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Perspective

Visions of Alternative (Unpredictable) Futures and Their Use in Policy Analysis

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ABSTRACT

The most critical task facing humanity today is the creation of a shared vision of a sustainable and desirable society, one that can provide permanent prosperity within the biophysical constraints of the real world in a way

that is fair and equitable to all of humanity, to other species, and to future generations. Recent work with businesses and communities indicates that creating a shared vision is the most effective engine for change in the desired direction, yet most effort in "futures modeling" has focused on extrapolating past trends rather than envisioning alternative futures. Science and economics as applied to policy are in conflict more often over alternative visions of the world than purely "scientific" disagreements. Likewise, governance has gotten bogged down in mediating short term conflicts between special interests rather than its more basic role of creating broadly shared visions that can guide dispute resolution.

This paper addresses the question of what policies are most appropriate for society now, given alternative visions of the future and the enormous uncertainty about the reality of the assumptions underlying these visions. Four specific visions are laid out as being representative of the major alternatives. For each vision the benefits of achieving the vision, the assumptions that would have to be true in order for it to be achieved, and the implications of it being attempted but not achieved are explored. It is argued that dealing with uncertainty about the nature of the world, its carrying capacity for humans, the impacts of climate change, and other aspects of its future can best be done at this level of future visions and assumptions, not at more detailed levels (like the parameter uncertainty in models). Application of this vision/uncertainty analysis can help us both to design the future society we want and to maximize the chances of our getting there safely.

KEY WORDS: alternative futures, change process, envisioning, public judgment, public policy analysis, uncertainty.

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INTRODUCTION

The world is at a critical turning point. There is significant uncertainty about how things will go in the next few years, but there is growing consensus that the decisions we make as a society, at this critical point, will determine the course of the future for quite some time to come. There is a tendency in thinking about the future to simply extrapolate past trends. If we have been getting materially richer in the past, then the future will be more of the same. If the environment has been deteriorating, then it will continue to do so. But one of the lessons we can learn from history is that trends do not continue smoothly. There are turning points and discontinuities that were impossible to predict from past trends. The dissolution of the Soviet Union, the Berlin Wall coming down, and landing a man on the moon are three examples.

What we are learning about the change process in various kinds of organizations and communities is that a necessary ingredient to move change in a particular direction is having a clear vision of the desired goal which is also truly shared by the members of the organization or community (Senge 1990, Wiesbord 1992, Wiesbord and Janoff 1995).

In another context, Yankelovich (1991) has described the crisis in governance facing modern societies as one of moving from public *opinion* to public *judgment.* Public opinion is notoriously fickle and inconsistent on those issues for which the public has not confronted the system-level implications of their opinions. Coming to judgment requires the three steps of: (1) consciousness-raising or awareness; (2) developing understanding or "working through;" and (3) resolution or action. A prerequisite for all three of these steps is bridging the gap between expert knowledge (what Yankelovich (citing Habermas) calls the "culture of technical control") and the public. Information in the modern world is compartmentalized and controlled by various technical elites who do not communicate with each other. The result is that experts from various fields hold contradictory opinions and the public holds inconsistent and volatile opinions. Coming to judgment is the process of confronting and resolving these inconsistencies by dissolving the barriers between the mutually exclusive compartments into which information has been put. For example, many people in opinion polls are highly in favor of more effort to protect the environment, but at the same time, they are opposed to any diversion of tax revenues to do so. Coming to judgment is the process of resolving these conflicts and moving to action.

According to Yankelovich (1991), one of the most effective ways to start the dialogue and move quickly to public

judgment is to present complex issues in the form of a relatively small number of "visions," which lay bare the conflicts and inconsistencies buried in the technical information. The decisions we face today about the future of the planet are by far the most complex we have ever faced, the technical information is daunting even to the experts, and we have very little time to come to public judgment.

To enhance the process, this paper lays out four future visions of the planet Earth. Each vision is described as a "future history:" a history of the Earth written from the vantage point of the year 2100. In this way, some of the details and colors of the visions can be articulated. The visions include both desired and undesired aspects, both hopes and fears, allowing a richer exploration of what the future may hold, and a conscious choice among complex alternatives.

THE IMPORTANCE OF ENVISIONING

Vision can change the world. In fact, it is one of the few things that really can. The problem is, it can change the world for either better or worse, and the distinction is embedded in the vision itself. A "better" world is one that corresponds to one's preferred vision, whereas a "worse" world corresponds to other, less desired visions. For example, Hitler had a very clear vision of his desired world, and was able to convince enough people in Germany of this vision to significantly change the world. It was most definitely not the vision of a desirable world for many others in Germany, however, nor in the rest of the world. They did not buy into Hitler's vision of a "1000-year Reich," and, fortunately, it did not prevail for very long.

The challenge for the current generation of humans is to develop a *shared* vision that is both desirable to the vast majority of humanity and ecologically sustainable. This paper is an attempt to contribute to a broad discussion on what our vision of the future is, should be, or can be. As Yogi Berra once said, "If you don't know where you're going, you end up somewhere else." We have to decide where we want to go, and balance that with where it is possible to go. Its the only way to change the world.

There are several elements one can combine under the heading of "vision," some of which are "positive," having to do with theories and understanding about how the world works, and some of which are "normative," having to do with how we would like the world to be. The relationship between positive and normative (like the relationships between basic and applied science or between mind and body, or logic and emotion) is best viewed as a complex interaction across a continuum, rather than a simple dichotomy. Likewise, the strict dichotomy between basic and applied science has often proven to be more a hindrance than a help in developing useful understandings of complex systems, as has the mind-body dichotomy.

Visionaries and theorists have often been characterized as mere impractical dreamers. People become impatient and desire action, movement, measurable change, and "practical applications." Yet we must recognize that action and change without an appropriate vision of the goal and analyses of the best methods to achieve it can be worse than counterproductive. In this sense, a compelling and appropriate vision can be the most practical of all applications. To some extent, we can change the way the world is by changing our vision of what we would like it to be (Jones 1977).

This need for vision applies to every aspect of human endeavor. Far from being immune to this need for vision, science itself is particularly dependent on it. In the words of Joseph Schumpeter (1954: 41),

"In practice we all start our own research from the work of our predecessors, that is, we hardly ever start from scratch. But suppose we did start from scratch, what are the steps we should have to take? Obviously, in order to be able to posit to ourselves any problems at all, we should first have to visualize a distinct set of coherent phenomena as a worthwhile object of our analytic effort. In other words, analytic effort is of necessity preceded by a preanalytic cognitive act that supplies the raw material for the analytic effort. In this book, this preanalytic cognitive act will be called Vision. It is interesting to note that vision of this kind not only must precede historically the emergence of analytic effort in any field, but also may reenter the history of every established science each time somebody teaches us to 'see' things in a light of which the source is not to be found in the facts, methods, and results of the preexisting state of the science."

Meadows (1996) notes that the processes of envisioning and goal setting are extremely important (at all levels of problem solving) and they are also very underdeveloped skills in our society. We must therefore begin to train people in the skill of envisioning and begin to construct shared visions if we hope to achieve a sustainable society. She begins this process by telling the personal story of her own discovery of the skill of envisioning, and her attempts to use the process of shared envisioning in problem solving. From this experience, she develops several general principles, including:

1. In order to effectively envision, it is necessary to focus on what one really wants, not what one will settle for. For example, the list below shows the kinds of things people really want, compared to the kinds of things they often settle for.

Really want	**Settle for**
Self-esteem	Fancy car
Serenity	Drugs
Health	Medicine
Human happiness	GNP
Permanent prosperity	Unsustainable growth

2. A vision should be judged by the clarity of its goals, not the clarity of its implementation path. Holding to the vision and being flexible about the path is often the only way to find the path.

3. Responsible vision must acknowledge, but not get crushed by, the physical constraints of the real world.

4. It is critical for visions to be shared, because only shared visions can be responsible.

5. Vision has to be flexible and evolving. Thus, the process of envisioning is at least as important as the particular visions themselves.

Probably the most challenging task facing humanity today is the creation of a shared vision of a sustainable and desirable society, one that can provide permanent prosperity within the biophysical constraints of the real world in a way that is fair and equitable to all of humanity, to other species, and to future generations. This vision does not now exist, although the seeds are there. We all have our own private visions of the world that we really want, and we need to overcome our fears and skepticism and begin to share these visions and build on them, until we have built a vision of the world that we want.

To contribute to that process, this paper lays out four visions of the future. Although there are an infinite number of possible future visions, I believe that these four visions embody some basic patterns within which much of this variation occurs. The visions are based on some critical assumptions about the way the world works, which may or may not turn out to be true. This format allows one to clearly identify these assumptions, access how critical they are to the relevant vision, and recognize the consequences if they are wrong.

FOUR VISIONS OF THE FUTURE

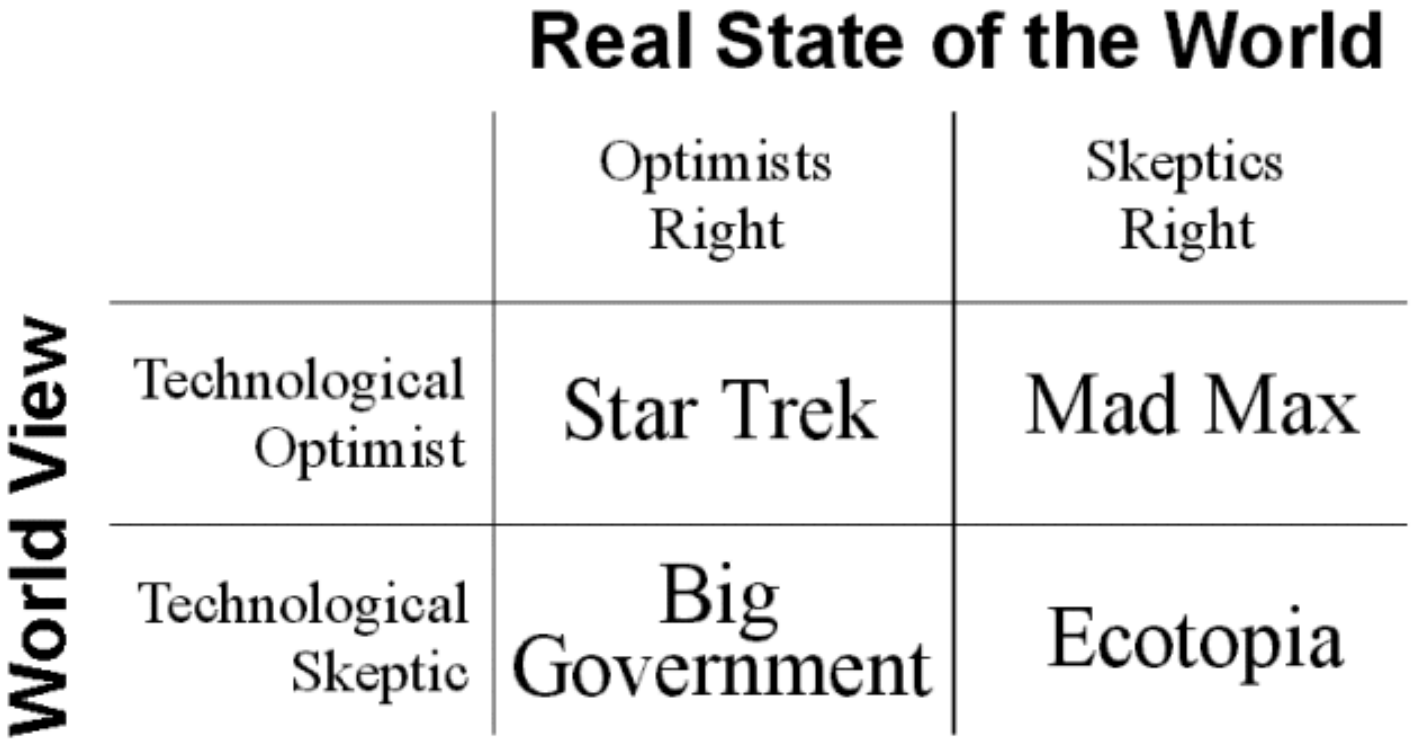
The four visions derive from two basic worldviews, whose characteristics are laid out in Table 1. These worldviews have been described in many ways (Bossel 1996), but an important distinction has to do with one's degree of faith in technological progress (Costanza 1989). The "technological optimist" world view is one in which technological progress is assumed to be able to solve all current and future social problems. It is a vision of continued expansion of humans and their dominion over nature. This is the "default" vision in our current Western society, one that represents continuation of current trends into the indefinite future. It is the "taker" culture, as described so eloquently by Daniel Quinn (1992) in *Ishmael.*

Table 1. Some characteristics of the basic worldviews.

Technological optimist	Technological skeptic
technical progress can deal with any future challenge	technical progress is limited and ecological carrying capacity must be preserved
competition	cooperation
linear systems with no discontinuties or irreversibilities	complex, nonlinear systems with discontinuties and irreversibilities
humans dominant over nature	humans in partnership with nature
everybody for themselves	partnership with others
market as guiding principle	market as servant of larger goals

There are two versions of this vision, however: one that corresponds to the underlying assumptions on which it is based actually being true in the real world, and one that corresponds to those assumptions being false, as shown in Fig. 1. The positive version of the "technological optimist" vision I will call "Star Trek," after the popular TV series that is its most articulate and vividly fleshed-out manifestation. The negative version of the "technological optimist" vision I will call "Mad Max," after the popular movie of several years ago that embodies many aspects of this vision gone bad.

Fig. 1. Four visions of the future based on the two basic worldviews and two alternative real states of the world.



The "technological skeptic" vision is one that depends much less on technological change and more on social and community development. It is not in any sense "anti-technology." However, it does not assume that technological change can solve all problems. In fact, it assumes that some technologies may create as many problems as they solve, and that the key is to view technology as the servant of larger social goals rather than the driving force. The version of this vision that corresponds to the skeptics being right about the nature of the world I will call "Ecotopia," after the semipopular book of the late 1970s (Callenbach 1975). If the optimists turn out to be right about the real state of the world, then what I will call the "big government" vision will come to pass: Ronald Reagan's worst nightmare of overly protective government policies getting in the way of the free market. Each of these future visions is described here from the perspective of the year 2100. The visions are described as narratives with specific names and events, rather than as vague general conditions, in order to make them more real and vivid. They are, of course, only caricatures, but I hope that they capture the essence of the visions they represent.

(*Note: To help with a voluntary survey of attitudes toward these visions, please vote on each vision immediately after reading it's description. Click here to open the survey in a separate browser window. Click the "Submit" button on the survey form after you have completed voting on all four visions.*)

Star Trek: the default technological optimist vision

The turning point came in 2012, when scientists at Cal Tech finally confirmed the reality of what had once been thought to be a scientific hoax. The "cold fusion" that was crudely detected by scientists Flieshman and Ponds in Utah in the 1980s had been perfected and reemerged as the "warm fusion" that ultimately powered humanity to the stars. By 2012, things were really starting to get dicey on Earth. Population pressure was mounting, because of the ascendancy of Julian Simon's theory that more people were actually better for the planet. In his seminal work, Simon (1981) recognized that the real limiting factor was not technology or natural resources, but the number of human brains working on solving problems. Those human brains came up with the solution just in the nick of time, in 2012. By then, natural resources were definitely being strained. The "greenhouse effect" caused by burning fossil fuel was beginning to cause some major disruptions, and warm fusion allowed a rapid reduction of global fossil fuel burning to practically zero by the year 2050, with eventual reversal of the greenhouse effect. Although warm fusion was not quite as convenient as cold fusion had promised to be, it was infinitely better and

cheaper than any alternative, and was inexhaustible, to boot. The air pollution problem was essentially eliminated over the period from about 2015 to 2050, as cars were converted to clean-burning hydrogen, produced with energy from warm-fusion reactors. Electricity for homes, factories, and other uses came increasingly from warm fusion, so the old, risky nuclear-fission reactors were gradually decommissioned. Even some hydropower stations were eliminated, returning some great rivers to their wild state. In particular, the dams along the Columbia River in Oregon were completely eliminated by 2050, allowing the wild salmon runs and spawning grounds to be reestablished.

Although clean, unlimited energy allowed the impact of humans on the environment to be significantly lessened, the world was still getting pretty crowded. The solution, of course, was space colonies, built with materials taken from the moon and asteroids, and with energy from the new warm-fusion reactors. The initial space colonies were on the Earth's moon, the moons of Jupiter, and in free space in the inner solar system. From there, it was a relatively short step to launch some of the smaller space colonies off toward the closer stars. By 2050, about 10% of the total population of 20 billion was living in space colonies of one kind or another. Currently (year 2100), the total human population of 40 billion is split almost equally between Earth and extraterrestrial populations. The population of Earth is not expected to rise above about 20 billion, with almost all future growth coming in space-based populations. The prospects for near-light-speed space ships seems very good in the next few years, and some people are even speculating that faster than light space travel may actually be possible, and may one day allow colonization of distant stars and galaxies.

Because food production and manufacturing are mainly automated and powered by cheap warm-fusion energy, only about 10% of the population actually needs to work for a living. Most are free to pursue whatever interests them. Often the biggest technological and social breakthroughs have come from this huge population of "leisure thinkers." People also have plenty of time to spend with family and friends, and the four-child family is the norm ... .

Mad Max: the skeptic's nightmare

The turning point came in 2012, when the world's oil production finally peaked, and the long slide down started. There were many who said at the time that it was all a hoax or another "invented" crisis like the Arab oil embargo of 1973, but this time it was for real. The easy-to-get oil was simply exhausted and the price started to rise rapidly. All of the predictions about the rapidly rising price of oil causing new, cheaper alternatives to emerge just never came to pass. There *were* no cheaper alternatives, only more expensive ones. Oil was so important in the economy that the price of everything else was tied to it, and the alternatives just kept getting more expensive at the same rate. Even now, there is still lots of fossil fuel around in lower grade forms like coal and oil shale, but all of these alternatives are more expensive in real energy terms to extract and use, and they couldn't stop the slide (although they did make it a lot more gradual). Solar energy continues to be the planet's major source, through agriculture, fisheries, and forestry, but direct conversion using photovoltaics never achieved the price : performance ratios to allow it to compete, even with coal. Rising oil prices caused the price of photovoltaics to shoot upward as well, because they were mostly constructed using fossil fuels. Of course, it didn't really matter anyway, because the greenhouse effect was really kicking in and the Earth's climate and ecological systems were in a complete shambles. If the oil crisis hadn't come first, the pollution crisis was not far behind. Rising sea level inundated most of the Netherlands, and big chunks of Bangladesh, Florida, Louisiana, and other low-lying coastal areas by about 2050.

Of course, once the financial markets figured out what was happening, the bubble really burst. The stock market crash of 2016 was an order of magnitude bigger than the 1929 crash. The Dow Jones average went from 3,584,000 to 448,000 in a little over three days in December, a loss of over 87% of its value. Although there was a brief partial recovery to about 1,500,000, it has been basically downhill ever since. Both the physical infrastructure and the social infrastructure have been gradually deteriorating, along with the natural environment. The human population has been on a long, downward spiral since the global "airbola" (airborne ebola) virus epidemic killed almost 25% of the human population in 2025-2026. The population was already weakened by regional famines and wars over water and other natural resources, but the epidemic came as quite a shock. The world population peaked in 2020 at almost 10 billion. More than 2 billion died in the epidemic in the course of a little over a year and a half. Since then, death rates have exceeded birth rates almost everywhere, and the current population of 4 billion is still decreasing by about 2% per year.

National governments have become weak, almost symbolic, relics. The world has been run for some time by

transnational corporations intent on cutthroat competition for the dwindling resources. The distribution of wealth has become more and more skewed. The dwindling few with marketable skills work for global corporations at good wages and lead comfortable and protected lives in highly fortified enclaves. These people devote their lives completely to their work, often working 90-100 hour weeks and taking no vacation at all. The rest of the population survives in abandoned buildings or makeshift shelters built from scraps. There is no school, little food, and a constant struggle just to survive. The majority of the world's population lives in conditions that would make the flavellas of 20th century Rio seem luxurious. The almost constant social upheavals and revolutions are put down with brutal efficiency by the corporate security forces (governments are too broke to maintain armies anymore) ... .

Big Government: Reagan's worst nightmare

The turning point came in 2012, when the corporate charter of General Motors was revoked by the U.S. Federal Government for failing to pursue the public interest. Even though GM had perfected the electric car, it had failed to make its breakthrough battery technology available to other car makers, even on a licensing basis. It preferred, instead, to retain a monopoly on electric cars, to produce them exclusively in China with cheap labor, and to gouge the public with high prices for them. After a series of negotiations broke down, government lawyers decided to invoke their almost-forgotten power to revoke a corporation's charter and made the technology public property. This caused such a scare to run through corporate America that a complete rethinking of the corporate/public relationship took place, which left the government and the public with much more control over corporate behavior.

Even though "warm fusion" had been discovered in 2015 at Oak Ridge National Lab, strict government regulations had kept its development slow while the safety issues were being fully explored. No one wanted a repetition of the overly optimistic rush into nuclear fission energy that occurred in the late 20th century and that ended so disastrously. The Three-Mile Island and Chernobyl accidents were nothing compared to the meltdown of one of France's fission breeder reactors in 2005, which left almost 25% of the French countryside uninhabitable, killing over 100,000 people directly and causing untold premature cancer deaths throughout Europe. It therefore came as no surprise when warm-fusion energy got a very long and careful look, especially after early enthusiastic supporters started touting the claim: "Too cheap to meter," reminiscent of the early claims for fission energy. Government regulators were also careful to require that the new fusion power plants bore the full financial responsibility for their liability (unlike the earlier fission power plants whose liability was heavily subsidized by governments). This caused a much more careful (albeit slightly slower) development of the industry, with inherently safe reactor designs being the norm from the beginning.

Warm fusion's slowness in coming on line was balanced with high taxes on fossil energy to counteract the greenhouse effect and stimulate renewable energy technologies. Global CO_2 emissions were brought to 1990 levels by 2005 and kept there through 2030 with concerted government effort and high taxes, after which the new fusion reactors, along with new, cheaper photovoltaics gradually eliminated the need for fossil fuels. The worst predicted climate change effects were thus averted, even though there were some significant costs, such as the complete destruction of the city of New Orleans in the devastating hurricane "John" of 2020, which coincided with unseasonable fall flooding of the Mississippi River. Some attributed the severity of this storm and the river flooding to climate change effects, but it is likely that New Orleans was doomed by its precarious position below sea level on the river, and that it would have met the same fate eventually, regardless of climate change.

Government population policies that emphasized female education, universal access to contraception, and family planning managed to stabilize the global human population at around 8 billion, where it remained (give or take a few hundred million) for almost the entire 21st century. A stable population finally allowed many recalcitrant distributional issues to be resolved, and income distribution has become much more equitable worldwide. In 1992 (UNDP 1992), the richest one-fifth of the world's population received 82.7% of the world's income, while the poorest one-fifth received only 1.4%. By 2092, in contrast, the richest one-fifth received 30%, while the poorest one-fifth received 10% of the world's income. The income distribution "champagne glass" had become a much more stable and equitable "tumbler." Some libertarians decried this situation, arguing that it did not provide enough incentive for risk-taking entrepenures to stimulate growth. However, governments explicitly advocated slow or no-growth policies, preferring to concentrate instead on assuring ecological sustainability and more equitable distribution of wealth.

Stable human population also took much of the pressure off other species. The total number of species on Earth declined during the 20th century from about 3 million to a low of about 2.2 million in 2010. However, that number

has stabilized and even recovered somewhat in the 21st century, as some species previously thought to be extinct were rediscovered, and some natural speciation of fast-growing organisms has occured. The current estimate of the number of species on Earth is about 2.5 million and there are strict regulations in effect worldwide, not only to prevent any further loss, but also to encourage natural speciation ... .

Ecotopia: The low-consumption sustainable vision

The turning point came in 2012, when ecological tax reform finally was enacted almost simultaneously in the United States, the European Union, Japan, and Australia after long global discussions and debates, mostly over the internet. Coincidentally, it was the same year that Herman Daly won the Nobel Prize for Human Stewardship (formerly the prize for Economics; the title and goals were changed in 2005 to reflect the obsolesce of 20th century economics) for his work on sustainable development (Daly 1992). A broadly participatory global dialogue had allowed an alternative vision of a sustainable world to emerge and gain very wide popular support. People finally realized that governments had to take the initiative back from transnational corporations and redefine the basic rules of the game if their carefully constructed vision was ever going to come to pass. Some thought this could never happen because of the powerful vested interests in the system, and those interests certainly tried to derail it. Yet, democracies do bow to the will of the people when that will can be articulated clearly and consistently. The public had formed a powerful judgment against the consumer lifestyle and for a sustainable lifestyle. The proliferating corporate abuses certainly helped the cause, but what really seemed to do the trick was the work of a coalition of Hollywood celebrities and producers, led by Robert Redford, who got behind the idea and began making a series of movies and TV sit-coms that embodied the "sustainable vision." Not only did this help people to see the positive implications of the sustainable alternative, but it also suddenly became "cool" to be sustainable, and un-cool to continue to pursue the materialistic consumer lifestyle. The results were astounding. The slogan for the new revolution became the now-famous: "Sustainability, equity, efficiency!" The longer form of these principles was embedded in the revised constitutions of many countries as the three goals:

1) Insure that the scale of human activities within the biosphere is ecologically sustainable;

2) Distribute resources and property rights fairly: within the current generation of humans, between this and future generations, and between humans and other species; and

3) Efficiently allocate resources (as constrained and defined by 1 and 2), including both marketed and nonmarketed resources (especially ecosystem services).

The tax shift became the rallying cry to give the power of positive incentives back to sustainable activities and lifestyles, and to take it away from unsustainable consumer lifestyles. All depletion of natural capital was taxed at the best estimate of the full social cost of that depletion, with additional assurance bonds to cover the uncertainty about social costs. Taxes on labor and income were reduced for middle- and low-income people, with a "negative income tax" or basic life support for those below the poverty level. Ecological tariffs on goods produced in countries without ecotaxes were enacted simultaneously to level the playing field, along with major changes to national income accounting methods to allow a better assessment of the real quality of life (as opposed to mere economic income). The QLI (Quality of Life Index) came to replace the GNP as the primary measure of national performance. The reforms were brought on line gradually over the period from roughly 2012 to 2022 in the United States, European Union, Japan, Canada, and Australia, giving businesses ample time to adjust. The rest of the world followed soon thereafter with almost all countries completing the reforms by 2050. They had very far-reaching effects.

Fossil fuels became much more expensive, and this both limited travel and transport of goods and encouraged the use of renewable alternative energies. Mass transit, bicycles, and sharing the occasional need for a car became the norm. Human habitation came to be structured around small villages of roughly 200 people, whether these were in the countryside or inside urban concentrations. The village provided most of the necessities of life, including schools, clinics, and shopping, all within easy walking distance. It also allowed for a real sense of "community," missing from late-20th century urban life. Other urban functions were within bicycle distance, and public transport connected communities to each other and to bigger centers where there were special functions like universities, specialized hospitals, and research facilities. Although these changes drastically reduced the GNP of most countries, they drastically increased the QLI. People recognized that GNP was really the "gross national cost," which needed to be minimized while the QLI was being maximized. In fact, the QLI : GNP ratio came to be used to measure efficiency at the national level.

Because of the reduction in consumption and waste, there was only moderate need for paid labor and money income. By 2050, the work week had shortened in most countries to 20 hours or less and most "full time" jobs became shared between two or three people. People could devote much more of their time to leisure, but rather than taking consumptive vacations far from home, they began to pursue more community activities (suc as participatory music and sports) and public service (such as day care and elder care). Some of this time was exchanged using community LETS (Labor Equivalent Trading Systems). LETS kept track of the hours you spent in community service, which you could redeem from someone else in the community who wanted to contribute a service you needed. For example, you could trade day care for piano lessons. Unemployment became an almost obsolete term, as did the distinction between work and leisure. People were able to do things they really liked much more of the time, and their quality of life soared (even as their money income plummeted). The distribution of income became an almost unnecessary statistic, because income was not equated with welfare or power, and the quality of almost everyone's life was relatively high.

Although physical travel decreased, people began to communicate electronically over a much wider web. The truly global community could be maintained without the use of consumptive physical travel ... .

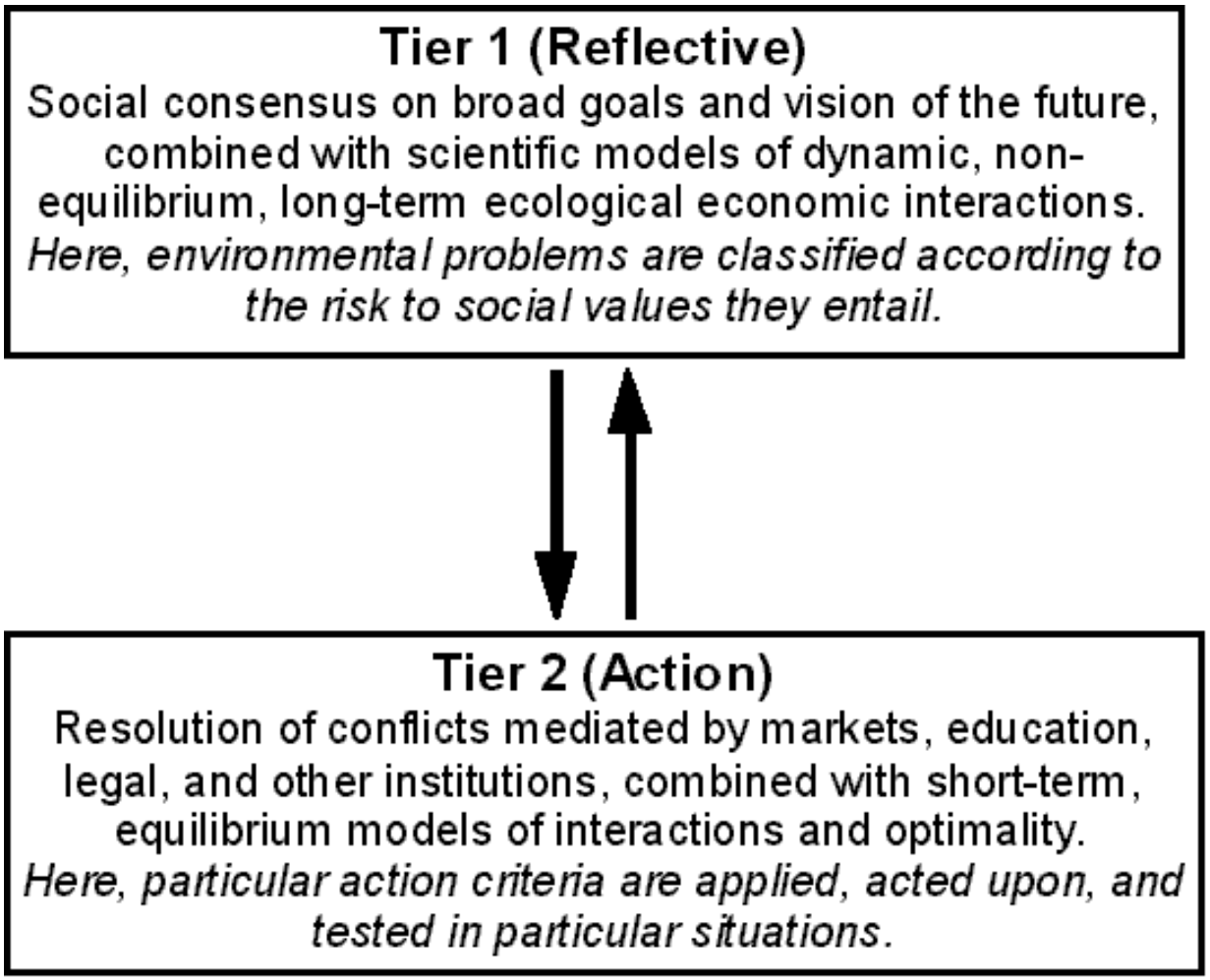
DEALING WITH UNCERTAINTY AT THE LEVEL OF FUTURE VISIONS

How should society decide among these four visions? Does it even need to decide? Why not just let what happens happen, letting everyone have their own independent vision of the future as it suits them? Isn't that the essence of democracy: everyone being able to do exactly as they please? If everyone lived in their own completely isolated world where their actions and decisions had no effect on anyone else, this might be appropriate. A basic tenet of democracy is that individual rights are not to be limited *unless they impact the rights of others.* Yet we live in a very interconnected world, one that is becoming more and more interconnected every day as the human population grows. All of our futures are intertwined, and the actions and decisions of everyone affect everyone else, both those alive today and those yet to be born. The essence of democracy in this "full world" context is *government by discussion and mutual value formation.* The key, as Yankelovich (1991) suggests, is coming to public judgment about the major value issues facing society, its goals and visions. This process can be accelerated by first laying out the options in the form of relatively well-articulated visions, as I have started to do here.

A TWO-TIER DECISION PROCESS: VALUE FORMATION AND DECISION MAKING

How does one integrate these goals and visions and their related forms of value into a social-choice structure that preserves democracy? A two-tiered conceptual model (Norton et al. 1998) makes value formation and reformation an endogenous element in the search for a rational policy for managing human activities. Fig. 2 outlines this process. Tier 1 is the "reflective" level, where social discourse and consensus is built about the broad goals and visions of the future, and the nature of the world in which we live. This consensus then motivates and mediates the second, or "action" tier, where various institutions and analytical methods are put in place to help achieve the vision. There is feedback between the two tiers, and the process of envisioning, goal setting, and value formation is an ongoing and critical one. There is a vital connection between value formation and decision making, but the very existence and necessity of tier 1 is often ignored. The "culture of technical control" (Yankelovich 1991) that dominates our current social decision making views the problem as merely a tier 2 implementation of fixed goals and values.

Fig. 2. Two-tiered social decision process (from Norton et al. 1998).



Conventional social-choice theory has, in general, also tended to avoid this issue of the connection between value formation and the decision-making process. As Arrow (1951:7) put it: "we will also assume in the present study that individual values are taken as data and are not capable of being altered by the nature of the decision process itself." But this process of *value formation through public discussion,* as Sen (1995) suggests, is the essence of democracy. Or, as Buchanan (1954:120) puts it: "The definition of democracy as 'government by discussion' implies that individual values can and do change in the process of decision-making." Limiting our valuations and social decision making to a fixed set of goals based on fixed preferences prevents the needed democratic discussion of values and future options and leaves us with only the "illusion of choice" (Schmookler 1993).

PAYOFF MATRIX FORMULATION AND SURVEY

We can go further in elaborating the consequences of the four visions outlined here in an effort to come more quickly to public judgment. Three of the four visions are "sustainable," in the sense that they represent continuation of the current society (only Mad Max is not). However, one needs to take a closer look at their underlying worldviews, critical assumptions, and the potential costs if those assumptions are wrong. I have already set up the four visions with this in mind.

The worldview (and attendant policies) of the "Star Trek" vision is technological optimism and free competition,

and its essential underlying assumption is unlimited resources, particularly cheap energy. The cost of pursuing this worldview and its policies if the assumption of unlimited resources is wrong is something like the "Mad Max" vision. Likewise, the worldview (and attendant policies) of the "Ecotopia" vision is technological skepticism and communitarianism (the community comes first), and its essential underlying assumption is that resources are limited and cooperation pays. The cost of pursuing this worldview and its policies if the assumption that resources are limited is wrong is the "Big Government" vision, in which a "community first" policy slows down growth relative to the "free market" Star Trek vision. Fig. 3 lays out these possibilities in the form of a "payoff matrix," in the same format as Fig. 1. Each of the four cells in the matrix indicates the "payoff" of pursuing the policy and worldview on the left, in combination with the real state of the world on the top.

Fig. 3. Payoff matrix for technological optimism vs. skepticism.

World View & Policy	Real State of the World: Optimists Right (unlimited resources)	Real State of the World: Skeptics Right (limited resources)
Technological Optimist (free competition)	Star Trek (positive) (2.3)	Mad Max (very negative) (-7.7)
Technological Skeptic (community first)	Big Government (slightly positive) (0.8)	Ecotopia (very positive) (5.1)

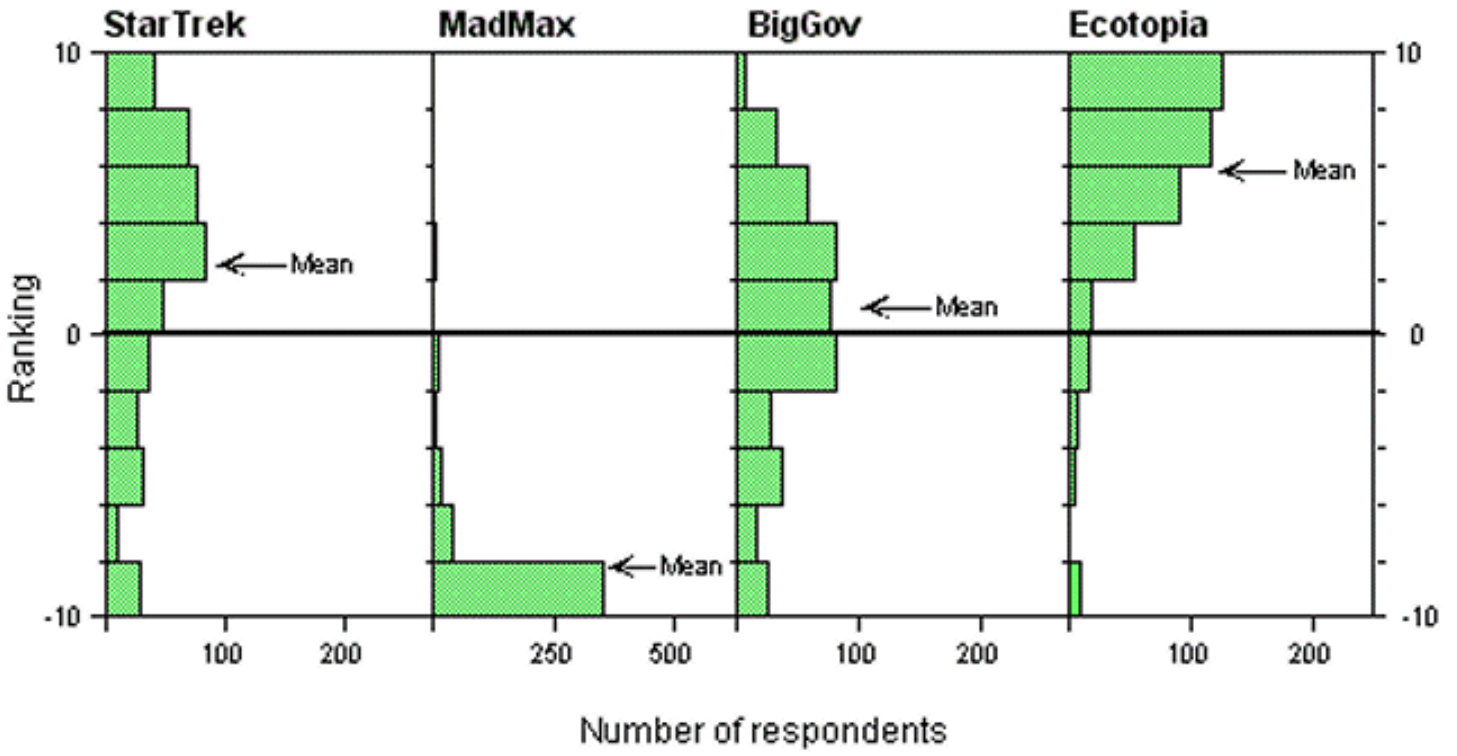
To fill in the elements of the payoff matrix, one would need to discuss the four visions with a broad range of participants and then have them evaluate each vision in terms of its overall desirability. So far, I have conducted a preliminary (nonscientific) survey with 418 participants. [The Americans consisted of 17 participants in an Ecological Economics class at the University of Maryland, 260 attendees at a convocation speech at Wartburg College, Waverly Iowa (27 January 1998), and 39 via the World Wide Web. The Swedes consisted of 71 attendees at a Keynotes in Natural Resources Lecture at the Swedish University of Agricultural Science, Uppsala (20 April 1999), and 31 attendees at a presentation at Stockholm University (22 April 1999).] The survey form is attached as Appendix 1. The respondents were read each of the four visions in turn, and were then asked: "For each vision, I'd like you to first state, on a scale of -10 to +10, using the scale provided, how comfortable you would be living in the world described. How desirable do you find such a world? I'm not asking you to vote for one vision over the others. Consider each vision independently, and just state how desirable (or undesirable) you would find it if you happened to find yourself there." They were also asked to give their age, gender, and household income range on the survey form. The surveys were conducted with groups from both the United States and Sweden. The results (mean ± one standard deviation) are shown in Table 2 for each of these groups and pooled.

Table 2. Results of a survey of desirability of each of the four visions on a scale of −10 (least desirable) to +10 (most desirable) for self-selected groups of Americans and Swedes. Standard deviations are given in parentheses after the means.

	Americans (*n* = 316)	**Swedes** (*n* = 102)	**Pooled** (*n* = 418)
Star Trek	**+2.38** (± 5.03)	**+2.48** (± 5.45)	**+2.48** (± 5.13)
Mad Max	**-7.78** (± 3.41)	**-9.12** (± 2.30)	**-8.12** (± 3.23)
Big Government	**+0.54** (± 4.44)	**+2.32** (± 3.48)	**+0.97** (± 4.29)
Ecotopia	**+5.32** (± 4.10)	**+7.33** (± 3.11)	**+5.81** (± 3.97)

Frequency distributions of the results are plotted in Fig. 4. The majority of those surveyed found the Star Trek vision positive (mean of +2.48 on a scale from -10 to +10). Given that it represents a logical extension of the currently dominant worldview and culture, it is interesting that this vision was rated so low. I had expected this vision to be rated much higher, and this result may indicate the deep ambivalence many people have about the direction in which society seems to be headed. The frequency plot and the high standard deviation also show this ambivalence toward Star Trek. The responses span the range from +10 to −10, with only a weak preponderance toward the positive side of the scale. This result applies to both the American and Swedish subgroups.

Fig. 4. Frequency distributions of the responses to the survey.



Those surveyed found the Mad Max vision very negative at -8.12 (only about 3% of participants rated this vision positive). This was as expected. The Americans seemed a bit less averse to Mad Max (-7.78) than the Swedes (-9.12), and with a larger standard deviation.

The Big Government vision was rated, on average, just positive at 0.97. Many found it appealing, but some found it abhorrent (probably because of the limits on individual freedom implied). There were significant differences between the Americans and Swedes, with the Swedes (+2.32 ± 3.48) being much more favorably disposed to Big Government, and with a smaller standard deviation than for the Americans (+0.54 ± 4.44). This also was as expected, given the cultural differences in attitudes toward government in the United States and Sweden. Swedes rated Big Government almost as highly as Star Trek.

Finally, most of those surveyed found the Ecotopia vision "very positive" (at 5.81), some wildly so, some only mildly so, but very few (only about 7% of those surveyed) expressed a negative reaction to such a world. Swedes rated Ecotopia significantly higher than did Americans, also as might be expected given cultural differences.

Some other interesting patterns emerged from the survey. All of the visions had large standard deviations, but (especially if one looks at the frequency distributions) the Mad Max vision was consistently very negative and the Ecotopia vision was consistently very positive. Age and gender seemed to play a minor, but interesting, role in how individuals rated the visions. Males rated Star Trek higher than did females (mean = 3.66 vs. 1.90, P = 0.0039). Males also rated Mad Max higher than did females (-7.11 vs. -8.20, P = 0.0112). The means were not significantly different by gender for either of the other two visions. Age was not significantly correlated with ranking for any of the visions, but the variance in ranking seemed to decrease somewhat with age, with younger participants showing a higher range of ratings than older participants.

Work is in progress to expand this survey and to conduct a scientific, random sample of the population, but the general conclusions are fairly insensitive to the exact results.

WORST CASE ANALYSIS

We find ourselves as a species facing the payoff matrix outlined in Fig. 3. What do we do? We can choose between the two worldviews and their attendant policies. We face pure and irreducible uncertainty concerning the real state of the world. Who knows whether or not "warm fusion" or something equivalent will be invented? Should we choose the Star Trek vision (and the optimist policies) merely because it is the most popular, or because it is the direction in which things seem to be heading already?

From the perspective of game theory, this problem has a fairly definitive answer. This is a game that can only be played once, and the relative probabilities of each outcome are completely unknown. In addition, we can assume that society as a whole should be risk averse in this situation. The mean values of the numerical rankings for each vision (from the preliminary survey, as summarized in Table 2, rounded to one decimal place) make it a bit easier to talk about. [Pooled rankings are used in the discussion, but the conclusions would be the same if using just the American or just the Swedish rankings. In fact, the conclusions are fairly insensitive to the exact values of the rankings, as long as Big Government is rated higher than Mad Max, and Star Trek and Ecotopia are rated higher than Big Government.] Star Trek was ranked, on average, at +2.5, Mad Max was −8.1, Big Government was +1.0, and Ecotopia was +5.8. One would look at each row in the matrix (corresponding to a policy set) to see the worst outcome for that policy set. For the optimist's policy, Mad Max (-8.1) is the worst case. For the skeptical policy set, Big Government (+1.0) is the worst case. One would then choose the policy set with the largest (most positive) worst case. +1.0 is much larger than −8.1, so we would choose the skeptic's policy. This is a standard "maximin" decision rule. If we choose the skeptic's policy set, the worst thing that can happen is Big Government, which is much better than the worst thing that can happen under the optimist's policy set (Mad Max). The conclusion that we should choose the skeptic's policy set is fairly insensitive to the specific values of the rankings. The rankings would have to change so that either Big Government or Ecotopia was rated worse than Mad Max to reverse this outcome. In fact, the way the payoff matrix is set up, Mad Max is the one really negative outcome and the one really unsustainable outcome. We should develop policies that assure us of not ending up in something like Mad Max, no matter what happens.

There are other considerations in favor of choosing the skeptic's policies. The skeptical policies do not close any options. One could still switch to the optimist's policies, once the real state of the world was shown to conform to that view. For example, if warm fusion or its equivalent were ever discovered, one could easily switch to the Star Trek vision from the Big Government vision. The reverse switch from Mad Max to Ecotopia could not be made, because the infrastructure would not be there. The skeptic's policies preserve options, the optimist's policies do not.

It should be pointed out as well that this is not a static, once-and-for-all decision. Both the players and the game are evolving and changing over time as our vision evolves and as we learn more. At the current moment, however, we have to decide on a set of general policies. The four visions I have laid out, I believe, summarize our current choices and fundamental uncertainties. One could also argue that the probabilities of each state of the world being correct are not completely unknown. If one could argue that the prospects for cheap, unlimited, nonpolluting energy were, in fact, very good, then the decision matrix would have to be weighted with those probabilities. If anything, the complete dependence of the Star Trek vision on discovering a cheap, unlimited energy source argues for discounting the probability of its occurrence. It is like leaping off the top of the World Trade Center building and hoping that you can invent a parachute before you hit the ground. Better to wait until you have the parachute (and have tested it extensively) before you jump. By adopting the skeptic's policies, the possibility of this invention is preserved, but without utter dependence on it.

CONCLUSIONS

Designing a sustainable and desirable world in the presence of irreducible uncertainty requires the integration of a shared vision of that world with appropriate analysis and innovative implementation. This is the "full package" necessary to achieve sustainability. All three aspects of this task need much improvement, and their integration is lagging farthest behind. This paper briefly describes the importance of envisioning in coming to public judgment on the important policy decisions facing humankind at this critical juncture. It also argues that the major source of uncertainty is at this level of visions and worldviews, not in the details of analysis or implementation within a particular vision. By laying out four alternative "future histories" of the Earth, the critical assumptions and

uncertainties underlying each vision can be more easily seen, and a rational policy set that assures sustainability can be devised. A cooperative, precautionary policy set that assumes limited resources is shown to be the most rational and resilient course in the face of fundamental uncertainty about the limits of technology.

RESPONSES TO THIS ARTICLE

Responses to this article are invited. If accepted for publication, your response will be hyperlinked to the article. To submit a comment, follow this link. To read comments already accepted, follow this link.

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APPENDIX 1

A Survey of Attitudes toward the Visions

I'd like you to participate in a survey about attitudes toward these four visions of the future. Your response will be tabulated and used to replace my "guesses" in the paper, and to enrich the analysis of the visions. For each vision, I'd like you to first state, on a scale of -10 to +10, using the scale provided: ***how comfortable would you be living in the world described?*** *How desirable do you find such a world? I'm not asking you to vote for one vision over the others. Consider each vision independently, and just state how desirable (or undesirable) you would find it if you happened to find yourself there. I've also left space for any comments and suggestions you have about each vision.*

Go to Survey

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