Chapter 1

A History of Our Future

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Some 40,000–50,000 years ago, a group of Middle Eastern people developed a type of tool that seems to have precipitated a radical expansion of the human mind. Or to put it more cautiously, the tool alone may not have done this—the critical factor may have been a new way of thinking about tools. Or maybe even a new way of thinking in general. Whatever it was, these Stone Age, preagricultural people apparently touched off the first episode of rapid, large-scale social change in the history of our species.[1]

Until their innovation set them apart, these people shared in the general culture that prevailed over most of the inhabited Old World. The principal technologies of this general culture were the use of fire and a relatively simple kit of stone flake tools. This tool kit was the product of nearly 2.5 million years of development. Improvement in it had come at a pace that is, by our standards, excruciatingly slow—so slow that it could be likened to evolutionary change. You might even argue that the kit evolved slower than we did, since it passed through the hands of at least two of our precursor species (*Homo habilis* and *H. ergaster*) before it arrived in the hands of our own.

During all that time, the kit underwent only one major revision: the transition about 1.7 million years ago from the rudimentary choppers and scrapers fashioned by *H. habilis* to the larger, more specialized stone tools of *H. ergaster*. One more major revision, about 250,000 years ago, introduced the stone-flake technology that those Middle Eastern people inherited. Three hominid species, 2.5 million years, and only two major bouts of refinement: doesn't sound like much of a program for mastering the planet, does it?

What those Middle Eastern people did was to break that slow, evolutionary tempo of technical development and create an opening for accelerating change. They did this, essentially, by fashioning blades from stone. In general, these new blade-like tools were larger than the flake tools, and they showed a much

Units of measure throughout this book are metric unless common usage dictates otherwise.

greater investment of design. This new technology is known as the Aurignacian, after the Aurignac rock shelter in the French Pyrenees, where anthropologists first identified it. Aurignacian blades are simple artifacts of modest dimensions—a good-sized blade might be 15 centimeters (about 6 inches) long. But they are beautiful, efficient, and occasionally somewhat menacing.[2]

We have only one or perhaps two generations in which to reinvent ourselves.

For reasons that remain obscure, this technology broadened rapidly, to create a vast expansion of social and cultural life. The tool kit itself came to include more and more novel, specialized equipment like ivory needles, reindeer horn spear points, and rope. More sophisticated tools encouraged more extensive trade. Sea shells from the Black Sea arrived in the Don River valley, 500 kilometers to the north; Baltic amber traveled to southern Europe. Flutes were carved out of bone; music had evidently become a part of life. Complex visual art appeared for the first time as well, in the form of bone pendant jewelry, cave paintings, and carvings in bone, stone, and ivory. It became a widespread practice to include some of those carvings and pendants in human burials—strong evidence for the emergence of complex religions. All these developments got their start in a span of fewer than 10,000 years, which amounts to less than one half of 1 percent of the entire previous life of the stone tool kit. In an evolutionary instant, without any obvious precedent, humanity had reinvented itself.[3]

The development of the Aurignacian technology, which marks the transition from the middle to the upper Paleolithic, is arguably the greatest transformation that our species has ever been through. All the major transformations that followed—the development of metal tools, agriculture, and the various industrial revolutions of more recent times—all these transitions may look more dramatic, but none seems to contain as profound a psychological fault line as does the Aurignacian transition. The people on the far side of these other transformations are all recognizably human in the fullest sense of the term. But the apparently very simple, nearly static way of life in pre-Aurignacian times appears to lack at least one characteristic essential to the makeup of all modern people: the habit of innovation. In this fundamental respect, the Aurignacian transition created us—not biologically, but culturally.[4]

Because it was a kind of cultural equivalent to the primordial Big Bang, the Aurignacian transition may offer important perspectives on our basic psychology—and especially on our capacity for change. Unfortunately, however, the causes of the transition remain obscure, although not for lack of theories. (One explanation, for example, invokes environmental stress: it is known that the transition occurred during a period of climatic instability, and climate change might have challenged the ingenuity of societies in areas where resources were dwindling.)

But turn from causes to consequences, and it is possible to draw some broad conclusions, which might be useful for understanding constructive social change in general. Consider the following three characteristics of the transition as a whole. First, the transition seems to have paid an immense "solution dividend": it improved aspects of life that probably had little to do with whatever caused the initial wave of innovation. Second, the transition moved from the merely technical to become profoundly cultural: it apparently began as a way of making better tools, but it progressed into the arts, trade, and religion. And third, the transition magnified the world:

it created new ways of interpreting the world—new ways of building "deep context" for social and individual life, as is apparent, for example, from the magnificent cave paintings that the peoples of the upper Paleolithic era have left us.

The Challenges We Face

The people who set the Aurignacian transition in motion lived perhaps 2,500 generations ago. Fewer than 500 generations later, the world's first great culture was well established and *Homo sapiens* had become something more than merely a large, common primate. It took only an eyeblink of evolutionary time. We, the generations who share the planet today, are facing a challenge to innovate on a level that may be as profound as the achievement of our distant ancestors. But we do not have 500 generations' worth of time to accomplish the task. Depending on the degree of misery and biological impoverishment that we are prepared to accept, we have only one or perhaps two generations in which to reinvent ourselves. An eyeblink of an eyeblink. Consider five of the most serious threats that future historians might use to define our era.[5]

First, ours is a world in which increasing numbers of people lack the means for a decent life. Global population now exceeds 6.2 billion, more than double what it was in 1950, and is currently projected to rise to between 7.9 billion and 10.9 billion by 2050. Nearly all of that increase will occur in the developing world, where resources are already under serious strain. In these countries, nearly 1.2 billion people—almost a quarter of the world's population—are classed by the World Bank as living in "absolute poverty." These people are surviving on less than the equivalent of $1 a day, and they are generally very vulnerable to additional misfortune—whether in the form of disease, drought, or food shortage.[6]

Worldwide, about 420 million people live in countries that no longer have sufficient cropland per capita to grow all their own food. These nations must rely on imported food—a risky form of dependence for the poorer countries in this group. By 2025, the population of countries that must import food could exceed 1 billion. The quality of cropland in many poor countries is also declining; about one quarter of developing-world cropland is thought to be significantly degraded, and over the past 50 years the rate of degradation has accelerated. But in many places, the biggest threat will not be a shortage of land; it will be a shortage of water. Already, more than a half-billion people live in regions prone to chronic drought. By 2025, that number is likely to have increased at least fivefold, to 2.4–3.4 billion. It is true that there are enormous and largely avoidable inefficiencies in the current food and water supply systems, but a probable minimum population increase of 27 percent over the next half-century is hardly likely to foster either social or ecological stability.[7]

A second threat: our world is in profound geochemical flux. Certain forms of pollution are altering the global chemical cycles that "regulate" key ecosystem processes. The carbon cycle is the best known of these. A vast quantity of carbon that had been removed from circulation millions of years ago—by being absorbed by plants, which were in turn converted to coal and oil—is now being reinjected into the atmosphere. Annual carbon emissions from fossil fuel combustion reached a record 6.55 billion tons in 2001, driving the atmospheric concentration of carbon dioxide to 370.9 parts per million, the highest level it has reached in at least 420,000 years, and probably in 20 million years. Because carbon dioxide traps heat, its increasing concentration is likely to provoke rapid climate change.[8]

The nitrogen and phosphorus cycles, both important regulators of plant growth, are undergoing a similar amplification. Nitrogen becomes biologically available when it is converted from its inert elemental form by being "fixed" into molecules that also contain hydrogen and oxygen. This happens naturally, through the actions of certain soil microbes and through lightning strikes. But human activities have greatly increased the rate of fixation, primarily through fertilizer production, fossil fuel combustion, and the widespread cultivation of plants in the bean family, which often have colonies of nitrogen-fixing microbes on their roots. The destruction of forests and wetlands releases a great deal of additional, already-fixed nitrogen, which had been sequestered in plants and soils. All told, human activities appear to have at least doubled the annual release of fixed nitrogen, to 350 million tons per year. (That figure does not account for changes in the marine portion of the nitrogen cycle, which is not yet well understood.)[9]

The phosphorus cycle is being augmented primarily through fertilizer production. The phosphorus in fertilizer generally comes from mining—a radical amplification of the natural process of phosphorus release, which results from the weathering of rock. The annual release of phosphorus appears to have increased from its natural rate by a factor of 3.7, to 13 million tons per year.[10]

Since both phosphorus and fixed nitrogen are plant nutrients, their presence in vastly greater than natural quantities is liable to cause pervasive ecosystem change. In aquatic ecosystems, this nutrient pollution leads to eutrophication—dense algal growth that chokes out sunlight and causes dissolved oxygen levels to crash. On land, nutrient pollution can homogenize diverse plant communities by encouraging an overgrowth of the weedy species best able to use the excess nutrient. Too much nitrogen also apparently predisposes many plant species to disease and insect attack. (Plants, like people, can "overeat.") In certain forms, excess fixed nitrogen is also a major component of acid deposition, better known as acid rain (even though much of the pollution arrives in the form of gases and dust, rather than as rain or snow). The immediate effect of acid rain is to acidify soil and water, but it also works long-term change in soil chronically subjected to it: it leaches out calcium and magnesium, essential plant nutrients, and it frees aluminum from the mineral matrix that keeps it biologically inert. Free aluminum is toxic to plants and aquatic life.[11]

A third threat: our world is increasingly burdened by the long-term risks associated with toxic chemicals. By a very conservative estimate, for example, global production of hazardous waste has reached 300–500 million tons per year. Depending on what the waste consists of, disposal may involve condensing (the usual first step for contaminated wastewater), incineration, recycling, or neutralization through chemical or biological treatment—all with varying degrees of thoroughness. Or the waste may be injected into deep wells or dumped into landfills in the hope that it will stay put—at least long enough to become somebody else's problem. Of course, many materials not classified as hazardous waste—or as waste at all—are also major pollutants. Pesticides, the antifreeze compounds used to de-ice the wings of airplanes, the chromated copper arsenate in lumber treated for outdoor use: we call such materials products, not wastes, but from an environmental perspective, that's false accounting. They are all destined for the Great Outdoors at some point, either in their original form or as their (sometimes equally noxious) breakdown products.[12]

Our capacity to track the materials moving through our economies is too sketchy to convey more than a vague idea of the chemical insult that we are inflicting on the natural world—and on our own bodies. But there are good reasons for thinking that this insult is enormous and growing. There is, for example, widespread evidence of the pollution of aquifers (underground water deposits) with petrochemicals, heavy metals, nitrates from fertilizer, and other toxics. Aquifer pollution is a serious concern because aquifers frequently contribute more than half the volume of lakes and rivers; they are also a major source of irrigation and drinking water. And because water circulates through most aquifers very slowly—complete renewal generally takes centuries—such pollution is effectively irreversible.[13]

The composition of the pollutants themselves, especially the synthetic ones, is also a matter of concern. Some 50,000–100,000 synthetic chemicals are thought to be in production, as plastics, pesticides, lubricants, solvents, and so forth. Others are created unintentionally, as manufacturing byproducts or as breakdown products of manufactured materials. Many synthetics are not known to be harmful, but others have been found to be extremely dangerous even in trace quantities. Cancer, immunodeficiency, hormonal abnormalities, and birth defects are among the risks associated with them—in wildlife and in people. Some of these toxics bioaccumulate—that is, they contaminate living things in increasing concentrations at higher links of the food chain, a tendency that poses special dangers to high-level predators like eagles, porpoises, and us. Many synthetics are now pervasive in trace quantities, and many have half-lives that are measured in hundreds of years. So for centuries to come, living things themselves will be a reservoir of contamination.[14]

A fourth threat: our world is subjected to an unprecedented degree of biotic mixing. Growing numbers of organisms of virtually every type are moving through the global trading system and emerging into regions where they are not native. These exotic species travel in the ballast water of ships, in packing material, in raw wood products, in crop shipments, and in many other ways. Most exotics do not survive in their new homes, but a small portion succeed in establishing colonies. If an established exotic finds nothing in its new home to keep its population in check, it may go on a reproduction binge. Depending on what it is, an invasive exotic may outcompete native species for some essential resource, or launch an epidemic, or prey on natives directly.[15]

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The result often goes beyond the suppression of the exotic's immediate victims to include other species that depend on those victims in some way. For example, the highly invasive Argentine ant is displacing many native ant species in dry areas of the tropics and warm temperate zones; the loss of the native ants, in turn, suppresses the plant species that rely on them for pollination or seed dispersal. Eventually, a cascade of ecological effects may work profound change in the invaded community by simplifying its structure, altering its nutrient cycles, and homogenizing its species composition. Even though comprehensive statistics on the problem are not available, the growth of the trading system virtually guarantees that the rates of invasion are increasing. More and more of the world's diverse natural communities are in danger of being dominated by a relatively small number of highly invasive organisms.[16]

And finally, a fifth threat: by virtually every broad measure, our world is in a state of pervasive ecological decline. Primary tropical forests, in general the most diverse ecosystems on the planet, are disappearing at a rate probably exceeding 140,000 square kilometers per year—an area nearly the size of Nepal. Total global forest cover, which now accounts for about a quarter of the planet's land surface excluding Greenland and Antarctica, may have declined by as much as half since the dawn of agriculture. About 30 percent of surviving forest is seriously fragmented or otherwise degraded, and during the 1990s alone, global forest cover is estimated to have declined by more than 4 percent. Wetlands, another highly diverse ecosystem type, have been reduced by more than 50 percent over the past century.[17]

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Coral reefs, the world's most diverse aquatic ecosystems, are suffering the effects of overfishing, pollution, the spread of epidemic disease, and rising sea surface temperatures that many experts link to climate change. By the end of 2000, 27 percent of the world's coral reefs were thought to be severely damaged, up from just 10 percent in 1992. Throughout the oceans, overfishing is taking an ever greater toll: some 60 percent of the world's marine fisheries are now being exploited at or beyond capacity—an invitation to extensive ecological disruption. And according to the IUCN–World Conservation Union, about one quarter of the world's mammals are now in danger of extinction, as are 12 percent of the world's birds. Comprehensive figures do not exist for other major groups of organisms, but in samples of other vertebrate classes, levels of endangerment were similarly high: 25 percent for reptiles, 21 percent for amphibians, and 30 percent for fish.[18]

Ordinary Miracles

These damage assessments often have an air of unreality about them because they bear little obvious relation to life as it is ordinarily lived—at least by the likely readers of this book. There are several reasons for this disconnect. In the first place, large economies tend to displace the ill effects of behavior from the behavior itself. Few of us ever encounter the toxic waste, soil degradation, or unsustainable mining and logging that support our collective consumption patterns. There may be a basic psychological problem at work here as well, since a great deal of environmental degradation cannot be readily seen. Human beings understand their worlds largely on the basis of sight; invisible threats, especially long-term ones, do not appear to play to our evolutionary strengths.

More generally, it's conceivable that our own inherent adaptability is to some degree working against us—preventing us from recognizing the gravity of the situation. *Homo sapiens* is the ultimate all-terrain animal, as is apparent from the successes of our distant ancestors. Fire and a few simple stone tools were all the equipment they needed to colonize entire continents. We are a generalist species, not a specialist species. We're not like pandas, tanagers, or orchids. We are much more like dandelions, starlings, and rats. We don't need a high state of natural integrity in order to thrive—and apparently, we are not predisposed to react with alarm at its loss.

But the biggest obstacle to reinventing ourselves may simply be a kind of paralysis of hope. It is possible to see very clearly that our current economies are toxic, destructive on a gargantuan scale, and grossly unfair—to see all this and yet still have difficulty imagining effective reform. It's not that it is hard to envision the paths that reform would have to take; at this point, we have a fairly clear sense of where we need to go (on a technical level, at least, if not always on a cultural one). In the energy economy, for example, the path of reform leads away from fossil fuels and toward renewable energy sources, like wind and solar. In materials production, it leads away from a primary reliance on mining and toward cycles of continual reuse. In trade, the path would presumably lead to meaningful engagement of ecological issues like bioinvasion, and social ones like the loss of local production. And in international relations, the path might begin with a recognition of the obvious: we have built a global economy that assigns one quarter of humanity to the misery of absolute poverty, while the wealthiest 20 percent of the world's people account for 86 percent of total private consumption. Even apart from the offenses to reason and ethics, it is hard to see how "secure" such a world could ever be.[19]

And yet despite the obvious need for change, and despite our obvious technical competence, it can still be hard to believe that real, fundamental change is possible. We are used to constant flux in the daily details of existence, yet the basic structure of the status quo always looks so unalterable.

But it's not. Profound change for the better does occur, even though it can be difficult to see because one of the most common effects of success is to be taken for granted. What looks perfectly ordinary after the fact would often have seemed like a miracle before it. Or sometimes maybe more than a miracle: the results of the Aurignacian transition would probably not even have been comprehensible before the fact. Consider two ordinary miracles from our own era—two changes in which technical effort has created vast cultural opportunity, and in which benefits are accruing far out of proportion to costs.

Consider first the eradication of smallpox. In January 1967, when the World Health Organization (WHO) announced a program intended to eliminate smallpox within a decade, the disease was infecting 10–15 million people every year, primarily children. It killed 1.5–2 million of them and left many of its survivors blind or covered with disfiguring pockmarks. More than 1 billion people, 29 percent of the world's population at the time, lived in countries where the disease was endemic (that is, continually present). Even in industrial countries, where comprehensive vaccination programs had eliminated it as an endemic threat, smallpox remained a chronic security problem because of infection risks from abroad.[20]

When it was announced, the WHO program looked naive at best to many scientists and public health officials. It had grown out of an agreement reached at the Twelfth World Health Assembly in May 1959, which had also called for the elimination of smallpox but had achieved almost nothing. The precedents with other diseases were similarly discouraging. Eradication campaigns had often yielded promising results in particular regions, but always seemed to founder when scaled up to the global level. The first of these efforts, a campaign to eradicate the hookworm parasite, had been launched in 1913 on the strength of a successful control program in the U.S. Southeast. But by the early 1920s it was clear that the parasite was not well enough understood to be eliminated everywhere. The global campaign against yellow fever, begun in 1918, had grown out of early successes in Panama and Cuba, but the eradication objective had to be abandoned in the early 1930s after researchers in South America discovered yellow fever in wild mammals—reservoirs of the pathogen that they had no way of eliminating.[21]

Malaria eradication had taken a similar course. In northeastern Brazil in the late 1930s, a campaign against a newly arrived African mosquito, *Anopheles gambiae*, completely eradicated it in less than two years. This mosquito is Africa's most important malaria vector. Its removal from Brazil was an astonishing achievement, but that success also turned out to be a deceptive precedent: global malaria eradication, begun in 1955, was running out of steam by the mid-1960s. It was abandoned in 1969 with the recognition that, in most areas with endemic malaria, it was not possible to suppress the mosquitoes long enough to clear human populations of the parasites that cause the disease. (See Chapter 4.) By the mid-1960s, the concept of disease eradication as a policy goal was falling into disrepute. In his 1965 book, *Man Adapting*, the distinguished scientist and philosopher René Dubos caught the prevailing attitude: "eradication programs," he wrote, "will eventually become a curiosity item on library shelves, just as have all social utopias."[22]

Lack of credibility was not the smallpox program's only problem. It was also chronically starved for funds; it lacked any authority other than moral; and it was not always seen as a priority in developing countries, where smallpox was often just one among many serious threats to public health. But despite all the obstacles, the program succeeded—thanks to persistence, a willingness to adapt to varying conditions, and a thorough understanding of the pathogen's weaknesses. (Smallpox was a good target for eradication because it is not "vectored"—it has to be transmitted directly from one person to another—and because there was a reliable vaccine for it.) The world's last "natural" (nonlaboratory) case of smallpox was discovered in Somalia, on October 26, 1977, just 10 months beyond the original target date for eradication. The total cost of the WHO program probably amounted to less than $300 million (equivalent to $700–800 million today). Even in the crudest economic terms, every country benefited because preventative measures against the disease were no longer necessary. The United States, the largest single donor to the campaign, is estimated to make back its total contribution every 26 days. Barring the release of the pathogen from one of its artificially maintained stocks, smallpox is a problem solved and the world is a better place because of that.[23]

Smallpox eradication required the cooperation of thousands of officials and fieldworkers—and millions of parents of unvaccinated children. But as a WHO program, it was still essentially change from the top down. On many fronts, however, constructive change will likely depend much more heavily on public initiative—on a sense of direction supplied by nongovernmental organizations and large numbers of individual people. Change from the bottom up is likely to be more diffuse and less "focused," but here too there are encouraging precedents.

Consider population growth, one of the biggest environmental problems of all, yet in a sense one of the least "public." The increase in our numbers is an aggregate consequence of personal attitudes toward sex and procreation—subjects that are just about as private as you can get. Significant change on this front is a fundamental type of cultural change, and in the usual view, that is not something that is likely to happen quickly. In societies that value large families, we might hope to see ideal family size shrink, but only gradually.

And certainly this view has some strong evidence to support it. The baseline precedent for such change is the European demographic transition, a complex development in which improvements in sanitation, nutrition, education, and general standards of living accompanied declines in child mortality and in the average number of births per woman (known as the total fertility rate, or TFR). The European demographic transition took over 100 years. In the late nineteenth century, the continent's TFR was around 4 or 5; today, the continental average has dropped below the 2.1 "replacement rate." (Over the long term, a population that maintains a 2.1 TFR will stabilize: the number of births will eventually come to equal the number of deaths.)[24]

To demographers, the lesson from the European experience seemed clear: the decline to replacement rate is gradual because the necessary social changes are complicated, expensive, and slow to mature themselves. But by the late 1980s, the experts were beginning to see a pattern that did not fit the European precedent. Several East Asian countries were undergoing the "classic" transition (that is, declining TFRs and rising standards of living), but they were doing it in a radically compressed time frame. In Indonesia, Japan, Singapore, South Korea, Taiwan, and Thailand, TFRs had been dropping at least since the 1960s; today, all these countries have reached the replacement rate or will soon do so. Their transitions, most of which took only 25–30 years, are usually credited to rapid economic growth accompanied by several technical and administrative advances, primarily well-developed family planning programs and substantial improvements in health care and education.[25]

Demographers did not, however, see these East Asian transitions as a reason for major revisions in the global population projections. Nor, in retrospect, should they have: world population nearly quadrupled over the twentieth century, and while it is true that industrial-country TFRs now average 1.6, the vast majority of humanity is not living in places that are likely to undergo classic demographic transitions, accelerated or otherwise. South Korea is no model for India, China, or Nigeria. So as recently as the first half of the 1990s, the standard estimates held that global population was increasing by 86–90 million per year, and that it would continue to grow at that rate for years to come. For example, the report of the International Conference on Population and Development, held in Cairo in 1994, cited current U.N. projections for its estimate that "annual population increments are likely to remain close to 90 million until the year 2015."[26]

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But once again, reasonable expectations have been ambushed by unanticipated change. Eight years after the Cairo conference, the annual increment of population increase is now estimated at around 77 million. In part, this lower number results from a sort of accounting restatement: demographers now think that the annual increment at the time of the Cairo conference was probably around 81 million, not 86–90 million. But the rest of the difference is believed to reflect an actual decline in the increment, on the order of 4 million people. (Note that the population as a whole is still increasing; the decline is in the number of people added to it every year.) This drop in the increment marks a new trend. Until the early 1990s, the increment had been growing; it is now declining, and the decline is projected to continue.[27]

The new trend results from a couple of unexpected developments, one of which is very bad news: the death toll from AIDS is now large enough to influence global population statistics. But the main reason for the decline is not more deaths; it is fewer births. In about a dozen heavily populated developing countries, TFRs have declined substantially, even without significant improvements in standards of living. Iran, for example, reduced its TFR from 5.6 in 1985 to 2.0 in 2000, despite a long, debilitating war with Iraq from 1980 to 1988, economic stagnation, and the Revolutionary government's initial hostility to birth control—a position that was reversed in 1989.[28]

Organic farming is now the fastest-growing sector of the world agricultural economy.

Even where the declines have still not brought the TFR to the replacement rate, they are nevertheless remarkable. For example, Bangladesh, a very poor country, has seen its TFR decline from 7 in the 1970s to 3.3 between 1996 and 2000. Neither Bangladesh nor Iran has seen major improvements in most living standards, but they do share one important social feature: both have managed to develop extensive family planning programs that enjoy strong official support and broad public acceptance.[29]

A looser example of such change can be found in Latin America and the Caribbean, a region that now has an overall TFR of around 2.5, down from 6.0 in the first half of the 1960s. It is not surprising that here too the drop in TFR often correlates with increased availability of family planning services, particularly contraception. It is somewhat surprising, though, that the trend is apparent even in some of the region's poorer countries—Peru, for instance. In the *2002 Human Development Index* prepared by the U.N. Development Programme, Peru ranks eighth among the 12 South American countries, yet this nation has seen its contraceptive usage rate rise from around 40 percent of married women in the late 1970s to 64 percent by 1996. Peru's TFR fell from over 5 to 3 during the same period.[30]

Of course, these partial "transitions on the cheap" were well under way at the time of the Cairo conference. And in a sense, they were in plain sight. But it was very difficult to see them because the pattern had not been recognized.

Do these various TFR declines mean that population growth will soon cease to be a major social and environmental concern? Hardly. In fact, the U.N. medium projections for global population growth have recently been revised slightly upwards. The medium projections are often considered the "best bet" about where population trends are headed. (See Chapter 3.) There are several ways in which current TFRs factor into those projections. For one thing, there are still countries, primarily in sub-Saharan Africa, where TFRs remain high and where demographers do not anticipate significant declines anytime soon. And of course in highly populated countries, even "moderate" TFRs can yield enormous increases in population size. India is by far the most dramatic example of this: with a population of a little over 1 billion and a TFR of 3.2, India is currently growing by 17.6 million people a year. Nor is it inevitable that "moderate" TFRs will just keep dropping at a steady rate: unfortunately, over the past few years TFR declines have slowed in several densely populated countries, including Bangladesh, India, and Nigeria. And even after a country's TFR drops below the replacement rate, its population may continue to expand for decades—a phenomenon called "population momentum." China, for instance, has a TFR of only 1.8, but its population of nearly 1.3 billion is still increasing by 11.5 million per year.[31]

Population momentum is easier to understand if you think in terms of the age structure of the population. Societies that have just arrived at the replacement rate tend to be disproportionately young: there are usually many young people but far fewer older ones. Since most deaths occur among older people, there are not initially enough deaths to compensate for the births, even at the 2.1 TFR. The compensatory deaths occur later, as that young demographic bulge moves into middle age and beyond. In the meantime, the population keeps growing. Overall, the developing-world TFR is now a little less than 3, about half of what it was as recently as 1970. The current projection, for whatever that is worth, puts the average TFR in developing countries at 2.17 in 2050.[32]

These unexpected demographic transitions offer no grounds for complacency, but they do offer reason for hope. We are not inevitably destined for the demographic worst-case scenario—a crowded, denatured planetary dystopia of war, poverty, and disease.

There are reasons for hope in many other fields as well—developments that are broad-based although often only partially realized, and that are not yet well integrated into the predominant views of the world. Such change can be seen, for instance, in organic farming, which is now the fastest-growing sector of the world agricultural economy and which could rejuvenate rural communities in countries as varied as the Philippines, Sweden, and the United States. It can be seen in renewable energy technologies, where rapid technical advances and declining production costs are driving increases in wind and photovoltaic generating capacity on the order of 25 percent a year or more. (See Chapter 5.)[33]

Some grounds for hope can be found even for that most famous and least successful cause on the environmental agenda: the conservation of tropical nature. The park—a concept that has often been maligned as politically unrealistic in much of the tropics—has over the past several decades quietly proved its worth. Parks contain almost all that is left of nature on a grand scale in Cuba, the Dominican Republic, Ghana, India, Madagascar, the Philippines, South Africa, and Thailand; they contain most of what is left in many other Latin American, African, and Asian countries. Major investments in this simple approach—essentially, setting places aside for nature—are as critical to the well-being of the planet as investments in renewable energy or family planning.[34]

Roughly 50,000 years after innovation became a human trait, we live in a world that is increasingly of our own making. But it is no less mysterious and challenging than was the world inhabited by those Stone Age authors of innovation. By many measures, the distance between those people and ourselves is so vast that it would be difficult to measure. Our technologies and social consciousness would hardly seem to have a parallel in their culture. And yet in some fundamental respects, our struggles echo theirs. We too rely on technical achievement to catalyze cultural change. We too have a habit of creating "solution dividends." And who knows? Maybe 50,000 years from now, our distant descendants will wonder how we managed to magnify their world in ways that we ourselves could not have imagined.