PREFACE TO THE CHOEISHA EDITION

The sun cannot know
the smudge on the ground
once had a name.

– Diane Mayr[1]

Most prefaces to a new edition mark time, and much indeed has transpired since our first edition was published in 1990, over two decades ago. In particular, this publication commemorates the first anniversary of the nuclear disaster at Fukushima. I offer for the occasion a personal meditation about public choice in our uncertain, rapidly changing world, making connections over time and space, and distinctions between good and evil.

Bombs

The day after I was asked to write this preface, the Nuclear Regulatory Commission approved construction of the first new nuclear power reactors in the United States since the Three Mile Island accident occurred over thirty years ago.[2] They are to be built by the Japanese-owned Westinghouse Electric Company, which Toshiba bought in February 2006. Five months before that acquisition, on September 16, 2005, my coauthor, former business partner, friend, and mentor Jay M. Gould died at the age of 90. Jay had been retained on behalf of Westinghouse in 1979 (the year of TMI) to break the cartel controlling uranium prices, in recognition of his statistical expertise that led to the U.S. Supreme Court's famous 1962 verdict regarding the Brown Shoe Company, setting the postwar legal standard for antitrust litigation in America.[3]

Jay's own mentor on nuclear matters is the physicist Ernest Sternglass, who worked at Westinghouse from 1952 until 1967 as Scientific Director of their Apollo Lunar Station program, and who

in 1947, had the honor of spending a day with the father of the atomic age himself. They discussed their latest ideas about particle physics, but Ernest was most affected by Albert Einstein's deep regrets about contributing to the creation of nuclear weapons.[4]

Two years earlier, the U.S. Army Air Force dropped Little Boy and Fat Man on Japan, accelerating the end of the last world war. Akira Iwasaki directed the filming of the aftermath of these two bloodiest days in human history until the occupying forces arrested his cameramen.[5] During the war, the imperial regime had imprisoned Iwasaki for opposing its Nazi-inspired cinema law, then confiscated all of his books and forbade him from writing. In strange twists of fate, the U.S. military allowed Iwasaki to direct Nippon Eiga Sha, the former newsreel corporation of Imperial Japan (Nichi-ei), during the Allied Occupation, only to impound all of his bomb-related footage by 1946. It remained classified in the U.S. National Archives for over twenty years until my grandmother Lucy B. Lemann learned of its existence through a January 26, 1968 story in the *Asahi Evening News*. She secured a complete copy from the federal government and funded production of *Hiroshima-Nagasaki, August 1945* by Eric Barnouw at Columbia University.[6] When it premiered at the Museum of Modern Art in 1970, the *Boston Globe* called it "the most important documentary film" of the 20th Century.[7] A representative of Tokyo Television attended the screening and arranged for its prime-time telecast across Japan later that year. Two years later, my grandmother was added to Nixon's "enemy list."[8]

I graduated from college ten years after that and moved to New York City for my first job as a nuclear weapon systems researcher at the Council on Economic Priorities (CEP). That was the think tank where I first met Jay. On Sunday evenings, I would serve as my grandmother's technical aide, inserting a video of the Hiroshima film into her VHS player, so she could show visiting diplomats and dignitaries the horrifying effects of radiation exposure, certain that this would convince them to support a nuclear freeze. For the publication of my first book in 1986, Alice Tepper Marlin, my boss

at CEP, appeared on the *Today* show, holding up a copy of its red cover.[9] I was 26 and the Chernobyl explosion had happened the day before. The book was about hazardous waste management in the United States, but the news anchors just wanted to ask Alice about radiation from Russia.

Jay's Afterword tells some of what happened next, with our founding the Radiation and Public Health Project (RPHP) in 1988 after the *Wall Street Journal* published his findings of summertime spikes in infant and total mortality that correlated with Chernobyl fallout across the United States (also see Chapter 2). But the story continues, and it is largely a depressing one, with history apparently destined to repeat itself, with new iterations of technological advances and blunders, denials and censorship, and seemingly inevitable but uncertain magnitudes of human and ecological harm.

Scale

What is different about the human tragedy today is that it reaches from subatomic to cosmological proportions in ways that most of us cannot comprehend. Thirty years before RPHP, Hannah Arendt proclaimed the launch of Sputnik—heralding the space age—an event "second in importance to no other, not even to the splitting of the atom," but for the strange reason that we had become alienated from our planet and for the first time in human history could "escape from men's imprisonment to the earth."[10] The mind-boggling reach of science and technology at the dawn of the atomic and space ages was best illustrated by *Cosmic View*, a book by Dutch educator Kees Boeke showing 40 magnitudes of scale, ranging from the size of a nucleus (10^{-13}) to the extent of the visible universe (10^{26}).[11] The eerie soundtrack of *Powers of Ten*, the film adaptation that Charles and Ray Eames created for IBM, made our place in the world seem all the more alien. Decades later, this work inspired the invention of Google Earth and Google Maps, aiding our everyday navigation of the world.[12]

Our popular imagination began to reverse itself as soon as Arendt articulated the concept of "earth alienation." That same year,

Rachel Carson started writing *Silent Spring*, and within a decade, astronauts looking back from Apollo 8 took the "Earthrise" photograph, then took "The Blue Marble" from Apollo 17, an image the *Whole Earth Catalog* forever made a symbol of environmentalism, and finally, Voyager 1 took "Pale Blue Dot" from nearly 4 billion miles away, inspiring astronomer Carl Sagan to write:

> *Look again at that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives.*[13]

A global movement arose that recognized not only the preciousness of our earthly habitat, but also its rarity. As the physicist Stephen Hawking puts it: "our universe and its laws appear to have a design that both is tailor-made to support us and, if we are to exist, leaves little room for alteration." [14] The incredible, miraculous improbability of coincidences required to support life on earth can make even the most rational of scientists pause in silence or pray for insight, and should make everyone think long and hard before tinkering with its fundamental properties.

Evil

Sternglass said his greatest lesson from speaking with Einstein is "that no one can control the direction in which his research is used, for evil or for good."[15] I think there is an even deeper truth: if we can rarely control the outcomes of what we think we know, then how can we possibly control what we do not fully understand? Just because the most brilliant human minds have figured out how to split an atom, and how to turn that knowledge into technological applications, that does not mean we yet understand the consequences of their use.

The problem for humanity becomes far more complex when there are deep gaps in the distribution of that limited knowledge and the decision-making authority to use it. Another truth I have learned from working in this field is this: environmental injustice is the

inevitable result of decision-making processes that do not represent the interests of all impacted parties across multivariate social, geographic, temporal, and cross-species dimensions. In policy-speak, that is the very definition of an environmental impact; they are called economic "externalities" precisely because they affect parties who are external to the economic decision making. It is the scale of the impacts from nuclear power—or, more precisely, the vast ranges in scales across multiple dimensions—that is unlike any other environmental impact known to man.

This brings us to the ethical question: if we know a technology can cause grave but uncertain risks, is it evil to deploy it? It is one thing to say "don't play with fire," but quite another when we know the fire will burn for thousands of years. This book is all about uncertainty, as is radiation, and, for that matter, life itself. A half-life is really just an expression of probability, as Hawking points out: "when we say the average life-time of a particle is 10^{32} years… what we mean is that each year, the particle has a 1 in 10^{32} chance of decaying."[16] Is it simply evil to play with fire of this kind?

This book is largely about coincidences of time and space and asks the same question repeatedly: how likely is it that the observed phenomena are random, and if unlikely to a significant degree, then what may have caused them? Surely, if there is a demonstrable good from a technological choice, with little observable or potential adverse impact, then a reasonable decision may be to proceed despite the imperfect information. And if the potential harm is far outweighed by the expected benefit, then even a mistake can be justified under the circumstances. But when a technology is lethal at its core, generating enormous risks at every stage of a complex industrial lifecycle—from the mining of poisonous raw materials, through production processes that routinely emit low-level and occasionally catastrophic toxic releases, through the generation of extremely hazardous wastes that must be isolated for eons to come, and with all of these risks bedeviled by profound gaps in our understanding of how ionizing radiation affects biological and ecological health—what system of ethics could possibly justify such

a choice? But for the scale of life at stake, two words suffice: ignorant or arrogant. Given the scale, we must consider a third: evil.

GRIEF

I have no first-hand knowledge of the terrors of Fukushima, have never been to Japan, and left this field of research within a few years of *Deadly Deceit*'s publication two decades ago. But as I write these words—this very paragraph—on the anniversary date of March 11, 2012, I clearly see how we are all connected and all know something of human pain. The Ides of March echo grief throughout history and the world, just as I experience the greatest moment of uncertainty and mourning in my own life. My nuclear family was split this weekend as we told our children that my wife and I are separating. Small comfort that the Centers for Disease Control show the odds are fifty percent that my marriage could end this way.[17] Divorce is slightly less common in Japan, but rising in prevalence as it is the U.S.[18] It all feels so unlikely—and I have not even mentioned that my father-in-law was stationed in Japan after the war or that our adopted daughter's genetic maternal great-grandmother was Japanese—more seemingly random byproducts of a military occupation. We have all heard about six degrees of separation; this book's investigations, however, are about significantly greater statistical improbabilities and significantly greater harms.

In 1991, the year after *Deadly Deceit* was published, I travelled newly wed to Elliot Lake, deep in the forests of Northern Ontario. Known as the "uranium capital of the world" for its postwar role as a primary source of nuclear fuel—including the uranium in the bombs dropped on Hiroshima and Nagasaki—Elliot Lake is now home to nearly 200-million tons of uranium mining wastes covering four square miles, making it probably the largest radioactive dump in the world. Kazakhstan dethroned Canada's long reign as the world's top uranium producer in 2009; even so, Canadian suppliers remain so sensitive to Japanese demand that their stock prices fell by as much as 28% upon news of the Fukushima disaster.[19]

My research there helped stop the expansion of the domestic nuclear power industry in Canada as part of expert testimony prepared for the Northwatch Coalition by Radioactive Waste Management Associates, which was founded by the physicist Marvin Resnikoff. Marvin's work led Jay to CEP in the early 1980s where we all first met (see Afterword). His projections that the uranium mill tailings could cause nearly three-million cancer deaths over the next million years formed the basis of my doctoral dissertation at New York University (where Jay recommended that I study with Nobel Laureate Wassily Leontief). When I returned to New York, I absentmindedly threw the old shoes I wore across the sandy tailings under our bed—could that be why my wife and I could not have children for so many years…?

Probably not, but at the time, I neither considered that risk nor absorbed the full magnitude of the temporal scale of these findings, because the potential damages to human health and the environment were themselves so overwhelming. In *Discounting Human Lives*, the book I eventually published on the subject, I quoted economist Armartya Sen, who went on to win a Nobel Prize: "the analogy with torture is not absurd… lasting pollution is a kind of calculable oppression of the future generation."[20]

Loss

My book was just that: a dizzying set of calculations to determine the costs and benefits of nuclear power. The highest estimate of global financial loss, which resulted from a series of meticulously documented empirical equations, was more than $600 trillion; whereas, the maximum global net benefit under the most optimistic assumptions was a mere $15 billion (1990 Canadian dollars). That is 14 orders of magnitude of uncertainty. How uncertain is that? Think the difference between our human scale (10^{0}) and the nucleus of a single carbon atom (10^{-14}), the basis of all forms of life, or, scaling up, between a single human and the size of our solar system (10^{14}).

The difference between these potential upside gains and downside risks is staggering.[21] The worst projected damages are equivalent to a single industry—nuclear power generation—wiping out the gross domestic product of the entire world for decades. The maximum projected net loss is more than 500-times greater than International Monetary Fund's estimate of total losses due to the recent global financial crisis.[22] The maximum potential net benefit, in comparison, is just one-half-of-one-tenth-of-one percent (0.057%) of a single year of global GDP, enough to cover little more than one percent (1.3%) of the Great Recession's bank losses.

Would you take those odds? Our society has done just that. The largest contributor to the estimated losses and associated uncertainties is the present value of the projected lives lost due to cancer fatalities from exposures to low-level radiation emitted by the uranium mining wastes. That is just one measure of the horrific gamble we have allowed with this technological choice. In this casino, the grim reaper deals, and the deck is stacked in the house's favor unlike any fair game. If uranium is the nuclear industry's cradle, this book attempts to quantify its midlife crisis, barely mentioning the risks from the high-level wastes at its grave, the inevitable legacy of the atomic age even if the industry were shuttered today.

Updates

RPHP has continued to investigate the industry's "midlife crisis" over the past twenty years, the latter half of which has been under the direction of public health expert Joseph J. Mangano. They have published more than two-dozen articles in peer-reviewed medical journals, authored three books, and generated dozens of editorials, press conferences, newspaper reports, television appearances, and testimony before government agencies.[23] They have updated, expanded, and drilled down on all of the findings in this book, examining strontium-90 in baby teeth, thyroid-cancer increases near operating reactors, declines in childhood cancer near closed reactors, breast cancers on Long Island, and, most recently, rises in U.S. mortality after the arrival of fallout from Fukushima. Their work has

attracted the support of celebrities such as Alec Baldwin and Christy Brinkley. Here are just three highlights of the many findings from researchers associated with RPHP:

- 22,000 excess deaths occurred in the United States during the fourteen weeks following the 2011 Fukushima accident, based on an updated analysis of mortality statistics in 122 cities.[24] This is similar in scale to the 17,000 excess deaths that underlie our findings in Chapter 2 for the summertime peaks after the Chernobyl fallout reached the U.S.

- 985,000 global excess deaths resulted from the Chernobyl catastrophe from 1986 through 2004, according to a compendium of 5,000 studies for which physician and RPHP researcher Janette D. Sherman was the consulting editor. The report goes on to project that "the number of Chernobyl victims will continue to grow in the next several generations."[25]

- A 50% increase in strontium-90 levels in baby teeth took place during the 1990s, with the highest rises near nuclear plants and correlated with childhood cancer trends. Strontium-90 in the baby teeth of male cancer victims from St. Louis was twice that for living men from the same area.[26]

Jay also updated our Chapter 7 estimates of the potential scale of premature deaths in the U.S. resulting from the 35 years of atmospheric weapons tests from 1945 until 1980.[27] During this time, various nations of the world detonated more than 500 nuclear devices into the air, yielding 440 megatons of explosive power, 30,000 times the 15 kiloton bomb dropped on Hiroshima.[28] Jay's updated estimate based on mortality rates through the end of the last century increased from nine- to nearly 20-million excess deaths, including a million infant deaths. If Jay is right, that is the equivalent

of the entire populations of New York City and Tokyo being wiped out within a generation, and—maybe even more disturbing—without anyone barely noticing. (A similar deviation in the downward slope of Japan's age-adjusted mortality is also evident during this period, suggesting that the global toll of excess deaths from the decades of atmospheric testing may be even greater.[29])

Undoubtedly, there is a high degree of uncertainty associated with this shocking statistic and with all of the estimates of excess death cited here. Our understanding of the biochemical mechanisms by which ionizing radiation disturbs healthy individuals and ecosystems is profoundly limited (See Methodological Appendix and The BEIR V Report). But the odds are infinitesimal that chance alone accounts for the orders of magnitude of health impacts projected herein using the best-available scientific models and correlated in time and space with documented radiation releases.

Technological decisions that affect all life on earth are being made today within the context of such great uncertainty and potential impact that few of us are able to grasp. Let's do a brief accounting so far: potentially tens of thousands of excess deaths from Fukushima fallout in America, one million from the Chernobyl accident, three million from uranium mining, 20 million from atmospheric testing, and who knows how many as a result of day-to-day emissions and mishaps at 435 operating power reactors in 31 countries, let alone possible future acts of nature, terror, or human error, associated weapons proliferation or damage to other species.[30] Add it all up and you have easily quantified one of the top-five atrocities in all of human history.

VIOLENCE

Just as the parlance of physicists becomes alien at extreme scales—with M-Theory, multiverses, supersymmetry, and the like—death at this magnitude involves the strangeness of necrometrics, multicides, and Hemoclysm, a term coined for the greatest historical "blood flood" of wars and genocides ever, killing 150-million people in the first half of the 20th Century.[31] Despite our shared memory of

this recent carnage, psychologist Steven Pinker documents a secular decline in violent death since the dawn of humanity in his magisterial history of violence.[32] But Pinker only got it half right.

There are many kinds of violence in this world, possibly more than there are ways to die (not all violence is lethal, and some deaths are said to be peaceful). There are mass killings and individual murders, intentional injuries and unintentional ones, brutal acts of nature as well as man. Sen points to the major distinction that Pinker overlooks entirely: in addition to the fatal blows of fisticuffs, spears and detonations—what epidemiologists call "acute" incidents—are the far more prevalent "chronic" harms of humankind.

Pollution is the insidious violence of consumer society, and it has been on the rise for centuries. In 1871, the great German military strategist Helmuth von Moltke declared that "without war, the world would wallow in materialism."[33] From the start of the Industrial Revolution, Immanuel Kant complained that "a long peace favors the predominance of a mere commercial spirit," calling war "sublime" in comparison.[34] Even Aristotle decried how "good fortune and the leisure that comes with peace" tend to make men "insolent."[35] Before them all, Sun Tzu identified the hidden dangers of such insolence in the Sixth-Century BC:

> *If you know the enemy and know yourself, you need not fear the result of a hundred battles. If you know yourself but not the enemy, for every victory gained you will also suffer a defeat. If you know neither the enemy nor yourself, you will succumb in every battle.*[36]

This is the most deceptive enemy of all. Inside each of us, hiding in baby teeth, accumulating in fish, rising into the upper atmosphere, concentrating in tiny pockets or spreading far and wide, striking indiscriminately or with deadly precision, rapidly or with the patience of generations. It has so many names and disguises that our best scientific methods lose its trace. As tempting as mother's milk and sweet as honey from a bee, it is in the food we eat, the clothes we wear, the light by which we read, the warmth in our homes at night,

and the very air we breathe. Insidious, pernicious, ambiguous, ubiquitous, injurious, and contentious, pollution is our fiercest mortal enemy today. How fitting that Jay's last book was entitled *The Enemy Within*… but that is getting ahead of ourselves.[37]

DEATH

Back to the year after *Deadly Deceit*: my book *The Truth About Where You Live* presented what may still be the most comprehensive set of environmental health statistics ever compiled in the United States.[38] The 52-million curies of mostly "routine" radioactive emissions from U.S. commercial power reactors was just one of dozens of measures of industrial pollution, and not even the most highly correlated with the health indicators mapped in the book. More than 85,000 chemicals are in commerce with 2,000 introduced each year, and the vast majority lacking toxicological studies adequate to determine effects on human health and wildlife.[39]

To this day, some of the most basic facts we uncovered about environmental health in America remain largely unknown. Few are aware of the elevated death rates along major river systems and especially downstream, such as in Louisiana's "cancer alley" on the lower Mississippi. Or that there is a kind of permanent stroke belt in the Southeastern United States. Most doctors and health professionals do not even know that these sticky geographic structures of age- and population-adjusted mortality exist. It is easy to get lost in the details, which stymies much activism and policy debate. Who knew, for example, that island living would cause Nantucket to have the highest death rate of any U.S. county or that the second highest is right downwind from Three Mile Island?[40]

Stepping back for perspective: most of us know that seven-billion people share our planet today, but did you know we can also calculate how many have ever lived? That number, according to the Population Reference Bureau, is 108 billion.[41] By subtracting the former from the latter, we can learn something else that is almost unimaginable: approximately 101-billion people have died on this

earth since the beginning of time. For every one of us alive today, fourteen souls have perished. How unlikely that sounds! But unlike the many orders of magnitude of uncertainty regarding environmental hazards, we can be confident that the accuracy of these estimates are well within one. There were never more humans on earth than there are today; speculation is limited to the slope of the population curve back to the first two *Homo sapiens* to reproduce. However you draw that curve, ninety percent probably died before the Industrial Revolution began in the mid-18th Century, 96 percent before the Age of Oil began at the turn of the last century, and 99 percent before the Atomic Age began nearly seven decades ago.

We can also estimate how they died. It is likely that as in our day, more than ninety percent died from disease and the rest from injuries of one kind or another. Injuries were certainly more fatal in prehistoric times, but they did not have cars, which account for a third of all unintentional injuries in modern times. All other unintentional injuries account for just four percent of global deaths today.[42] In contrast, communicable diseases still cause nearly a third of all deaths; the top-dozen pandemics alone have killed over a billion people throughout the ages (smallpox, measles, plague, malaria, influenza, and tuberculosis—even AIDS, at 25-million deaths, barely registers on this gloomy scale).

Intent

Intentional fatalities from murders and wars, while declining over time, have accounted for a remarkably small percentage of total mortality, below two percent for at least the past two centuries, according to estimates by physicist Lewis Fry Richardson.[43] Just the top-100 multicides of all time (from WWII in the 20th Century to the Taiping Rebellion in the 19th, Conquests of Timur in the 14th, Genghis Khan in the 13th, slave trade since the 7th, Second Persian War in the 5th BC, and so on) may account for a third of all violent deaths of this kind, killing nearly 500-million people.[44] Similarly, despite the infamy, horror, and historical significance of industrial

disasters, including even the most gruesome—Bhopal, Exxon Valdez, Minamata, Deepwater Horizon, Triangle Shirtwaist Factory, Seveso, hundreds of mining accidents, and of course Chernobyl, Fukushima, and TMI—death tolls from their acute fatalities range from single digits to tens of thousands, accounting for at most a tiny fraction of just one percent in the history of global mortality.

In comparison, a recent study of 120 scientific papers estimates that water, air, and soil pollution cause 40 percent of deaths worldwide, and the American Cancer Society blames six percent of all cancer deaths on exposures to occupational and environmental pollutants.[45] Rates such as these would put chronic fatalities from man-made pollution at more than four-billion deaths since the beginning of the industrial age. That means man-made pollution has probably killed the equivalent of more than half of our species' current population. Even if these estimates are off by an order of magnitude or two (and far more likely well within just one), the toll for most of us is simply incomprehensible, and clearly the greatest violence ever unleashed by man against man or against nature. Biologists now speak of the "sixth extinction."[46] The fifth, which an asteroid probably caused 65-million years ago, killed off the dinosaurs along with 75 percent of earth's other species. This time, we are the cause as well as one of the many victims.

CHANGE

The depressing depth of these statistics is not the only reason I left the field in the mid-1990s. More discouraging was what seemed like their inevitability in the face of diverse but ultimately futile efforts to change course. On the bright side, by 1992, the largest gathering of heads of state in history took place in Rio de Janeiro to address problems of economic development and the environment. I attended the Earth Summit and became executive director of the citizen group that coordinated participation of U.S. non-governmental organizations, but found that financial support for the necessary follow-up dried up immediately. Instead, funders were off to their next global conference. Now, on its twentieth anniversary,

the biggest impact in America at least seems to be Tea Party activists fearful that *Agenda 21* is a United Nations conspiracy to kill the suburbs and individual liberties.[47]

Also on the bright side, my work gained national recognition, leading to federal appointments and contracts from the Clinton Administration, and even a Presidential Executive Order.[48] I was at the top of my game: lecturing at universities and conferences throughout the country, running the first national organization advocating for green jobs, flying to Washington every other week to serve on federal panels, and writing reports for the U.S. Department of Commerce and U.S. Environmental Protection Agency (EPA) in addition to national environmental groups.[49] In retrospect, however, it is difficult to gauge whether any of this work has had any measurable impact on improving environmental quality.

It is now the 25th anniversary of the EPA's Toxic Chemical Release Inventory (TRI), which is not only the world's largest database of toxic pollution, but also the very first congressionally mandated online public information system. I spent much of my early professional life fighting for its creation. Public Data Access, Inc., the firm that Jay and I cofounded in 1986 with the economist Michael Tanzer, was one of three bidders considered to operate the system. TRI shows a steady decline in toxic emissions since the 1980s; however, the data are so fraught with limitations, it is hard to know how to interpret these results.[50] Some of the reductions may be real or they may result from corporations gaming the system (the data are self-reported estimates, not independently measured), or off-shoring production to China or wastes to Africa or elsewhere on the globe.[51] Whichever, U.S. industry voluntarily reports an increase in 2010 that totals nearly four billion pounds of toxic releases, the equivalent of 13 pounds per year for every American.[52]

Unequal

The disparities in the racial and socioeconomic distribution of hazardous wastes in the United States have also deteriorated, according to a report published on the 20th anniversary of my

original research.[53] I cringe when I read Bill McKibben, one of the leading environmental writers and global-warming activist in the United States, who writes that inequality is "the most common and least fundamental objection to our present economy."[54] What this perspective fails to see is it that we are all in trouble as long as the few make decisions for the many, and as long as voiceless interests go unrepresented. Epidemiologists Richard Wilkinson and Kate Pickett have eloquently demonstrated how inequality poisons all aspects of society, just as economists Daron Acemoglu and James Robinson have shown that throughout the ages it has determined whether nations succeed or fail.[55] Global measures of inequality have increased dramatically in recent decades both within developed and less-developed countries alike, as well as between them—reversing the centuries-long trend in the opposite direction.[56]

The "99%" mantra of Occupy Wall Street is but one recent manifestation of civic protest against rising inequality; the "leaderless" decision-making that is central to the movement, however, may also be its downfall. Upgrading methods for democratic decision-making within the context of increasing magnitudes of inequality, uncertainty, and human impact is the central but possibly most under-recognized issue of our time. To repeat the biggest lesson from my career: the scope of environmental impacts echoes the inadequacies of decision-making processes that create them. Yet we are still using simplistic centuries-old methods for making our most important public choices (*e.g.*, picking political leaders and representatives by ballot once every four years), while allowing the most complex private calculations (often instant, high-frequency, and computer-generated) to wreak havoc on the world's economy and ecology. With the technology now at our fingertips, there has got to be a better way.[57]

SWAY

Most Americans have probably never heard the rich Japanese vocabulary for the sometimes-ancient oligopolistic decision-making traditions that characterize the intimate relationships between Japan's

public and private sectors, especially with regard to the generation of nuclear power, including *keiretsu* (cartel), *zaibatsu* (financial clique), *amakudari* (revolving door), *yakuza* (mafia), *oyabun* (don), *gyosei shido* (administrative guidance).[58] But they should be as familiar as anyone in Japan with how money corrupts political processes and how monopolies are antithetical to the competitive efficiency of capitalism. Eisenhower's "Atoms for Peace" program, which created the nuclear power industry in 1953, is the ultimate cozy offspring of the public-private partnership that he later condemned with the phrase "military-industrial complex" in 1961. Just think of Iran or North Korea, the two latest countries trying to join the club, in order to sense the dangerous connection between peaceful and military uses of nuclear technology and the necessarily deep involvement of national government throughout the industry's entire life-cycle.

I will never forget giving a talk at a hospital in Saskatoon, Saskatchewan about the risks of uranium mining, when the head of radiology stood up holding a faxed smear-sheet about *Deadly Deceit* from the U.S. Energy Awareness Committee (USEAC), the primary lobbying organization for the nuclear industry. He claimed it debunked our findings, because U.S. mortality continued to fall after the bomb tests. As you can see in Chapter 7, this accusation neither accurately depicts nor undermines our findings, since the statistical test involves the degree of diversion from a historical rate of decline, and not whether an absolute increase occurred or not. That drove home for me the nefarious reach of the propaganda apparatus behind the nuclear industry, following me across countries, topics, and professions with disingenuous analyses aimed at undermining the credibility of our work at all cost.

The U.S. government issued two unusual press releases that point to the greater ferocity and coordination of attacks from the nuclear industry than from the relatively fractured petrochemical polluters. In one, the EPA (tasked with regulating the environmental impacts of every industry in America except radiation from nuclear power) issued a press advisory specifically about my last environmental justice study, confirming the problem we identified and identifying it

as a "top priority" of government.[59] A decade later, in contrast, the Nuclear Regulatory Commission (tasked solely with the nuclear industry) issued an advisory attacking RPHP's work as having "little or no credibility."[60] I can certainly vouch for the similar methods used in all of this work, so the difference here is primarily in the eyes and interests of the beholders. Advanced searches of both agencies' websites indicate neither has ever issued another press advisory (before or after) about the work of an individual nonprofit organization in this manner (in favor or against).[61]

The Nuclear Energy Institute (NEI), the latest incarnation of the industry's private lobbying arm (replacing the USEAC in 1994), continues to attack RPHP with "backgrounders" that are remarkably similar to the NRC's governmental press advisory.[62] With an annual budget of nearly $50 million, the institute has been one of the most successful "green-washing" efforts ever, creating the widespread (mis)impression that a fundamentally toxic industry is not only "clean", but part of the solution to climate change—as if there were some magical calculus that would make sense of trading meteorological for radiological uncertainty. Fukushima should teach the lesson that nuclear power poses even greater risks under conditions of extreme weather that accompany climate change.

NEI not only makes sure that radiologists in Saskatoon get smear-sheets about visiting speakers, but also funds reams of studies with absurdly self-serving findings (such as claiming the nuclear industry has received less federal subsidies than wind and solar energy since 1950—omitting, for example, the more than $30-billion worth of liability caps provided by the Price-Anderson Act), strategic investments to convert youth, minority, and female audiences (such as advertising on the "Daily Show with Jon Stewart," or making large donations to the Congressional Hispanic Caucus, Greater Washington Urban League and Women in Government), and co-chairmanships for self-described environmentalists such as a former EPA Administrator and a former Greenpeace co-founder to the wonderful-sounding nuclear-advocacy

group called the "Clean and Safe Energy Coalition."[63] The influence peddling certainly does not end there….

Just as George W. Bush fancied himself a Texas oil man, Barak Obama's chumminess with the nuclear industry is legend. If his home state of Illinois were a country, it would be the tenth largest nuclear power in the world, just behind China, and generating more nuclear energy than any other state in the nation.[64] Executives and employees of Exelon Corporation, which runs all of Illinois' reactors, including John W. Rowe, chair of Exelon and former chair of NEI, have contributed more than a quarter-million dollars to Obama's Senate and Presidential campaigns.[65] The ties are personal as well as professional, including Obama's former senior advisor David Axelrod having consulted for an Exelon subsidiary, his former chief of staff Rahm Emanuel having helped form the company, and Exelon board member John W. Rogers having not only contributed $50,000 to the Pro-Obama Super PAC, but he also brought Obama's brother-in-law to Princeton (where First Lady Michelle followed) and was married to former White House Social Secretary Desiree Rogers.[66] Obama's biggest supporter may be Duke Energy, the third largest nuclear power company in the U.S., which is underwriting the 2012 Democratic National Convention in Duke's hometown of Charlotte, North Carolina, with a $10 million line of credit.[67]

Mind

Obama's pro-nuclear policy stance is officially couched within the bland and ever-so-rational-sounding premise of supporting all available energy options. But it is also based on a mindset fostered by a long-entrenched bipartisan political, technical, and business elite that has claimed nuclear power players among its top members from the start of the Atomic Age. Nuclear technology (weapons and power) has always been the primary focus of the U.S. Department of Energy, which traces its organizational lineage directly to the wartime Manhattan Project and its successor Atomic Energy Commission. Responsibility for the nation's vast nuclear weapons production, research and development complex dominates the

DOE's budget to this day. Fittingly, just as George W.'s outgoing Energy Secretary was a chemical engineer, Obama chose Steven Chu, an impeccably credentialed pro-nuclear physicist (with a Nobel no less and research into renewable energy as well as such esoteric astrophysics as gravitational redshift, about which he continues to publish even while running a federal agency!) to lead the DOE.[68]

The mainstream press fixates on a solar-energy flop like Solyndra, with Republican cries of "crony capitalism," while Obama's 2012 budget triples the loan guarantee for reactor construction, bringing the total to $58.5 billion, 100-times the $535-million Solyndra loan! A single accident at the Indian Point reactor near New York City could cause a 1,000-times-greater loss than Solyndra, and twenty-times greater than the damages from 9/11—but with nuclear catastrophes in America, taxpayers pick up the tab in addition to suffering the human toll, just as they do in Japan.[69]

The President kicked off his 2012 energy policy tour visiting a photovoltaic facility, while planning to fund $450 million to design and license small reactors throughout the country. Building big ones has proven so onerous, why not try fast-tracking smaller ones, thereby multiplying the risks with dispersion—the latest spin on the cynical old yarn: "the solution to pollution is dilution"?![70] For every dollar spent on renewable energy, the federal government has spent ten dollars on nuclear power, which, according to the Union of Concerned Scientists may have cost 40 percent more than the value of all of the electricity it ever produced.[71] In other words, despite $250 billion in subsidies since Sternglass met Einstein 65 years ago, the nuclear industry still requires taxpayer subsidies for viability![72]

Such is the state of mind of a power elite that would approve the first new reactors in a generation just weeks before Fukushima's anniversary, overriding the dissenting vote of the NRC's own Chair, who objected because post-Fukushima safety improvements had not been finalized. This is the mindset of a naïve technological optimism rooted in a kind of Cartesian reductionism that is blind to everything not proven with the certainty of mathematical causation. Health physicists are the ultimate Cartesians, but Descartes was

wrong, or at least may have missed a more profound truth than "I think therefore I am." Rational thought does not define our existence as conscious beings, but rather, as Eckhart Tolle elucidates, it is our awareness that we are able to think.[73]

Spirit

The distinction between atomistic rationality—while no doubt an essential ingredient of scientific progress—and the many other forms of human awareness is critical in our age of rapid technological change. The Renaissance was launched with Gutenberg's invention of mechanical reproduction, midway between today's world of digital reproduction and publication of the *Diamond Sutra*, the world's first printed book. The last verse of that illustrated scroll, which spread Buddhism throughout Asia, posited the antithesis of Descartes' worldview:

> *This fleeting world is like a star at dawn, a bubble in a stream, a flash of lightning in a summer cloud, a flickering lamp, a phantom, and a dream.*[74]

The disciple Subhuti was filled with joy—as were priests and priestesses, gods, titans and men—by this reference to the central doctrine that dividing the world into entities—even naming Buddha as an individual—is an illusion. The colophon that follows reads:

> *Reverently made for universal free distribution by Wang Jie on behalf of his two parents on the thirteenth of the fourth moon of the ninth year of Xiantong* [May 11, 868].[75]

A thousand years ago, today's technological revolution was anticipated in this way with the world's first public domain notice.[76]

We are approaching what futurists such as Vernor Vinge and Ray Kurzweil see as a possible "technological singularity" later this century, when a hand-held device will have computational powers many multiples greater than all human brainpower combined.[77] The emergent evolutionary complexity accompanying such change—with

advances in nanotechnology, genetics, robotics and the like—creates a kind of "event horizon" beyond which predictions are all but impossible. Such extreme uncertainty demands the greatest maturity and wisdom we can muster for technological decision making. Even the most advanced artificial intelligence—thinking machines comprised of Cartesian automata—will be incapable of such wisdom unless we can figure out at least how to make them aware that they are thinking. Maybe first, we should figure out how to instill such mindfulness in the all-too-human institutional processes that currently determine our most important technological choices.

We have reached such mind-spinning speeds of technological change as we enter the latest "Age of Big Data" that the very notion of wisdom sounds quaint and old-fashioned. Twenty years ago, when most of our groundbreaking work on toxics, radiation, and environmental health was done, the Internet Age had barely begun. What are the odds that Jay's work would be brought to the U.S. Supreme Court a second time, three decades after *Brown Shoe*? Well, in *Federal Election Commission v. Political Contributions Data Inc.*, the Reagan Administration sued a subsidiary of our tiny firm in an attempt to prevent us from providing public access to information about federal campaign contributors.[78] They lost, and in 1994, the Supreme Court made the FEC pay our attorney fees (David Vladek was at Public Citizen when he represented us and is now Director of the Federal Trade Commission's Bureau of Consumer Protection).[79] Ever since, it has been easy for Americans to see who tries to influence elections with cash. More recently, however, in *Citizens United v. FEC*, the Court ruled in 2010 that corporations are people too, with First-Amendment rights, opening the floodgates for concentrated financial interests to distort political decisions in ways that extractive elites have doomed societies since the fall of Rome.[80]

Just as computers are not conscious, corporations will never have a conscience, even if both operate under the most sophisticated sets of ethical standards or digital code. We need individuals at the helm who are not only mindful of human impacts, but also of their reach across time, space, and difference (think species, demography, etc.),

as well as the limits of our understanding of these impacts. If corporations and computers can empower more people to act with an empathetic understanding of such parameters, then such systems could improve the wisdom of our most important decisions.[81] I left the field of public policy, however, because I saw the exact opposite happening: large institutions rich with technological and other resources trampling over the efforts of vastly under-resourced independent groups trying to uncover truths and right wrongs. My spirit was broken by that degree of institutional imbalance combined with the depressing findings of my analytical expertise.

Moving forward, we need to harness the collective wisdom of the still-living seven percent of all souls who have ever graced this earth (that is how many of us are left). To do so, we must learn that wise policy choices are as much art as science, and can never be left to institutional or technological systems alone, no matter how much smarter or more powerful than each of us they become.

Time

So I became an artist, and have spent most of the time since *Deadly Deceit* running arts organizations and making art. I wanted to be surrounded by color and bring beauty into the world. Forty years after my grandmother's film premiered at the Museum of Modern Art, MoMA sold a frame I designed in its holiday catalog, featuring a print by Andy Warhol, and my own paintings have been exhibited in 33 cities throughout the world.[82]

For me, creativity is as important as mindfulness in making wise choices: both help us see above and beyond, to the left and right, underneath and inside a problem, all necessary to discover new solutions and envision a better future.[83] Creativity is at the core of both art and science, as well as sustainability, a distinctly human concept about how our own behavior affects our own survival. Sustainability means mindful adaptation. Its human focus reveals that creativity is the difference between permanence and endurance. Our species' ability to change the evolutionary trajectory of life on

earth—for better or worse—is the result of our own invention. To endure, we must change, and that is a creative act.[84]

This past year, I finally found time to visualize the temporal scale of my decades-old work.[85] I stumbled across a book about a new field of research called "big history" before giving a talk on art and the environment to undergraduates at Parsons The New School of Design.[86] The field examines the past from the Big Bang to modernity and is unlike anything I studied as an undergraduate history major.[87] In the book was a chart showing *Homo erectus* had evolved a million years ago at the beginning of the Stone Age, hundreds of thousands of years before the first *Neanderthal* or modern human.[88] They had not even figured out how to make fire. That most-primitive technology alone took longer to discover than the entire subsequent time-line of *Homo sapiens'* existence until now.

What does it really mean to project that nearly three-million cancer deaths will accumulate over a million years as a result of technological choices made today? It is the same as if those cave men tossed a handful of their sharpest rocks into the future and killed all of the inhabitants of a city ten-times larger than Fukushima today. The radioactive spoils of our nuclear technology are by far the longest-lived toxic footprints that humans will ever leave on earth.

Here we are, a million years in, doing stuff that will ripple a million years out. That is "*nel mezzo"* in geologic time, quoting Dante's first canto of the *Divine Comedy,* possibly the most recited words in all of Western literature:

> *In the middle of the road of my life*
> *I awoke in the dark wood*
> *where the true way was wholly lost.*[89]

Nel mezzo, in the middle, is where I am in my life. When we are honest with ourselves and present in the cacophony of our lives, it is where we all always are: apprenticing, searching for our vocation, relearning why we are here and what we should do next.[90] It is also roughly where all earthly life is at this very moment: a billion years or so since the beginning of sexual reproduction caused the Cambrian

explosion of multicellular organisms, and a billion years or so until the sun's heat vaporizes our atmosphere and oceans, making earth uninhabitable once again.

Enriched uranium, ripped, milled, and processed from underground ore, is the core of nuclear weapons and power technology. With a half-life of 700-million to over four-billion years, its radioactivity will outlast life on earth. "The Miracle of U-235," a 1941 *Popular Mechanics* cover story extolling its promise of "universal comfort" and "free transportation," would be laughable if not for continued glowing claims in influential periodicals such as the *Wall Street Journal* on Fukushima's anniversary seven decades later that radioactive pollution, rather than being harmful, may actually "immunize the body against cancer and birth defects."[91]

We are all witness to the discordant mid-life promise of the Atomic Age, but it seems our vision is impaired. When a geomagnetic disturbance such as the 1859 "Carrington Event" solar storm happens again, it could knock out electric grids throughout the world. That would be a really major pain if we lived in a world where wind, solar, hydro, and the like powered our electrical systems. In our current world, however, imagine instead 400 simultaneous Fukushima disasters—with all the world's reactors melting down from a week-long global power outage—in nothing short of nuclear Armageddon.[92] Host to a quarter of the world's operating reactors, a third of all Americans (over 100-million people) would need to be evacuated beyond the 50 miles that the U.S. government recommended near Fukushima.[93] Why would our society voluntarily choose to step up the ladder of complexity and risk from physical to chemical to radiological when there are clearly better alternatives?

If it is just a matter of price, what an incomplete accounting our economy provides! For a few more pennies per kilowatt hour, I can now chose to power my home with 100% wind energy instead of the generic mix that my utility provides of two-thirds fossil fuel and one-third nuclear. How can our society continue to make this choice sound difficult—for that matter, how can it allow the latter to be the default option—given the scale of the potential risk, no matter how

uncertain? If we are worried about how to pay for it, why not shift a (large) portion of the trillion dollars of annual global military spending to convert the world to renewable energy, since the chronic effects of pollution causes twenty times the annual death toll of all forms of wars and other acute violence by man against man? Instead, peaceful anti-nuclear protesters in India are themselves accused of waging war and arrested for terrorism and treason.[94]

It is time for a chain reaction of wiser choices. Japan can lead the way. Twelve countries are more dependent on nuclear power, but only two generate more nuclear megawatts (U.S. and France).[95] None have suffered more at the hands of nuclear technology than Japan.

Wild

Nuclear power is the ultimate "wild man" of industrialization, the mythological Enkidu from the *Epic of Gilgamesh*, humanity's oldest text from four-thousand years ago. We need to reach back into our deepest myths to understand how such perverse priorities continue to survive. The Gods sent Enkidu to punish king Gilgamesh for brutally coercing his subjects to build a giant wall around the city of Uruk. But they became best friends instead, and Gilgamesh forgets his wall, making the people happy. The pair of alter egos, civilization and savage, leave Uruk to chop down the cedar forest and kill the evil Humbaba. In confronting evil, however, the wild man—long since domesticated by a woman—succumbs to a fatal chronic disease. The king is determined to avoid such fate, but alas, a snake steals the gift of eternal youth, and Gilgamesh is left to grieve, returning to his city, with its imperfect fortifications, neither full of love for nor able to escape entirely from nature.

Economist Tomas Sedlacek sees Enkidu as the invisible hand, the wild harnessed for the good.[96] But this is a complicated story, far more complex than the summary above, with verses and meanings that evolved over time. Siduri the innkeeper says to the king:

> *Gilgamesh, wherefore do you wander?*
> *The eternal life you are seeking you shall not find.*[97]

She was wrong: the king refused to be sated by daily joys, pursuing his heroic quest to the end, achieving immortality in the written word, a story known throughout the millennia. The memory of the wild man inspired Gilgamesh always to reach beyond his wall.

The poet Robert Bly explores the Brothers Grimm fairy tale *Der Eisenhans* or "Iron John" as a vehicle to trace the wild man archetype to contemporary times.[98] Bly laments the loss of male initiation in the modern world, stunting the maturation of generations of men. The wild man is not inside us, but someone we seek in the wilderness, healing from injuries along the way that open us to both grief and understanding. Maybe the historic and projected damages from nuclear technologies are the ritual scarification that humanity must endure in order to mature into a green economy. Just think of the two-mile-long trench under the former Navajo lands of southern New Mexico filled with highly-radioactive transuranic waste from nuclear weapons for thousands of years, or the 300,000 tons of highly radioactive spent fuels scattered in pools across the globe that must also be permanently stored.[99] This everlasting atomic legacy will remind us of our foolish youth for many more generations than the mere seven evoked in *Gayanashagowa*, the Great Law of the Iroquois Confederacy, which dates back a thousand years and has not only inspired so much contemporary ecological thought and action, but was also an inspiration for the United States Constitution.[100]

Near Elliot Lake, the Ojibwa people told me the story of the great Serpent's eggs, which would do no harm as long as they lay undisturbed. But then the white man came. First they were trappers who took all of the beaver and otter and mink. They left only the bush and the rocks. Then they were loggers who cut down all the trees, the red pine and white, and left only the bare rocks. Then they were miners who carried little black boxes that chattered like squirrels whenever they walked near the Serpent's nest. And the old man said: "now, they come back for the rocks."[101]

With the scars of Fukushima, Hiroshima, and Nagasaki, maybe Japan will be the first to reawaken to such aboriginal wisdom and

lead the world into becoming a sustainable, nuclear-free community. We need a second wave of *Japonisme*, which overtook Western culture in the thick of the industrial revolution, with stunning Zen-inspired wood-cut *Ukiyo-e* prints, "pictures of the floating world," shaking artistic traditions from their academic roots, changing the way we see reality, expanding the appreciation of our present lives.

The haiku that began this meditation won a 2010 award from the Mayor of Nagasaki and was written by a librarian and children's author from New Hampshire. Let's end with a classic haiku by a foremost author of the Meiji period, whose portrait once adorned Japanese currency:

Over the wintry
forest, winds howl in rage
with no leaves to blow.

– Sōseki[102]

Both poems echo the alienating bleakness of the Atomic Age, despite being written a half-century before and a half-century after it began. But just as spring has always followed winter, vibrant flaming-red canna lilies blanketed Hiroshima's radioactive rubble after the bombs fell.

And we have yet to be silenced….

– Ben Goldman
March 2012

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[3] U.S. Supreme Court, *Brown Shoe Co., Inc v. United States* (370 U.S. 294, 1962).

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[5] Erik Barnouw, *Media Marathon: A Twentieth-Century Memoir* (Durham, NC: Duke University Press, 1996), pp. 193-217.

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[15] Freeman, *op. cit.*

[16] Hawking and Mlodinow, *op. cit.*, p. 111.

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