Global Scenarios for the Millennium

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It sounds too clichéd to be true, but the major scenarios for the years around 2000 really are catastrophe or transformation. To see why, we need a way of looking at history with a wide-angle lens.

Two measures can help us do this—one is global human population, and the other is the flow of materials through the economy. We know how these two have changed over very long periods of time, and we also know that they are among the most important factors shaping future global conditions.

The growth to today's population level of 5.8 billion was sudden and historically anomalous. Sometime around 1750, at the onset of the industrial revolution, the population began to grow at an unprecedented exponential rate. Exponential growth means a doubling with each given unit of time. Like a rocket taking off, at first it appears slow, and then suddenly accelerates into an astonishingly fast increase.

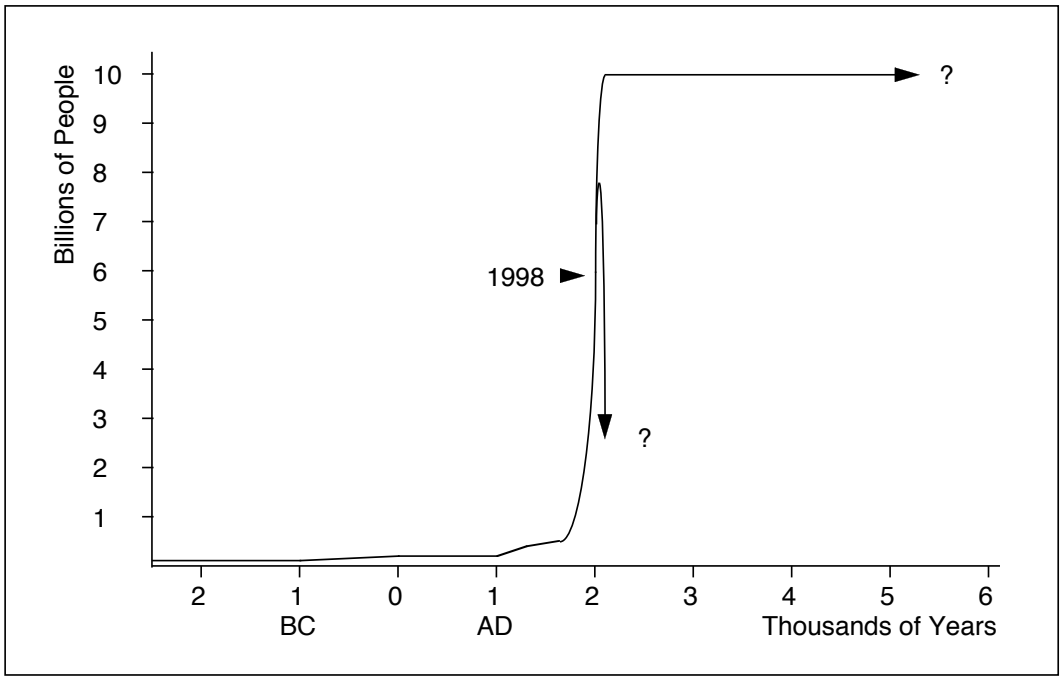


Figure 1: Global Population Growth

Figure 1 shows a simplified view of world population for the past several thousand years. It also shows the extraordinary jump that has happened in the last 250 years. For thousands of years, the human population bumped along at a few hundred million people worldwide, growing slowly. In fact the increase was not steady during this period—there were alternating surges and contractions—and there was no consistent exponential growth towards present levels as many people assume. The average growth rate from 1650 to 1950 was about 12 times greater than during the previous 10,000 years, and it more than doubled again after 1950.

Today, the world population is still growing extremely fast, even though the growth rate is slowing slightly. More people have been *added* to the world population in the 1990s than existed in the entire world in 1750. The world population has doubled during the lifetime of anyone now over 40, and if present rates of growth are maintained, the total population will double again within the next 40 to 50 years.

The graph for the flow of materials through the industrial system over the same timeframe looks similar to Figure 1, except that growth is twice as fast—during the last few decades it has been doubling every 20 years. Environmental impact is determined by industrial throughput, so, for example, the amount of carbon dioxide released into the atmosphere every year has also doubled twice over since 1950.

The shape of the curve in Figure 1 looks like a quantum jump, or a square-wave trace on an oscilloscope. Nothing in history up to 1750 gives a hint of what was about to happen. And the question now is whether anything in our experience helps us to understand what is going to happen next. Even if the human race eventually masters space travel and spreads to other planets, there will presumably still be an upper limit to the viable population size on any one planet.

There is general agreement that the Earth cannot support indefinite exponential growth. But what will bring this growth to an end, and how soon? Scenarios help answer these questions by preventing us from getting locked into denial or apathy. If we can't be sure there will be a crisis we tend to stop thinking about it, but if we do predict it we become fatalistic. Either way we stop looking for solutions. Scenarios cut through this dilemma. They work by allowing us to think about future possibilities without having to decide which one is "true." Far better to put an optimistic scenario next to a pessimistic one and realize that the choice of outcome can be ours.

The official scenario of governments around the world is that world population will smoothly decelerate and the growth curve will flatten out, like the upper "question mark" curve in Figure 1. This is not an unreasonable scenario: the population appears to have passed its peak growth point, and many biological systems do show this "S-shaped" growth pattern.

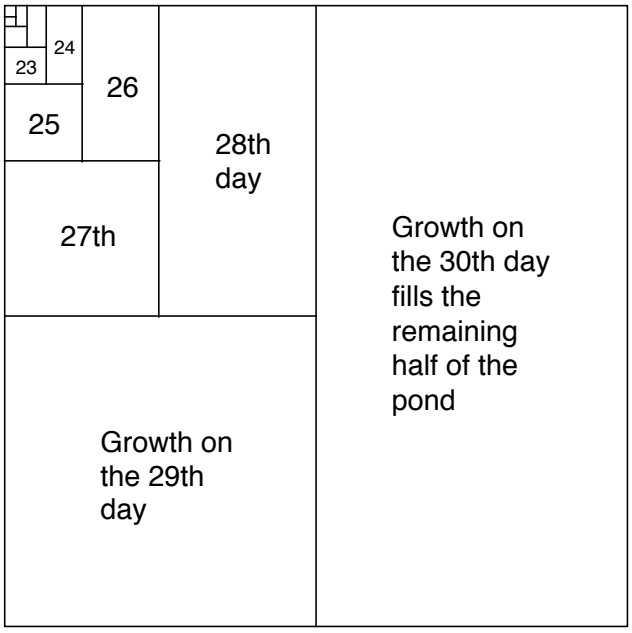
But this optimistic outcome is not guaranteed: extremely rapid growth is causing social and cultural dislocation around the world, and technological advance is running ahead of our ability to control it. By almost every measure, we are living at a historically unique time of high risk. There is a real but unquantifiable possibility that instead of a smooth deceleration, the population could plunge as a combination of economic and ecological disasters strike, triggering wars and causing food production to plummet. Hence the other basic possibility shown by the lower "question mark" curve in Figure 1 is a future population collapse.

BOX: Exponential Growth.

A French riddle for children, quoted by Donella Meadows, illustrates what happens if there is exponential growth in a closed system: "Suppose you own a pond on which a water lily is growing. The lily doubles in size each day. If the plant were allowed to grow unchecked, it would completely cover the pond in 30 days, choking off all other forms of life in the water. For a long time the lily plant seems small, so you decide not to worry about it until it covers half the pond. On what day will that be?"

The answer, surprising on first encounter, is on the 29th day. What is also worth noting is just how small the lily is for most of the month—as late as the 25th day it still covers only 1/32 of the pond.

The figure below shows the last few days of this growth diagrammatically, and shows that the first 20 days are far too small to even show at this scale. Having reached the halfway point, it only takes one more doubling to use up the remaining resources—in this case half the surface area of the pond. By analogy, if the exponentially-growing human economy is now using half the output of the biosphere (see text), we may well have reached the global "29th day."



A water lily doubles in size every day for 30 days. When is the pond half full?

Source: Donella Meadows et al, *Beyond the Limits* (Vermont: Chelsea Green, 1992).

This frightening possibility is certainly plausible: many biological systems show population crashes when crucial environmental resources are depleted. And the global human population has crashed in the past—for example the Black Death killed between a third to a half of the population of Europe and Asia in the 14th century.

Of course, even if the global system does go into crisis there is always a chance of recovery. In fact, some people believe we will not get serious about change unless there is a crisis. But waiting for a crisis is risky: it could undermine our ability to respond—and an uncontrollable collapse of population, society and industry could spell the end of technologically advanced civilization just as surely as total nuclear war.

If these scenario possibilities are far in the future they are perhaps a distant concern for today's generation. Unfortunately there is every indication that they may be imminent. One of the unnerving features of exponential growth in a finite environment is that it will use up all remaining available resources during a single doubling period after it reaches the halfway mark. And we do appear to be close to that point.

An estimate made in 1986 by Peter Vitousek at Stanford University indicated that the human economy was then using 40% of the total annual biomass production of the land-based biosphere. If we are now close to the 50% mark, it will only take one more doubling of consumption to use up the other 50%. Because industrial production is doubling every 20 years, within 20 years we may be using 100% of total biospheric output, leaving nothing for natural habitat and natural ecosystem functioning.

But we may not be able to reach 100% without running into serious problems such as water supply shortages and the cumulative effects of chemical pollution, not to mention the resulting possibility of armed conflict. In short, we may only have as little as 10-15 years (or less) left before things go seriously and suddenly wrong. This is also the timespan within which we must act if we are to voluntarily decelerate exponential physical growth.

All these possibilities are summarized in Figure 2. The entry path to each of the scenario outcomes is the same: "business as usual." This path is unsustainable and leads inevitably to crisis if no other action or change occurs. But there is also a path of "voluntary transformation," in which the economy becomes much more sustainable and reaches a state where it no longer depends on continued exponential growth of people and industrial throughput. If a crisis does happen, there are two possible paths. One is a total collapse, and the other is a recovery leading to the same kind of post-physical-growth economy as the voluntary transformation path.

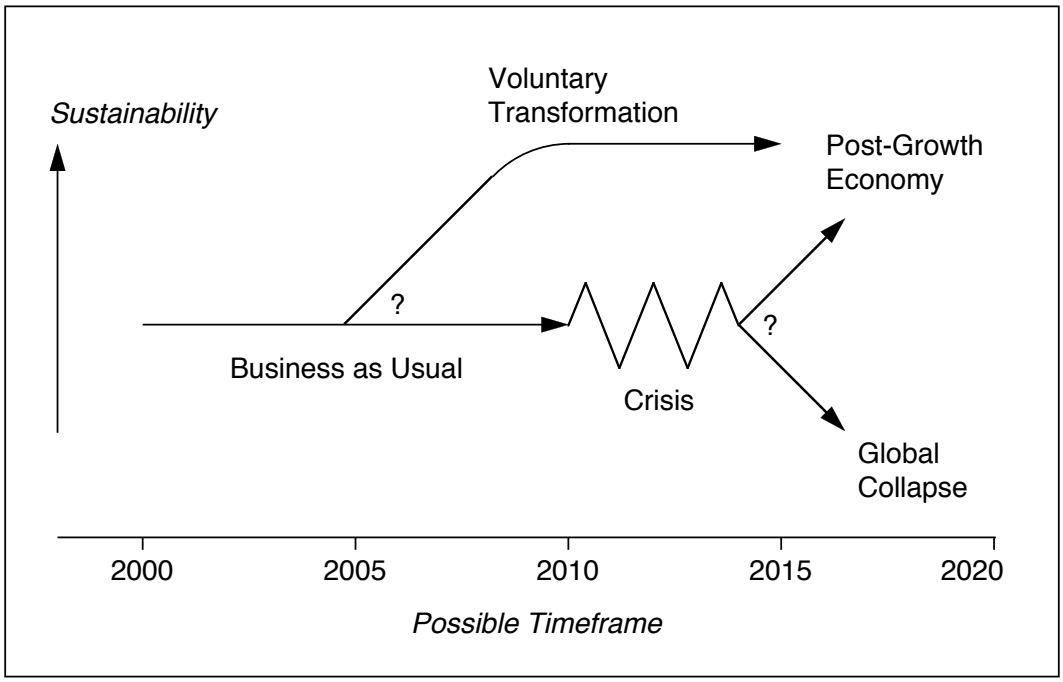


Figure 2: Global Scenario Framework

The downside scenario is not pleasant to think about, yet it is not difficult to paint the picture of major global problems reaching crisis pitch. There are plenty of candidates: global climate change, food and water shortages, weapons of mass destruction, genetic depletion and damage, antibiotic-resistant epidemics, social inequity and injustice, energy shortfalls, economic depression, chemical pollution, and ecosystem failure, to name just a few.

These problems are not isolated—many have common root causes, and they tend to amplify each other. Under adverse circumstances they could all reinforce to create one mega-crisis, a crisis of crises. This is the downside scenario, and it is easy to become mesmerised by the apparent inevitability of the slide into chaos.

This is why it is important to understand the positive changes that are needed to prevent a global crisis, to fully appreciate the nature of the upside scenario. If we clearly see the risk, and if we understand what is needed to avoid it, we stand a chance of acting with constructive foresight.

If it is inevitable that population and materials flows will decelerate in the relatively near future, what are the implications of the scenario pathways which can get us to a new kind of economy successfully? First, the positive pathways, whether voluntary or through a crisis, imply very significant social, technological

and economic change—hence the use of the term "transformation." In the positive scenarios, the outcome is a completely new kind of economy. It would be able to deliver prosperity equitably around the world, in balance with the natural environment, without depending on exponentially-growing materials flows, and at the same time population growth would slow and stabilize.

How can this outcome be achieved? We will have to learn new ways of doing things, and this implies new attitudes and ways of behaving, new laws, and new technology. Technology is a particularly important source of change, because it most directly determines the scale of materials flows through industry, but it is not the whole story.

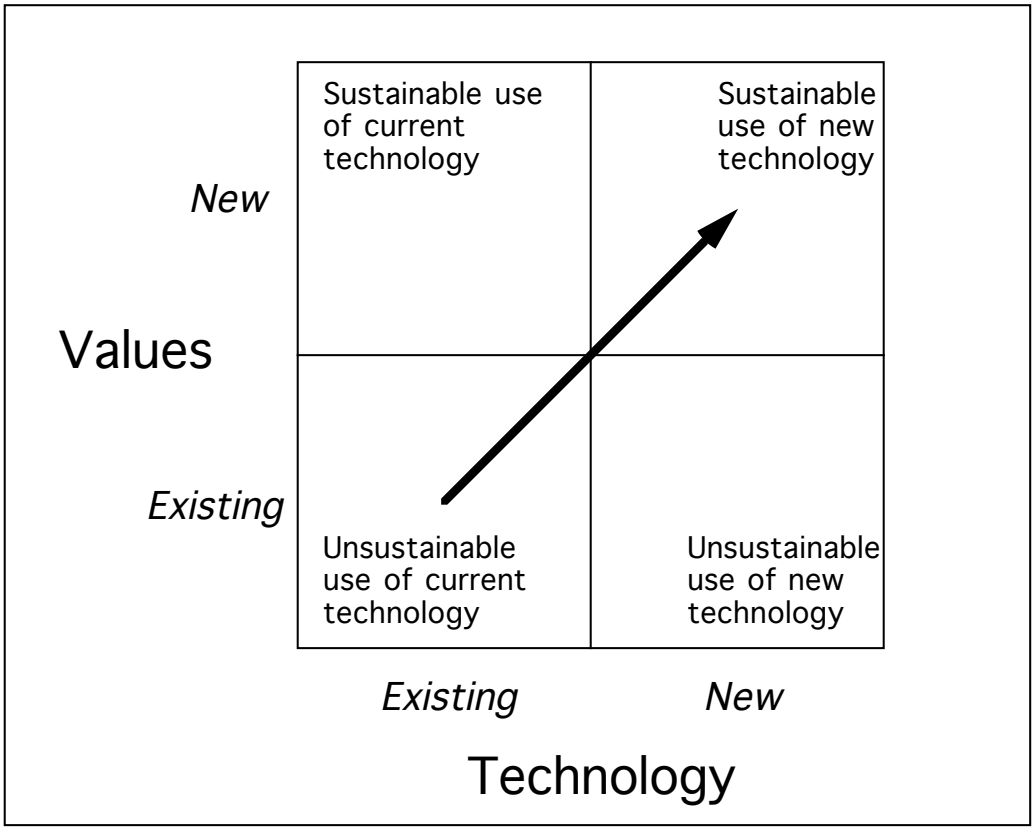


Figure 3: How Values Shape Technological Outcomes

Figure 3 shows the contribution technology can make. The path of viable future development in any optimistic scenario is from the bottom left quadrant of the matrix towards the top right, as the arrow indicates. Change in either values or in

technology alone is not enough: the two must happen in conjunction. One of the reasons for this is that technology—and new technology in particular because it is more powerful—can either help provide solutions or make the situation worse. What makes the crucial difference is human intention.

Technology and scientific knowledge are advancing extremely rapidly and are now providing the capabilities we need to create an economy that does not depend on ever-increasing physical growth. If underlying social beliefs shift—with a growing interest in less materialistic personal values and deeper meaning—this can be expected to lead to greater concern about global issues and the environment, leading in turn to new priorities in technological design. In this way, new technological potentials can be directed along a path of development which is part of the solution rather than part of the problem.

For example, if biotechnology in agriculture is applied in a narrow reductionist way (bottom right quadrant), it could contribute to ecosystem destabilization. Yet exactly the same technology applied within an ecosystemic paradigm (top right quadrant) could result in increased food production and improved ecosystem health. (Another way of expressing this would be to say that just because biotechnology is biological, does not mean that it is also ecological.)

Equally, expressing new social values using only today's technology is likely to mean unnecessary austerity. For example, a sustainability outlook might lead people to choose to give up heating and air conditioning and shiver or swelter in conventional houses (top left quadrant). But by expressing their new intent in terms of technology they could choose instead to be comfortable in houses with passive heating and cooling (top right quadrant). Behaving less wastefully is praiseworthy, but why ignore the potential of new technology?

The matrix in Figure 3 does not tell the whole story of the scenarios—our beliefs shape more than simply technology—but it does illustrate why new technology is not enough on its own to enable the safe deceleration of exponential growth.

If our beliefs and values change, the way we determine value in transactions will also change. This means change in economics, which today has become the most powerful expression of the mechanistic paradigm. Economics started as an overlay on a rich field of social values. Today, most of the underlying values have been driven out in favor of the values inherent in economics itself—which are not human values at all, but the values of mechanism. The transformation in economics must start with a renewal of human values, and a growing need to reassert them in the way we value activity and productivity.

Our infatuation with mechanisms has led us to elevate the automatic machine-like functioning of the market to be the highest value in economics. We treat the market as if it is able to make moral decisions. As a result, society has become increasingly insensitive and lacking in compassion. Only humans can make judgements about conditions humans should experience—this cannot be delegated to a non-human machine, however ingenious and computer-like.

The market does have value as a computing platform, but in effect it is running the wrong software. Economics analyzes "the allocation of scarce resources among competing wants." But with today's technological capability we could in principle provide for everyone. And we are coming to see the world itself as a living, provident organism, not a lonely lump of rock in an empty universe. Economics and the market need to be reprogrammed for abundance and cooperation, instead of scarcity and competition.

But can we have abundance and deceleration of exponential physical growth at the same time? The keys to this are better satisfaction of non-material wants, more equitable distribution (made easier by a mindset of abundance), and reducing the amount of materials and energy needed per unit of economic output.

Technologically, providing many more people with an adequate material standard means each product must use less material—a process referred to as dematerialization—allowing more products to be manufactured with the same flow of materials. If nanotechnology—manufacturing with atomic-level precision—lives up to its promise it could profoundly accelerate dematerialization.

The exact shape of a future economy of post-exponential abundance is still speculative and the technical details are complex, but it would probably involve a balanced expression of four sets of key values. These would be: material (like the current economy); ecological; communal; and personal. Aiming for quality in each of these four categories would lead to developing and maintaining four corresponding kinds of capital—manufactured, ecological, social, and human. The economist Paul Ekins calls this the "four capitals" model of a sustainable future economy, in contrast with today's economy, which is based on *exploiting* three factors of production: land, labor and capital.

In a sustainable economy, issues such as global social equality would be a primary concern. Although this article uses population growth as a primary indicator of the situation we find ourselves in, it is *not* a proposal that we should try and manipulate population levels directly. The most powerful means of slowing population growth are indirect, but valuable in their own right: alleviating

poverty and improving education. If people have a sense of economic security and a feeling that they have some say over the course of their lives and can make a meaningful contribution, they are less likely to resort to large families as a form of insurance policy.

The idea that the richest need to help the poorest is a familiar refrain, but probably the most effective way this could happen would be by addressing the way the global economic system perpetuates inequality. This would mean a rethink of such things as international trade arrangements, international debt, interest rates, international intellectual property rights, exchange rate speculation, and international armaments manufacture. However, the northern countries will not even be able to appreciate what the problem is without a shift of perspective that appreciates the condition of the whole, instead of upholding the narrow interests of one country or economic grouping.

Continued blind belief that we already have a system that can deliver the best long run outcomes "automatically" is a major obstacle to the change that is needed. The entire existing system is a human construct, which has evolved as a result of conscious design decisions reflecting past priorities. But the priorities in today's world of globalizing industrialization and growing global inequality are very different.

We now need to think about designing—with the participation of all—a new global framework of internationally binding laws, institutions, and economic structure that can deliver prosperity equitably to the population of the entire world. In fact, the scenarios suggest that we will inevitably find ourselves doing something like this if we move along the optimistic scenario path.

The scenarios presented here are "global scenarios." They deal with global-scale developments that can frame customized scenarios developed by corporations, government agencies, and non-profits. Global scenarios are useful, because they assemble and present the findings of background research in a way that allows individual organizations to relate their planning to larger-scale issues without first having to do their own detailed research and analysis. When focused scenarios are nested within global scenarios, fine-grain futures are given a large-scale backdrop. Then, if developments in a particular industry are seen to parallel large-scale trends, the industry's strategic environment can be interpreted with more confidence.

For example, the global scenarios indicate (when developed in more detail) that energy sources will "decarbonise" in the optimistic scenarios. In other words, the percentage of carbon in the world energy mix will begin to approach zero—the

completion of a long term trend that has been underway for 150 years or more. This insight allows companies in, say, the electricity business to reinterpret the Kyoto agreement as the first formal step in an inevitable process of global materials throughput reduction.

Similarly, the global scenarios point to major changes in manufacturing industry. Substantial reductions in the environmental impact of industrial activity will be achieved by a conscious effort to reconfigure and redesign industry. It is likely that materials will move in closed-loop pathways—from factory to product and back to factory, to be turned into new products once again. Once industry is based on a cyclic flow of materials, the demand for ever more raw materials will decline.

Perhaps the most powerful overall message is that any optimistic view of the future must contain very significant transformational change, as materials flows and population growth decelerate. Whether we view these changes defensively or proactively, it is apparent that most industries and activities will experience a deep shift of perspective and values, and a parallel shift to a new legislative, economic and technological base. Put simply, either there will be a system-wide crisis, or a solution will emerge. But the solution will not be an incremental modification of the way we do things now—it will be an entirely new kind of economy.

The analysis in this article shows that the year 2000 marks the threshold of a major transition in human development, and the scenarios show that the stakes are high. But we do have a say in the outcome. If we are willing to think and act in new ways, each one of us can help create a sustainable global civilization as our gift to the future.

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