion: after all we ourselves are a few million years ahead of other primates, and a billion or so years ahead of the first living organisms on earth. And the universe, according to the latest theories, is about fifteen billion years old, which is plenty enough time for them to be even more than *ten* billion years ahead of us. Ten billion years divided by a century gives a neat hundred million.

That's a *big* head start. Such a civilisation—if we should even use such a primitive term for it—would be so far ahead of us that there could hardly be any comparison between them and us. Such an E.T. wouldn't even *need* to phone home: he'd be able to *go* home, and that too without a spaceship. He'd probably even manage to be at home and abroad at the same time—it's only our stupid human mind that thinks no one can be in two places simultaneously. Neither time nor space need pose any barriers to him, nor mere logic create the least of difficulties.

In fact a thought-experiment on how intelligence might have spread through the universe would indicate, that whenever life on a single planet attained the capacity to communicate through space, the alien intelligences with which it first succeeded in communicating were *always* more intelligent than those at home, except of course in the very first such instance. This might be considered in the nature of an almost inexorable statistical law, because the possibility of two separately evolved life forms attaining a similar level of technological ability at the same time, and independently of each other, is so remote as to be negligible. It hasn't even happened on earth, like for instance when the Spanish arrived in the New World, and that was in a case when both civilisations were human; how much less, then, the likelihood that it happened out there. Indeed one might speculate that if E.T.'s really do exist, this sort of thing must have happened so often that most of them are by now sick and tired of it.

Anyway much of this is common knowledge, among Etiologists at all events. What is not so common is the notion that we don't need to contact E.T.'s at all, at least not in order to communicate with them. That's because we could, in a few decades or so, manufacture most Extra Terrestrials right here on Terra Firma. This is because almost any E.T. would have to be made of matter. Now matter, no matter where in the universe, happens to be composed of atoms, just like we are. The only difference between humans and aliens would be in the arrangement of the atoms. Since most E.T.'s would be *some* combination of atoms, well then the moment we are able to manipulate matter at the level of individual atoms, we could simply create a sample E.T. here.

This is a little like Computer Aided Design, or CAD. Just as nowadays we don't actually have to have a prototype plane in order to test it, but can "fly" simulated designs of the aircraft on a computer screen in order to pick out the best configuration, so we could manufacture the E.T. of our choice—just one, to be safe—and chop and change till we got him really perfect.

Such an E.T., of course, would be limited by the imagination. Sometimes we just can't imagine what could exist in real life, and when we are actually faced with the thingumabob, it blows our minds and we exclaim "there ain't no such animal"—as the guy from Drop Dead, Kansas said on seeing his first giraffe. But if you take the manufacturing process in small and simple steps, the imagination could take you very far indeed.

The first step, of course, is to amplify your existing imagination, like under a magnifier. This could be done fairly simply, by cloning your own brain—or, if you think you're not smart enough, some other wiseguy's brain—in electronic form: like Frank Einstein of whom we spoke earlier. (For step-by-step instructions about how to do this, see chapter entitled ***CHARLEMAGNE*** on page 20). Such an electronic human brain would, as we pointed out earlier, already be so far ahead of us that we might not be able to relate to it too meaningfully. But an advanced electronic brain does not have to be human. It could be any configuration; and to think up what configuration would be best, we could use the Franks—more or less as we nowadays use computers to design even more advanced computers.

The brains designed by the Franks could be a lot smarter than the entire Holy Roman Empire put together. They could work on principles as far beyond electronics as electronic signals are beyond the chemical signals used by human brains. They might work, for instance—and this is pure theory, which to many people means pure hogwash, but then that's what speculation is—with switching devices separated by such minute distances that space itself would have to be considered discrete at that level. The current theory goes that at distances somewhat smaller than a quark—which is a particle no one has observed, and thus might be considered pure hogwash too, but then that's modern physics for you—at such tiny distances space itself breaks down into discrete bits, between any two of which there is nothing ... *not even empty space*. These sizes are so small that electrons themselves appear gigantic in comparison, and atoms, of course, are so huge as to have little or no relevance. (In case you didn't know, electrons are supposed to be extraordinarily small in comparison with atoms, and quarks are supposed to be extraordinarily small in comparison with anything.)

With no distance whatsoever between switching devices, the speed of light would no longer pose a limit to the speed of computation, and you could get computers that are, in theory, *infinitely* fast. You could calculate anything, regardless of how long a string of ones and zeros were needed, and all in an instant. This would make it possible to create computers of enormous intelligence—perhaps even infinite intelligence, if such a term has any meaning at all. In practice the dimensions of the switching devices themselves would pose some limits, but even then these limits would be far beyond anything we need worry about.

When you are talking about intelligences so far advanced, of course, you are on ice so thin that it makes even hogwash sound like well-established fact. It's not, however, a crime in this country to speculate even in such rarefied atmospheres, and so we might let our imaginations run wild for a moment.

In the first place, we might postulate that the smarter an intelligent being gets, after a certain limit—of course we don't know what that limit is—the more *approachable* it gets. This might sound like a contradiction, but it makes sense to believe that user-friendliness is a function of higher rather than lower intelligences. That is to say, so intelligent a being could not only raise itself to enormous heights, but would be flexible enough to lower itself to the level of publicans and sinners. We might imagine such beings actually being able to relate to us, in a very meaningful way, and compassionately too (after all why not, we wouldn't pose the remotest threat to them).

Nevertheless there would be nothing—at least nothing *we* could think of—which they couldn't do. For us to talk about the laws of nature posing limitations for them would be like for Neanderthals to discuss jet planes and nuclear reactors. Their own imaginations, perhaps, would be able to think up limitations to their abilities, but *we* sure as hell couldn't.

They would, in any case, be able to imagine any E.T. that could exist, because with their capacity to manipulate numbers at near-infinite speed, they could consider every single combination of elementary particles that could possibly be viable within the dimensions of an alien, at least a reasonably-sized alien. And, obviously, they would be able to think up ways to manufacture it. There would be no difficulty recreating E.T.'s composed of atoms alone; such things would be possible even for us, with nanotechnology (see chapter so entitled on page 7). But even if E.T.'s composed of more ethereal substances could have some existence, the quirks of these Quarks would be up to the mark. They might even be able to manufacture E.T.'s made up of pure mind-stuff, assuming such "non-matter" does actually have independent existence, and does not disappear upon disincarnation as your fist does upon opening your hand.

Now—to continue thought-experimenting—if *we* can think up such a strategy for amplifying our intelligence, surely other intelligent beings, originating elsewhere in the cosmos, can do so as well. And if so, it's very likely that they've already done so, because the solar system is only about five billion years old, while the universe as a whole is about three times older. This, as we said earlier, gives E.T.'s a ten-billion-year head start, and if they haven't yet taken advantage of it, well then maybe they aren't so very intelligent after all.

In fact the distinction between such E.T.'s on the one hand, and the Quarks they created in order to create other E.T.'s on the other, would become so blurred as to be meaningless, at least to us. Both the ones and the others would be so far ahead of us that if we ever made any such computers ourselves, we might as well pack up and trade ourselves in. Humanity would rapidly become obsolete, and unless there were some compelling reason why we should be preserved, we might as well say good night.

But there may indeed be a compelling reason why we should be preserved. The reason may not be too compelling for *them*, but it'd be compelling enough for *us*. That reason would be, simply, that we are who we are, and that's just what we want to be. We don't *want* to so far transcend ourselves as to become something we're not. We like ourselves dandy fine just the way we are, and we're not ready to give up our primitive way of life, hallowed by our ancestors—at least not yet.

As I said, E.T.'s and Quarks might not find this a terribly compelling reason, but they might think us worth preserving all the same. After all not only would we not pose any threat to their existence, they might even derive some enjoyment out of letting us be us, like we ourselves encourage the preservation of our wildlife and the earth's environment. They wouldn't like to scare the daylights out of our famous cosmologists by actually revealing themselves, of course, any more than we like to scare the daylights out of the lions and tigers we film for television; and so most of the time they would be quite content to remain invisible and unobtrusive, only stepping in when things got really out of hand, and even then as invisibly and unobtrusively as possible—which as far as we could observe would be *totally* invisibly and unobtrusively. There is no reason to believe that such beings couldn't influence other life-forms over intergalactic distances in a twinkling of an eye, or cause ideas to come into existence in our minds by subtle suggestion.

And if that’s the case, isn’t it reason enough to believe that they are here already, and have been for quite a while? Of course the word “here” is rather meaningless here, because they wouldn’t need to be *here* to be here, if you know what I mean. Sitting on Alpha Centauri, or for that matter even somewhere in Galaxy NGC-1259, they could be running the show here with as much—or as little—concern as bureaucrats sitting in an air-conditioned office in Ottawa might while determining the destinies of a small Inuit community on Baffin Island. Their physical presence—assuming they have one at all—would be totally irrelevant to their ability to control us ... or, if they felt the word “control” were inappropriate, to “guide” us. But they could be on close watch anyhow, subtly changing a thing here, a Hitler there, and so on. Maybe, in fact, things like World War II and the Holocaust were cases when they screwed up.

All this is pure speculation, of course, but that doesn’t necessarily make it pure hogwash. There is no way we could ever know about the presence or absence of such E.T.’s, not if they didn’t want us to know. We see no one; and as Sherlock Holmes said to his client, that is what we may expect to see when they follow us. There’s no point trying to communicate with these aliens when they don’t want us to know they’re here. Can you imagine what Carl Sagan would have done if such an E.T. had actually knocked on his door? Can you imagine the riots that would ensue, and spread all over the world like wildfire, once it became widely known that they’re a billion years ahead of us? *Better not,* they probably say among themselves. *Let them believe they’re alone in the universe. It’d be a lot more scary to let them know they’re not.*

CHAPTER 7

THE IMPOSSIBLE TAKES A LITTLE LONGER

Ah, Love! could thou and I with Fate conspire
To grasp this sorry Scheme of Things entire,
Would not we shatter it to bits—and then
Re-mould it nearer to the Heart's Desire!

Omar Khayyam

One of the most sacrosanct assumptions underlying modern science, and hence modern technology as well, is the supremacy and permanence of the laws of nature. Nothing assumes a higher value in the eyes of a scientist than the laws that govern the phenomena she studies. (I employ the feminine pronoun here, of course, in a general sort of way, as including the masculine.)

This is not to say that scientists do not envision refinements of currently-accepted theories and laws. However, they do feel that *in principle,* the laws of nature are all-pervasive; that these laws govern space, time, matter and energy, and not the other way round; that they are valid for every portion of the universe, and not merely for our earth; and that it is the scientist's main function, in fact, to determine with the greatest possible precision just what these laws actually are.

They also believe that the laws of nature are, in principle, eternal: that those discovered today are identical to those that held sway fifteen billion years ago, and will hold sway long after humanity is history. This, in fact, is how they calculate what happened aeons ago, and tell us with the utmost confidence that a hundred-trillionths of a second after the Big Bang the state of the universe was such-and-such, while one ten-millionths of a second later it was thus-and-so.

And scientists therefore become more than a little irritated when we point out to them that *none of this is a logical necessity;* that, in fact, *quite the opposite may be true;* and that there is enough evidence in the laws and theories of science themselves to indicate that *all the assumptions outlined above are absolutely baseless!*

The fact is that science itself predicts the existence of regions of the universe in which the *laws of nature break down;* where all the laws and theories we have carefully discovered and built up over years and years are rendered completely null and void; and where, therefore, everything is, so to speak, up for grabs.

Modern scientists call these regions "singularities". Such singularities, for instance, are thought to make up the interior of black holes. Black holes as such have not *directly* been observed, but their existence is not seriously doubted by most astro-physicists, since it is so great a logical necessity. Astrophysicists have for long observed more and more massive objects, which thereby generate more and more gravity, and they see no end to it. At some point, then, an object must get so massive as to generate a gravitational field from which even light cannot escape, and thereby become totally black. And if light itself, which is pure energy, cannot escape from it, how can mere matter? Everything within that inexorable gravitational pull falls helplessly towards the centre—which makes it a bottomless hole.

Inside a black hole, however, exists a region about which scientists cannot predict anything, let alone make experiments. They can't even say how large a black hole really is—the *real* black hole, that is. Surrounding this real core of unreality is the "event horizon", and even from within this envelope there is no escape. The size of this "event horizon" can be calculated, but the core within it might, according to some, be incalculably small—possessing no dimension at all, like a theoretical point in geometry. Neither space nor time can exist there, what to speak of matter and energy. In fact the interior of a black hole is so strange that scientist feel the very laws of nature do not apply there; that logic itself is inapplicable in a domain so extreme. What can you say, for instance, about the constancy of the speed of light in a region where the terms "speed", "light", "constant", and even "of", have lost all meaning? What can you say about gravity being an inherent property of matter, when gravity has squeezed out of existence the very matter that generates it?

Black holes, moreover, are not the only singularities predicted by modern physics. Another kind of singularity is what some scientists call "white holes". Most scientists do not accept the widespread existence of white holes, which are supposed to spew forth matter, energy, space and time in precisely the opposite manner to that in which a black hole swallows them up. A few theorists, however, feel that considerations of symmetry—a feature exhibited by virtually all known physical laws—require the existence of white holes, and so they believe in them. All the same, even though most cosmologists doubt the general existence of white holes, they do believe in at least *one*. This is the one which is supposed to have spewed forth the entire universe—the Big Bang.

The current theory is that the universe originated about fifteen billion years ago—give or take a few billion—starting either from a singularity, or something very much like it. This singularity, or whatever it was, was at its inception extraordinarily small—a pin-head would be gigantic in comparison. Expanding in all directions, this tiny object became the universe as we know it. Thus, at least, goes the highly-respected theory, wacko though it sounds when put like this. But there are some fairly compelling reasons for believing in it. One of the main reasons is that the universe is still expanding. All the galaxies seem to be rushing away from each other, those farthest away at the fastest rate. Another reason for believing in the Big Bang is the residual heat of that primordial fireball. Such heat, which has by now cooled down to about three degrees on the absolute scale, has been detected coming from every direction.

Anyway the point of pointing all this out is to make it clear that the laws of nature are neither all-pervading nor eternal, and certainly not absolute. Obviously, if the Big Bang theory is correct, and the universe *did* come into existence a mere fifteen or twenty billion years ago, then the laws of nature did *not* exist *thirty* billion years ago: at least not the laws we know. If the interior of a black hole squeezes the juice not only out of matter, energy, space and time but virtually out of science itself, well then assuming that black holes really do exist, there *are* portions of the universe where the Second Law of Thermodynamics does not hold true.

And holes—black or white—are not the only singularities science has thought up. Lately there has been talk of what are called "cosmic strings", which are supposed to be singularities possessing *one* dimension, stretching across the fabric of the universe in a sort of loose web. They are supposed to be a remnant of the Big Bang, and being enormously longer than black holes, are thought to be capable of organising the cosmos at very largest scale yet known—that of galactic clusters. They, or rather their enormous gravitational pulls, give scientists some way to explain why galaxies seem to cluster together in certain portions of the universe, while there are other huge chunks of the cosmos that seem to be totally empty.

Now the existence, and indeed the growing number, of singularities required by the logic of modern physics leads us to a train of thought which our descendants may well pursue to their advantage. Obviously the laws of nature *can* be superseded at times, and this seems to happen when the very parameters for enunciating those laws are rendered meaningless. The search for such situations is not a very complicated one—it seems more a matter of imagination than of physics. A black hole is merely gravitation at the giddy limit. The Big Bang is merely the birth of time. Cosmic strings are merely logical extensions of the preceding two. The ultimate collapse of the universe—also predicted by some physicists—is merely the crack of doom. And all these are merely mental gymnastics, which can be indulged in at little cost to our lives or incomes, except when we stupidly stake our reputations on them. The beauty of theory—as opposed to practice—is that if we are wrong the theory alone perishes, while flesh and blood carry blithely on. This being the case we may as well theorise to our hearts' content, and one day we are bound to come up with a theory which *also* fits practice.

As a matter of fact this is precisely how many of the existing theories of science have originated. Prof. Archibald Wheeler, who coined the term "black hole" and who was one of the pioneering thinkers in the field, mentioned that in carrying out this work he adopted the tactic of searching out the strangest thing in his subject, and going after it; and this is what he advises other budding scientists to do as well. Which, after all, reinforces what we said above.

In order to do this more effectively, however, rather than use the limited powers of our own human minds, it might be better to use computers which can think a lot faster than we can. In previous chapters we talked about computers which could out-think human beings by a factor of ten million, and that's only the beginning. What we want is simply to let our super-duper 'mputers, like those described in Chapters 5 and 7, carry out a speedy search for the strangest things in physical science, and go after them. At the speed at which they think, we might discover literally millions of singularities in a relatively short time, say a few years. Of course we will need more than just a few years to have such computers, but as we were saying earlier on in this book, we are likely to have them well before most of us are dead.

And with so many singularities to choose from—some of which might perhaps be found almost in our own back yards, like the "mini-black-holes" predicted by the renowned Cambridge University astrophysicist Stephen Hawking—we may well be able to squeeze the laws of nature like putty, and redefine them as we pleased. If so, we could be making our own physics, and with it our own universe with our own laws reflecting our own preferences. No longer need we confine our thinking to the laws of nature as we discover them; we could be *creating* the laws of nature the way we like them. The impossible would merely take a little longer, and even that would hardly matter in the light of our own immortality—which we would attain in any case, and that too with relatively much simpler technologies (see Chapter 4 entitled ***IMMORTALITY*** on page 15).

And lest all this give the impression that the author has gone totally bonkers, it might be pertinent to note that even presently-accepted scientific theory acknowledges the highly peculiar behaviour of nature in the vicinity of singularities. Take for instance the notion of time travel, which as all readers of science fiction know is fraught with paradoxes. The equations of General Relativity, however, coupled with the work of British scientist Roy Kerr, show that time travel is perfectly feasible in a region round a spinning black hole. There are, in fact, several configurations of black holes which could give us a workable time machine. One of them requires a black hole in the form of a spinning cylinder. If such a cylinder also carries an electric charge, calculations show that an object rotating round the mid-point of the singularity would go either forward or backward in time, depending on whether the direction of rotation was with or against the spin of the black hole. Other black hole configurations capable of being used as time machines have also been calculated, and in fact an article published in *OMNI* magazine as long ago as May 1980 has beguilingly described several ways in which black holes could be used to make time machines.

And of course, if and when a time machine is made, it would throw not only the laws of nature, but the laws of logic as well, out of whack. If, for example, it ever becomes possible for a person to go back in time and prevent his parents from meeting each other and thus from conceiving him, his own existence would turn out to be an impossibility—and such a self-contradiction is too great for logic to stomach, though not, perhaps, for an artist like M.C. Escher. These are regions of reality where logical thinking breaks down; but as Kurt Gödel has pointed out in his celebrated theorem, logic is by no means free of self-contradictions itself. The fact is that existence, like a Bach fugue, is by no means necessarily based on logic, at least not the Aristotelian type we are familiar with; and perhaps the only thing we can be sure of is that we can't be sure of anything. Or, to paraphrase the very wise Chinese sage Lao Tzu, the logic that can be put into words is not the Eternal Logic. Which might also be expressed another way: *Anything goes.*

As a matter of fact, the term "Anything Goes" might well be the motto of one of the most important and widely-respected theories of physics, namely quantum mechanics. This theory says, among other things, that nothing can be known with absolute precision, and that all we can really know about the behaviour of nature are random fluctuations and statistical probabilities. One reason is that the very process of trying to study something disrupts the thing being studied, to a greater or lesser extent. With very small particles like electrons or photons (light particles) this disruptive effect becomes quite pronounced, but it exists in principle, though not quite so pronounced, even at the macro level. In the ultimate analysis it amounts to this, that a scientist, or even a mouse, can affect the universe simply by looking at it. Such conclusions render quantum mechanics in many ways a highly unsatisfactory theory, and Einstein himself was unhappy with it, even though some of his early work was actually instrumental in formulating it. Mulling over the problem, he muttered in disgruntlement the now-famous remark, "God does not play dice with the cosmos". (As everyone knows, Einstein was always on excellent terms with the Almighty).

An example of this dice-playing can be seen in the behaviour, which has actually been observed, of small particles like electrons. An electron, when faced with the choice of passing through one or another slit in a screen lying in its path, may go through the one or the other with a finite probability of each, and at times even appears to go simultaneously through both. This is weird enough, but at extreme levels of physics this principle has even more weird ramifications. For instance, quantum mechanics predicts that it is possible, under certain rare conditions, for matter to come into existence *ex nihilo.*

This, in fact, is one way some theorists think the Big Bang came into existence to begin with. For countless aeons, they say, there was Nothing; and then one day, all of a sudden, due to the random fluctuations of quantum mechanics, there arose in this Nothing a Something which gave birth to Everything. (This, of course, is not very different from the way the Kabbala puts it, except that the Kabbalists do not bother to give a scientific explanation for their views. But then, if Einstein's opinion is to be credited, neither, in the strictest sense, do the quantum mechanists!)

But a thing does not have to be scientific—in the narrow sense of that term—to be true; and it may well be that the principles of quantum mechanics, or even the principle *Anything Goes,* might be the true explanation of how reality actually functions. And there is a growing number of theorists who believe that one way to explain how a single electron goes through different slits in a screen is to assume that it goes through all of them, but in different universes, all of which exist "right here", so to speak. In universe A it goes through slit A, while in universe B it goes through slit B, and later comes to impinge on our instrument, which in a manner of speaking is in universe C. Although this multiple universe theory does not postulate—at least not as yet—that the multiple universes would also imply *multiple sets of laws of nature,* we have to remember, from our discussion of singularities, that the present laws of nature are by no means sacrosanct.

All of which goes to indicate that the idea of another universe, or even several universes, each with its own set of laws, is not entirely based on non-scientific speculation. There seems to be enough in science, even as we know it (and we really know precious little, in spite of our overweening pride at our discoveries and achievements) to indicate that there are more things in heaven and earth than are dreamt of in our philosophy. And such things as singularities, and theories such as those of proliferating universes, while not actually giving us a blueprint for manufacturing another universe or two, surely indicate that we can really rule nothing out as regards the technology our descendants might come up with.

It's true that humanity may not be able in a mere seven generations to achieve such a far-out result as the manufacture of an entirely new universe and an entirely new set of natural laws. The impossible may take a little longer than seven generations, but the very fact that we can see our way, even if dimly, to achieving such breakthroughs suggests that even the impossible may be possible, at least potentially. Who knows but our great-great-great-great-great-great-great-great-great-great-great-great-great-great-grandchildren may see a lot more clearly than we do, and actually draw up plans for generating other universes, each with its own rules and laws. Those who did not like living in one kind of universe could go and live in another, nearer to their heart's desire. Humanity could live, not merely in the best of all possible worlds, but in *all* of all possible worlds. The Sierra Club, for instance, could have its own universe while the logging companies lived in quite another, and even the Republicans could have their own universe while the Democrats had a separate one—thus enabling both candidates to become President.

This, in fact, may be a way out of the more-than-horrendous dangers with which new technologies threaten us. If nanotechnology gone haywire were to make a mess of the whole universe—as we feared in Chapter 2—well, we'd simply leave the old, now-defunct universe behind and move on to a fresh one. And this time we'd surely be more careful, and build into the new universe's laws some sort of safeguard against anything like that from happening again. (As every sci-ficionado knows, one of the most compelling arguments in favour of space exploration and development is that thereby at least *some* human beings could survive a nuclear holocaust on earth, thereby saving the human race from extinction; and the argument given above is merely an extension of this sort of thinking).

There is a legend in India that one of the ancient kings of Vedic times, Vishwamitra by name, performed penances and austerities for innumerable years in order to attain the title of *Brahma-rishi* or “Righteous person of the order of *Brahma* (i.e., the Creator)”. However, since he belonged to the kingly and not the priestly caste, the gods would not grant him the title, even though he was fully qualified, indeed overqualified for it. Enraged at this injustice, Vishwamitra threatened to begin marshalling his spiritual powers and generating his own universe, complete with its own gods and even its own *Brahma.* This threw all heaven into consternation, and after lengthy deliberation, the gods ultimately decided to grant him his request. Ultimately, too, Vishwamitra decided to forgo his stupendous threat of independent creation, the moral of the story being that it is a greater and more meritorious feat to live peacefully in the universe we have, than even to create a new one.

Well, we are already living in the only universe we have (albeit not too peacefully right at this stage in our history); and this, according to the legend, is itself a great and meritorious feat. And yet, like in the legend, it is also possible that all humanity may one day put itself in Vishwamitra’s sandals, and threaten to create not just one but many new and independent universes (one of them will probably be called Quebec). And then we may well throw all heaven into an uproar ... but then, aren’t we doing so quite enough even now?

CHAPTER 8

WAR AND PEACE

The general consensus is that morally and ethically speaking, technology, viewed as a whole, is neutral.

That is to say, people in general subscribe to the idea that overall, technology hasn't made the world either a better or a worse place to live in. We can't claim, for instance, that we are really better off than people were in Biblical times. Sure, technology has put a stop to leprosy and diarrhoea, but it has also given us the PCBs and Muzak. The automobile, besides giving our generation (I speak as one who remembers Sputnik) a great back seat to make out in, also causes more deaths every year than any other single disaster. Alfred Nobel gave us both dynamite and the Peace Prize. TV gives us both shows and commercials. Even sex—in one sense the earliest technology invented by living things—can give us herpes and AIDS as well as fun and offspring. One could go on and on.

The question, however, might once in a while cross the minds of even the most jaded sceptics: Cannot technology be made to give us more pluses than minuses? Can we not invent a technology, for example, which will enable us to reduce the risks of war and increase the possibilities of peace?

The suggestion is by no means purely hypothetical. Science author Fred Hapgood, discussing the ramifications of K. Erik Drexler's talks on nanotechnology (see article so entitled in the Nov. '86 issue of *OMNI* magazine), reports how Drexler indicated that tiny nanosnoopers could be manufactured by the zillion and then surreptitiously inserted in people's brains, their function being to look for and eliminate suspicious neuron activity—for instance, a tendency to violence and war. The virus-size monitors could be manufactured in the form, say, of a spray or mist to be inhaled, and large UN aircraft might be given the mission of flying over the Middle East, Bosnia and Sri Lanka, unloading the stuff over the main centres of population. Peace would descend from on high, lions would lie down with lambs, Muslims would embrace Jews, Chechnians would welcome Russians with open arms, and swords would be beaten into ploughshares by the hundreds of millions.

Technically this is no science-fantasy, at least in theory. After all, every war and every act of violence begins as a thought or emotion—a mental activity—in someone's or some group's brains. That, in fact, is how the founders of the UN put it, and they were not wrong there, however wrong they may have been in other matters. As things stand we are not in a position to put a stop to the very emotions that give rise to wars, but that is merely because we do not have sufficiently precise instruments to work with. So we try to stop a Hitler by blanket-bombing Dresden, or the Viet Cong with Agent Orange. Crude, and by no means invariably effective. You may clobber the other guy, but that won't make him *like* you. And if you decide to take that line, the risk is that *he* may clobber *you* instead ... but that won't make *you* like *him* either. For an emotion cannot be killed by the sword; it can only be killed by another—and more positive—emotion, and sometimes not even then. The Buddha put it very cleverly more than 2,500 years ago:

> Never can hatred be put to an end by hatred;
> Only by non-hatred can it be put to an end.

Dhammapada, Chapter 1, verse 5.

That's high tech, if you will. After all, the whole point of technology is to enable you to attain goals you couldn't without it. *With* the appropriate technology you can go to the moon, plumb the depths of the oceans, and light up your cities at night. You can't do that *without* the appropriate technology. And without changing thoughts and emotions and negative mental activity generally, you can't really put an end to violence. In other words, *that's the appropriate technology* if you want to put an end to war.

And remember, moreover, that technology helps us attain our goals with less and less effort. We light fires with less effort using matches than by rubbing sticks together. We milk cows with less effort using milking machines than by hand. We travel across the country with less effort using the airlines than our legs.

The old way of changing the other guy's mental activity was to talk him out of it. Be reasonable, see things from his point of view, and try to get him to see things from yours. The great Japanese Shogun, Tokugawa Iyeyasu, is reputed to have said that the best way of eliminating your enemy was to make him your friend; and that indeed sounds most reasonable. Jesus went even further: he suggested turning the other cheek, not because you couldn't strike back if you wanted to, but because striking back wouldn't make your enemy your friend, whereas turning the other cheek might, just. It did work with the British in India. However, people in general doubt that it would have worked with Hitler or Genghis Khan. It was never tried on them, of course, to any serious extent—probably because people didn't think it was worth the effort.

Well, future technology might give us a more fool-proof way of changing the other guy's mental activity, and one that requires considerably less effort. Mental activity, from the point of view of the physics of it, is all in the firing of the brain's synapses. That's what neurobiology confirms; and that's also what seems logical, because that, in essence, is how computers also work (the only difference being that in computers the signal-switching devices are called transistors and not synapses). The firing of synapses can be detected even with our crude present-day instruments, although we can't yet detect all the firings of all the synapses in *every* living brain. In theory, however, if we could manufacture small enough instruments in large enough quantities—instruments capable of lodging themselves within the brains of all human beings and monitoring the firing of the synapses—we could do even that. And if we could connect up such instruments to powerful enough computers, we could identify which patterns of firing resulted in hatred, or anger, or frustration, or in fact any mental activity whatsoever; and if necessary eliminate it.

Well, if you have read the chapter entitled ***NANOTECHNOLOGY*** which begins on page 7, and especially if after reading it you went to the library and borrowed Drexler's book, you'd know by now that when and if we begin manipulating matter at the level of individual atoms, manufacturing such instruments and such computers would be a piece of cake. And you'd also know that we're not very far from achieving that goal.

After all, molecular engineering, or nanotechnology as Drexler calls it, is simply miniaturisation taken to its physical limit. Our engineers are rapidly attaining the ability to make useful things out of smaller and smaller chunks of matter. Five hundred years ago the smallest man-made artifacts were about the size of Benvenuto Cellini's masterpieces: they contained some quintillions of atoms. Fifty years ago our instruments were much smaller: about the size of the components of a good Swiss watch, containing some trillions to maybe a few quadrillion atoms each. Today the smallest products of our engineering are about the size of the transistors in a microchip, each containing several millions of atoms. That's a billion to a trillion times smaller than the finest WW-II equipment, and a quadrillion times smaller than Galileo's telescopes. If you extrapolate this rate of progress on a graph, the ability to make useful things out of individual atoms, each in precisely the spot the engineers have designed for it, is considerably less than fifty years away. In fact the graph would seem to indicate that if our engineering graduates *can't* achieve this rather modest goal in half a century, they—and their professors—ought to be thoroughly ashamed of themselves.

The possibility of manufacturing gadgets the size of viruses is not so much a question of "if", or even of "when", as of "how soon?" Such instruments could easily be inserted into any living body—they could penetrate mucous linings in the nose, mouth or intestinal tract, or even pass through the skin, and then be carried through the bloodstream to any desired part of the body. Even the so-called "blood-brain barrier"—the membrane which protects the brain from most blood-borne bacteria and other foreign particles, while allowing the blood cells and plasma themselves free access to the grey matter—need not pose an obstacle to these bugs. They could, in the first place, be designed small enough to pass through the membrane—as small, let's say, as the red blood cells. But if for any reason they could not be that small, they could be designed to break up into smaller units, pass through the barrier, and reassemble themselves once they are on the other side. Once there, they could be designed to lodge themselves at any desired location—say at every synapse. They could then monitor every single firing of every single brain cell.

And with such instruments—especially if they were also hooked up to really powerful computers—it would be a simple matter to eliminate violence and war. The results these monitors could bring about would be nowhere near as crude as those of a frontal lobotomy. They need not cause any side effects whatsoever. You would not even have to eliminate the subjects' *capacity* for violence—all that would be required is to eliminate their *desire* for it.

The difficulty—say, forty or fifty years from now—will not be so much in *doing* it, as in *allowing ourselves* to do it. The possibility of manufacturing such nanosnoopers opens up the very real ethical dilemma whether it is justifiable, from the point of view of personal privacy, to impose peace on those who don't want it. I mean, is it *right?* Doesn't it sound too much like wire-tapping people's phones and opening people's mail? Isn't it kind of unconstitutional or something? Does the end justify the means?

The question, in fact, is likely to become, not whether we *can* impose peace on others, but whether we *should.* Some people—probably most people in the West—would likely think it reprehensible. Even my wife Claire, who abhors all violence whether in fact or in fiction, and says that *Mortal Kombat* was the worst movie she ever saw in her life, is nevertheless adamantly opposed to making people peaceful without their prior consent. After all, who are we to dictate to others what their lifestyle should be? Or take away their right to bear arms, to shell sleeping villages just before dawn, to drop napalm on little children and cause them third-degree burns, or to blow up airliners? Many people might legitimately share such concerns.

All the same, I'm sure there will be a fairly large sub-culture which sees nothing wrong in imposing peace on warring peoples, even against their wishes. We could, probably within the lifetimes of many of us, see emerging a world-wide movement aimed at promoting peace at all costs. A "Peace Without Consent" Party could attract a considerable number of adherents, especially among the more radical sections of the populace. The PWC Party would look upon the military of any and every country as fair game. You'd find their agents everywhere, aerosol cans of the stuff in bulging overcoat pockets, ready and willing to squirt it up any uniformed person's nostrils. Their letterhead would carry their motto: *Up Yours.* And they'd mean it: fact if you opened one of their envelopes it'd probably be programmed to puff peace-powder up your nose before you could as much as read a word. They might even market suppositories contaminated with the stuff. Non-violence—like it or not.

You see the dilemma. On the one hand you don't want war. But on the other you don't want these non-violence fanatics either. And with these peace pests there doesn't seem to be much room for a middle ground. You'd either have peace, or you'd have war, but not something in between, like you have today.

The dilemma, however, is not necessarily one which might arise only in the future. In a sense you could say it arose long ago. What, for instance, do you say about the moral and ethical justification of *praying* for peace? Especially if you believe that your prayers will actually be granted. Do you have any right, sitting there in the quiet of your living room, or in the pew of your church, to pray for peace in other parts of the world, and thereby to impose it on people who may not even share your religious beliefs? Of course if your own religious convictions are wishy-washy—if you believe only half-heartedly in the efficacy of prayer, or in the capacity of the Higher Power to Whom you pray to bring about peace in the world—in that case there is nothing more to be said. When you harbour such serious doubts about the Deity's omnipotence, praying for peace might be considered about as effective, from the point of view of actual results, as wishing someone Happy New Year, or saying Good Luck when they buy a lottery ticket. You don't really expect them to be any happier this year than last, or to win the jackpot. But if you truly are convinced that prayers are granted, then isn't praying for peace in the former Yugoslavia in more or less the same ethical category as spraying peace deodorant over Bosnia? Is it any more *moral?* Does the end justify the prayers?

Some readers may object to this analogy, saying that you can't discuss religion and technology in the same breath, as if they were both the same kind of subject. The context of each is different: the one deals with morality and spirituality, and the other with capacity and ability. I don't think, however, that I can subscribe to this view. Religion and spirituality, if you really take them seriously, cannot be divorced from the rest of life—and the "rest of life" certainly includes technology. In fact technology is perhaps the most important part of the rest of life, for it affects every single aspect of it. You might even say that technology, particularly when taken to its imaginative limits, aims at the same results religion hopes to bring about. Right from the ability to light a fire and to communicate thoughts by means of language—technological breakthroughs immortalised in the oldest religious literature we possess, the Vedic Hymns of Hinduism—all the way through helping the dumb to speak, the blind to see and the lame to leap like an hart, and ultimately to resurrection and immortality and life eternal, technology attempts to fulfil the very prophesies of the scriptures.

Come to that, in the Buddhist religion, technology—or what it more poetically calls “skill in means”—has been elevated to the rank of righteousness itself. Buddhism, in at least some of its various forms, does not subscribe so much to the idea of “sin” as opposed to “righteousness”, but rather to the idea of varying degrees of skill. The Buddhist does not believe that a person does wrong because he or she is *sinful,* but rather because he or she is trying to achieve a particular goal in a rather *unskilled manner.* In the Buddhist view a person who has to resort to stealing or robbing, for instance, comes by his wealth less skilfully—and also, in all probability, less successfully—than one who earns it by carrying on a legitimate business: and the proof is that even Al Capone in all his glory was never as rich as Bill Gates. To give another example: a person who has to shoot dead a mad elephant rushing to trample him would be considered much less skilful than the Buddha, who when confronted with such a situation simply raised the palm of his right hand—a quiet gesture which calmed the beast immediately. And all this is irrespective of how skilfully one steals or kills: the very fact of having done so is proof enough of a certain lack of overall life-skills, for one’s enjoyment of the fruits of one’s labours is bound to be marred, at least to some degree, by unpleasant feelings such as guilt or remorse.

This thinking pervades much of Far Eastern life and literature. For instance, in the martial arts of China and Japan—many of the principles of which are based on Buddhist philosophy—the highest honours go to the master who can defeat his adversary with the least effort. Sun Tzu, the greatest military theorist of China, wrote that the highest skill in war is to defeat the enemy *without* fighting.

As we pointed out earlier, technology is simply more and more skilful means of achieving our goals. Therefore in Buddhist terms, the higher the technology, the more righteous it is. For instance, a nuclear bomb is much more “low tech”, and thus much less righteous, than a nuclear power station. In fact a power station based on nuclear fusion (as opposed to fission) is so high tech, the best brains in the world haven’t yet been able to get one to work; while fusion bombs are in comparison so much easier to make—in other words so much more low tech—that they’re stockpiled by the tens of thousands.

It is perhaps a telling comment on this Buddhist way of thinking that during the last forty years, in all the wars that have been fought worldwide, at least one of the parties has been a low tech society. Once the people of a nation see that they can achieve their goals in ways less crude than war—as the Japanese and the Germans have, apparently, since their defeat in World War II—they not only seem to get more peaceful, they even do better than their erstwhile conquerors. Why fight a war for *lebensraum,* and to that end burden yourself with a crippling military expenditure, when you can amass all the wealth you could possibly spend by simply letting the Yen and the Deutsche Mark rise in value against the dollar?

Perhaps no one will ever be able to resolve the ethical dilemma of whether it’s right to impose peace on a Hitler or a Saddam Hussein against their will, whether through the medium of prayers or sprayers. To those who are against it, and like Claire are of the opinion that the peace bug is itself a form of violence, I need only point out the far more violent alternative: untold misery, loved ones maimed and killed, millions of Jews and Gypsies put to death—and very possibly, with nuclear weapons, the end of all life on earth. To those who are for it, I need only ask whether they prefer living under Big Brother's benevolent malevolence. And to those who are neither for nor against, I need only point out the indecision of Hamlet. Whichever way you squirm the answer's bound to be wrong.

However, with respect to the broader issue of whether technology as a whole is ethically and morally neutral, there seems to be room for a certain amount of guarded optimism. If technology makes us more and more skilful at achieving our goals, and helps us attain them with less and less effort, then ultimately we ought to be able to get what we want without violence and war, because violence and war require more effort and a lower degree of skill. As Isaac Asimov has very correctly put it, violence is the last refuge of the incompetent. And the more competent we get at manipulating our environment, the less we have to bludgeon it into submission, or resort to violence and war. The easier it gets to produce goods, for instance, the more willingly might we create desirable things and situations for us to enjoy, rather than deriving a puerile kind of satisfaction out of destroying other people's goods and their capacity for enjoying them.

This conclusion is supported by the results of the Allies' treatment of the vanquished after the two World Wars. The Treaty of Versailles was a great burden on the Germans, and hurt their feelings pretty badly; and these hurt feelings were probably the main reason they voted Hitler to power. The Marshall Plan was, in marked contrast, a great relief to them, and neither they nor the Japanese have gone back to their earlier militarism. Surely a lesson is to be learned from this contrast. Make it easier for the other guy, and maybe he won't think in terms of clobbering you any more.

And it's technology—using the term in its broadest sense—which can really make it easier for the other guy. Technology, or competence in manipulating our environment, can free us from all kinds of frustrations: those of hunger and poverty, illness and disability, unfulfillable temptations and wealth disparity. Isn't it just these the Germans experienced after the First World War, and isn't it just these even Lenin and Trotsky wanted to eliminate by turning the world Red? When the Japanese became technologically competent enough to trade in industrial goods with other developed countries, didn't even the racist South African government of the time grant them the status of "honorary whites"?

And look at it this way. If technology makes it possible to attain more and more of our goals with less and less effort, it ultimately ought to make it possible to attain *all* our goals with *no effort at all.* Isn't this the ultimate aim of every religion, and every system of ethics including Marxism? The Kingdom of Heaven, Nirvana, the Great Liberation, the Workers' Paradise? Doesn't it jive perfectly with the profound view of the great Sage of China, Lao Tzu, who wrote: "The Tao does nothing, yet nothing remains undone; the man of Tao does nothing, yet accomplishes everything"? And is this not, in the final analysis, a moral victory *ne plus ultra?*

CHAPTER 9

CRIME AND PUNISHMENT

I think it's pretty much a given that serious people no longer believe punishment puts an end to crime. It hasn't done so in centuries.

In fact evidence is mounting that punishment actually does the opposite. It certainly hardens criminals, and many convicts after their release from prison return to a life of crime. Come to think of it, wouldn't you? Would you really harbour warm feelings towards a society which has deprived you of some of the best years of your life, no matter how justified it felt in doing so? Would you really enjoy accommodating yourself to its rules? Would you really feel you *belonged?*

To some extent even our penal systems are recognising this problem, and in many cases prescribing milder alternatives to traditional prison terms. Some "white-collar" criminals are nowadays sentenced to minimum security prisons, where they give their word of honour that they will not walk out the gate, even though it's never locked. Others are confined to house arrest with near-constant electronic surveillance; yet others are sentenced to so many days of community service. All these alternatives, besides being more humane than penitentiaries, are also a lot cheaper, and so governments see in them a great boon—not so much to the criminals as to their coffers. In each case, of course, if the convicts break the good faith required of them, they are transferred to a traditional jail. The threat of life getting a lot worse keeps them in line, at least in most cases.

Nevertheless the principle itself, namely punishment as retribution for crime, is not abandoned; all that is changed is the nature of the punishment.

It is, of course, society's frustration with crime which prompts it to punish the criminal. If we didn't get so frustrated—if we could deal with crime in a more elegant fashion—we probably could close down, not only all our penitentiaries, but all our criminal courts as well.

Isn't there a more elegant fashion of dealing with crime, even of preventing it altogether? This would appear to be a more positive approach to the problem, and probably a lot cheaper than even house arrest. Let us examine the implications of such a line of thinking.

The first question we have to ask ourselves is what makes some societies more crime-free than others. Take for instance Japan: I hear that stealing is almost unknown there, and no one locks their doors when leaving the home. Or take Switzerland: in spite of the fact that every Swiss male between the ages of eighteen and fifty-five keeps his army-issue assault rifle at his residence at all times, there has hardly been a single case of this powerful weapon having been used to commit a violent crime.

What prevents the Japanese from stealing their neighbours' VCRs, or the Swiss from murdering each other? What makes Chicago a violent city and Ottawa, which is not too distant from it, a comparatively non-violent one? What keeps the Israeli kibbutzim almost completely crime-free, despite their total lack of police, lawyers, judges or prisons? What makes the Inuit of the Far North refrain from rape? What makes the average Gurkha so gosh-awful honest?

Many of us, when we read about such wonderful far-away things, wish we were living there rather than here. But this envy is somewhat misplaced. The fact is that the vast majority of us *already* live in a largely crime-free environment. We're just not conscious of it, as a rule. But let me ask you: how many of the dozens, maybe hundreds of people you come into contact with, year in and year out, are crooks? Unless you're a lawyer or a judge, you probably don't know a single criminal personally. Most people are *not* criminals; if they were, there would be no way to bring them to justice—the bad guys would simply lock up the good guys.

The conclusion seems obvious: all we have to do, to render every society as crime-free as those others, is to eliminate the *causes* of crime. And that, logically speaking, ought to be fairly easy to do, since in any case criminals constitute only a minority of the population.

The hard step, however, is the one which comes *before* that: to determine just what these causes are. Even while living in a largely crime-free society, many of us are only foggily aware of what makes our society so very crime-free in the first place.

We do have some indications, however. Bruno Bettelheim, a survivor of Nazi concentration camps, developed from his experiences there a quite valid-sounding theory about what makes or breaks a person. His idea, in a nutshell, was that one's total environment exerts a powerful impact on one's psyche; and if the environment in which one lives is a negative one—say, ugly, or restrictive, or degrading, or lonely, or intimidating—one develops negative patterns of behaviour, which basically are merely attempts at coping with an impossible situation. His subsequent work in Chicago was carried out mainly with children, and not with criminals, but that makes it all the more valid, because all criminals were children at one time: indeed those were their most formative years.

Bettelheim's cure for the disturbed children under his care was to vastly improve their environment. Great importance was laid, for example, on making their living quarters as attractive and pleasant as possible. Walls were freshly painted, pictures hung, attractive furniture provided, and so on. The *total* environment was addressed. Music, cleanliness, good food, green plants, nice clothes, friendly staff, play time, all were emphasised. It worked splendidly, and today he is renowned as a great pioneer in the field.

This idea could, in all likelihood, be adapted to large societies. I am not aware that of the disturbed children Bettelheim worked with, many—or indeed any—turned to a life of crime when grown up: even though Chicago, as we pointed out earlier, is a fairly violent city, compared to most others. It probably explains why Switzerland and the Israeli kibbutzim—both very attractive environments—are comparatively crime-free. It does not explain everything, of course, but then nothing does.

However, there *is* a tool soon to become available to us which, while not quite explaining everything either, is likely to come a lot closer to it than anything we have possessed till now. I call this tool *total hypermedia,* and it deserves very close scrutiny, for it may help us put an end to crime, and to many other problems as well.

This tool is not, like a screwdriver, something you can touch. On the contrary, it is, like language, mathematics, science, art, law, politics and economics, something more mental in nature. I like to call such tools “the software of society”, borrowing my terminology from standard computerese.

Let me explain. A computer by itself is pretty much useless without programs—software—to run it. It may be sold with built-in programs, as pocket calculators are, but whether you buy the programs separately or they come as part of the machine, the software is *absolutely necessary* to make the hardware work.

However, most people don’t realise that this applies to our other technological marvels as well. For instance, the majority of aircraft would pretty much have to remain grounded without pilot instruction; automobiles would be bumping into each other all over the place without the rules of the road; and university classrooms and labs would be rather useless without the knowledge of those who teach in them. I refer to these intangible and evanescent things, such as pilot instruction and rules of the road, as “the software of society”. They are as much tools of technology as *Quicken* or *AutoCAD.* Without them our much-vaunted technological hardware would be just so much junk.

Perhaps the most important software society possesses, and without which it would be virtually impossible to have any society at all, is language. Next in importance is probably logic (and its offshoot, mathematics); without these there wouldn’t be any science or technology, at least not as we understand them.

Other important social software include our economic system, which among other things makes it possible for each of us to concentrate on doing what we do best, and withal produce a wide variety of goods and services; and our political system, which among other things keeps in line the guys who run our economic system. (We don’t yet know for sure who in turn keeps the politicians in line; conventional wisdom says it’s the people, but there is a growing body of theory, fuelled mostly by TV shows, which claims that in reality it’s the media).

Total hypermedia is like these things, only better. Its main function is to increase society’s collective intelligence quotient.

It does this by providing instantaneous access to any information in existence, providing someone, somewhere, has it, and has recorded it either on paper or in electronic form. The basic way it works is quite simple. As a first step, all the recorded information that exists today, whether in the form of text, diagrams, charts, pictures, musical notation, movies, videotapes, or any other—and there is a vast amount of such information, enough to keep any serious student busy for a million years and more, even if she could understand everything—all this material is first fed into a humungous computer, or more accurately a humungous computer *system.* (The Internet is of course the prime candidate, though in theory it could be done via any other world-wide computer system just as well). This inputting can be done fairly easily nowadays. For text and pictures, one could use scanners, which can convert every kind of paper information into bits and bytes. Robots could be devised whose only job would be scanning every available book, magazine, newspaper, report, application form, restaurant menu and theatre program into the ’net. And since more and more people are using word processors and graphics programs to produce their stuff, there’d be less and less need, as time goes on, to scan the printed page; you could feed the material into the system directly. With other kinds of equipment, you can even feed in recorded music, videos and films.

Then a software program is used to cross-link every piece of information with every other. This is also easily done, and indeed *is* done with many modern software programs such as *WordPerfect 6.1*. Theodor Nelson, the originator of the idea of hypertext (the first form of hypermedia), has founded a project, going by the exotic name of *Xanadu*, which been working on such a software program for years. In essence this is done by tagging each piece of information with an identifying number. This idea is somewhat like the Dewey Decimal System used in libraries, except that the computer would do it more automatically and rapidly than librarians. It would also link up many more pieces of information, even the most apparently trivial. You never know what might become vitally important later on.

And after these herculean tasks are completed, *all the knowledge in the entire world* could be made available to everyone everywhere, via the phone lines and the Internet: that is to say, the recorded knowledge through total hypermedia on the 'net, and the oral or unrecorded knowledge over the regular phone lines.

With such a system, provided you had access to a phone line, a personal computer and an Internet link, you could instantly call up any information you require. Well, almost instantly. The program might take a few seconds to search out precisely what you want, or you might have to wait a few minutes for someone to come to the phone, but the wait would be nothing like what you now have to endure when searching for a piece of info in the library. And the cross-referencing would make it easy for you to call up every scrap of related material, thus enabling you to catch anything you might have missed otherwise.

It has even been suggested that the system be programmed to automatically pay a small royalty to the author every time his or her work was called up by a reader, except perhaps when browsing—this would encourage everyone to use the system, not only to read other people's ideas, but to put forth their own; and would also reward good, readable authorship. If the royalty were small enough—say, one hundredth of a cent per reading—people would probably not mind. Even so, with a large enough readership the authors would make millions, since there'd be hundreds of millions of readers out there.

The power of such a system can hardly be overemphasised. Buckminster Fuller once predicted that anyone in the future would be able to exhibit an IQ of 300. And he wasn't wrong there, although he did not know, of course, that this super-genius level would not be genetic, but acquired by utilising total hypermedia. And society's *collective* IQ level would go up way beyond even that, because the rapid flow of information between people would stimulate vast leaps of the imagination. We all know how stimulated our imagination gets at a brainstorming session. The same thing also happens when we visit a good science and technology museum, or a trade show featuring the latest in this or that. Total hypermedia could put us in that frame of mind permanently.

The advantages of a world-wide total hypermedia system are too great to fully enumerate or even foresee at this stage in its development. One may be sure that more and more work will be done on it as time passes. Like almost all our technological advances, the inventors of the system are probably only dimly aware of its full potential. Did the inventor of the wheel even remotely imagine the power of his brainchild to transform the world? Did the inventors of the transistor or the laser foresee all the myriad uses to which these inventions have been put in the last few years—

digital watches, CD players, laser printers, Walkmen? Total hypermedia is, in some respects, more powerful than even the wheel.

The system would, in fact, be as indispensable to future thinkers as airline schedules are to today's travellers. Just imagine a world in which there was no way of finding out which plane took off when, nor where it was headed, short of going to the airport and asking the crew. The world of today is about as far behind total hypermedia, as such a world would be behind what we have in air travel.

Total hypermedia could come close, in fact, to transforming all of humanity into one gigantic unified and integrated electronic-speed thinking entity. With its help, humanity as a whole might be able to out-think the individual human being to about the same extent the ten-billion-celled human brain out-thinks a single-celled organism like a bacterium. It might even be able to do more, for according to the latest ideas on the subject, intelligence could well be a function, not of the number of nerve cells, but of the number of their mutual *connections*. And although the human brain has only a few hundred trillion connections or synapses, a global hypermedia membership of as low as four hundred million active, thinking and participating people—less than one-tenth of the human race—could have almost eighty *quadrillion* connections: several hundred times greater than any human brain.

And who knows what such a gigantic intellectual leap would bring in its wake? As Karl Marx pointed out, quantitative changes, if carried far enough, bring about qualitative changes previously undreamed of. Perhaps with the advent of total hypermedia, the collective intelligence of humanity will rise so much that we'll be able to solve not just the problems we have at present, but any problem that could possibly arise in the future. Especially if the hypermedia revolution is accompanied, as seems very likely, by supercomputers using neural pathways. Such computers, while mimicking the human brain in terms of network, would as we discussed earlier (page *20 ff*) be capable of functioning millions of times faster.

At any rate, it will surely be admitted that the more we advance in the direction of sophisticated technological hardware, the greater will be the necessity to increase our intelligence. We're surely going to need every ounce of intelligence we can muster, even if only to deal with the dangers our hardware already poses, not merely to us but to all life on the planet. And it will surely also be admitted that we have not progressed along this path nearly as much as we ought to have. Total hypermedia seems to be the most promising candidate for filling this lacuna, at least for the near future.

And its help in determining the causes of crime could be inestimable. You could instantly call up any reference, say, to Bettelheim's work in connection with crime; you could research the total environment of Kibbutz Kol Ha-Kavod and instantly compare it with that of Chicago; and you could make innumerable projections with almost every variable you could think up, including the sexual preferences of Inuit males. You could also link yourself up with others doing the same work elsewhere in the world, and compare notes. And all this could be done in a matter of a few minutes, or a few hours at the outside. (You're likely, however, to find it so much fun that your parents might have to drag you screaming and kicking from the screen to eat your supper.)

And when you and your colleagues come to the limits of available knowledge, you could devise ingenious and rapid experiments to find out more. Many of these experiments might, in fact, be possible to carry out in a few seconds at the computer terminal itself, by processes analogous to the simulations NASA employs to find the best configurations for spacecraft.

In the end, of course, you'd probably find innumerable causes for crime. You might even find a number of ways to eliminate them. And even if you didn't, all your work would have been stored in the system for use by some other smart alec somewhere else in the world, who could have a whack at it tomorrow. Surely within a month's time, or at most a year's time, someone would have an answer figured out. It would take more than a year, of course—or even a generation—to actually *implement* the answer, but seven generations is a long time.

Not to mention that with the help of total hypermedia every member of society would find it immeasurably easier to fulfil his or her wishes without resorting to crime in the first place. Whatever else you may say about criminals, you can't deny that they exhibit a fine entrepreneurial spirit. And with so much information literally at their fingertips, even criminals would be able to make intelligent and wise decisions about the direction in which they canalise this highly profitable drive. For instance, instead of going into the somewhat risky profession of fencing stolen goods, a person might decide, on reviewing the situation, to establish himself in the comparatively lower-diastolic business of retailing ready-to-wear jewellery, and market it over the 'net itself. And with total hypermedia, all the information needed to become quite wealthy in such an activity—or in any other, for that matter—would be readily and rapidly available.

Just imagine how much more pleasant than our own, a world without crime would be. Just imagine how much we spend today on prisons and judges, district attorneys and defence lawyers. Just imagine how much we'd save on insurance premiums. And then tell me, even if setting up a total hypermedia system costs a couple of trillion dollars, that it's not, even at that price, dirt cheap.

CHAPTER 10

SOFTWARE

Most people will not believe me, but it is very easy—indeed in many cases childishly easy—to make important technological inventions.

Take for instance one of the first and most important inventions of all history, the wheel. You can't tell me this wasn't really child's play. As a matter of fact, although some cultures, such as those of pre-columbian South and Central America, did not use the wheel in the manner we do, they nevertheless possessed kids' toys which rolled on wheels threaded upon axles. Such toys have been discovered at archaeological digs, a fact which suggests that in our own cultures it was the adults who pinched the idea from nursery schools.

Or take flying machines. It is childishly easy to make a paper plane, especially the streamlined delta-winged dart type, which as a matter of fact looks a bit like an arrow, and flies like one too. And paper has been in existence for centuries. Maybe it was the Chinese, the inventors of paper, who made the first paper plane as well. Or perhaps Egyptian children used to amuse themselves by flying papyrus planes from the summits of the pyramids. As for helicopters, drawings from the Renaissance period have been found depicting a plaything made up of three propeller blades held together by a ring, the kind you can buy in any toy shop today. At any rate the invention of flying machines must have been so easy, the inventors (there must have been several, independent of each other) have not even bothered to keep records of their inventions. Which probably explains why we instead credit the glider to Lilienthal, aeroplanes to the Wright brothers, and the helicopter to Sikorsky.

Of course it's a bit of a jump from the wheel on a toy to a wheel on a Toyota, or from a paper plane to a Space Shuttle. But the jump does not have to be taken in one big bound. In reality every such great leap is made up of a large number of small steps, each of which is quite easy to take. An invention of a thousand moving parts, to paraphrase the wise Chinese saying, begins with but a single such step; and each step is actually very simple and elementary. Rockets, for instance, were invented by the Chinese; the Germans made them larger and a bit more sophisticated; and the Americans and the Russians sent them into space. And in doing all this, each improvement in the basic design was small and incrementary. After all the average engineer, even in Japan, is no genius.

Anyway the reason I am mentioning this is that I wish to dispel the idea which exists in the minds of many people, that technology consists mostly of *things.* The wheel, the plane, and even the Space Shuttle are fine examples of human achievement, no doubt, but they are basically very simple, and in any case they are by no means even close to the pinnacles of technological accomplishment. There is no *thing* created by man which can rival, in complexity or technological attainment, the *systems* developed over the millennia by humanity in its attempts to better itself.

Take for instance our economic system, just one of many we normally take for granted. It is so incredibly complex that there is not a single economist, alive or dead, who even half understands it; and most of them—at least the honest ones—will cheerfully so admit. No one, for instance, has the foggiest notion why Black Monday occurred back in October of ’87, nor for that matter why a world-wide recession did not immediately follow suit. Nor does anyone know how to wipe out the national debt, short of selling their country’s embassy in Tokyo, which given real estate prices there might just about do it. Everyone knows the best way to bring forth three fresh and brand new theories of economics is to get two economists arguing with one another, and the best—and often the only—way to settle the argument is to change the subject.

And yet the economic system is not something that exists in nature, but was created by us, and by our ancestors. It was created, in fact, by ordinary people, housewives and tradesmen, buyers and sellers. It is one of humanity’s great achievements, even though it cannot be said to have been “invented” by any one person. It is something totally artificial, and yet it is not a “thing”.

Nevertheless it has enormous power. It is so powerful that without it we probably would not have bothered to devise 99 per cent of our technological inventions. Would the Space Shuttle ever have been made, do you imagine, if the scientists and engineers who worked on it had not been paid for their efforts, and the sub-contractors had not been reimbursed for their participation? Or for that matter if Congress had not decided to allocate the necessary billions for it? Would Northrop, Boeing, IBM and Mitsubishi make fighter planes, airliners, computers and television sets if they couldn’t sell them? Would *you* work for your boss if he didn’t pay you your salary?

The economic system is in fact so powerful that very often dictators as well as democracies have to bow to its demands. Even the Ayatullah Khomeini had to make overtures to the western powers he despised and hated, because the long war with Iraq had drained Iran’s treasury. Napoleon called England “a nation of shopkeepers”, and how right he was; England did better at trade than did France, and that is one reason there has always been an England. The Swiss held off Hitler, at least partly because they held on to their numbered bank accounts. Israel has more taxpayers in the United States than at home; she well knows what makes her strong. The Hong Kong Chinese have a saying: “No money, no life”—which may be taken, in a sense, as their national motto. The Japanese, having learned so much from other nations—Buddhism from India, writing from China and electronics from the United States—have also learned that the dollar talks, and have made the yen talk just as loud.

And powerful as the economic system is, it is only one of several such. There’s the legal system, for instance, which in some ways is even more powerful: in some countries it can chop off people’s heads. There’s the media, which can bring about the downfall of the high and mighty, like the Shah of Iran and President Nixon. There’s the educational system, without which there wouldn’t be large enough numbers of engineers and scientists to make any technological impact on society. There are our various political systems, without at least some of which we would be little more than slaves of whoever happens to wield power. There’s the air traffic control system, without which flying would not be safe. There’s the highway code, without which road traffic would not be safe. There’s the criminal code, without which—at least according to some people—*nothing* would be safe.

The majority of these systems are, in fact, far more powerful than any *thing*. In spite of their intangible and evanescent nature, they exert a greater effect on our lives than even the wheel. The wheel, really, is not all that useful a device without a flat and relatively smooth surface on which it can roll. People restricted to wheelchairs are only too annoyedly aware that without curb-cuts and ramps, many places even in our most modern cities—what to speak of the countryside—are quite inaccessible to them. This sort of limitation on the wheel's usefulness probably explains why it does not occur naturally among living organisms. Natural selection must have seen little survival value in the wheel, since the earth does not also provide roads on which it can roll. Such reasoning may also explain why some otherwise sophisticated civilisations, particularly those in mountainous or heavily forested areas, did not find much use for it. In all likelihood the only places the wheel could have been used in these cultures was indoors, which could be the reason it appeared only on toys. This in spite of the fact that some of these civilisations—like the Incas and the Mayas—were highly advanced for their time, in most other ways. Even the mediaeval Japanese did not use the wheel very much, because roads were hard to construct in their mountainous and earthquake-ridden land. The Shoguns themselves used to ride in palanquins or on horses, or else walk. In marked contrast to the wheel, with all its limitations, the systems of which we spoke above are far more powerful and all-pervasive. It is difficult to imagine what the world might been like without them. Perhaps we'd still be wearing fig leaves.

We briefly mentioned these systems in the previous chapter, where I called them "the software of society". This, as I explained on page 47, is an analogy with computers. Just as computers cannot function without software, society cannot function without such systems. We also talked in the previous chapter about total hypermedia, a system which may arise in the future and make society a lot more social, by putting many more minds in touch with each other than is possible at present. As we mentioned, a total hypermedia system may be one of the most significant improvements in society's software in the coming decades.

Total hypermedia is not, however, the only possible improvement in the software of society. In fact, if humanity puts its mind to it, it may decide that the greatest technological improvements it can make from here on are precisely in these fields. By now we have made quite a lot of improvement in our technological hardware, not least because it is much easier—as we showed above, sometimes childishly easier—than making improvements of equal magnitude in our technological software. In marked contrast to economics, which no one understands, it is quite possible to understand even as complex a work of engineering as the Space Shuttle, completely and in every detail. The design of the Shuttle having been finalised, in fact, it may even be possible to manufacture Shuttles by the dozen in a factory "manned" entirely by robots. This may never actually happen, because we may have neither the money nor the inclination to do it, but it just goes to show how much simpler the Space Shuttle is in comparison to economics, or in fact in comparison to the majority of our society's software.

But we may be reaching a stage in our competence at which we can make meaningful improvements in our existing social software, and even invent new kinds. As a matter of fact we are already doing so, albeit in a very limited way. Credit cards and computerised banking, for instance, enhance the power of the economic system, and stretch our dollar considerably more than in the past. Even though inflation has reduced the value of our money, we still get more bang for our buck than did our forefathers. In the old days people couldn't afford the American Way of Debt, which enables us to live well beyond our means. If you don't believe me, just try living like an American in a third world country. In India, for instance, most buyers have to pay cash for their cars. I wonder how many Americans could afford cars if they had to pay cash for theirs.

But improvements such as these are really only scratching the surface. The difference, say, between the Wright brothers' *Flyer* and a Space Shuttle is a good deal greater than between the economic system current at the time of Queen Victoria, and ours. We may have improved our software to some extent, but by no means as much as we have improved our hardware. The improvement in hardware, in fact, is at a runaway stage. For instance, we already know how to make cars capable of more than two hundred miles per hour, but where except in Germany are such speeds legal? In most of North America even half that speed can cost you your driver's license. Our highway code is just not up to handling modern automotive technology.

The crying need, at least at this stage in our technological development, is to improve our society's software so that we can really use, rather than misuse, our hardware. We have reached a point in hardware advance which makes it near-impossible to control its side effects. Witness the depletion of the rain forests, the greenhouse effect, PCBs and nuclear waste. Software has not kept up with the hardware, so we have hardware too hot to handle.

Our only salvation seems to lie in creating software commensurate with our hardware. If, for instance, we had adequate political and legal systems, we could make it possible for any concerned citizen—say, you or me—to simply e-mail or phone someone, and rapidly and effectively bring a stop to activities which cause problems like those mentioned above. As things stand, the insolence of office and the law's delay both work on the side of chaos. Something is obviously rotten in the State of Denmark, and not just there. And the only way to improve such a state of affairs is to improve our affairs of State, and all the rest of society's software.

There is, however, no easy-to-follow recipe for doing so. Not only is the software incredibly complex to begin with, it also seems to have been created in a haphazard manner, and to a large extent without the conscious will of those who created it. For instance the economic system, as we already mentioned, was created by lots and lots of quite ordinary people; and none of them imagined at the time, I'm sure, that they were embarking upon one of the most stupendous creative tasks of human history. In fact the systems created by humanity have, over the millennia, acquired a sort of life of their own, independent of humanity's wishes in the matter. Air traffic, for example, is controlled in pretty much the same way in all countries, regardless of political affiliation. And nobody can control such things as technical education, even though Stalin tried (and failed). This is because of most of our systems have their own internal logic. They *have* to develop in a certain way, or they don't develop at all.

There is, however, one way to improve our social software which may work, and which up till now has not been tried. This is based on the same principles we employ to improve our hardware. I thought this one up myself, so maybe I should take a bit of time to explain it.

When confronted by a technical problem of some magnitude, we do not hand it all to one person to solve. Take (again!) the Space Shuttle. No single person, however highly talented, could possibly have designed the whole thing himself. The task was too hard for one person, so it had to be broken down into manageable segments, and each segment given to a different person to tackle. In the case of the Shuttle, in fact, it was a team effort requiring the brains of thousands of engineers and technicians, all co-ordinated by innumerable management experts, and financed by the government to the tune of billions. The size of such an effort is impressive, but the Shuttle is not alone in this team approach to solving technical problems. Even in the case of such small things as food processors or electric razors, most firms rely on teamwork. Those that don't, don't often succeed, because team work works better. The Japanese excel in it; indeed many experts believe that they do so well in manufacturing precisely because of this trait, which is more pronounced in their culture than most elsewhere.

However, up till now we have not used this approach to solving problems of what I have called society's software. No nation, for instance, has put together a team as large as NASA and given it a budget of billions, and then told it to go ahead and unravel the world's economic woes. Most economists—even the Nobel Prize winning ones—work alone, or at best with a handful of graduate students. No wonder they haven't come up with an answer. It would have been as practical to ask a professor of engineering at UCLA to design the Shuttle, complete in every detail. The "Mad Professor" scenario of old-time movies no longer works for hardware, if ever it did; and it sounds equally ludicrous to expect it to work for software.

But we know that team effort *does* work for hardware, and indeed most capitalists routinely bet their shares on it. Therefore there seems to be no *a priori* reason to believe that it won't work for software too. The only problem seems to be that it is an as-yet-untried theory. I once thought of trying it out myself, by bringing together as many of my intelligent friends and acquaintances as I could, and asking each to contribute his or her share of human brain. I asked them to give me their views on whatever social problem they had thought most about, and their recommendations for an answer. Of course this was a totally *ad hoc* way to go about it, and it also did not work out too well because we did not have financial backing. Most of us live in different parts of the world, and long distance calls are expensive. Moreover most of us did not have a computer at that time, so the Internet was also out of the question. The experiment is now pretty much dormant, although I'd love to continue it sometime in the future, and probably will, given the increasing capacities of the Web.

But from humanity's point of view it should not be necessary to do this sort of work on an *ad hoc* basis. It ought to be taken up by governments, or at least by some large organisations—like maybe the Ford and the Rockefeller Foundations—which aim at promoting the welfare of the world. The United Nations should also take up such work. After all, even if they spent ten times as much on improving the world's economic system as they have spent on the Space Shuttle, it would be cheap at the price. A mere one per cent improvement in the world's economic system would be enough to repay such expenditure a hundred times over. An improvement of fifty per cent would transform the world. And an improvement of five hundred per cent—not altogether to be ruled out, considering that improvements of such magnitude have often been made, with the right team effort, in our hardware—would make all of us rich beyond our wildest dreams.

And if in addition they also found a way to reduce wealth disparity, it might go a long way to reducing tensions between nations, and maybe bring about a new era of peace, or at least of disarmament. After all, much of communism's grouse against capitalism, and vice versa, used to be that the other system leaves a lot of people poor and needy. Take away that excuse and there'd have been little else for the two to fight over. They could, of course, have thought up something new to quarrel about, but how long could this sort of thing have gone on, with most people busy taking out their new and improved cars for a spin on the new and improved highways in the daytime, and watching new and improved mindless shows on new and improved high-definition TVs at night? As Lao Tzu says, a tempest does not last all morning, nor a thunderstorm the whole day. And if heaven and earth themselves cannot make such violent things last long, how much less the puny efforts of mere men!

Anyway that's my idea. I am aware that there are a lot of questions that remain to be answered, and that it may well be that the very nature of software makes it harder to do this sort of thing with it than with hardware. But we won't know for certain until we try, will we? Perhaps in the course of trying it, we might discover ways around the difficulties. You know, where there's a will, etc., etc. At any rate the need to work on our software certainly does exist. Necessity being the mother of invention, someone may well consider my plan and give it a go. That's the reason I am writing about it. Perhaps someone with a billion or two to spare will donate it to this worthy cause. A guy like the Sultan of Brunei would hardly miss that kind of pocket money—he'd probably make it up in less than a week, in interest alone.

The future, in any case, looks bright. With the advent of total hypermedia, as Eric Drexler also mentions in his book *Engines of Creation,* it will be a lot easier to work on our society's software, and we may be able to make a lot of improvement even without specific teams being set up to handle this or that social problem. The internal logic of a total hypermedia system itself will cause such teams to come into being, spontaneously. And with the advent of hypercomputers functioning on neural network principles—like those mentioned in Chapter 5—the work is bound to be easier still. Nevertheless, work on the software of our society may still be necessary even then. There is probably a law of computing which says that the better the hardware, the better the software ought to be, simply in order to take advantage of the hardware. No sense in using a Pentium machine to run only DOS programs, now is there? (Actually, there's little sense in running a Pentium machine to run Windows either, since that, too, can be done on a Macintosh—but that's another matter altogether). We also know that the more talented the child, the better—and often the more expensive—his education has to be. The same thing probably applies to the hardware/software combination. So it is very likely that even at the most advanced stages of technological advance a little financial backing will not be amiss.

And at all events we need improvements in our software *now.* We just can't wait to set the world right till we have our total hypermedia system in place or until we can get neurocomputers working for us, because if we wait that long we might have nothing left to set right. North America, for instance, is fast drowning in a sea of garbage. In fact one of my close friends in Toronto bought himself a half-million-dollar home and a Lincoln Continental, all within a couple of years, and all with money earned simply by buying up garbage, sifting through it, and then selling the valuable stuff found in it to all kinds of interested buyers. He keeps advising people that "the future lies in garbage". If that truly is where the future lies, don't you think we had better do something about it right now?

CHAPTER 11

CAN WE MAKE THE WORLD A BETTER PLACE TO LIVE IN?

Let's suppose you died and went to heaven. What do you imagine it'd be like?

Every religion has its own idea of what heaven is like. In Christianity we have the New Jerusalem, the wall of it being of jasper, and the city of pure gold, like unto glass, with its foundations garnished with all manner of precious stones, and its twelve gates each made of a pearl. In Islam we have gardens beneath which waters flow, in which beautiful maidens and handsome youths feast on delicious fruits and meat, and drink wine which does not cause headache. In Buddhism we have the Western Paradise of the Buddha Amitabha, He of the Boundless Light. In Zoroastrianism we have the "Domain of Song", where the blessed sing the Lord's praises continually. In Communism we have the Workers' Paradise, where the State will finally have withered away. In Capitalism we used to have Southern California, and now we have Hawaii.

And each of us doubtless has his or her individual idea of what paradise is like. Most people would prefer their heaven custom-designed, and in particular to abound in that which they most like but most lack in this life. If you don't have peace and quiet, that's what you want in the life to come. If you don't have money, you want to be rich. If you don't have sex you want sex. If you don't have good looks or brains or health, those are the things you want. It goes without saying, of course, that you want eternal life. Just consider the alternative.

In this book we have tried to estimate what can be achieved with a modicum of technology tempered with a bit of good will. Eternal life, for instance, is well within our reach, as we showed in Chapter 4. The Islamic Paradise has already been recreated—all but the hangover-free wine—in every Israeli kibbutz. I'm not sure most of us today would particularly enjoy the Christian heaven—at least not the one described in St. John's *Revelation*—because gold and precious stones in ostentatious quantities have gone out of fashion; but if we really wanted them, nanotechnology could give us as large a city of emeralds and sapphires as we desired. If it's songs you want, a CD player can give them to you non-stop. There is hardly a single description of heaven in the scriptures which cannot be reproduced, at least in outward manifestation, with either today's technology or tomorrow's.

Then why aren't we all jumping for joy? Maybe because heaven is not an outward manifestation. It's something one feels inside, and what you have or don't have doesn't, or shouldn't, make all that great a difference. The average middle class family today, for instance, lives in homes which would be considered palatial by Biblical standards. We even have indoor plumbing, which at one time only Caesars and suchlike could afford. And Kublai Khan himself in fabulous Xanadu didn't have air conditioning. Nevertheless—or so goes convention—we are not much happier now than they were then.

Or aren't we? Happiness is a rather difficult quality to compare, and unless you *can* compare it you can't really say we aren't happier than our forefathers, can you? After all, any comparison requires some way to compare whatever it is that's being compared, with whatever it is it's being compared *to*. And if you put it like this, you can't say there has been absolutely *no* improvement in social conditions for centuries or millennia. Most people who contract leprosy, for instance, must surely consider themselves better off nowadays than the lepers of Jesus's time, who couldn't be healed except by divine intervention. We don't have mass crucifictions in public parks these days, nor do we throw Christians to the lions in the Astrodome. Witches are no longer burned at the stake, nor the disabled and the retarded chained or put away behind bars—at least not in the majority of what might be called civilised countries. Slavery, in the form in which it existed in most ancient lands, as well as in the southern United States before the Civil War, has been abolished most everywhere; and cannibalism is nowadays frowned upon.

These are surely *real* improvements. You can't deny that the world is a better place because of them. A world in which the insane are mocked and stoned is surely an unhappier place than one in which they are afforded some sort of medical treatment, however imperfect. A world in which ships are driven by men chained to the galleys is surely an unhappier place than one in which they are driven by fossil fuels or nuclear power. I'm sure most Americans would be appalled by a suggestion that Presidents at the end of their term should be ritually slaughtered, and then entombed with pomp and ceremony. In Celtic days numerous kings and chieftains had to face this—to us barbaric, though to them no doubt right and proper—end to their careers. Surely in this respect America, or at least American Presidents, are happier than ancient Ireland and ancient Irish kings—even if many Irishmen, as is likely, may question that conclusion. Human sacrifice is no longer publicly acceptable; and even animal sacrifice is mostly conducted, where it does survive, in secret. Surely this counts as *some* social improvement.

But—and this is the crux of the matter—if social improvement *has* taken place, however slowly, over the years, *there is no reason to believe that it can't take place in the future*—and take place, for that matter, even faster than in the past. The historical facts briefly noted above—and there are a great many more, which you can think up yourself—show that we *can* make the world a better place to live in.

Many of the improvements we have described above are a result, in fact, of science and technology, directly or indirectly. It's medical science, and not mere good will, which has afforded lepers a cure. It's steam turbines and diesel engines, and not royal decrees, which have freed the galley slaves. We don't kill ex-Presidents, at least partly because modern technology can feed, clothe and shelter them even in retirement. The disabled live a much better life today than in the past, at least partly because we can make wheelchairs, stair-lifts and prosthetic gadgets to enable them to function in an environment not originally designed for them.

There is also the indirect effect of science and technology. More food and wherewithals for the entire population means that more people can take more time to educate themselves before embarking upon a wage-earning livelihood, which in turn means that the population as a whole grows wiser, or at least more sophisticated. Many of us still derive pleasure from watching fictional violence on TV, but we no longer find it entertaining to watch real criminals being hanged or, more gruesome still, crucified. In Roman times people went to the Coliseum, and in the middle ages to witch-burnings, in the same spirit as we might nowadays go to the ball game or the hockey rink, or watch *Die Hard 3* at the movies. But for us, crude violence in real life is no longer entertaining; and this is probably because we are somewhat better educated, and thus more selective in our choice of entertainment. Hockey, football and even boxing—not to mention TV—though violent enough in their own way, are not quite in the same class as Roman sports.

Bernard Shaw once wrote: “We learn from history that men never learn anything from history.” Probably true; but now that, thanks to Shaw, we have learnt this lesson, maybe we *can* actually learn something from it, if you know what I mean. Maybe, from our study of social improvement over the ages, we can distil a method to accelerate such social improvement. There may indeed be an approach to bettering the world—one which has not yet been tried, simply because no one has felt it was worth while making a serious effort. Maybe it is time we actually started to learn something from history.

Having said all this, however, I confess I do not know how we are going to go about, from a practical perspective, making the world a better place to live in. That’s why in my Introduction I said I’d like *your* input on the subject. Let’s suppose that there are 500 million English-speaking people in the world—a reasonable enough assumption—and let’s presume, pessimistically, that only one in a thousand is interested enough in the future to want to speculate about it. Even so there are at least half a million people, somewhere out there, interested in the same subjects as you and I. And if to these you add the people who don’t speak English, you might end up with considerably more than a million people with whom we might be able to establish some sort of dialogue, at least with the help of translators. Two heads are better than one; and maybe two hundred thousand are better than two. The whole point of course is to make it possible, in such discussions, to weed out the nonsense and to emphasise the important. That, probably, is why the North American native peoples used to discuss the impact of their decisions all the way to the fifth generation. (You remember we talked about that in our Introduction).

So let’s have it. *You* (yes, I mean you!) surely have an idea or two worth discussing, not merely among your intimate friends, but among everyone interested in such things. And if you do, why then here’s your chance. You know my thoughts. You know my e-mail and snailmail addresses. You even know my phone and fax numbers. (Not that I’m always available; but there’s an answering machine hooked up to the phone; and my fax is always on). For my part, I intend to take seriously all the suggestions I receive. I may not, myself, be competent enough to debate everything; but I *am* competent enough, I feel, to figure out *who* is competent enough to do so. I can surely suggest many novel interactions among my readers, and even among those who are not (yet) my readers. Not all these interactions will bear fruit, but some of them may; and in any case, with such a set-up, we could have the beginnings of a modern version of the Native American fifth generations discussions.

And since we established above that it *is* possible to make the world a better place to live in, maybe we’ll be able to do just that. Having finally learned something from history, we may be able to create a better future for our children, and our children’s children, and so on several generations into the future. We may not, perhaps, be able to fully reproduce heaven on this earth; but we should surely be able to leave the world somewhat better than we found it.

And then the effort I spent writing this book, and (for you, perhaps, more importantly) the time you spent reading it, will have served some practical purpose—notwithstanding the far-out nature of the subjects it deals with. After all, that's exactly why it's called *The Seventh Generation.*

APPENDIX

Page 7: ***NANOTECHNOLOGY*** Of all the chapters in this book, this one is the most throughly researched, even though it is one of the most far-reaching in its implications. Drexler's book *Engines of Creation* is available, of course, for everyone to read, and in it he goes far—unnecessarily far, in my opinion—to prove that every one of his theses is based on sound scientific and logical thinking. Drexler, after writing his book, founded the *Foresight Institute* in Palo Alto, California, from which he directs a great deal of world wide activity in the field. I sent him a copy of the first draft of this chapter in August 1988, and to date the Institute has sent me several large envelopes stuffed with literature on the latest in nanotechnology. Sceptics who have voiced doubts about nanotechnology being feasible need only read Drexler's book, or write to him c/o *The Foresight Institute,* Box 61058, Palo Alto, CA 94306 USA.

[Note made in 1996] It was only in February 1996 that I finally read the paper *Plenty of Room at the Bottom* (available on the World Wide Web) authored by Nobel Prize winning physicist Richard Feynman in 1959, and I realise now that it has all the elements of the concept of nanotechnology (though not the name). So maybe Drexler was not, strictly speaking, the first person to think of nanotechnolgy. Nevertheless, it seems that after Feynman first propounded his ideas he did nothing more about it, while Dresler is still a leader in the field. So perhaps the baseball bat or stuffed toy animal *should* be given to Drexler after all.

Page 7: ***It's a wonder no one thought of it long ago ...*** Actually, in some small ways, people *did* think of it before Drexler did. Robert Heinlein, the well-known sci-fi writer, once when quite young wrote a story called *Waldo,* in which the protagonist, a guy called Waldo, invents little robots like those Drexler talks about, which work at the molecular and even atomic level. In the story the protagonist calls the robots "waldoes", so named modestly after himself. However, this was in those days considered to be pure science fiction, with the emphasis on fiction. Just a few years later, in or around the year 1949, the celebrated physicist Richard Feynman (who at that time was not quite so celebrated) gave a talk in which he indicated that it may come to pass one day that humanity would be able to manipulate matter at the level of individual atoms. His talk was later published under the title *Plenty of Room at the Bottom.* However, neither Heinlein nor Feynman ever took their thinking to its logical limits, as Drexler did. Drexler, by the way, thought of it all on his own, before reading what the other two had to say on the subject. (Later, of course, he did read their stuff).

In this matter of who thought of it first, there is always some controversy. (See also the initial pages of my chapter entitled ***SOFTWARE,*** about who invented flying machines). To give another instance: Ben Franklin, always the free thinker, once speculated that it might be possible for people to become immortal in this very body—and that, not with the aid of religion, but with the aid of science. As you can see from my chapter entitled ***IMMORTALITY,*** this is quite feasible now.

Page 7: ***In a decade or two ...*** Those who do not doubt that *some day* nanotechnology will come into existence, and are only haggling over the time it's going to take, can reassure themselves that miniaturisation is fast approaching the capability of manipulating matter at the level of individual atoms. Quite a few years ago AT&T used to run prominent ads claiming that their scientists were able to create microchips in which dimensions were as small as 200 atoms across. And as we all know, molecular biology can already manipulate matter at the level of individual atoms for the creation of artificial substances like insulin. The only question is how long it's going to take us to manufacture these little robots and computers Drexler talks about. But surely seven generations is more than enough time for this to happen.

Page 7: ***You could, almost literally, turn a pumpkin into a Porsche*** I am saying "almost" here, because a pumpkin would not have a large enough number of atoms, especially of iron and aluminum, to make a Porsche. So you'd have to supplement these, and also some copper and magnesium and, conceivably, a few other metals. But there would not be such a big difficulty turning a Porsche into a pumpkin, since a Porsche contains a lot of plastic, and plastic contains virtually all the atoms needed to make a plant: indeed plastic comes from petroleum, which was originally plant matter.

Page 7: ***... robots the size of viruses, controlled by computers the size of microbes ...*** These sizes may be questioned by laymen, but one should remember that biology has been doing this work for millions of years. After all, the information required to produce a complete human being—arguably the most complex object in the entire known cosmos—is contained in every single cell in the body. And this includes the smallest body cells, which are considerably smaller than bacteria. The sperm and the ovum, in fact, may be looked upon as crude and imperfect specimens of the kind of computers Drexler is talking about. And as for robots the size of viruses, every biology student knows that ribosomes (which are often even smaller than viruses) have been working under the instructions of the cells' genes for precisely the jobs nanotechnology requires: rearranging individual atoms according to a predetermined design.

However, the computers Drexler envisions need not work electronically. Not all computers have to work that way; some of us older folks still remember office adding machines, which were basically simple computers, and which worked on mechanical principles. Charles Babbage, who is credited with inventing the computer, also designed a mechanical computing machine. The bacterium-sized computers used for nanotechnological computations could work mechanically, the only difference being that instead of wheels and gears they would use atoms—which never require lubrication and never wear out. (The reason, in fact, why Drexler calls this technology *nano*technology is because atoms are measured in *nano*metres: billionths of a metre.) Although mechanical computers are much slower than electronic computers of the same size, the fact that these nanocomputers would be so much smaller than even the best present-day electronic computers would give them an edge in speed over anything we possess now. Details of such computers can also be found in Drexler's book, which I think should be *must* reading for everyone concerned with humanity's future.

Page 8: ***With great difficulty and at enormous expense, you manufacture one such robot and one such computer ...*** Manufacturing them is not quite as complicated as one might suppose. Richard Feynman has suggested a neat solution to this problem in his above-mentioned talk *Plenty of Room at the Bottom.* Make a machine, he said, which has the property that it can make exact copies of itself, only smaller. Each copy would then, by definition, possess this same property, and could make smaller copies which could make still smaller copies which could make even smaller copies. This however could not go on *ad infinitum*, because the size of the smallest copy would be determined by the size of individual atoms. Once that's reached, all further copies would have to be of the same size. But that's okay, because that is precisely the size required in nanotechnology.

Of course the problem lies in making, or more accurately designing, this kind of machine in the first place. Not only would it have to be able to make exact but smaller copies of itself, it would also have to do at least *something* else, because if it couldn't, all it would be good for would be making copies. In fact it would have to be able to make other such nanomachines—nanorobots and nanocomputers—which could manipulate matter the way we want it manipulated. Designing such a machine, even at the macro size, has not up till now been found possible; but if the mind were applied to it, and succeeded, nanotechnology could be only a week or so away after that. That's not too far in the future. You and I may well be alive when it happens.

Moreover if each machine made only two (smaller) copies and it took only fifty stages to get to the smallest possible size, you'd end up with literally more than a quintillion nanomachines. (See the note below to find out how).

Page 8: ***... in a matter of days quintillions*** Laymen are often incredulous when such numbers are mentioned, but one has but to calculate the rate of geometric progression. Let's say, pessimistically, that it takes a full hour for the little critters to self-replicate. (This is slower than the reproductive cycle of many bacteria, some of which self-replicate in as little as 20 minutes). Well then in two hours you'd have four, in three hours eight, in four hours 16, in five hours 32, in six hours 64, in seven hours 128, and so on. You see that in *x* hours you have 2^x critters. Thus in 10 hours you'd have 2^{10} or a little over a thousand; in twenty hours you'd have 2^{20}, or a little over a million; and within 30 hours you'd be pushing the billion mark. It would, in fact, take only 50 hours—just a bit over two days—to hit the quintillions. In actual practice, of course, the growth rate would slow down after the initial head start, as it does in bacteria as well, because the very presence of so many nanorobots would make it difficult for the raw materials from which they are constructed to reach the replicating sites.

But even if it slows down ten-fold, it would still mean only 20 days—less than three weeks—for the goal to be reached.

Page 8: ***MIT's Marvin Minsky ...*** And he's not the only one; another of Drexler's ardent supporters is Gerald Feinberg, a very well known physicist, educationist and author (among his books: *What is The World Made of?*) working at Columbia University. With gentlemen of such prestige supporting this stuff, I am amazed more people haven't heard of it!

Page 8: ***This ... is how life works*** Biology is, in one sense, crude nanotechnology. This discipline of the future can, in fact, be regarded as the culmination, or extreme limit, of several present-day disciplines. The way Drexler approached it, it is the ultimate in engineering. Maybe that is because his degree was in engineering. My own degree was in agriculture, so I look upon it as the ultimate in agriculture. What we are doing in agriculture is basically converting inanimate substances—mostly water and carbon dioxide, along with some inorganic salts—first into plant life and then, if so desired, into animal life. And this is done in precisely the way Drexler is talking about: by rearranging individual atoms, which in this case are obtained from the soil, water and air. And the more efficiently we do the rearranging, the better our agricultural practice is deemed to be. Most competent farmers can produce tons of biomass every season—all as a result of rearranging individual atoms.

Not to mention that in modern agriculture we are not content to leave life the way nature intended it, but are continually trying to improve upon her handiwork. Wild corn, for instance, bears little or no resemblance to the stuff we buy in the supermarket. Wild cattle give less than a tenth as much milk as cattle bred for the purpose. We can even create fruits, like nectarines and tangelos, which never grew in Eden. With even more sophisticated methods, such as tissue culture, we can tailor-make our agricultural produce and grow pretty much what we please: miniature cows and giant hamsters, for instance. The extreme limit of this process is, in fact, none other than nanotechnology.

By the way, some people object to the notion of nanotechnology from a practical point of view: that is, they claim that it would be impossible in practice because of Heisenberg's Uncertainty Principle. As you probably know, the Uncertainty Principle says that one can never precisely know both the position and the momentum of any small particle. So these objectors claim that no individual atom could be positioned in precisely the spot intended for it. If this were the case, though, neither agriculture nor, for that matter, life itself, would exist at all, now would it? Nor could you have genetic engineering, which in some small way we already have. There's a fallacy in the above argument: although it's certainly true that the Uncertainty Principle applies to all particles, including atoms—and for that matter even to trucks and planets and quasars—it doesn't become pronounced enough to be actually *relevant* until one gets down to the dimensions of electrons and protons, which are a thousand to ten-thousand times smaller than atoms.

Page 8: ***All Scotty would have to do is take you apart here and reassemble you there ...*** Atoms have a very convenient property, at least as regards their use in nanotechnology: all atoms of a particular kind are *exactly* alike. Every hydrogen atom, for instance, is exactly like every other hydrogen atom, down to the most minute detail. The atoms of which you are composed can be exchanged for others of the same type and you'd never know it. This exchange, in fact, is actually taking place in your body every moment of your life. If, therefore, you were taken apart on planet Genesis, the atoms of which you were composed discarded, and then you were exactly reassembled in the *Enterprise's* transporter room using atoms available on the Starship, you'd be beamed up clean, clear and complete! Am I right Mr. Spock?

Page 10: ***... rearrange the entire universe ...*** The interior of most stars is not composed of atoms at all, but of what is known as plasma: a state of matter in which electrons, protons and neutrons are not bound to each other in any recognisable manner, but are swimming freely in a kind of soup. This is because of the extreme heat inside a star, of course. However, when plasma cools down, it begins to form atoms once again. Nevertheless most such atoms would initially be of the lightest elements—hydrogen or helium—and you can't make too many useful things out of these elements alone. All the same, there's no reason to assume that nanotechnology gone gaga could not also construct nuclear reactors far out in space, in which the lighter elements are converted into heavier—if these nano-organisms could construct spaceships, they could surely do this as well.

By the way, Drexler in his book has suggested some ingenious safeguards that could be built into nanotechnology, which may reduce the risk of such things from happening. He suggests, for instance, redundant duplication of critical sites on his nanocomputers and nanorobots. Every single one of these sites would need to be altered, on any particular nanocritter, to produce a mutation of the type we ought to be afraid of. However, we do not (as yet) know of any safeguard that would *prevent* such occurrences: all we can do is *reduce the statistical chance* that nanotechnology will go haywire. Which means that there still remains a small but distinct possibility that a nanotechnoecological disaster of cosmic magnitude will take place! Sounds too true to be good, doesn't it?

Page 11: ***WARP 57*** This chapter was written as a bit of a challenge. Drexler in his book *Engines of Creation* writes that natural law will always pose a limit to what can be accomplished. For instance, he said, we will never be able to travel faster than light, since Einstein had demonstrated that such a thing was impossible. I felt that this was too sweeping a statement—after all, who did he think Einstein was, God?—and I felt it needed a rebuttal. Sitting at home thinking, I conjured up the chapter you have before you. This process, by the way, which is called "thought-experimenting", is the one used by Einstein himself to conjure up Relativity, so I feel I am in good company.

Page 11: ***We know from Relativity that under certain conditions there occurs a phenomenon known as "time-dilation"*** For the benefit of laymen I should point out that this is an established fact, and well documented. It seems weird, though, to say that a clock will run slower simply because it's going faster; in fact it almost sounds like a self-contradiction. Nevertheless we know that this is so. Synchronised clocks of extreme accuracy have been carried on airliners travelling in opposite directions, and one of them—the one travelling in the direction of the earth's rotation, which adds about 1,000 mph to the plane's speed—has been found to run a mite slower. This weird phenomenon, however, has its advantages when trying to circumvent "natural law". I have simply taken advantage of these advantages—after all, that's what advantages are for.

Page 11: ***Imagine ... an extremely massive object such as a Black Hole ... shaped more or less like a doughnut or a ring*** The reader may wonder how such a Black Hole could be stable—the gravitational pull of the ring would be so strong, wouldn't the doughnut collapse onto itself? The answer is a little complicated, but worth discussing. The doughnut shape is meant to be the shape of the "event horizon" of the Black Hole (see also page). Now it is true that everything *inside* the event horizon would fall inexorably into the Black Hole; but objects *outside* the event horizon do have a chance—a small chance, admittedly, but still a chance—of preventing themselves from falling into it. If the doughnut were set spinning at a rate fast enough, therefore, the gravitational attraction of portions of the doughnut on opposite sides to each other could be exactly counterbalanced by centrifugal force. In other words, the doughnut *would* be stable.

The idea of constructing a doughnut shaped Black Hole, by the way, is not my own: I picked it up from an article in the May, 1980 issue of *OMNI* Magazine.

However, it should be clear from my chapter that time-dilation does not absolutely require a Black Hole. *Any* sufficiently massive object could create a region of time-dilation around it; and if, for some reason, the reader feels that a doughnut shaped Black Hole is either not possible or not desirable, a massive object of some other nature—say a ring of neutrons—could do the same trick.

Page 11: ***... time-dilation of the order of 1 to 1,000,000 ...*** I have indicated a large and improbable (though not impossible) figure merely in order to make my point. As I have noted on page 13, however, the figures given here are quite flexible, and a much lower time-dilation factor would also give a faster-than-light speed. It might not be as fast as Warp 57, but even *one* mph faster than light speed should be enough to make Relativity cringe.

Page 13: ***One of Einstein's own thought-experiments has been shown to be erroneous*** Most people, even in the scientific community, believe that Einstein never made errors. In the early 80's I read an article in *Scientific American* in which the authors, professors at a fine American university, wrote *inter alia* about Einstein's elevator thought-experiment as if it were an undisputed fact. I found it surprising that the editors of so highly respected a journal should allow such things to be printed in it, since at the time I myself, and at least one lay acquaintance of mine, had known for a while that it contained an error. I wrote to the editors pointing this out, and describing the error in some detail; but they merely sent back a polite reply acknowledging receipt of my "interesting" letter, without actually acknowledging the error itself. I can only presume that the editors of *Scientific American,* along with just about everybody else, were firmly convinced that Einstein can do no wrong.

My wife Claire has evolved her own theory—with which I fully concur—for explaining this widespread belief in Einsteinian infallibility, almost as resolutely entrenched in our days as the Pope's in the past. It has less to do with Einstein's ideas themselves, than with his grooming. Einstein was a genius all right, more so in PR than even in physics; he discovered long before Prof. Parkinson that an ounce of image is worth a pound of performance. In his early years, before he acquired his now-well-reproduced appearance, he couldn't even pass his entrance exams to the Zürich Polytechnic; and his Nobel Prize, in case you didn't know, was not awarded for his Theory of Relativity—which no one understood at the time anyway—but for a much more insignificant paper. It was probably then that he figured something drastic needed to be done. He therefore grew his greying hair and adopted his rumpled-sweater style in clothes, which has since become *de rigueur* for all college students; and cultivated a moist benevolent look in his eyes, as if nuclear bombs wouldn't melt in his mouth. It worked so well that today you find his portrait everywhere: in shopping malls, on T-shirts, even in the offices of government bureaucrats—who, I'm perfectly sure, haven't the foggiest notion what his work actually was. His ploy was so successful, in fact, that he advised a Canadian poet friend to cultivate a similar appearance, declaring that no one would believe him otherwise to be a poet. The at-that-time obscure poet followed this advice, worthy of an Ogilvy; and to his everlasting delight, duly acquired renown. The only other person, to my knowledge, who independently discovered what I call "Einstein's Law of Grooming" was Albert Schweitzer, who was once asked by mistake for Einstein's autograph.

Page 15: ***IMMORTALITY*** This chapter is, of course, only a small offshoot of nanotechnology. It is, however, one of the most far-reaching, from the moral, ethical and even religious points of view. Nevertheless, as I think I have shown quite clearly, it is essentially quite easy to accomplish. Science has, in any case, established beyond question that all living things, including human beings, are composed of atoms. Plants can even turn inanimate atoms into living tissue: in fact that is exactly what photosynthesis does. Dead plant cells, for instance, are continually being repaired or replaced with structures constructed atom by individual atom. And this reconstruction takes place with the help of inanimate material derived from the air, water and soil. We ourselves, during dinner and its digestion, turn dead meat and vegies into live muscle and brain tissue. All this, in effect, is nothing less than life emerging from the lifeless. Nature conquers death again and again before our very eyes, and yet for some strange reason immortality is considered too far out even for sci-fi, not to mention medical schools. Neither *Star Trek* nor *Star Wars*, for instance, postulate immortality as a viable technological achievement, even in the 24th century—while TransWarp Speed and Jumps through Hyperspace are regarded as commonplace. In actual fact immortality is a lot easier to achieve than most of the stuff Dr. McCoy and Luke Skywalker take for granted.

Page 17: ***but it seems fairly certain that eventually we will ...*** Actually *Star Trek: Voyager* had an episode a few years ago (1995) featuring Amelia Earhart (who comes back to life after being frozen in space for a few centuries), which thereby admits to the argument given in my chapter; and yet in general when a person dies on any *Star Trek* show, he or she is considered to be *permanently* gone. This is obviously self-contradictory: even if humanity hasn't yet learned in the 24th century to repair broken people all the way from the bone up, they can at least reasonably presume that at *some* time in the future this capability will become available.

Page 17: ***Now present-day technology is not capable of rearranging atomic structure, but it IS capable of preserving it*** It should, therefore, not be surprising to learn that there already exist enterprising businessmen, and even firms, who are offering this service. One of them is The Alcor Life Extension Foundation, mentioned in Drexler's book *Engines of Creation.* He mentions others as well. Drexler writes (in 1986) that such firms charge upward of $35,000 for a good freeze or pickle; and that if you can't afford that kind of outlay, you can take out a suitable life insurance policy for the purpose. (He doesn't say, however, whether the insurance company will want its money back when you turn up alive and well in fifty years' time. It may well argue that you planned to defraud them all along, since you never had any intention of dying, really. I don't see how you're going to wiggle out of *that* one.) You can contact the Alcor Life Extension Foundation at 4030 North Palm No.304, Fullerton, California 92635, USA. Prices may have gone up, of course, by the time you read this.

Page 18: ***indeed that is what much of present-day neurobiology seems to indicate*** It may be remembered that when brain tumours destroy different parts of the brain, different bodily and/or mental functions become impaired or even disappear. This includes memories. This seems to indicate that memories are in some sense physical; and thus reconstructing the physical structure with sufficient precision ought to bring them back.

Page 20: ***CHARLEMAGNE*** The human brainhas yet to be fully surpassed by any electronic computer. Computer experts therefore think that if they could construct electronic computers working on the principles of the brain's neural networks, they could improve their machines' performance significantly. So for quite some years they have tried to reconstruct small portions of the brain in electronic form.

However, no one to my knowledge has thought of skipping the small steps in neurocomputer construction, and reproducing an *entire* brain in electronic form—and for the life of me I don't see why not. It would be a lot simpler than trying to figure out which portion of the brain does what, and how it does it. The brain of a genius is a ready-designed and perfected blueprint for a neurocomputer: why not use it? You don't even have to be a genius to use a genius's brain. Not being a genius myself, I have decided that the easy way is also the best.

Page 20: ***... half the speed of light*** One might think that electrical signals travel at the speed of light, but I'm told they don't, at least not in a computer. I'm not exactly sure why not, but I have a feeling that it is because the speed of light is the speed at which electromagnetic waves travel *in a vacuum,* while in the computer the signals have to travel in wires. But it doesn't matter, at least as far as the argument goes. Half the speed of light is plenty fast enough for our purposes.

Page 22: ***A synapse ... also works more or less like a switch, the way transistors work in electronic circuits*** The latest findings show that synapses do not have just "on" and "off" states—the way a perfect switch should have—but also possess *intermediate* states, which are neither "on" nor "off". However, we have not yet determined for sure what these indeterminate states actually do. It's quite possible, in fact, that the synapses are *imperfect* switches, and that this quality is merely one of those quaint imperfections which make human beings so endearing.

But even if these intermediate states are *not* imperfections, but execute some vital function in the brain, there is no *a priori* reason similar intermediacies could not be built into electronic circuitry. And as I said a few sentences earlier on page 21, these are mere details, because with nanotechnology we ought to be able to study and reproduce the brain's function in detail as microscopic—or perhaps I should say, nanoscopic—as we please.

Page 22: ***But because of his electronic construction, Frank could be a lot smaller than a human brain, less than a cubic centimetre in size*** The fact is, most of the brain is there merely to keep it, and the body to which it is attached, alive. A neuron, besides containing synapses—the part which enables the brain to think—also contains a whole lot of other stuff, like DNA to enable it to self-replicate, ribosomes to enable it to get nourishment, dendrites to enable it to reach the other neurons, a cell membrane to keep it separate from the others, and so on and on ... all of which material is quite useless as far as *thinking* goes. An electronic brain doesn't need to be kept alive, so it can consist of transistors and very little else. Let's say—and let's be generous—that each transistor is made up of a million atoms (that's 10^6 atoms); then ten billion transistors—10^{10} transistors—could be made from 10^{16} atoms. These could obviously be squeezed very easily into a cube 10^6 atoms per side: actually one could squeeze in a hundred times more, because 6 times 3 is 18, not 16. An average atom is anything from one to ten nanometres (10^{-9} to 10^{-8} metres) in diameter, so 10^6 atoms—of any element—can be put in a straight line in a space of only 10^{-3} to 10^{-2} metres: that is, anything from one millimetre to one centimetre. Which is the same as saying that a cube smaller than one cubic centimetre could easily contain ten billion transistors—about as many as the neurons in a human brain!

Page 22: ***... a thousand years' worth of thinking in an hour ...*** We humans tend to take pride in the fact that we can think—as opposed, I dare say, to animals and computers, who, we think, can't. We ought to be careful of what we say, however, because already we have machines which can out-think most of us. On every sidewalk, even in third-world cities like Bombay and Calcutta, you can buy pocket calculators capable of outsmarting the most brilliant mathematicians, at least in simple calculations. Some calculators are even smarter than the first electronic computer made, the gigantic UNIVAC, which was brought into existence for designing the first atomic bombs. Scientists of such great repute as Oppenheimer, Fermi and Teller couldn't do without the UNIVAC, and yet any schoolboy today can possess a pocket calculator more powerful. If we think that today's computers are at the end of the line in machine intelligence, we'll soon be at the end of the line in our own.

Page 23: ***They would have little difficulty doing so, being able to see as far beyond us as we see beyond the amoebas*** We really have very little idea of how little we actually know. Richard Feynman, the Nobel Prize winning physicist, once calculated (and the calculation has since been proved to be correct, at least from the mathematical standpoint), that the information contained in all the books in the entire world could be stored in encoded form within an object smaller than the size of a pinhead. An *ordinary* pinhead, mind you.

All the knowledge humanity possesses could be put comfortably into the *head of an [expletive deleted]* ***pin!*** (Not to mention that most books hardly contain any information worth knowing anyway). If Frank Einstein had a “brain”, as we calculated above, the size of a cubic centimetre, he could store all of humanity's hard-won knowledge in a small corner of it and never even miss it if it got chipped off. Just imagine how much more all the Franks taken together could know.

Page 24: ***DON'T LEGO*** This chapter is actually a joke, because in transportation there are going to be advances which most people don't even dream about. I and my wife Claire thought up one ourselves, quite a few years ago. We happened to be driving along the freeway when I remarked to Claire: “Just think how much air those flat-nosed trucks must be pushing apart as they thunder down at the speed limit.” Claire said: “Why don't they put them in a vacuum?”

Why not, indeed, I thought when I returned home, and wrote up a patent application outlining my idea of the transport of the future. You'd have all these vacuum tubes cris-crossing the nation, with mag-lev trains or shuttles running inside them, held away from physical contact with the tube by magnetic force, which would also propel them. For passenger travel the trains would have to be pressurised inside, of course, but for freight they don't even have to have that. They also don't have to be streamlined: what's the need? They could be accelerated to a top speed as fast as one wished, because there'd be no air to hinder their motion. They could be a lot faster than a Space Shuttle: indeed for passenger travel I figured that *twice* orbital speed would be the most comfortable, the centrifugal force generated as the train goes round the curvature of the earth providing a sensation on exactly one *g* (but facing *away* from the centre of the earth, naturally—the direction of which, however, the passengers need not be aware of). For freight, of course, you could go a lot faster, depending upon how many *g*'s the freight could stand, which for such things as gold bricks, steel ingots and so on, could be enormous. You could even regenerate most of the electricity used for acceleration during the deceleration phase, which would make this mode of transport the most energy-efficient there is. Moreover it would be totally silent, at least for people outside the tubes, since sound cannot be transmitted through a vacuum. Even inside the train the most you'd hear might be the low pitched hum of magnetic force being generated.

Then one day I discovered, reading a book on cosmology, that this idea has been around for a great amny years already; so I daresay I won't make my first million dollars with *this* invention. (Luckily, I have others!) But it just goes to show that air travel will soon go the way of rail travel, and both the way of the dodo, because even space travel will not be fast enough—let alone cheap enough—to compete with vacuum-tube mag-lev travel.

Of course, with nanotechnology (see page *7 ff*) we'll have not only the *Starship Enterprise's* Warp Drive, but also its Transporter Room; and then even vacuum tubes will be out of date.

The automobile, however, is one of those things we'll probably never do without, even when we can beam ourselves to Hawaii in a twinkling of an eye. Cars are so much fun to drive, especially when we finally get to Hawaii, that it's hard to imagine anything taking their place for sheer enjoyment. Witness the success of the Mazda *Miata* and the new VW *Beetle* in recent times. Even flying a plane cannot duplicate the delicious sensation of working one's way though the gears in an open two-seater convertible on a fine day, negotiating a narrow mountain road intermittently covered with a canopy of fall leaves, giving way every now and then to a breathtaking vista: something you'll never see, of course, from a vacuum tube even if it's transparent, whizzing by (as you will be) at 36,000 miles per hour.

One of the problems with driving, however, is its inherent danger. Cars are many *times* more dangerous than the airlines, even when terrorist bombs are taken into account. As of now there are over 50,000 fatalities every year on American roads alone. Assuming that there are 100 million licensed drivers in the US—a reasonable enough assumption—this amounts to one fatality for every two thousand vehicles. And this counts only the *fatal* accidents. If you add to these the ones in which the occupants are merely maimed, the percentage rises considerably; and if to those you add the accidents in which only property damage is done—although no one is physically hurt—you have a frightening number of collisions.

We do, however, possess technology capable of drastically reducing automobile collisions. All that needs to be done is to make it mandatory to install sensing devices—whether working on hypersonic, infrared or microwave emissions—in every motorised vehicle. Such devices are routinely employed at supermarkets for opening doors automatically, so that shoppers don't have to struggle with their carts when entering or exiting. This is also the principle behind TV remote controls. If in addition each vehicle also had an emitting device capable of registering its effect on other vehicles' sensing devices, it would make it even more foolproof. This would be similar to how radar guns work; and their readings are so foolproof they are accepted unquestioningly by the law itself. In conjunction with a microchip, such a system would be able to judge a car's velocity relative to all nearby vehicles, and could even be designed to apply the brakes or take other evasive action automatically, in case of vehicles being on a collision course.

However, applying the brakes or taking evasive action is no good unless the tires grip the pavement securely. A skidding car is out of control, and no amount of braking and steering is going to do any good. The answer, of course, lies in making cars skidproof. But since skids take place at *the contact point* between the car and the pavement, we need to improve not just the car but the pavement as well.

And that would be so easy to do ... but who's going to do it?

Page 26: ***The best surface would probably be rubber, but that would surely be too costly, except maybe for racetracks*** There *is* one tactic that just might work; and that is, that an enterprising entrepreneur will finance the construction of a racetrack featuring a "Won't Lego" surface, and run races on it with cars equipped with the right kind of tires. As many people know, numerous advances in automobile technology have originated on racetracks. Races on tracks such as these could be a lot faster than Formula One or Le Mans, especially on the curves; and they'd be a lot safer too. Most racing accidents—as can be readily discerned on TV—are initiated by a car or cars skidding out of control. If this can be prevented, races could be run at speeds today's audiences merely dream about. People might flock from all over the world to see such "super-races", and the sale of TV rights could make the promoters millionaires. Once such technology becomes public knowledge, the public might bring enough pressure to bear on the bureaucrats to introduce these surfaces for general use as well. One of the reasons I have written about this technique—which, as far as I know, I have been the first to think up—is that by making such knowledge public, something might be done about it.

Page 29: ***Let's suppose the second alternative is true: that there is someone out there*** There happens to be a better argument for the *existence* of extraterrestrial life than for its *non*-existence—or at least for the existence of *other rocky planets* around other stars than for their non-existence. (We already know there are *gas* planets around other stars, but I think gas planets would find it hard to support life as we know it). The argument goes as follows. Many—indeed some astronomers say, most—stars are binaries: that is to say, two stars rotating around a common centre of gravity. Our Sun turns out to be an exception, but only just barely. It has been calculated that had Jupiter been a bit more massive, it could well have become the Sun's binary star. As it is, Jupiter radiates more heat, generated by its own enormous gravity, than it receives as radiation from the Sun. Current theories of the birth of the Solar System seem to indicate that Jupiter narrowly escaped becoming the Sun's binary.

Now Jupiter—as indeed almost all the planets in the solar system—has satellites: Jupiter in fact has a great many satellites, not just a few. Some of them are earth-like in size and, probably, composition. Had Jupiter become the Sun's binary, *those satellites would have been planets of Jupiter;* for Jupiter would then have been classified as a star: *viz.*, the nearest star to our own Sun. So there are in fact many heavenly bodies—and not very far from us either—which very narrowly escaped becoming planets around a star other than the Sun. Their existence very strongly suggest that others like them might exist elsewhere in the Universe, because there are literally quintillions of stars out there. And if there are indeed so many planets, it stands to reason that life may have originated on at least a few of them; and that this life may even have evolved to become intelligent, perhaps more intelligent than we are.

Page 29: ***Life ... has a tendency to spread to the very limits of its technological viability*** This has, apparently, always happened, at least on earth. One argument against it happening in some cases—like those of human beings—is that if reproduction is carefully controlled, attrition by death can take care of it, so that the population remains static. This argument, however, doesn't hold water. In such a case the species in question—whether human or otherwise—would sooner or later be wiped out; because natural disasters, being unpredictable, would not be accounted for in the number-of-deaths-equals-number-of-births theory. This mathematical inevitability would, at some point, all of a sudden increase the death toll. In fact such a species would find it hard even to come into existence, because in the normal course of things it would have to start off with one single individual, or at best a few; and they would never, according to the theory, increase in number. In the case of humanity, in a few western nations, the population does appear to be near-static at present; but this is a very recent phenomenon, and by no means world-wide. In the past humanity has always increased in population, and there is no a priori reason for it not to do so in the future—except, of course, if a nuclear holocaust were to take place on earth before we colonise space in reasonable numbers.

Page 31: ***They might work ... with switching devices separated by such minute distances that space itself would have to be considered discrete at that level*** I should, perhaps, point out that at such giddy limits of miniaturisation—which are far smaller than those needed for nanotechnology—we get what are called quantum effects, and they prevent us from effectively predicting anything. This trait precludes our designing a reliable quantum-level machine (after all, nobody wants a machine which is likely to go off on a tangent at its slightest whim). However, quantum theory, as I have pointed out in Chapter 7, is built on a rather flimsy logical foundation. All it does is satisfy empirical observations, and in some cases is able to make reasonably accurate predictions. Some of its other predictions, however, are quite unreasonable. It predicts, for instance, that a cat enclosed in a ventilated box with a source of radiation, a Geiger counter and a poison vial which can be activated by the counter, could in certain cases be *neither alive nor dead*—which sounds preposterous. (This theorem is called "Schrödinger's Cat", and it has its supporters as well as its detractors. It can be looked up in many books dealing with quantum theory.) As Einstein hoped, quantum theory may one day be replaced by some more common-sense view of the very small; and in that case switching devices such as those I have proposed may well become practical.

Page 31: ***... intelligences so far advanced*** There's always been one serious problem with Etiologists, including the well-known group called the *Search for Extraterrestrial Intelligence* or *SETI*: and that is, that they have always been looking for *extraterrestrial* intelligence, with the emphasis on extraterrestrial, while what they might have more profitably been looking for was extraterrestrial *intelligence*, with the emphasis on intelligence. Exercising a little intelligence on their own part might have led them to realise that once any intelligence gets to be intelligent enough, it wouldn't *necessarily* behave the way we do—indeed, given our track record, *most likey* not.

Page 32: ***For us to talk of the laws of nature posing limitations for them would be like for neanderthals to discuss jet planes and nuclear reactors*** These days we exhibit a reverence for the laws of nature almost as great as the Biblical Jews used to have for God. Laws of nature are not, however, of divine origin; the happen to be only such as *we* have discovered—or more accurately, such as we *think* we have discovered. There is nothing permanent about them, nor anything absolute; they are simply a particular way of looking at reality. Many other views of reality could, at least in a speculative way, be imagined. For instance, it's quite possible to imagine an alien life form which would not experience time as we do. Most of our laws of physics would just be so much nonsense as far as they are concerned—because almost all our physical laws take into account, directly or indirectly, a time component. As regards other sciences, such as chemistry or biology, most of their "laws" are not laws at all but merely rules of thumb, often with numerous exceptions. The only principles more (apparently) absolute and unchanging than the laws of physics are the principles of mathematics and logic; but even these, as Kurt Gödel has shown, rest on somewhat shaky ground. I have discussed this matter at somewhat greater length in the chapter entitled ***THE IMPOSSIBLE TAKES A LITTLE LONGER.***

Page 32: ***Humanity would rapidly become obsolete ...*** This is more likely to happen, and sooner, than most people think. We may, in fact, be among the last few generations to be the most "advanced" creatures on this planet. (I have put that word in quotes because there is no satisfactory definition of the word "advanced". Perhaps, as *A Hitchhiker's Guide to the Galaxy* points out, dolphins are more advanced than humans, precisely because they have *not* developed science and technology, with their concomitant horrors.) But there is no doubt that we are rapidly acquiring the ability to create "life forms", even such as have greater computing power than our brains. Certainly this would be within the capacity of any civilisation possessing technology a few hundred years ahead of ours. All life forms—or at any rate all life forms we know about—are composed of a finite number of atoms; and their life traits arise solely from the way their atoms are put together. The atomic level being so much larger than the sub-atomic, it would be quite easy, for any civilisation able to manipulate matter with femtometre accuracy, to create any and every life form possible anywhere in the universe. (One femtometre is one-quadrillionth of a metre, and is thus a billion times smaller than a nanometre. The sizes of sub-atomic particles are measured in femtometres).

Which means, of course, that soon we shall be able to do so as well. And there is no guarantee that once we start on this path, we will restrict ourselves to creating only such life forms as are less intelligent than we are. Our intelligence, as far as we are aware, is also just a function of the way our atoms—more specifically, our brains' atoms—are put together; and putting them together in some smarter way could produce smarter brains. And at this point in evolution you would get a geometric progression in intelligence, because the smarter brains we create would be able to think up even smarter ways to create even smarter brains than their own. This could just go on *ad infinitum* ... unless, of course, the smarter brains at some point decide that the smartest thing to do is to put a stop to this nonsense altogether. However, since we ourselves are just not smart enough to stop it, humanity will have become obsolete long before that happens.

Page 34: ***THE IMPOSSIBLE TAKES A LITTLE LONGER*** This is one of those chapters which—at least in my opinion—is a *must* for any futurologist. In my ***INTRODUCTION*** I said I would try to imagine at the limits of my imagination; yet virtually all I have written about so far is fairly elementary, and does not really tackle the Great Problem of Existence. We have not yet asked ourselves, for instance, Why Is Everything The Way It Is? and, Can It Not Be Different? No one seriously believes that It Can—not even Omar the Tent-Maker, who could only *wish* longingly for that sort of happy ending. And yet I could see that such an attitude of resignation, however noble, was not in the best spirit of technological innovation. Just how much we can do with technology, carried to its limits, was a question always at the back of my mind—as, probably, at the back of yours as well. Perhaps not in seven generations; but let's suppose we can advance technologically as far as is imaginable: where then would the limits lie? Being an incorrigible optimist—and also somewhat ambitious—I felt I had to try for something greater than mere Immortality.

Page 38: ***... quantum mechanics predicts that it is possible, under certain circumstances, for matter to come into existence ex nihilo*** Those circumstances are as follows: We know from both theory and experiment that matter and anti-matter annihilate each other on contact, yielding a burst of energy; and at times the reverse process also takes place, in that a burst of energy turns itself into a pair of particles, one of which is composed of matter and the other of its anti-matter counterpart. Now suppose that both these phenomena occur within a short time of each other: first a pair of particles—say an electron and a positron (the electron's anti-matter counterpart)—get created, and very shortly thereafter they collide again, destroying each other and thereby vanishing again. Now quantum mechanics predicts that if the time interval between the two events is short enough, they can never be detected. That's because in order to detect these events one would have to send forth a light particle or some other such detecting object, and measure its deflection by the pair of newly-created but briefly-existing particles; and if their existence were brief enough, there would not be time enough to carry out such an observation. In fact quantum mechanists say that such goings-on are going on all the time, but we just can't detect them; and the pair of particles so produced are therefore called by them "virtual particles". They have virtual existence, but not real existence.

Now suppose that a pair of virtual particles is produced just at the event horizon of a black hole. (As we mentioned earlier, the event horizon of a black hole is an imaginary envelope surrounding it, from within which there is no escape for anything, including the most energetic of energies. However, between the event horizon and the black hole proper there is a space within which both matter and energy can exist in more or less their usual forms. It is only at the black hole's surface itself that matter and energy are thought to be squooshed out of existence).

Now suppose further that of the two particles thus created, the anti-matter particle is thrown by the force of its creation *towards* the black hole; while the other particle, composed of normal matter, is thrown in the other direction—*away* from the black hole. The anti-matter is in that case swallowed up for good, while the matter remains within our universe. In this fashion matter is created out of "nothing", so to speak. Even though in "actual fact" it is not created *ex nihilo*, the energy from which it was created, as well as its anti-particle, have left forever our plane of knowledge—in fact they were never in it to begin with; and since we can never know anything about them, past present or future, they are as good as non-existent, at least as far as *we* are concerned.

This kind of thinking is typical of quantum mechanics. Basically what quantum mechanists are saying is that if we cannot know something, it doesn't exist. This sounds a bit infantile, like a child covering its eyes while doing something naughty, thereby thinking nobody can see what it's doing. Nevertheless many scientists believe in quantum mechanics, simply because there is as yet no better theory to describe the world of sub-atomic particles.

This is also a bit like the old philosophical saw about whether a tree falling in an uninhabited forest makes a sound if it falls, since no one is around to hear it. One can, however, argue about such things indefinitely. Which is perhaps why it is better not even to start.

Page 38: ***Humanity could live, not merely in the best of all possible worlds, but in all of all possible worlds ...*** And some impossible ones too. This is obvious when you consider how "impossible" time travel is (see page above). If time travel, which is theoretically possible (at least according to some modern theorists) would in practice cause impossible things to come about, it is obvious that we need not confine ourselves, even in practice, to the possible. At least not the *logically* possible.

The idea that we could live in different universes, by the way, is not very different from the manner in which different characters in fiction and in films "live" each in his or her own "world". You don't expect to see Royal Candian Air Farce, for instance, invading the world of Seinfeld, nor do you expect Doctor Who to barge in upon Darth Vader. Yet it is conceivable that someone (Mel Brooks, perhaps?) will make a movie in which both the above could come to pass. Our own reality seems to be on a somewhat stronger footing than that of the Doctor, but that may only *seem* that way to us because we happen to be *in* it. Looking at ourselves from a more detached point of view—say the point of view of a God, or a Being who has Absolute Existence—I don't suppose there is much difference between you and me on the one hand, and Hamlet or the Klingon Empire on the other. The majority of scientifically minded theorists today, in fact, think that the entity we each call "me", "my self" or "I" is nothing more than some kind of sum total of the pattern of signals within our respective nervous systems. Our sense of self certainly isn't our arms, legs, eyes, ears, noses, or even our kidneys or hearts or blood: and the proof is, we can exist without these body parts and fluids—or at least have them replaced by others which once belonged to another person—without in any way losing our sense of who we really are. Thus our own existence rests, ultimately, on fairly shaky ground: indeed many philosophers and writers, from mystics to Shakespeare, have testified to this truth, or at least put it forward as an eminently workable hypothesis. “We are such stuff / As dreams are made on”; and if that’s all we are, how are we so very different from Batman or The Joker, both of whom are also nothing more than some kind of sum total of the pattern of signals imbedded in a quantity of videotape?

Page 40: ***War and Peace*** Virtually all the stuff I have written about up to this point is pure technology; it does not discuss whether the results to be anticipated are good or bad. However, it only makes sense to foresee what might happen in the years to come, if by foreseeing it you want to weigh its *merits,* whether prgamatic, ethical or spiritual. Now one of the most difficult problems of our times—indeed throughout human history—has been that of war. We’ve never been able to put an end to it, nor have we ever considered whether we could do so in the future. Most of the stuff that has been written about war discusses how to *win* it, not how to *eliminate* it. Even our elected representatives in the nation’s capital speak and act as if the best thing we could do, in the event of a military conflict, would be to win. But as Lao Tzu has correctly said: “Rejoicing in a military victory means rejoicing in the slaughter of men, women and children! How can the government of a nation be entrusted to people who rejoice in such things?”

If we look at it from an unbiased and objective point of view, looking at the problem though the eyes, say, of an Alien Life Form, war does not only seem sad, it also seems stupid. Surely there’s a better way to resolve human conflicts, an ALF might say to itself. Any philosophy that countenances war, under any circumstances, has announced thereby its lack of skill, for as Sun Tzu has pithily said (page 44), the most skilful general should be able to win without fighting. But how that skill is to be achieved is still not clear. Christian and Buddhist peoples, blatantly ignoring the clear teachings of both Christ and the Buddha, have gone to war no less than Muslims or Hindus, whose religions do happen to countenance war under certain circumstances. Perhaps that is because our life skills are not as great as those of the Great Spiritual Masters.

But if it is a matter of skill, then should we not try to improve it in this field, just as we have in many others, with the help of science and technology? One way in which this could be done is given in the chapter before you.

Page 43: ***... isn’t praying for peace in the former Yugoslavia in more or less the same ethical category as spraying peace deodorant over Bosnia?*** The question about prayer is, I think, very relevant here. As I mentioned in this chapter, technology is all about enabling us to accomplish more and more with less and less. Take for instance transportation. A steam locomotive, and the train it pulls, is a technologically crude piece of equipment: many tons of steel are used for transporting people and goods, at fairly low speeds, and all confined to the rail tracks. Cars and trucks are somewhat more sophisticated: less metal, and sometimes even a bit of plastic, accomplishes the same object, sometimes faster, and often right to your door. Aeroplanes and helicopters, which are more sophisticated still, use even less matter and yet transport people and goods a lot faster than even cars and trucks. *Star Trek’s* “Transporter Room”, which could beam you up in the twinkling of an eye, would—if it existed—be still more efficient, and thus more high tech.

Prayer can be looked upon, in some ways, as the ultimate in this process. (That, of course, implies that you believe prayers are actually granted; but what the heck! even if they're not, let's pretend they *can be.*) If you could "beam up" people and goods *without* a Transporter Room—just by praying—you'd certainly be in a position to upstage even Captain Janeway. If you could heal the sick—or even raise the dead—*without* using medicine or hospital equipment, you could upstage the Holographic Doctor. And if you could make peace *without* nanosnoopers, you could upstage the PWC Party. It would simply be a more efficient—more high tech—way to go about it. But then, would it be *right?*

Page 46: ***Would you really harbour warm feelings towards a society which has deprived you of some of the best years of your life?*** The problem with punishment is that it does not take into account the *feelings* of the person punished. As we pointed out in the chapter called ***WAR AND PEACE*** , it is *negative emotions*—hurt feelings—that give rise to violence and war. It is also negative emotions that give rise to other kinds of anti-social behaviour. A person harbouring negative emotions towards society in general is not likely to behave in a social manner, unless compelled to do so one way or another. Punishment merely satisfies the emotions—such as they are—of the *punishing* party. It does nothing for the feelings of the *punished,* except perhaps exacerbating them. And this is irrespective of the nature of the punishment; mild forms are almost as pernicious as severe forms. This is because what is being hurt is not the body but the *feelings* of the punished.

In some cases, in fact, when the punished party feels that the law itself is unjust, they even commit unlawful acts in full sight of the law. In these cases they go to prison, or even to the gallows, with pride; and like Mr. Gandhi in British India, insist they be sentenced in the severest manner their "offence" deserves. This indicates once again that what counts is the emotions of the person concerned, and not the physical severity (or otherwise) of their punishment.

But there is no guarantee—indeed, no evidence either—that making people feel bad is going to make them better citizens. It wouldn't work with most of the people you know personally: right? Then why imagine it works with those you don't?

Page 47: ***Bettelheim's cure for the disturbed children under his care was to vastly improve their environment ...*** He also used another tactic, and that was to punish, not the child, but the toy or object being used by the child in a wayward manner. The emotions of the child were thereby protected; the child did not feel hurt. It is not clear, of course, that this could work for adults. But it does bear out what we said above, that what counts, in making people social, is their underlying *emotions,* and not their actions *per se.*

Page 47: ***total hypermedia ...*** When I first wrote these lines in 1989, hypertext (the first form of hypermedia) was but a gleam in the eyes of users of *WordPerfect 4.0 for DOS.* As any Internet surfer knows, however, hypertext is only too commonplace now: for that matter, *Windows* "Help" files use hypertext extensively as well, and always have done so. (And if you are reading my electronic version of this book, you already have it in hypertext).

All the same, even the World Wide Web with its millions of interlinked Web pages is but a drop in the ocean compared to a world-wide *total* hypermedia system. What I am talking about here is a World Wide Web where *all the information in the entire world* will be available, any of it just a few mouse clicks away. And this will ultimately include not just text and pictures, but sounds, full motion videos, perhaps even smells and tastes and touchie-feelies. (MIT is already working on that last one, and you can find out how far they have progressed if you contact their Artificial Intelligence labs in Cambridge, Mass. In fact, with their program you can touch, not just things thousands of miles away, but things that *don't exist at all* except in some remote computer's memory!) Right now we have just Web pages; what we need is Web magazines, Web books, Web movies, Web operas and Web Virtual Reality. As things stand (January 1996), I can't even get the full text of the *Ontario Condominium Act* on the Web. Of course we don't have the bandwidth to transmit such material at present, at least over the phone lines, so that even a Web page—let alone a Web book—takes forever to load today. But in a few decades we'll surely be able to overcome these piddling obstacles.

Page 49: ***It has even been suggested that the system be programmed to automatically pay a small royalty to the author every time his or her work was called up by a reader*** A lot of people are against this suggestion, because they believe that information should be free, or as near to free as possible. Maybe they are right. But I am myself not too sure. Since I am a writer, I would, of course, welcome any income I could get from my writing. But I am also a voracious reader, and it would irk me to pay all my income from writing—and perhaps even more—just to read everything I want to read. Perhaps there ought to be the equivalent of public libraries on the total hypermedia system. Or perhaps it would be best to take a poll about this on the system itself.

My personal penchant—in case a poll *is* taken—is for the "shareware" system. This is what I have adopted for my own books, at all events. In shareware—with which people downloading software from the Internet are quite familar—one can use the downloaded material for free, and if one likes it and wants to keep it, one is honour bound to send a small amount of money (usually not more that $20, and often much less) to the author of the software. If, on the other hand, one doesn't like the software, one deletes it, and sends nothing. Since most books in print retail for about $20 to $50 (U.S., or the equivalent in your own currency), and since the author usually ends up with only 10 per cent of that, or even less (the rest goes to the publisher, the printer, the binder, the manufacturers of paper and ink, the transporter, the distributor, the government, etc. etc.—the list is almost endless), the average author nets only $2 to $5 per copy for his or her books. Now that's a paltry sum, and could easily be afforded by anyone downloading a book. Readers who like the book could be encouraged to send the author $5 (or the equivalent in their own currency); and in that case, even if some dishonourable readers sent nothing at all, the author would still make more money with the shareware system than if he or she were to have the book published in the traditional manner, on paper.

Page 53: ***Nor does any one know how to wipe out the national debt, short of selling their country's embassy in Tokyo, which given the real estate prices there might just about do it ...*** This, in fact, is how the Australians wiped out their national debt some years ago. Apparently in the late eighties they were in debt up to their ears. They also had a very antiquated, but rather large, embassy in Tokyo; and they wanted to modernise, but couldn't afford it. They hit upon a brilliant solution: knock down the embassy, sell half the land on which it had stood, and on what remained build a better and higher new one. Not only did this raise enough money to modernise, but what was left over was almost enough to wipe out the Deficit. The Government in power took great credit for the manoeuvre, but nobody was fooled: everyone knows the real credit goes to the Japanese economy.

Page 55: ***... we already know how to make cars capable of more than 200 miles per hour ...*** Porsche came out more than a decade ago with their *959* wundercar, whose top speed was just south of the 200 mph mark. Not to be outdone, Ferrari answered with their F-40, which claimed 201 mph. Then the tiny tune-up firm of Ruf Automobile, based in the sleepy little German village of Pfaffenhausen, took a standard Porsche 911, added a couple of turbochargers and special suspension and mag wheels, and a little of this and a little of that, and went on to record 211 mph. If you have the money, you can actually buy such a car from Ruf, and drive it on real roads, in Germany even up to the maximum speed it is capable of, without getting a ticket. Many of Ruf's discerning and affluent customers have done exactly that, and have often had to brake hard on the autobahn to let a 160 mph Mercedes or BMW move over and allow them to pass. Now Jaguar, Lamborghini and Bugatti (among others) have also jumped on the 200 mph bandwagon; and of course for the very ultimate in driving thrills, there's the million-dollar-plus McLaren *F1,* which can place you firmly in the driver's seat bang in the middle of the car, with a passenger (preferably of the preferred sex) on either side of you; and then the three of you can whizz off faster than a *real* Formula One car *... on the public roads!*

Page 58: ***The Islamic Paradise has already been recreated—all but the hang over-free wine—in every Israeli kibbutz ...*** I have spent six years on an Israeli kibbutz, so I know what I am talking about. It is true, of course, that on a kibbutz you have to work, but that's not such a big drawback: strangely enough, the atmosphere on a kibbutz makes most people *want* to work, and some kibbutzniks work 12- and 14-hour days simply because they like to do so. (Most other kibbutzniks, however, consider that kind of attitude sick). As far as the gardens beneath which waters flow, anyway, an extensive system of pipes, plus a team of gardeners, provides that luxury. And most of the youngsters on the kibbutzim are *very* good looking; and the fruit is often fresh and tasty.

Page 59: ***The disabled live a much better life today, at least partly because we can make wheelchairs and other gadgets to enable them to function in an environment not originally designed for them ...*** People don't often realise that the so called "disabilities" of the disabled are merely a result of an environment *not* designed for them. Just imagine, for instance, that you and I were transported to a world of “bird-people”, where everyone can fly, and no one walks more than a few hops. Their entire environment would be designed differently from ours. They may not have any roads, or even paths laid out for anyone to walk on; their dwellings may be scattered here and there, high and low, without any way to reach one from the other on foot; they’d be going and coming around us at a dizzying rate while we would find it difficult even to function in what we would call a “normal” manner. We would find ourselves, in fact, in more or less the same situation as most disabled persons do in our own world, simply because *the environment would not be designed for ambulatory beings.*

The same thing applies to so called “disabled” persons in our world. We go to enormous lengths to invent the wheel, and then we construct stairs and curbs so that the wheel’s movement is impeded at every turn. We provide our automobiles with effort saving equipment like power steering and automatic transmissions, but not with joysticks so that a person who has lost the use of his legs can use them. We construct all our buildings and design all our equipment so that those who are different in ability from the average cannot use them; and then we label such people “disabled”. Now ain’t that stupid?

Page 60: ***Having said all this, however, I confess I do not know how we are going to go about, from a practical perspective, making the world a better place to live in ...*** That’s why in my Introduction I said I’d like *your* input on the subject. And that’s another reason why I am offering this book on disk as well as on the Internet, in all the major computer formats. On your computer, you can make your comments, revisions, etc., and pass them ’round. It could be a lot faster and easier than paperwork, don’t you think? This book is interactive in a way most books just aren’t: you can even edit it.

Page 85: ***Reviews*** The brilliant Polish author Stanislaw Lem once wrote a book entitled *Perfect Reviews of Nonexistent Books*. Not to be outdone, I decided to write here some nonexistent reviews of a (nearly) perfect book!

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REVIEWS

"Brilliant ... a masterpiece ... just couldn't put it down ... many years ahead of its time ... one of the best books on the subject in seven generations." —*The author*

"Couldn't believe what I read." —*One of the author's friends*

"This is crazy". —*Another of the author's friends*

"I haven't actually read it, but I'm sure it's really quite good." —*The author's wife*

"We haven't actually read it, but we're sure it's bloody awful."
—*The reviewers of a literary journal to whom the author did **not** send his book*

"No thanks; better luck elsewhere."
—*A great many literary agents to whom the author **did** send his book*

"Not my cup of tea."
—*A professional editor to whom the author sent the first draft of this book for polishing up*

" Too light to be a good door stop."—*The author's secretary*

{total silence} —*The author's father-in-law, a prolific reader of books*

"Is that your book, daddy?" —*The author's 9-year-old son*

"He's ripped it, daddy!!!" —*The author's 7-year-old (other) son*

"A must read." —*The author, once again*