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Beneficial Precaution: A Proposed Approach to Uncertain Technological Dangers

*Edward L. Rubin**

ABSTRACT

As a result of the specialization and cumulation of knowledge in the era of High Modernity, research and development in most technical fields is largely incomprehensible to anyone outside that field. What should policy makers do when technical specialists disagree, and particularly when some predict an oncoming catastrophe and others dismiss the concern? This is the situation with the so-called Singularity, the point at which machines design, build, and operate other machines. Some experts in cybernetics and artificial intelligence argue that this is imminent, while others consign the possibility to science fiction. If the skeptics are right, nothing need be done. But if the Singularity occurs, and we are not prepared for it, then economic inequality will increase exponentially and a large proportion of the workforce will be unemployed and unemployable. The resulting social disruptions seem certain to destroy democracy.

This Article suggests a general strategy for addressing such a situation. It makes use of the history of climate change, a similarly serious challenge about which technical specialists disagreed for about three decades, and argues that policy makers should develop and energetically implement strategies that would at least ameliorate the crisis if it does occur while providing immediate benefits or only minor detriments. In the case of climate change, such strategies would have included renewable energy sources, mass transit, and intelligent buildings. For the possible Singularity, responses with short-term benefits would include comprehensive job retraining (moving currently unemployed workers into service positions), increased funding for the arts and other self-fulfilling pursuits, and restructured education that prepares people for leisure as well as vocations. This Article discusses

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each of these possibilities as providing immediate benefits and partial preparation in the event that the Singularity occurs.

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I. THE POLICY MAKER'S DILEMMA IN A TECHNOLOGICAL AGE

Ever since the invention of language, human beings have been able to build on previous discoveries and insights. With the Scientific Revolution, however, there has been a dramatic increase in the pace at which knowledge cumulates. Institutional systems of recordkeeping, training, and directed research now display a level of coordination and sophistication far beyond anything that existed in previous societies. The truly monumental change, however, lies in the structure of knowledge itself. Our understanding of the physical world is now based on well-understood scientific principles. These principles interact with practical applications to generate exponential growth along discrete and well-defined lines of inquiry and development. Modern technology, and thus the complex technological environment in which we find ourselves, is the product of this process.

The result is that all of us inhabit a world that we cannot understand, a technological world shaped by the cumulation of knowledge in a wide range of separately defined, highly specialized

fields.¹ To reach the advancing edge of any given field requires nearly half a lifetime of education and training. It was once sufficient to complete four years of medical school to become a surgeon; now surgery is divided into subspecialties that can only be mastered after four years of medical school, a three-year residency, and a two-year fellowship.² Advances in other areas of technology are typically achieved by people with seven years of graduate training, two years of postdoctoral studies, and extensive practical training once employed. No one can master more than one such field.

We benefit from this cumulated knowledge in innumerable ways, but it poses a dilemma for those who govern our society. Our government leaders, although sometimes ignorant demagogues, are often intelligent and thoughtful people, but their training and experience tend to be limited to the realm of politics and management in which they have succeeded.³ It does not matter whether we regard them as the last of the generalists or as possessing their own particular form of expertise. The structure of modern knowledge guarantees that they will rarely be expert in any technical field, and virtually never in more than one.

This means that they will not be able, on their own, to understand the state of knowledge that prevails in this era of High Modernity.⁴ Obviously, a conscientious policy maker, when confronted

1. See JÜRGEN HABERMAS, *THE THEORY OF COMMUNICATIVE ACTION, VOLUME 2: LEIFEWORLD AND SYSTEM: A CRITIQUE OF FUNCTIONALIST REASON* 332–73 (Thomas McCarthy trans., 1987) (describing the cumulation of technological knowledge as part of the colonization of the lifeworld).

2. See PAUL STARR, *THE SOCIAL TRANSFORMATION OF AMERICAN MEDICINE* 355–59 (1982); Amy E. Thompson, *A Physician's Education*, 312 *JAMA* 2456, 2456 (Dec. 10, 2014). The formal structure of medical specialization began in the United States during the 1930s. As Paul Starr states, “At least three years of training after internship were required for certification in any specialty.” STARR, *supra* at 357. Starr goes on to note that “[t]he percentage of doctors reporting themselves as full-time specialists jumped from 24 percent in 1940 to . . . 69 percent [in 1966].” *Id.* at 358–59; see also James E. Dalen, *Where Have the Generalists Gone? They Became Specialists, then Subspecialists*, 130 *AM. J. MED.* 766, 766–68 (2017) (continued increase in specialization and length of training).

3. Of the 535 Members of the 115th Congress, 238 listed their background as politics (44 Senators, 194 Representatives), 218 as law (50 and 168), 208 as business (29 and 179), and 99 as education (20 and 79). JENNIFER E. MANNING, *CONG. RESEARCH SERV.*, R44762, *MEMBERSHIP OF THE 115TH CONGRESS: A PROFILE 2* (2017). The numbers add to more than the total due to multiple listings. Both business and education might include specific areas of expertise as well as general governance (i.e., management experience), but those who opt for political careers are likely to have shifted from specific fields to generalized management fairly early. In terms of education level, which can be divided more readily into mutually exclusive categories, 126 Members had nothing beyond a master's degree and 167 had law degrees, which means that 293, or about 55 percent, had no expertise outside the governance area, except in the rare case of someone with a second degree besides law. Only 42, or 8 percent, held any kind of an advanced degree other than law, and at least some of those were PhD or EdD degrees. *Id.* at 5.

4. For a definition of High Modernity, see EDWARD L. RUBIN, *SOUL, SELF, & SOCIETY: THE NEW MORALITY & THE MODERN STATE* 16–17 (2015).

with the need to make decisions in a given field, will rely on the advice of knowledgeable experts in that field. What happens, however, when the experts disagree? By virtue of the very circumstances that make the views of experts essential for responsible decision-making, public officials will not be able to evaluate the relative merits of these contending views. They can, of course, choose one or the other and use the experts they have chosen for political cover. But as members of this society, we do not want them to do this. What we want is for them to get the right answer, to choose the optimal course of action. They cannot do so on a rational basis, however; they simply cannot be knowledgeable enough about a technical field to determine whether one group of experts in that field are more likely to be right than an opposing group.

Perhaps we are willing to rely on a combination of instinct and elections to resolve this dilemma. We may believe that there is an undefinable but authentic quality of judgment possessed by those who have risen to leadership positions that would enable them, in situations of uncertainty, to make choices that are significantly superior to random variation. We may believe as well that this decision-making ability is favored by our democratic and administrative systems of selection, such that those who possess it are more likely to be elected or appointed to high public office. This could conceivably suffice for ordinary decisions with delimited impacts and reversible results. But what should we do when experts disagree about an issue with potentially catastrophic consequences? And what should we do if those consequences, once they begin to unfold, either cannot be reversed or can only be reversed by policies imposing massive costs on society? In other words, how should policy makers confront uncertain but potentially disastrous situations? To claim that they should simply rely on their own best judgment is playing Russian roulette with three bullets in the gun.

The argument advanced here is that the optimal policy response to the dilemma of potentially perilous uncertainty is to adopt beneficial precautions: strategies that will resolve or ameliorate the possible disaster in the future while providing immediate benefits in the present. If the disaster materializes—if those experts who predicted it were right—then society will be at least partially prepared to combat it. If the disaster does not occur—if the experts predicting it were wrong—then society will nonetheless receive the collateral benefits that flow from precautions that turned out to be unnecessary. It is, of course, implicit in this strategy that the immediate benefits of the recommended precautions were not sufficient to motivate their adoption in the absence of the potential crisis. Thus, implementation of these benefits will involve inconveniences that the society would

otherwise choose to avoid or require subsidies that the society would otherwise be unwilling to provide. It is argued that these are the costs of uncertainty but that, if the strategy is carefully designed, this cost will be much lower than the cost of the potential disaster discounted by the likelihood of its occurrence.

The argument for this strategy is advanced by means of two examples. The first is anthropogenic climate change. The response to this problem by our nation, and, to a lesser extent, other nations, has been dreadful, and we will all suffer with the consequences of this failure for many centuries to come. It is not difficult to identify beneficial precautions that could have been adopted once the problem was identified, precautions that would have been palatable at the time and provided effective, if not complete, solutions.

But the defining feature of a problem that beneficial precautions can address is its uncertainty, and the argument may seem unconvincingly easy when applied to a situation that is no longer uncertain. Thus, the second example that this Article uses is one that is highly uncertain at present. This is the danger that automation and artificial intelligence (AI) will advance to the point—sometimes called the Singularity—at which they will cause massive and permanent unemployment. Considering the beneficial precautions that could address this issue can thus provide a further argument for the value of this strategy. Of course, we cannot know, at present, how necessary or effective such precautions will be, and those who would consign the Singularity to science fiction might consider such precautions wasteful or chimerical. But the point is that other people regard the Singularity as an oncoming and inevitable crisis, and we simply do not know who is right. Thus, the two examples are designed to work together to demonstrate the value of beneficial precaution as a public policy approach—the first by showing how it would have helped solve a problem that materialized, and the second by showing how it can be applied to a problem that remains uncertain at this present juncture.

Part II considers anthropogenic climate change. Section II.A summarizes the process by which global warming was identified as a potential danger in the 1960s and 70s and became a certainty by the mid-1990s. With the benefit of hindsight, Section II.B presents three beneficial precautions that could have been adopted when the danger was predicted but uncertain—that is, precautions that would have provided immediate benefits at the time while combatting the potential dangers that have now become a certainty. These are renewable energy, specifically solar and wind, mass transit, and intelligent buildings. Part III then applies the same approach to the Singularity. Section III.A discusses the potential problem in its historical and economic context.

Section III.B considers beneficial precautions that we might undertake at present to address this uncertain but potentially severe development. These are increased job retraining, arts grants to substitute for employment, and a reconceived educational system emphasizing the development of technological and aesthetic capabilities.

II. THE LUGUBRIOUS EXAMPLE OF CLIMATE CHANGE

It is now apparent that public policy makers dealt poorly with the danger of anthropomorphic climate change. As a result, we are confronting the likelihood that our national wealth and quality of life will be significantly diminished by the end of the century.⁵ Less certain but still more disastrous consequences are within the realm of possibility. To take just one example, many predict that there will be between one and two hundred million refugees from deteriorating environmental conditions in the developing world.⁶ Some two million Syrian refugees have provoked a political crisis in Western European democracies and undermined the more fragile democracies of Eastern Europe.⁷ The stress of one hundred times as many refugees could potentially bring democratic government among developed nations to an end.

A. The Discovery of Global Warming and the Problem of Uncertainty

The idea that increased carbon dioxide concentrations in the atmosphere could raise the Earth's average temperatures was proposed in 1899.⁸ It was not until the 1940s, however, that Carl-Gustaf Rossby established the scientific basis for meteorological research that enabled climate-creating forces to be mathematically modeled and

5. David R. Reidmiller et al., *2018: Overview, in* IMPACTS, RISKS, AND ADAPTATION IN THE UNITED STATES: FOURTH NATIONAL CLIMATE ASSESSMENT, VOLUME II (David R. Reidmiller et al. eds., 2018).

6. GOV'T OFFICE FOR SCI. (U.K.), MIGRATION AND GLOBAL ENVIRONMENTAL CHANGE: FUTURE CHALLENGES AND OPPORTUNITIES 189 (2011); Rafael Reuveny, *Climate Change-Induced Migration and Violent Conflict*, 26 POL. GEOGRAPHY 656, 658 (2007). This is in addition to massive internal migration that will occur in the developing world and cause disruption to those nations that will have worldwide repercussions.

7. Georg Diez, *The Migration Crisis and the Future of Europe*, AM. PROSPECT (Apr. 5, 2019). Regarding the relationship between climate change and the Syrian conflict that produced the refugees, see John Wendle, *Syria's Climate Refugees*, 314 SCI. AM. 50, 50 (2016). Regarding the refugees' impact on European politics, see Lenka Buščíková, *The Radical Right in Eastern Europe*, in THE OXFORD HANDBOOK OF THE RADICAL RIGHT 565 (Jens Rydgren ed., 2018); François Heisbourg, *The Strategic Implications of the Syrian Refugee Crisis*, 57 SURVIVAL 7 (2015); Annastina Kallius et al., *Immobilizing Mobility: Border Ethnography, Illiberal Democracy, and the Politics of the "Refugee Crisis" in Hungary*, 43 AM. ETHNOLOGIST 1, 23 (2016).

8. T. C. Chamberlin, *An Attempt to Frame a Working Hypothesis of the Cause of Glacial Periods on an Atmospheric Basis*, 7 J. GEOLOGY 545, 548 (1899).

systematically explored.⁹ The early scientific work in the field focused on the drama of the ice ages that preceded the current geological era and the possibility that another ice age might occur.¹⁰ Well into the 1970s, there were predictions that the Earth was becoming colder, a view widely publicized in a 1974 BBC television feature on weather produced by Nigel Carter, a well-known science journalist.¹¹

At the same time, however, research applying Rossby's methodology was beginning to suggest the opposite conclusion. Based on data gathered during the International Geophysical Year (1957–58) and subsequent studies, Charles Keeling developed the first measurements of carbon dioxide increase in the atmosphere.¹² The data were presented at a 1963 conference sponsored by the Conservation Foundation.¹³ By the mid-to-late 1970s, a number of climate scientists had reached the conclusion that the carbon dioxide increase was real and was likely to produce significant and possibly catastrophic global warming.¹⁴ There remained many uncertainties, however, such as the source of the increase, the ability of the oceans to absorb carbon dioxide, the role of volcanoes, and the effects of deforestation and atmospheric pollution.¹⁵ These various and possibly conflicting factors could not be resolved into definitive predictions without an accurate model of the atmosphere, but the first model that was developed consisted of an aluminum dishpan filled with water and set on a record turntable to simulate the Earth's rotation.¹⁶

9. Douglas R. Allen, *The Genesis of Meteorology at the University of Chicago*, 82 BULL. AM. METEOROLOGICAL SOC'Y 1905, 1905–08 (2001); Robert Gall & Melvyn Shapiro, *The Influence of Carl-Gustaf Rossby on Mesoscale Weather Prediction and an Outlook for the Future*, 81 BULL. AM. METEOROLOGICAL SOC'Y 1507, 1507 (2000). The large waves that move through the atmosphere as a result of the Earth's rotation are called Rossby waves. See Michael E. Mann, *The Weather Amplifier*, 320 SCI. AM. 42, 44 (Mar. 2019).

10. See SPENCER R. WEART, *THE DISCOVERY OF GLOBAL WARMING* 44, 77–78 (rev. ed. 2008). There was also concern that nuclear weapons testing could affect climate patterns. *Id.* at 40.

11. NIGEL CALDER, *THE WEATHER MACHINE* (1974) (following and based on the BBC production); John J. O'Connor, *TV: 'Weather Machine' Is Effective and Clear*, N.Y. TIMES (Feb. 24, 1975); WEART, *supra* note 10, at 88; see also IMPACT TEAM, *THE WEATHER CONSPIRACY: THE COMING OF THE NEW ICE AGE* (1977); LOWELL PONTE, *THE COOLING: HAS THE NEXT ICE AGE ALREADY BEGUN? CAN WE SURVIVE IT?* (1976).

12. WEART, *supra* note 10, at 33–37.

13. *Id.* at 42.

14. This conclusion was presented in a series of papers published in *Science*, a leading journal. See, e.g., Wallace S. Broecker, *Climate Change: Are We on the Brink of a Pronounced Global Warming?*, 189 SCI. 460, 461 (1975) (possibly the first use of term); Wallace S. Broecker et al., *Fate of Fossil Fuel Carbon Dioxide and the Global Carbon Budget*, 206 SCI. 409, 409 (1979) (role of the biosphere); James E. Hansen et al., *Climate Impact of Increasing Atmospheric Carbon Dioxide*, 213 SCI. 957, 957 (1981) (carbon dioxide warming will become evidence by the end of the twentieth century); Roland E. Madden & V. Ramanathan, *Detecting Climate Change Due to Increasing Carbon Dioxide*, 209 SCI. 763, 763 (1980) (same).

15. WEART, *supra* note 10, at 77–87.

16. *Id.* at 53.

By the 1980s, however, a scientific consensus on climate change was rapidly developing. In 1983, the National Academy of Sciences issued a report stating that anthropogenic climate change was real, although not necessarily catastrophic,¹⁷ and the Environmental Protection Agency followed with a report that contained a similar scientific finding but predicted more serious consequences.¹⁸ Two meteorological conferences with worldwide attendance, the first in Villach, Austria, in 1985 and the second in Toronto in 1988, confirmed these findings and sounded increasing alarms.¹⁹ By then, vastly improved data from satellites, weather stations, and core samplings, plus exponentially expanding computer capacity, were allowing scientists to construct models of the entire climate system that included ocean conditions, cloud effects, and aerosol pollutants and were far superior to rotating dishpans.²⁰

In 1988, the Intergovernmental Panel on Climate Change (IPCC) was formed, an umbrella organization that included both scientists and governmental representatives from nearly every nation.²¹ It issued its first report in 1990²² and a follow-up report in 1995.²³ Given the comprehensive authorship of the 1995 report, and the definitive nature of its conclusions,²⁴ it is fair to say that anthropogenic

17. NAT'L RESEARCH COUNCIL, CHANGING CLIMATE: REPORT OF THE CARBON DIOXIDE ASSESSMENT COMMITTEE 1-3 (1983).

18. STEPHEN SEIDEL & DALE KEYES, CAN WE DELAY A GREENHOUSE WARMING? i-ix (1983).

19. WEART, *supra* note 10, at 146-49.

20. *Id.* at 91-98, 132-36, 159-63.

21. See *The IPCC: Who Are They and Why Do Their Reports Matter?*, UNION CONCERNED SCIENTISTS 1 (July 16, 2008), <https://www.ucsusa.org/global-warming/science-and-impacts/science/ipcc-background.html> [<https://perma.cc/H4KG-5ZQH>]; WEART, *supra* note 10, at 152-53.

22. CLIMATE CHANGE: THE IPCC SCIENTIFIC ASSESSMENT (John T. Houghton et al. eds., 1990).

23. CLIMATE CHANGE 1995: THE SCIENCE OF CLIMATE CHANGE (John T. Houghton et al. eds., 1995).

24. The report states its conclusion as follows:

We believe the essential message of this report continues to be that the basic understanding of climate change and the human role therein, as expressed in the 1990 report, still holds: carbon dioxide remains the most important contributor to anthropogenic forcing of climate change; projections of future global mean temperature change and sea level rise confirm the potential for human activities to alter the Earth's climate to an extent unprecedented in human history; and the long time-scales governing both the accumulation of greenhouse gases in the atmosphere and the response of the climate system to those accumulations, means that many important aspects of climate change are effectively irreversible. Further, that observations suggest "a discernible human influence on global climate," one of the key findings of this report, adds an important new dimension to the discussion of the climate change.

Id. at xi.

climate change became a proven fact at that point.²⁵ Subsequent reports by the IPCC and other reputable scientific researches have only confirmed and amplified this conclusion.²⁶

Everyone in grade school learns about the “scientific method” for conducting experiments, but the means by which agreement is achieved about a larger theory that cannot be confirmed—at least initially—by experimentation is a different matter. It might be called the “scientific process.” This consists of an initial proposal, the accretion of evidence (experimental or observational), the suspension of judgment, and the acquisition of certainty. An example is the recent discovery of the Higgs boson. This particle was proposed in the 1960s to correct a known defect in the so-called Standard Model of subatomic particles, which was the Model’s inability to explain why most particles (such as protons and electrons) have mass, rather than being massless like a photon.²⁷ As the Higgs hypothesis developed and evidence accumulated, physicists became increasingly convinced that it was correct, but they scrupulously desisted from announcing the particle’s existence because they lacked definitive proof. Such proof, it became clear, would only be possible once a new device was built that could produce higher energy collisions than anything in existence at the time. Finally, this device—the Large Hadron Collider at CERN, which happens to be the largest machine ever built²⁸—became available, and the Higgs boson hypothesis became a scientific truth.²⁹

This scientific process regarding the reality of the Higgs boson was conscientious and creditable, but the process’s more general desirability depends on the fact that the result has no conceivable

25. For subsequent confirmations of the 1995 IPCC report, see IPCC, *THE PHYSICAL SCIENCE BASIS* (Thomas F. Stocker et al. eds., 2014); John Cook et al., *Quantifying the Consensus on Anthropogenic Global Warming in the Scientific Literature*, 8 ENVTL. RES. LETTERS 024024 (2013) (meta-analysis finding that 97.1 percent of 11,944 articles published in peer-reviewed scientific journals between 1991 and 2011 concluded that anthropogenic warming was occurring); Stephen J. Farnsworth & S. Robert Lichter, *The Structure of Scientific Opinion on Climate Change*, 24 INT’L J. ON PUB. OPINION RES. 93, 93–97 (2012) (84 percent of 489 members of the American Geophysical Union and American Meteorological Society believe that anthropogenic climate change is occurring); Naomi Oreskes, *The Scientific Consensus on Climate Change*, 306 SCI. 1686, 1686 (2004) (meta-analysis finding that articles in peer-edited scientific journals are nearly unanimous in concluding that anthropomorphic climate change is occurring).

26. See, e.g., IPCC, *CLIMATE CHANGE 2014: SYNTHESIS REPORT* (Headline Statement (title page): “Human influence on the climate is clear, and recent anthropomorphic emissions of greenhouse gases is the highest in history. Recent climate changes have had widespread impacts on human and natural systems.”).

27. SEAN CARROLL, *THE PARTICLE AT THE END OF THE UNIVERSE: HOW THE HUNT FOR THE HIGGS BOSON LEADS US TO THE EDGE OF A NEW WORLD* 19–38 (2012); PAULINE GAGNON, *WHO CARES ABOUT PARTICLE PHYSICS?: MAKING SENSE OF THE HIGGS BOSON, THE LARGE HADRON COLLIDER, AND CERN* 1–38 (2016).

28. CARROLL, *supra* note 27, at 75–92.

29. *Id.* at 93–114; GAGNON, *supra* note 27, at 67–92.

impact on our lives. The Higgs boson does not even have any impact on our metaphysical beliefs; although the boson was sometimes regarded as the “God Particle,”³⁰ anyone who thought that the counterintuitive strangeness of subatomic particles challenged their religion would have come to that conclusion long before the boson’s existence was confirmed.³¹ When applied to an issue with serious or catastrophic consequences for our lives and equivalent impacts on our beliefs, the scientific process is unsatisfactory. It suffers from two problems, each of which involves our collective response to the problem of uncertainty.

First, and most obviously, we can cause ourselves great harm by waiting for definitive proof of a hypothesized threat. Anthropomorphic climate change was recognized as a serious possibility as early as the 1960s. It was not confirmed, to the satisfaction of reputable meteorologists, until the 1995 IPCC report some thirty years later. We now know that we did virtually irreparable harm to our environment during that long period of delay. Enormous quantities of greenhouse gas were spewed into the atmosphere as developed nations burnt fossil fuel at unabated rates. Developing nations, most notably China and India, made enormous industrial advances during this period that were based on those same fossil fuel technologies, thereby creating entrenched carbon-generating capacities that will be as difficult to reverse as the carbon dioxide concentrations themselves.

Second, there was only limited value to delaying action until scientific certainty was achieved because such certainty has only minimal effect when people’s beliefs and emotions are involved. At present, depending on the way in which the question is asked, either 18 percent or 31 percent of Americans believe that humans have always existed in their present form, rather than having evolved over time.³² To say that there is overwhelming evidence against this view is an understatement. Human evolution is a fact—the amount of uncertainty regarding its existence is exactly zero—but that does not prevent tens of millions of Americans from denying it because they perceive it as

30. LEON LEDERMAN & DICK TERESI, THE GOD PARTICLE: IF THE UNIVERSE IS THE ANSWER, WHAT IS THE QUESTION? 22 (1993) (“This boson is so central to the state of physics today, so crucial to our final understanding of the structure of matter, yet so elusive, that I have given it a nickname: the God Particle.”).

31. Even leading physicists have been astonished by the oddities of the “particle zoo.” When the existence of the muon, an unstable, very heavy electron, was announced, Isidor I. Rabi famously asked, “Who ordered that?” Marsha Bartusiak, *Who Ordered the Muon?*, N.Y. TIMES (Sept. 27, 1987).

32. Cary Funk, Greg Smith & David Masci, *How Many Creationists Are There in America?*, SCI. AM. (Feb. 12, 2019). Another survey, carried out by Gallup, found that 38 percent of Americans reject human evolution. See Art Swift, *In U.S., Belief in Creationist View of Humans at New Low*, GALLUP (May 22, 2017), <https://news.gallup.com/pol/210956/belief-creationist-view-humans-new-low.asp> [<https://perma.cc/PJ89-SNQA>].

inconsistent with their religious beliefs.³³ Apparently, nothing will convince them of the contrary, including certainty.

The reaction to definitive proof of anthropomorphic climate change has been similar. Since the publication of the 1995 IPCC report, outright denial has continued to be a widespread and politically dominant position in the United States. It is the official policy of one of our two main political parties,³⁴ the declared position of the two of the four Presidents who have served since the Report's publication,³⁵ and the firm belief of a significant proportion of the populace.³⁶ The energy

33. See EDWARD J. LARSON, *SUMMER FOR THE GODS: THE SCOPES TRIAL AND AMERICA'S CONTINUING DEBATE OVER SCIENCE AND RELIGION* 267 (1997); C.P. SNOW, *THE TWO CULTURES AND THE SCIENTIFIC REVOLUTION* 5 (1959). A number of major American religious denominations continue to reject evolution on scriptural grounds—for example, the Lutheran Church, Missouri Synod, which states “We teach that God has created heaven and earth, and that in the manner and in the space of time recorded in Holy Scriptures, especially Gen. 1 and 2, namely, by His almighty creative word, and in six days,” and the Southern Baptist Convention, which states, “Whereas, The theory of evolution has never been proven to be a scientific fact . . . the Southern Baptist Convention . . . express our support for the teaching of Scientific Creationism in our public schools.” THE LUTHERAN CHURCH: MISSOURI SYNOD, BRIEF STATEMENT OF THE DOCTRINAL POSITION OF THE MISSOURI SYNOD ¶ 5 (1932), <http://www.lcms.org/doctrine/doctrinalposition#creation> [<https://perma.cc/RWF5-PU6S>]; *Resolution on Scientific Creationism*, SOUTHERN BAPTIST CONVENTION (1982), <http://www.sbc.net/resolutions/967> [<https://perma.cc/4XZS-WTZ5>]. Other denominations, including the Catholic Church, have only modified their opposition recently. See DON O'LEARY, *ROMAN CATHOLICISM AND MODERN SCIENCE: A HISTORY* 53–54, 85–93, 94–108 (2006).

34. See REPUBLICAN PLATFORM 2016 22 (2016) (“The United Nations’ Intergovernmental Panel on Climate Change is a political mechanism, not an unbiased scientific institution. Its unreliability is reflected in its intolerance toward scientists and others who dissent from its orthodoxy.”); REPUBLICAN PLATFORM 2012: WE BELIEVE IN AMERICA 16 (2012) (promising to “[e]nd the EPA’s war on coal and encourage the increased safe development in all regions of the nation’s coal resources, the jobs it produces, and the affordable, reliable energy that it provides for America” and stating that “we oppose any and all cap and trade legislation”). James Inhofe, Republican Senator from Oklahoma, chair of the Senate Committee on Environment and Public Works, 2003–07 and 2015–17, has written a book declaring climate change to be a hoax. See *generally* JAMES INHOFE, *THE GREATEST HOAX: HOW THE GLOBAL WARMING CONSPIRACY THREATENS YOUR FUTURE* (2012).

35. See Press Release, Donald Trump, President, Statement by President Trump on the Paris Climate Accord (June 1, 2017), <https://www.whitehouse.gov/briefings-statements/statement-president-trump-paris-climate-accord> [<https://perma.cc/7LV8-ZR23>]. Whoever wrote this statement for Trump (he is demonstrably incapable of writing it himself) avoided his previously stated position that climate change is a hoax. See, e.g., Donald Trump (@realDonaldTrump), TWITTER (Nov. 6, 2012, 11:15 AM) (“The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive.”). <https://twitter.com/realDonaldTrump/status/265895292191248385> [<https://perma.cc/FWT8-2KUF>]. The arguments offered instead are that it would damage the economy and that other nations would not comply.

36. As of 2018, only 57 percent of Americans believe that anthropomorphic climate change is occurring. Jennifer Marlon et al., *Yale Climate Opinion Maps 2018*, YALE PROGRAM ON CLIMATE CHANGE COMM. (Aug. 7, 2018), <https://climatecommunication.yale.edu/visualizations-data/ycom-us-2018/?est=happening&type=value&geo=county> [<https://perma.cc/MS2N-XS53>]. People’s views are determined largely by their political orientation, not by scientific evidence. See ANDREW HOFFMAN, *HOW CULTURE SHAPES THE CLIMATE CHANGE DEBATE* 17 (2015); Dan Kahan et al., *The Polarizing Impact of Science Literacy and Numeracy on Perceived Climate Change Risks*, 2 NATURE CLIMATE CHANGE 732, 732 (2012). An alternative theory is that rejection of scientific findings about climate change results from inborn characteristics—specifically, the way our brains are

industry has predictably, albeit irresponsibly, opposed these facts; what is significant is that it has been able to recruit marginally knowledgeable people to concoct misleading arguments³⁷ and somehow persuade a substantial portion of the population to deny the truth.

The conclusion that follows from these observations is that waiting for certain confirmation of a scientific hypothesis may be good science, but it is bad public policy. When confronted with predictions by some experts of an impending danger or disaster, we need a strategy that acknowledges the uncertainty of the prediction and takes action on that basis. Waiting for the certainty that scrupulous science demands takes too long and will not produce a sufficient change in attitudes when it is achieved.

Suppose the commander of a military unit received information suggesting that an attack on the unit's position might occur during the next several days or received information that an attack was certain but from a source of uncertain reliability. Any commander who ignored the warning and failed to take any precautionary measures would be guilty of gross incompetence. The lack of certainty might persuade the commander to adopt only partial measures, such as placing part of the unit in a defensive posture while continuing preparations for a previously planned offensive maneuver with the remainder. But to demand certainty before taking any action is obviously irresponsible. It is perhaps unfortunate that military analogies come so readily to mind, but they provide a sense of urgency and command responsibility that seems to be lacking among our political leaders.

B. Beneficial Precautions Against Climate Change

What sorts of actions should have been taken during the thirty-year period when some experts were warning of impending disaster from anthropomorphic climate change, but consensus among experts had not yet been reached? One answer is to develop strategies that would combat the disaster but that will be beneficial even if it does not occur. This may not always be possible; there are certainly medical treatments, such as chemotherapy, that have only negative side effects

"wired." GEORGE MARSHALL, DON'T EVEN THINK ABOUT IT: WHY OUR BRAINS ARE WIRED TO IGNORE CLIMATE CHANGE 27 (2014). See generally Matthew C. Nisbet & Teresa Myers, *Twenty Years of Public Opinion About Global Warming*, 71 PUB. OPINION Q. 444, 451 (2007) (documenting a large number of studies assessing public attitudes toward climate change).

37. See, e.g., TIM BALL, THE DELIBERATE CORRUPTION OF CLIMATE SCIENCE (2014); CALVIN FRAY, CLIMATE CHANGE REALITY CHECK: BASIC FACTS THAT QUICKLY PROVE THE CLIMATE CHANGE CRUSADE IS WRONG AND DANGEROUS (2016); LAWRENCE SOLOMON, THE DENIERS (2008); A DISGRACE TO THE PROFESSION (Mark Steyn ed., 2015). While none of these authors are well-regarded meteorologists, they are sufficiently knowledgeable to sound persuasive to those who are themselves unfamiliar with the scientific evidence.

and serve no value if the diagnosis of the disease they are designed to combat is mistaken. But for complex social problems, it is often possible to identify precautionary strategies for uncertain, long-term disasters that provide immediate, short-term benefits.³⁸

This is clearly the case with respect to climate change. Three such strategies were renewable energy development, mass transit, and intelligent buildings. Renewable energy is perhaps most obvious and most important. When global warming predictions first appeared, hydroelectric power was well established, the first large alternating current electric generating plant having begun to operate at Niagara Falls, New York, in 1895.³⁹ While that renewable energy source is now fully exploited, other sources, most notably solar and wind, were almost entirely ignored when climate change warnings began in the 1960s and 70s.⁴⁰ According to current estimates, these additional sources could supply at least 80 percent of the nation's energy needs.⁴¹ To some extent, the estimates are based on technologies that have been developed during the half century since the first predictions.⁴² But we know that funding for research can produce significant technological advances.⁴³

The immediate advantages of solar and wind power—that is, the advantages that they provide apart from producing virtually zero

38. Although Nordhaus's predictions about the costs imposed by climate change were probably outdated by the time he advanced them, and his narrow economic focus fails to take account of the costs of political disruption, he can be taken as representing the views of reasonably rational people who oppose major changes in our economic system but recognize the reality of global warming. See CLIMATE CENTRAL, *GLOBAL WEIRDNESS: SEVERE STORMS, DEADLY HEAT WAVES, RELENTLESS DROUGHT, RISING SEAS AND THE WEATHER OF THE FUTURE* (2011); JAMES HANSEN, *STORMS OF MY GRANDCHILDREN* (2010).

39. EDWARD DEAN ADAMS, *NIAGARA POWER: HISTORY OF NIAGARA FALLS POWER COMPANY 1886–1918 VOLUME I 81* (1927); KEVIN WOYCE, *NIAGARA: THE FALLS AND THE RIVER: AN ILLUSTRATED HISTORY 117–30* (2015).

40. See MICHAEL AKLIN & JOHANNES URPELAINEN, *RENEWABLES: THE POLITICS OF GLOBAL ENERGY TRANSITION 23–36* (2018); GEORGE A. GONZALEZ, *ENERGY AND EMPIRE: THE POLITICS OF NUCLEAR AND SOLAR POWER IN THE UNITED STATES 38* (2012).

41. NAT'L RENEWABLE ENERGY LAB., *RENEWABLE ENERGY FUTURES STUDY 5* (M.M. Hand et al. eds., 2012) (predicting that 80 percent of predicted energy needs could be met by solar and wind power by 2050 if action is taken now).

42. See, e.g., G.K. Singh, *Solar Power Generation by PV (Photovoltaic) Technology: A Review*, 53 *ENERGY* 1, 1 (2013) (advances in photovoltaic cell technology); Nam-Gyu Park, *Perovskite Solar Cells: An Emerging Photovoltaic Technology*, 18 *MATERIALS TODAY* 65, 65 (2015) (use of organometal halides for photovoltaic cells); *CONCENTRATING SOLAR POWER TECHNOLOGY: PRINCIPLES, DEVELOPMENT AND APPLICATIONS 3* (Keith Lovegrove & Wes Stein eds., Woodhead Publ'g Ltd. 2012) (concentrating solar power technology); Nelson A. Kelly & Thomas L. Gibson, *Improved Photovoltaic Energy Output for Cloudy Conditions with a Solar Tracking System*, 83 *SOLAR ENERGY* 2092, 2092 (2009) (solar tracking systems).

43. A recent and particularly dramatic example is the Apollo program. See DOUGLAS BRINKLEY, *AMERICAN MOONSHOT: JOHN F. KENNEDY AND THE GREAT SPACE RACE* (2019); JOHN M. LOGSDON, *JOHN F. KENNEDY AND THE RACE TO THE MOON* (2010). The more general example, of course, is war. See MAX BOOT, *WAR MADE NEW 105* (2006); MARTIN VAN CREVELD, *TECHNOLOGY AND WAR 220* (1989).

greenhouse gas—are readily perceived. These energy sources are entirely renewable, and the 80 percent of our energy needs that they provide would be produced domestically in perpetuity. Unlike fossil fuel, they create virtually no aerosol pollution. Unlike fossil fuel or nuclear power, they generate minimal amounts of waste and pose virtually no danger for those who live nearby them.⁴⁴ Solar power does require land, but its generating plants can be built in remote, minimally exploited locations.⁴⁵ Wind power uses virtually no land, since the generating structures can be placed on agricultural land, in remote places such as mountain passes, or offshore.

Admittedly, wind and solar power, unlike fossil fuel and nuclear power, are intermittent, since the sun does not shine at night and the wind does not always blow. But solar and wind can support each other, being anticorrelated at some times or in some locations.⁴⁶ In addition, solar and wind can be supplemented by other renewable sources that are constant, such as hydro and geothermal. Technological solutions to provide constant power supply from intermittent sources, such as energy storage and transmission, can be readily developed. At present, the Nordic Grid system (Denmark, Finland, Norway, and Sweden) transmits energy generated from solar and wind by long-distance power lines and stores it by pumping water uphill.⁴⁷

Another beneficial precaution that would have provided short-term benefits is the expansion of mass transit. In the United States, average per capita energy consumption is about 313 million BTU per year; in comparison, France consumes 166 million BTU, the United Kingdom consumes 134 million BTU, and Japan consumes 164 million BTU.⁴⁸ Given that all these nations have relatively similar

44. Donald Trump has claimed that windmills cause cancer. Brad Plumer, *We Fact-Checked President Trump's Dubious Claims on the Perils of Wind Power*, N.Y. TIMES (Apr. 3, 2019), <https://www.nytimes.com/2019/04/03/climate/fact-check-trump-windmills.html> [<https://perma.cc/3GB8-P2MM>]. This is worth mentioning only as further evidence of the United States' failure to respond to the climate crisis.

45. Coal mining has destroyed 1.5 million acres of forest in Appalachia alone (three times the size of Great Smokey Mountains National Park). Andrew A. Pericak et al., *Mapping the Yearly Extent of Surface Coal Mining in Central Appalachia Using Landsat and Google Earth Engine*, 13 PLOS ONE 1, 2 (2018).

46. VARUN SIVARAM, TAMING THE SUN: INNOVATIONS TO HARNESS SOLAR ENERGY AND POWER THE PLANET 201 (2018). That is, winds often increase at night.

47. ORG. FOR THE NORDIC TRANSMISSION SYS. OPERATORS, NORDIC GRID MASTER PLAN 2–10 (2008); SIVARAM, *supra* note 46, at 201–06.

48. See *International Energy Statistics*, U.S. ENERGY INFO. ADMIN, <http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=44&pid=45&aid=2&cid=regions&syid=2007&eyid=2011&unit=QBTU> [<https://perma.cc/Q5QD-DA7B>] (last visited Nov. 21, 2016); *Energy Use (Kg of Oil Equivalent per Capita)*, WORLD BANK, <http://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE> [<https://perma.cc/VB7E-3X2A>] (last visited Nov. 10, 2019).

climates, levels of wealth, and levels of urbanization,⁴⁹ the reason that Americans use twice as much energy seems largely attributable to the paucity of mass transit in the United States. Further evidence for this conclusion is provided by differences within the US population. Residents of Manhattan use about ninety gallons of gasoline per capita per year, as compared to nearly four hundred gallons for Americans in general, and the one factor that would account for this difference is neither wealth nor climate but reliance on mass transit.⁵⁰

The substantial savings in energy consumption that would be achieved by expanding urban mass transit systems in the United States would be accompanied by immediate and ongoing benefits. Mass transit dramatically reduces urban air pollution, yielding obvious benefits to health and comfort.⁵¹ It decreases commute time for all residents by providing faster transit for many while relieving congestion on the highways for the others who continue to travel by car.⁵² In addition, those who use it suffer significant lower injury and fatality rates than car commuters.⁵³

The third precaution, this one implemented largely at the private level, is to require newly constructed buildings be intelligent and existing structures be retrofitted to that end. Such buildings feature control systems that are operated electronically through the use of automation or, at higher levels of complexity, artificial intelligence.⁵⁴

49. Japan is an outlier in urbanization, at 92 percent, but the other three nations have similar levels: 80 percent in France, 83 percent in the United Kingdom, and 82 percent in the United States. *Urban Population (% of Total)*, WORLD BANK, <https://data.worldbank.org/indicator/sp.urb.totl.in.zs> [<https://perma.cc/VR2P-DN56>] (last visited Nov. 10, 2019).

50. MICHAEL HOUGH, *CITIES AND NATURAL PROCESS: A BASIS FOR SUSTAINABILITY 205–06* (2d ed. 2004); RONALD K. VOGEL, *HANDBOOK OF RESEARCH ON URBAN POLITICS AND POLICY IN THE UNITED STATES* 400 (1997); Peter W. G. Newman & Jeffrey R. Kenworthy, *Gasoline Consumption and Cities: A Comparison of U.S. Cities with a Global Survey*, 55 J. AM. PLANNING ASSOC. 24, 26 (1989); David Owen, *Green Manhattan*, NEW YORKER, Oct. 18, 2004, at 111, 111. Residents of Houston, a sprawling city with inadequate mass transit, use an average of 567 gallons of gasoline per year. See VOGEL, *supra*, at 400.

51. Todd Litman, *Integrating Public Health Objectives in Transportation Decision-Making*, 18 AM. J. HEALTH PROMOTION 103, 103 (2003).

52. See PETER DERRICK, *TUNNELING TO THE FUTURE: THE STORY OF THE GREAT SUBWAY EXPANSION THAT SAVED NEW YORK 20* (2002) (describing the decision-making process that created the New York subway system as a response to problems of inner-city residential congestion); ETHAN N. ELKIND, *RAILTOWN: THE FIGHT FOR THE LOS ANGELES METRO RAILROAD AND THE FUTURE OF THE CITY 15* (2014) (describing the decision-making process that created Los Angeles Metro Rail as a response to problems of commute time and pollution).

53. The fatality rate, expressed in deaths per billion passenger miles, is 7.28 for automobiles and 0.24 for urban trains (subways). In other words, the fatality rate for automobile travel is nearly thirty times as high. Ian Savage, *Comparing the Fatality Risks in United States Transportation Across Modes and Over Time*, 43 RES. TRANSP. ECON. 9, 14 (2013). Buses are even safer, at 0.11.

54. For a more precise definition, see SHENGWEI WANG, *INTELLIGENT BUILDINGS AND BUILDING AUTOMATION 1–2*, 9 (2010) (discussing performance-based, service-based, and systems-based definitions).

The systems relevant to the present discussion are those that involve energy consumption, notably lighting and HVAC (heating, ventilation, and air conditioning). Intelligent control achieves substantial reductions in energy use by turning off lights and moving temperatures toward ambient levels when people are absent.⁵⁵ When combined and coordinated with energy production facilities, such as solar panels on the roof, and various systems for energy transfer, intelligent buildings can often operate with zero carbon footprints.⁵⁶

Here again, much of the technology for intelligent buildings has been developed in the years following the initial warning about climate change.⁵⁷ But these advances were also readily predictable at the beginning of this period. In fact, it seems reasonable to assume that they would have come more rapidly, and that we would be much further advanced at present, if intelligent home and commercial construction had been incentivized or mandated soon after the warnings began. Similarly, business and consumer resistance, equally predictable at the beginning of the period, would likely have diminished rapidly once the idea of an intelligent building became familiar and the economic savings were demonstrated. One obvious strategy would be to begin with new construction and then add requirements to retrofit existing structures.⁵⁸

The immediate advantages of intelligent buildings are readily apparent. The substantial reduction in energy consumption that such buildings achieve translate into reduced utility costs.⁵⁹ Within a few

55. See, e.g., Tuan Anh Nguyen & Marco Aiello, *Energy Intelligent Buildings Based on User Activity: A Survey*, 56 ENERGY & BUILDINGS 244, 244 (2013); G. Wood & M. Newborough, *Energy-Use Information Transfer for Intelligent Homes: Enabling Energy Conservation with Central and Local Displays*, 39 ENERGY & BUILDINGS 495, 496 (2007).

56. EDWARD DEAN, ZERO CARBON CASE STUDY HOMES: VOLUME 1 4 (2018) (examples of zero-carbon private homes, including both new and renovated buildings); Andreas Koch et al., *Towards a Neighborhood Scale for Low- or Zero-Carbon Building Projects*, 40 BUILDING RES. & INFO. 527, 527 (2012) (zero-carbon goal can be reached if individual building can transfer power within a neighborhood); Yangang Xing et al., *Zero Carbon Buildings Refurbishment – A Hierarchical Pathway*, 15 RENEWABLE & SUSTAINABLE ENERGY REVS. 3229, 3229 (2011) (describing technologies and their ordering needed to reach zero-carbon status for existing structures).

57. See Francis K. Aldrich, *Smart Homes: Past, Present and Future*, in INSIDE THE SMART HOME 17–18 (Richard Harper ed., 2003) (“The full-blown concept of the smart home is the acme of domestic technology we can envisage at present. The concept, at one time only encountered in science fiction, has moved closer to realisation over the last ten years.”); Peter Tolmie et al., *Towards the Unremarkable Computer: Making Technology at Home in Domestic Routines*, in INSIDE THE SMART HOME 183 (Richard Harper ed., 2003).

58. With respect to retrofitting, see DEAN, *supra* note 56; Xing et al., *supra* note 56.

59. See e.g., Dorota Chwieduk, *Towards Sustainable-Energy Buildings*, 76 APPLIED ENERGY 211, 214 (2003); Michael C. Mozer, *Lessons from an Adaptive Home*, in DIANE COOK & SAJAL K. DAS, SMART ENVIRONMENTS: TECHNOLOGIES, PROTOCOLS, AND APPLICATIONS 273, 291 (2005); Nguyen & Aiello, *supra* note 55; Pervez Hamid Shaikh et al., *A Review on Optimized Control Systems for Building Energy and Comfort Management of Smart Sustainable Buildings*,

years, the savings are generally sufficient to recoup the initial expense of installation, and these initial expenses decrease steadily as the technology advances, whereas the savings fluctuate with energy costs, which are as likely, and perhaps more likely, to increase over time. Intelligent buildings offer additional advantages as well. In large commercial structures, they can control security systems, visitor guidance, and emergency evacuation, in each case greatly reducing the number of paid employees who need to be assigned to these tasks.⁶⁰ In private homes, intelligent control also provides increased security, assists occupants with cognitive impairments, and can notify local health care services of occupant accidents or ailments.⁶¹

All three of these policies—renewable energy, mass transit, and intelligent buildings—not only provide benefits if predictions about global warming had proven false but also, by so doing, solve the free rider problem.⁶² This problem, which has featured prominently in continued arguments against taking decisive action to limit climate change,⁶³ is that a given nation may derive the benefits of other nations' greenhouse gas reduction without taking any action on its own (thereby "free riding" on the sacrifices of others). Beneficial precautions solve this problem because they represent policies that the nation in question should adopt in any event. Whatever impact these policies produce on the world's environment, and whatever credit that nation gains in international relations, are thus additional to the domestic benefits that the nation obtains domestically and immediately.

34 RENEWABLE & SUSTAINABLE ENERGY REVS. 409, 409 (2014). As all these sources note, optimal energy savings depends on occupant behavior patterns. This can be expected to develop over time.

60. See WANG, *supra* note 54, at 10–41, 224–43.

61. Christine Lisetti et al., *Developing Multimodal Intelligent Affective Interfaces for Tele-Home Health Care*, 59 INT'L J. HUM.–COMPUTER STUD. 245, 245 (2003). In fact, much of the impetus for intelligent homes has come from the needs of elderly homeowners, for whom the technology is of immediate benefit, perhaps a matter of survival. See Marie Chan et al., *A Review of Smart Homes—Present State and Future Challenges*, 91 COMPUTER METHODS & PROGRAMS BIOMED. 55 (2008); Jessica Lapointe et al., *Smart Homes for People with Alzheimer's Disease: Adapting Promoting Strategies to the Patient's Cognitive Profile*, PETRA 1 (2012); Elena Torta et al., *Evaluation of a Small Socially-Assistive Humanoid Robot in Intelligent Homes for the Care of the Elderly*, 76 J. INTELLIGENT & ROBOTIC SYS. 57, 57 (2014). This indicates the immediate benefit that results from using intelligent homes as a precaution against climate change. Obviously, the adoption of this mechanism would have proceeded more quickly if it had been conceived as a precaution, rather than driven primarily by health considerations for the elderly and disabled.

62. See WILLIAM NORDHAUS, *THE CLIMATE CASINO: RISK, UNCERTAINTY, AND ECONOMICS FOR A WARMING WORLD* 6–9, 254–57 (2013).

63. See Press Release, Donald Trump, *supra* note 35 ("I cannot in good conscience support a deal that punishes the United States—which is what it does—the world's leader in environmental protection, while imposing no meaningful obligations on the world's leading polluters."); Environmental Protection Agency, 69 Fed. Reg. 52922, 52931 (2003) ("Any potential benefit of EPA regulation could be lost to the extent other nations decided to let their emissions significantly increase in view of U.S. emissions reductions."); *Massachusetts v. EPA*, 549 U.S. 497, 551 (2007) (Scalia, J., dissenting) (describing the EPA statement quoted *supra* as "perfectly valid").

Despite their benefits, implementing renewable energy, mass transit, and intelligent buildings in the 1960s and 70s would have required government intervention. Arguably, the reason these policies were not produced by the operation of the market was that fossil fuel producers were not required to internalize the true cost they imposed on society, which consisted of the definitively known impact of pollution and the uncertain impact of global warming.⁶⁴ But requiring the fossil fuel industry to internalize these costs would, in effect, be a carbon tax.⁶⁵ The idea of a carbon tax was understood, both conceptually and politically, as a penalty inflicted on the important and powerful fossil fuel industry. It was precisely this perspective that led policy makers to believe implementing a tax (a precautionary measure) demanded certainty about global warming.⁶⁶ Thus, the truly persuasive argument for a carbon tax could only be advanced after a long, disastrous delay, by which point the tax had become vulnerable to concocted rebuttals that undermined its efficacy in the public's mind. Perhaps the beneficial precautions suggested here could have been instituted without mounting a frontal assault against the fossil fuel industry. This approach, however, could only have been implemented by providing subsidies or incurring public expenses.

First, with respect to renewable energy, solar and wind energy are much older sources of energy than fossil fuels and reach back into humanity's primal understanding of power itself.⁶⁷ But unlike hydropower, another renewable and primal source, and unlike fossil fuels, they require advanced technology to generate electricity in commercially viable quantities. Thus, their development needed to be subsidized, at least initially. Now they are increasingly competitive as sources of electricity, even with fossil fuels, whose producers continue

64. See NORDHAUS, *supra* note 62, at 6; WILLIAM NORDHAUS, A QUESTION OF BALANCE: WEIGHING THE OPTIONS ON GLOBAL WARMING POLICIES 12 (2008).

65. See generally SHI-LING HSU, THE CASE FOR A CARBON TAX: GETTING PAST OUR HANG-UPS TO EFFECTIVE CLIMATE POLICY 23 (2012); IMPLEMENTING A US CARBON TAX: CHALLENGES AND DEBATES 142 (Ian Perry et al. eds., 2015); Reuven S. Avi-Yonah & David M. Uhlmann, *Combating Global Climate Change: Why a Carbon Tax Is a Better Response to Global Warming than Cap and Trade*, 28 STAN. ENVTL. L.J. 3, 44 (2009); Gilbert E. Metcalf, *Designing a Carbon Tax to Reduce U.S. Greenhouse Gas Emissions*, 3 REV. ENVTL. ECON. & POL'Y 63, 70 (2009); Gilbert E. Metcalf & David Weisbach, *The Design of a Carbon Tax*, 33 HARV. ENVTL. L. REV. 499, 499 (2009); David Pearce, *The Role of Carbon Taxes in Adjusting to Global Warming*, 101 ECON. J. 938, 940 (1991); NORDHAUS, *supra* note 62, at 232.

66. Dawn Erlandson, *The BTU Tax Experience: What Happened and Why It Happened*, 12 PACE ENVTL. L. REV. 173, 183 (1994); Shi-Ling Hsu et al., *Pollution Tax Heuristics: An Empirical Study of Willingness to Pay Higher Gasoline Taxes*, 36 ENERGY POL'Y 3612, 3613 (2008); Edward L. Rubin, *Rejecting Climate Change: Not Science Denial, but Regulation Phobia*, 32 J. LAND USE 103, 124 (2016); HSU, *supra* note 65, at 147–80.

67. See, e.g., RENEE BARIBEAU, WINDS OF SPIRIT: ANCIENT WISDOM TOOLS FOR NAVIGATING RELATIONSHIPS, HEALTH, AND THE DIVINE (2018); WILLIAM TYLER OLCOTT, SUN LORE OF ALL AGES (2012).

to externalize the true costs they impose. This suggests that the subsidies would have rapidly decreased over time, particularly if they included generous funding for research and if they were accompanied by stricter enforcement of pollution controls.

Mass transit also required subsidies, particularly given the low density of American urban development.⁶⁸ This low-density development is itself the product of obvious and hidden subsidies, such as government highway construction and local land use policies. The national highway system, although justified as needed for national defense, provided massive funding for vehicular transportation and smeared American cities across vast stretches of their surrounding countryside,⁶⁹ a result greatly amplified by the separate jurisdictions that affirmatively encouraged development.⁷⁰ If the roads had to be financed by tolls, and had the central cities controlled their surrounding areas, our cities might be denser and mass transit more competitive. But since these policies were the product of political (not market) forces that were dominant after World War II, mass transit would have needed to be financed by government and might have required continued subsidies to be widely used. Technology, although it has led to substantial improvement in the quality of urban rail transportation, would not be able to fully overcome the overwhelming problem of sprawl; the countervailing effect of truly effective mass transit systems on the pattern of urban development might, however, decrease the required subsidies over time.⁷¹ In addition, mass transit itself might alter people's habits, leading to still greater willingness to rely on it for commuting and other intracity travel. Residents of New York City, after all, are part of the same species, and the same culture, as those of other American cities.

Lastly, intelligent buildings could have been mandated by regulation. This would not have been an unprecedented or even particularly unusual public policy, because building construction was

68. See JARRETT WALKER, HUMAN TRANSIT: HOW CLEARER THINKING ABOUT PUBLIC TRANSIT CAN ENRICH OUR COMMUNITIES AND OUR LIVES 109–15 (2012).

69. THOMAS L. KARNES, ASPHALT AND POLITICS: A HISTORY OF THE AMERICAN HIGHWAY SYSTEM 100 (2009); TOM LEWIS, DIVIDED HIGHWAYS: BUILDING THE INTERSTATE HIGHWAYS, TRANSFORMING AMERICAN LIFE 144 (2013); MARK H. ROSE & RAYMOND A. MOHL, INTERSTATE: HIGHWAY POLITICS AND POLICY SINCE 1939 96 (3rd ed. 2012); Martin Wachs, *Autos, Transit, and the Sprawl of Los Angeles: The 1920s*, 50 J. AM. PLAN. ASS'N 297, 310 (1984).

70. Peter O. Muller, *Transportation and Urban Form: Stages in the Spatial Evolution of the American Metropolis*, in THE GEOGRAPHY OF URBAN TRANSPORTATION 57, 77 (Genevieve Giuliano & Susan Hanson eds., 4th ed. 2017); Brian Taylor, *The Geography of Urban Transportation Finance*, in THE GEOGRAPHY OF URBAN TRANSPORTATION 258 (Genevieve Giuliano & Susan Hanson eds., 4th ed. 2017).

71. See WALKER, *supra* note 68, at 59–71.

already highly regulated in the 1960s.⁷² There were, and of course continue to be, numerous rules imposed by all levels of government addressing the materials used, the method of construction, and, in most places, the size and appearance of the completed structure. Intelligent building requirements would simply have taken their place among these other regulations. At first, the systems would have been relatively costly, which means that the initial cost would have taken longer to be recouped. This poses a particular problem for residential construction, where such initial costs conflict with the life cycle pattern of income and savings.⁷³ Possibly, it would have been advisable to begin with regulations for commercial buildings and extend the requirement to single-family residences once technological development lowered the cost and increased the effectiveness of intelligent control. Again, it could have been readily predicted that such advances would occur, given the large market for the control systems that the regulatory requirements would generate. In fact, society was on the threshold of the Electronic Revolution, which would, rather unexpectedly, enable most people in the nation to carry an inexpensive device in their pockets that has enormously greater computer power than is required for an intelligent home.

The costs that would have been incurred as a result of adopting the three recommended policies are precisely the cost of precaution against an uncertain but potentially disastrous danger. These costs would have been manageable at the time and, as suggested in the preceding paragraphs, would have decreased substantially in the ensuing decades, perhaps to zero in the cases of renewable energy and intelligent buildings.⁷⁴ While global warming remained an uncertain possibility, they could have been readily justified by the collateral benefits they provided for society—decreased pollution and decreased reliance on imported energy sources, lower energy costs for industrial and residential users in the case of renewable energy and intelligent buildings, and decreased traffic congestion and fatalities in the case of mass transit. Whatever costs were incurred—and might continue to be incurred in subsidizing mass transit or further research on renewable energy—must be balanced against the cost, discounted for both uncertainty and time, of continued and uncontrolled global warming.

72. See DAVID VON DREHLE, TRIANGLE: THE FIRE THAT CHANGED AMERICA 200 (2004); MELVYN GREEN, BUILDING CODES FOR EXISTING AND HISTORIC BUILDINGS 11–30 (2d ed. 2011); ELLEN VAUGHAN & JIM TURNER, THE VALUE AND IMPACT OF BUILDING CODES 1, 6 (2013).

73. See Martin Browning & Thomas F. Crossley, *The Life-Cycle Model of Consumption and Saving*, 15 J. ECON. PERSP. 3, 3 (2001).

74. See *supra* Section II.B.

With regard to climate change, we now know that the direst predictions of the 1960s and 70s are reality.⁷⁵ However, we still do not know the precise magnitude of the disaster and what measures will be necessary to counteract it. For example, if we can limit global warming by finding a way to sequester carbon emissions, we may only need to redesign industrial facilities, and the cost of doing so may be partially offset by the secondary advantage of reductions in aerosol pollutants. In contrast, if we need to build seawalls around our coastal cities or move those cities inland, our national wealth can be predicted to decrease by a massive amount while the process is being carried out, and no secondary advantages will result from having a high maintenance concrete wall across New York harbor or the Golden Gate, nor from moving Miami to north Florida or San Diego into the desert.

As expected, energy companies have been as adamant in opposing renewable energy, mass transit, and intelligent building regulations as they have been in opposing policies more directly aimed at preventing global warming.⁷⁶ This will continue to have a major impact on public policy as long as the well-known defects in our democratic system are permitted to continue.⁷⁷ A remaining question is the extent to which energy company opposition will be effective with the general public. By way of summary, it is suggested here that waiting for scientific certainty and then using that certainty as an argument for decisive measures aimed directly at the problem will generate more effective opposition than advocating for treating the problem at an earlier date. At the same time, adopting measures that will ameliorate the potential problem will also have immediate, or short-term, advantages if the predictions of disaster prove incorrect.

III. THE NEXT, AND POSSIBLY MORE SERIOUS, THREAT: THE SINGULARITY

The argument for beneficial precautions is relatively easy to advance in the case of global warming. It is easy to be wise, after all,

75. See CALDER, *supra* note 11 (citing early warnings regarding global warming and later confirmations of those warnings); IMPACT TEAM, *supra* note 11 (same); PONTE, *supra* note 11 (same); WEART, *supra* note 10 (same); CLIMATE CHANGE: THE IPCC SCIENTIFIC ASSESSMENT, *supra* note 22 (same); CLIMATE CHANGE 1995: THE SCIENCE OF CLIMATE CHANGE, *supra* note 23 (same); *The IPCC: Who Are They and Why Do Their Reports Matter?*, *supra* note 21 (same).

76. STEVE COLL, PRIVATE EMPIRE: EXXONMOBIL AND AMERICAN POWER 83 (2012); JOHN HOFMEISTER, WHY WE HATE THE OIL COMPANIES, 113–24, 159–74 (2010); AKLIN & URPELAINEN, *supra* note 40, at 136–45.

77. Most notably, of course, is the role of money in determining the outcome of elections. See BERNARD MANIN, THE PRINCIPLES OF REPRESENTATIVE GOVERNMENT 132–59 (1997); ROBERT E. MUTCH, BUYING THE VOTE: A HISTORY OF CAMPAIGN FINANCE REFORM (2014); ROBERT C. POST, CITIZENS DIVIDED: CAMPAIGN FINANCE REFORM AND THE CONSTITUTION 143 (2014).

when using the instrument that physicians refer to as a retrospectoscope. One way to develop the argument in more general terms is to explore its application to a future situation of uncertain but potential catastrophe. Unfortunately, it is not difficult to identify such situations, which include the promises and dangers involved in bioengineering human beings and the possible militarization of outer space. But perhaps the most serious threat we presently face is an event that some AI experts describe as the Singularity.⁷⁸

For present purposes, the Singularity can be defined, following David Chalmers, as “a rapid increase in intelligence to superintelligence (intelligence of far greater than human levels), as each generation of intelligent systems creates more intelligent systems in turn.”⁷⁹ The use of the astrophysical term in this context was first introduced by Vernor Vinge, a science-fiction writer, and refers to the idea that this process will produce an “event horizon” beyond which the speed of development will move toward infinity and past the capacity of human beings to control or conceive it.⁸⁰ There is a wide range of views among artificial intelligence experts about whether such an event will occur and, if it does, what its consequences for society will be.⁸¹ Public

78. See David Chalmers, *The Singularity: A Philosophical Analysis*, 17 J. CONSCIOUSNESS STUD. 7, 35–40 (2010) (analysis of the concept in relationship to uploading consciousness); Susan Greenfield, *The Singularity: Commentary on David Chalmers Symposium*, 19 J. CONSCIOUSNESS STUD. 1, 1–2 (2012) (analysis of concept in response to Chalmers, *supra*); Arkady Plotnisky, *The Singularity Wager a Response to David Chalmers Symposium*, 19 J. CONSCIOUSNESS STUD. 7, 7–8 (2012) (same); John Smart, *A Brief History of Intellectual Discussion of Accelerating Change*, ACCELERATION WATCH (2008), http://www.accelerationwatch.com/history_brief.html [<https://perma.cc/S6AS-8VNU>] (general history of the concept); Eliezer S. Yudkowsky, *Three Major Singularity Schools*, YUDKOWSKY.NET (2007), <http://yudkowsky.net/singularity/schools> [<https://perma.cc/NMX9-BTB8>] (categorizing different approaches to the concept).

79. David Chalmers, *The Singularity: A Reply to Commentators*, 19 J. CONSCIOUSNESS STUD. 141, 141 (2012).

80. Vernor Vinge, *First Word*, OMNI, Jan. 1983, at 10. For his follow-up, see Vernor Vinge, *The Coming Technological Singularity: How to Survive in the Post-Human Era*, WHOLE EARTH REV. (1993).

81. See MAX BORDERS, *THE SOCIAL SINGULARITY: HOW DECENTRALIZATION WILL ALLOW US TO TRANSCEND POLITICS, CREATE GLOBAL PROSPERITY, AND AVOID THE ROBOT APOCALYPSE* 175 (2018) (better lives through the transformation of social organization); ERIK BRYNJOLFSSON & ANDREW MCAFEE, *THE SECOND MACHINE AGE: WORK, PROGRESS, AND PROSPERITY IN A TIME OF BRILLIANT TECHNOLOGIES* (2016) (massive unemployment, increased income inequality, but great technological benefits); ERIK BRYNJOLFSSON & ANDREW MCAFEE, *RACE AGAINST THE MACHINE: HOW THE DIGITAL REVOLUTION IS ACCELERATING INNOVATION, DRIVING PRODUCTIVITY, AND IRREVERSIBLY TRANSFORMING EMPLOYMENT AND THE ECONOMY* (2011) (same); TYLER COWEN, *AVERAGE IS OVER: POWERING AMERICA BEYOND THE AGE OF THE GREAT STAGFLATION* (2013) (increased income inequality, great wealth for some, poverty with some new benefits for others); MARTIN FORD, *RISE OF THE ROBOTS: TECHNOLOGY AND THE THREAT OF A JOBLESS FUTURE* (2016) (massive unemployment); ELIZABETH KRAUSE & ISABEL SAWHILL, *BROOKINGS CTR. ON CHILDREN & FAMILIES, WHAT WE KNOW AND WHAT WE DON'T KNOW ABOUT DECLINING LABOR FORCE PARTICIPATION: A REVIEW* (2017) (declining jobs for men, moderate impact overall); RAY KURZWEIL, *THE SINGULARITY IS NEAR: WHEN HUMANS TRANSCEND BIOLOGY* (2005) (total transformation of the human body and human life); JAMES MANYIKA ET AL., *MCKINSEY GLOBAL INST., HARNESSING*

policy makers, who do not possess the lifelong training and experience of the AI experts, cannot possibly know which group of experts is correct. How should they respond to this uncertainty? It is possible that nothing needs to be done. While everyone agrees that automation will replace some jobs, it may create as many jobs as it destroys and do so at a relatively gradual pace that enables the free market to manage the resulting dislocations. But it is also possible that the Singularity will cause massive unemployment and enormous disparities in wealth, and that if nothing is done to counteract these effects, the resulting upheavals will tear society apart and bring democratic government among developed nations to an end.⁸²

A. *The Nature of Singularity, in Political and Economic Context*

To address this question, it is useful to start by placing the Singularity in a historical context. That context is the effect of technology on society, and in particular, the historical transformations that resulted from the development of tools, machines, and automation. A tool is a device that aids or extends the power provided by a human controller; the example that has played a central role in modern philosophy is a hammer.⁸³ A machine is a device that has a source of

AUTOMATION FOR A FUTURE THAT WORKS (2017) (limited unemployment as new jobs connected to automated systems are created); WILLIAM MEISEL, *THE SOFTWARE SOCIETY: CULTURE AND ECONOMIC IMPACT* (2013) (increased unemployment, new jobs facilitated by computer software); MATT RIDLEY, *THE RATIONAL OPTIMIST: HOW PROSPERITY EVOLVES* (2010) (automation will replace many jobs but create more); KLAUS SCHWAB, *THE FOURTH INDUSTRIAL REVOLUTION* (2017) (extensive disruption but new opportunities); DANIEL M. WEST, *THE FUTURE OF WORK: ROBOTS, AI, AND AUTOMATION* (2018) (massive unemployment); Melanie Arntz et al., *Revisiting the Risk of Automation*, 159 *ECON. LETTERS* 157, 157 (2017) (limited level of job displacement or elimination); Carl Benedikt Frey & Michael A. Osborne, *The Future of Employment: How Susceptible Are Jobs to Computerisation?*, 114 *TECH. FORECASTING & SOC. CHANGE* 254, 254 (2017) (extensive risk of unemployment due to automation in service industries as well as manufacturing and office work).

82. Klaus Schwab states the issue as follows:

The fundamental uncertainty has to do with the extent to which automation will substitute for labor. How long will it take and how far will it go? . . . There are roughly two opposing camps when it comes to the impact of emerging technologies on the labor market: those who believe in a happy ending—in which workers displaced by technology will find new jobs, and where technology will unleash a new era of prosperity; and those who believe that it will lead to a progressive social and political Armageddon by creating technological unemployment on a massive scale.

SCHWAB, *supra* note 81, at 35, 36.

83. MARTIN HEIDEGGER, *BEING AND TIME* 98 (John Macquarrie & Edward Robinson trans., 1962) (“[T]he less we just stare at the hammer-thing, and the more we seize hold of it and use it, the more primordial does our relationship to it become.”); MICHAEL POLANYI, *PERSONAL KNOWLEDGE: TOWARDS A POST-CRITICAL PHILOSOPHY* 174–75 (1962) (“We pour ourselves out into [tools such as hammers] and assimilate them as parts of our own existence.”) This relationship to equipment, which Heidegger calls ready-to-handedness and Polanyi calls personal knowledge, applies to tools where the human user supplies the motive power. The tool extends our capacity to

power independent of its human controller; an example is a jackhammer, which does not figure as centrally in philosophic discourse but makes more noise.⁸⁴ An automated machine is a device that operates independently of a human being because it has a control mechanism as well as a power source;⁸⁵ it replaces the brain as well as the hand, foot, or voice.

Tools were essential to the first great transformation in history, the Agricultural Revolution.⁸⁶ Even with the enormous increase in human population that resulted from this event, tool-based agriculture allowed societies to generate a surplus—that is, to produce sufficient food and shelter without spending all of every person’s available time on the process. For the most part, this surplus was captured by a small elite, generally those who exercised control over the agricultural land.⁸⁷ They built enormous palaces to provide themselves with various admirable and despicable pleasures while they were alive and even larger mausoleums to reassure themselves that those pleasures would continue after they died. In order to create these colossal constructions, they generally relied on *corvée* labor—not slaves, as previously thought, but the mass of ordinary people who were conscripted during the time in the agricultural cycle when they would otherwise have been at leisure.⁸⁸ To carry out this conscription, the elite sometimes relied on force, but they generally relied on the religious systems that reassured them of continued existence and leisure after death. They did so by convincing the working population that their own existence would also

affect the world, but it moves only when we move it, and thus can be understood as an extension of our body.

84. Here, the independent power source severs the sense of the tools as an extension of the user. The user is not extending the power of his or her own body but rather controlling something that moves of its own accord. In place of the “primordial” relationship described by Heidegger, the user becomes alienated from the tool. See HEIDEGGER, *supra* note 83 at 98. This is not exactly Marx’s sense of alienation. See KARL MARX, ECONOMIC AND PHILOSOPHIC MANUSCRIPTS OF 1844, IN ECONOMIC AND PHILOSOPHIC MANUSCRIPTS OF 1844 AND THE COMMUNIST MANIFESTO 29 (Martin Milligan trans., 1988). But it is closely related. The factory that divides production of an object into separate tasks, in contrast to the artisan’s workshop where one person produces the object in its entirety, does not necessarily require power tools, but it greatly facilitates the use of those tools and ultimately leads to the assembly line, where the structure of the work itself is controlled by an external power source. See JACQUES ELLUL, THE TECHNOLOGICAL SOCIETY (John Wilkinson trans., 1964).

85. *Automatic Machine*, *supra* note 84.

86. See MIRCEA ELIADE, A HISTORY OF RELIGIOUS IDEAS VOLUME I: FROM THE STONE AGE TO THE ELEUSINIAN MYSTERIES 29–55 (Willard R. Trask trans., 1978). Tools were, of course, developed earlier, during the hunter-gatherer era, but they were essential to the development of agriculture. See *id.* at 2–5.

87. This description is based, of course, on KARL MARX, CAPITAL: A CRITIQUE OF POLITICAL ECONOMY 197–255 (Samuel Moore & Edward Aveling trans., 1936) (1867).

88. See generally LABOR IN THE ANCIENT WORLD (Piotr Steinkeller & Michael Hudson eds., 2015); Gae Callender, *The Middle Kingdom Renaissance*, in THE OXFORD HISTORY OF ANCIENT EGYPT 172–74 (Ian Shaw ed., 2000).

continue after death and perhaps become as leisurely as the elite's lives.⁸⁹ In other words, the result of the Agricultural Revolution was that most people worked just as hard, or perhaps harder, than before. They may have had some increase in leisure time, which can be viewed as a means of celebrating the religion that justified their continuing hard work.⁹⁰ And certainly, the elite shared part of the surplus with artisan and priestly classes who served their needs and provided some benefits to ordinary persons in addition.⁹¹

The second great historical transformation was the Industrial Revolution of the nineteenth century.⁹² This resulted from Western society's development of powered tools, or machinery,⁹³ with steam providing the power in its first phase and electricity and the internal combustion engine providing increased power in its second. Machinery transformed agriculture once again, greatly increasing productivity and efficiency, and also transformed domestic life, enabling the preparation of food, the production of clothing, and the construction of housing with much less human effort than had previously been required. It also generated additional benefits, such as ease of transportation and communication, access to entertainment in the home, and superior home furnishings. Over time, the technological advances that it facilitated generated a range of new devices, providing ordinary people

89. The image of *corvée* labor that comes to mind is the construction of the pyramids. But this system was used in the Western world as well. See, e.g., HEINRICH FICHTENAU, *LIVING IN THE TENTH CENTURIES: MENTALITIES AND SOCIAL ORDERS* 355–58 (Patrick J. Geary trans., 1991); OTTO VON SIMSON, *THE GOTHIC CATHEDRAL: ORIGINS OF GOTHIC ARCHITECTURE AND THE MEDIEVAL CONCEPT OF ORDER* 159–82 (1974) (describing the reconstruction of Chartres Cathedral by the people of its relatively small town).

90. MAX WEBER, *THE PROTESTANT ETHIC AND THE SPIRIT OF CAPITALISM* 95–154 (Talcott Parsons trans. 1958) (1905) (arguing that Calvinism created an ethos of “worldly asceticism” that treated work as an indication of divine election). The well-known warning that concludes this study contrasts the “iron cage” of modernity, where work has become an end in itself, with Richard Baxter’s that “the care for external goods should only lie on the shoulders of the ‘saint like a light cloak, which can be thrown aside at any moment.’” *Id.* at 123 (quoting RICHARD BAXTER, *THE SAINTS’ EVERLASTING REST* (1650)). Weber argues that this iron cage is implicit in Baxter’s view that rest, or idleness, is not a proper condition in this life. See WEBER, *supra*, at 123–24. Baxter admonishes landowners from forcing their tenants to work excessive hours, but his rationale is that they need leisure time in order to worship—that is, to learn the religious doctrine that demands they spend the remainder of their time working. Richard Baxter, *The Poor Husbandman’s Advocate to the Rich Racking Landlords*, in FREDERICK J. POWICKE, *THE REVEREND RICHARD BAXTER’S LAST TREATISE* 173 (1926). Weber distinguishes the Calvinist position from Luther’s. See WEBER, *supra*, at 160. But the effect may be the same, for Luther argues that working hard at one’s vocation and obeying the orders of one’s superiors is a sign of divine grace. See, e.g., Martin Luther, *The Freedom of a Christian*, in LUTHER: *SELECTED POLITICAL WRITINGS* 25 (J.M. Porter ed., 1975).

91. ERIC HOBBSBAM, *INDUSTRY AND EMPIRE: THE BIRTH OF THE INDUSTRIAL REVOLUTION* 57–60 (1999); MARX, *supra* note 87, at 163–341.

92. See generally, PAUL JOHNSON, *THE BIRTH OF THE MODERN: WORLD SOCIETY 1815–1830* 541–626 (1991); PETER N. STEARNS, *THE INDUSTRIAL REVOLUTION IN WORLD HISTORY* (2013).

93. MARX, *supra* note 87, at 405–556.

with capacities and advantages that premodern people could not imagine even wizards or magicians as possessing.

But the Industrial Revolution only produced a limited change in leisure. Once again, the bulk of the surplus was captured by the elite, in this case those who controlled the means of industrial production.⁹⁴ Ordinary people continued to spend most of their available time (that is, time not devoted to physically maintaining themselves) performing labor, in this case, for wages that enabled them to survive and acquire the desirable benefits that industrial society offered. Once again, religion, with its promise of a leisurely afterlife, was used to convince people to accede to these demands for work. Weber attributes the particular idea that hard work provides reassurance of salvation to Calvinism, and he argues that this is the reason that Calvinist societies led the way in the Industrial Revolution.⁹⁵ But Luther also championed the fulfillment of one's economic role as central to Christian virtue,⁹⁶ and the Catholic belief, scorned by Luther and Calvin, that good deeds—generally described as good works—led to salvation was readily adapted to the same perspective.⁹⁷

As society became more secular or rationalized, the connection between work and virtue intensified and the rationale that work was the pathway to salvation became attenuated or irrelevant.⁹⁸ This is Weber's iron cage of deontological instrumentalism,⁹⁹ a conceptual development was concomitant with changes in the structure of society.

94. *Id.* at 255–404.

95. WEBER, *supra* note 90; *see also* R.H. TAWNEY, RELIGION AND THE RISE OF CAPITALISM 1927 (identifying Calvinism as a major influence but ascribing the rise of capitalism to other religious motivations as well). *See* TAWNEY, *supra*, at 261–63 n. 32 (cataloguing Tawney's differences with Weber).

96. Martin Luther, *The Babylonian Captivity of the Church*, in MARTIN LUTHER'S BASIC THEOLOGICAL WRITINGS 219 (Timothy F. Lull & William R. Russell eds., 3d ed. 2012); LEE HARDY, THE FABRIC OF THIS WORLD 45–54 (1990).

97. In response to Luther's argument for predestination, Erasmus wrote:

What does the parable of the laborers in the vineyard mean? What kind of laborers are they, who do nothing? . . . Why is the servant who has increased his fortune by industry praised by the Lord? Why is the lazy and unprofitable servant condemned if we are good-for-nothing. Again, in [Matthew] ch. 25, when He invites all to partake of the eternal Kingdom, he does not call to mind necessity but good deeds. . . . And in fact are not the Gospels and Epistles full of exhortations? "Come to me, all who labor and are heavy laden" (Matt. 11:28). . . . Are they not intended to incite us to striving, to endeavoring, to industry, lest we perish by neglecting the grace of God? These seem empty and vain if they all refer to necessity.

Desiderius Erasmus, *On the Freedom of the Will: A Diatribe or Discourse*, in LUTHER AND ERASMUS: FREE WILL AND SALVATION 35, 60 (E. Gordon Rupp & Phillip S. Watson eds., 1969). Luther's response was Martin Luther, *On the Bondage of the Will*, in LUTHER AND ERASMUS: FREE WILL AND SALVATION 101 (E. Gordon Rupp & Phillip S. Watson, eds., 1969).

98. WEBER, *supra* note 90, at 178–83.

99. *Id.*

In the agricultural village of the preindustrial era, an individual's place was determined by tradition.¹⁰⁰ But once people relocated to cities as a result of the Industrial Revolution, traditional role ascriptions ceased to function and work became the central means of defining a person's place in society.¹⁰¹ Men who had no job, and the women who were married to them, came to be regarded as outcasts, a status that increasing gender equality has now bestowed on unemployed women as well.

The Singularity, if it occurs, will constitute the third major transformation in the structure of society. Just as agriculture created an original surplus and machinery greatly expanded it, automation will expand it yet again. Automated machinery, according to some AI experts, will be doing most of the work we need or want.¹⁰² It will operate our factories, produce our food, drive our vehicles, manage our communications, cook our meals, and clean our homes.¹⁰³ The result will be a newfound and tremendous surplus. We will be able to maintain the same level of production, and quite possibly increase it, with a fraction of the human labor that we now expend. In other words, machines will replace human beings in the performance of productive work.

This is not an unexpected possibility, nor is it one that people have looked forward to with complacency. The prospect of automation, ever since electric power made it a conceivable occurrence, has spawned three major anxieties: that machines would degrade us, that they would conquer us, and that they would replace us. The fear of degradation was central to Marx's insightful and prescient account of alienation.¹⁰⁴ It motivated Dickens's contemporaneous depiction of the railroad as death itself in *Dombey and Son*¹⁰⁵ and, later on, inspired the feeding machine and assembly line scenes in Charlie Chaplin's *Modern Times*.¹⁰⁶

100. HEINRICH FICHTENAU, *LIVING IN THE TENTH CENTURY: MENTALITIES AND SOCIAL ORDERS* 333–79 (Patrick J. Geary trans., 1991); M. DOROTHY GEORGE, *ENGLAND IN TRANSITION: LIFE AND WORK IN THE EIGHTEENTH CENTURY* 20 (1931).

101. FRIEDRICH ENGELS, *THE CONDITION OF THE WORKING CLASS IN ENGLAND* 17 (1993); GEORGE, *supra* note 100, at 105; ERIC J. HOBSBAWM, *INDUSTRY AND EMPIRE* 57–74 (Chris Wrigley ed., Penguin Grp. 1999) (1968).

102. BORDERS, *supra* note 81, at 75; BRYNJOLFSSON & MCAFEE, *THE SECOND MACHINE AGE*, *supra* note 81, at 30, 33–34; KURZWEIL, *supra* note 81, at 108; MANYIKA ET AL., *supra* note 81, at 111; SCHWAB, *supra* note 81, at 38.

103. BORDERS, *supra* note 81, at 75; BRYNJOLFSSON & MCAFEE, *THE SECOND MACHINE AGE*, *supra* note 81, at 30; BRYNJOLFSSON & MCAFEE, *RACE AGAINST THE MACHINE*, *supra* note 81; KURZWEIL, *supra* note 81, at 216; MANYIKA ET AL., *supra* note 81, at 29; SCHWAB, *supra* note 81, at 140.

104. MARX, *supra* note 84, at 31.

105. CHARLES DICKENS, *DOMBEY AND SON* 200 (1848) (“[A]way, with a shriek, and a roar, and a rattle, and no trace to leave behind but dust and vapour: like as in the track of the remorseless monster, Death!”).

106. *MODERN TIMES* (Charles Chaplin Productions 1936).

Conquest was vividly conceived a century ago by Karel Kapek's *R.U.R.*¹⁰⁷ (which coined the term *robot*, the word for *slave* in Kapek's native Czech language) and has been a staple of science fiction ever since. While degradation is a contested interpretation and conquest merely a remote possibility, replacement is demonstrable and ongoing. As recently as Billy Wilder's 1960 comedy, *The Apartment*, a central character could still be an elevator operator in a corporate headquarters building, and a secondary character could be the telephone operator in that building.¹⁰⁸

Thus far, however, automation has only eliminated specific jobs and, if anything, has generated more employment than it has replaced.¹⁰⁹ Some AI experts predict that the Singularity will be different. They agree that automation has thus far generated more jobs than it eliminated, but their prediction is that the new jobs of the future will also be performed by machines.¹¹⁰ The question is whether the effect of this seemingly miraculous advance on the majority of people in our society will take the form of increased leisure or massive unemployment.

The answer to that question depends, in large part, on who will obtain the benefit of the surplus that results from this reduction in the need for human labor. Without governmental intervention, the surplus will almost certainly be controlled by those who own the means of production, as it has been throughout human history. Just as landowners controlled the agricultural surplus and the factory owners controlled the industrial surplus, it seems likely, perhaps inevitable, that the industrial and technology firms that develop automated machinery will control the surplus that it generates. In this case, the reduced need for human labor will lead to social disaster.

The two previous revolutions, the Agricultural and Industrial, may have allowed the owners of land and machinery respectively to retain most of the surplus, but they gave ordinary people a clear and important role in the society. People had to work to produce the surplus; in return for their work, they received the means of subsistence, however meager, the religious assurance that they would prosper in the afterlife, however illusory, and a definitive position as a member of the society, which is neither meager nor illusory but essential to the

107. KAREL CAPEK, *R.U.R. (ROSSUM'S UNIVERSAL ROBOTS)* (1923).

108. *THE APARTMENT* (The Mirisch Corp. 1960).

109. See MANYIKA ET AL., *supra* note 81, at 111; RIDLEY, *supra* note 81, at 114; David H. Autor, *Why Are There Still So Many Jobs? The History and Future of Workplace Automation*, 29 J. ECON. PERSP. 3, 4 (2015); Arntz et al., *supra* note 81; Michael Kremer, *The O-Ring Theory of Economic Development*, 108 Q.J. ECON. 551, 573 (1993).

110. COWEN, *supra* note 81, at 21; FORD, *supra* note 81, at 18; KURZWEIL, *supra* note 81, at 216.

individual's sense of self. The Singularity prediction, however, is that the oncoming revolution will not only produce an additional surplus but will do so by drastically reducing the amount of work that human beings need to perform.

What will happen to the ordinary people then? Consistent with our Calvinist or neo-Christian ideology, those in power will regard people's inability to find jobs as their own fault, the result of laziness or incapacity (that is, rationalized versions of damnation), and they will thus receive no more than the skimpy and inadequate support that the unemployed receive at present, at least in the United States.¹¹¹ US conservatives regard work as so essential to the value and status of an individual that they were once willing to allow children to work in factories¹¹² and now condemn them to impoverished lives unless their parents work.¹¹³ Accounts of life in America's urban communities where unemployment rates are high or the available work is underpaid reveal truly horrific conditions that preclude any chance for people to live fulfilling lives.¹¹⁴ Other Western nations that are not afflicted with the meanness and racism of American society provide more decent support for the unemployed,¹¹⁵ but what will happen if the number of those unemployed increases by an order of magnitude or more?

The result would be the creation of a massive proletariat or lumpen proletariat, living in abysmal conditions with no hope of betterment, while an increasingly small minority enjoys fabulously luxurious conditions. As this situation continues, the minority will only be able to maintain its position by armed force. Even in our society as it exists at present, many observers have noted that the unemployed and impoverished classes are controlled by criminal law and penal

111. See LYDIA MORRIS, *DAINGEROUS CLASSES: THE UNDERCLASS AND SOCIAL CITIZENSHIP* 22, 31, 61 (2002).

112. See JOHN A. FLITER, *CHILD LABOR IN AMERICA: THE EPIC LEGAL STRUGGLE TO PROTECT CHILDREN* 5, 9 (2018) (documenting conservative opposition to child labor and compulsory education laws, particularly in Southern states).

113. The 2016 Republican Platform takes credit for the 1996 welfare reform that made "welfare a benefit instead of an entitlement" and proposes "the dynamic compassion of work requirements in a growing economy, where opportunity takes the place of a hand-out, where true self-esteem can grow from the satisfaction of a job well done." *REPUBLICAN PLATFORM 2016*, *supra* note 34, at 32. In other words, children whose parents cannot find work, or choose not to work, must suffer.

114. MATTHEW DESMOND, *EVICTED: POVERTY AND PROFIT IN THE AMERICAN CITY* 251 (2016); KATHRYN J. EDIN & H. LUKE SHAEFER, *\$2.00 A DAY: LIVING ON ALMOST NOTHING IN AMERICA* 4–5 (2015); BARBARA EHRENREICH, *NICKEL AND DIMED: ON (NOT) GETTING BY IN AMERICA* 89 (2001); SUDHIR VENKATESH, *GANG LEADER FOR A DAY: A ROGUE SOCIOLOGIST TAKES TO THE STREETS* 197 (2008).

115. See Alberto Alesina et al., *Why Doesn't the US Have a European-Style Welfare State?* 3–4 (Harv. Inst. of Econ. Research Discussion Paper No. 1933, Nov. 2001).

incarceration.¹¹⁶ An increase in the number and proportion of these classes would seem to lead to an intensification of this policy, particularly when combined with the tendency of technology to undermine democratic mechanisms that would constrain it.¹¹⁷ In providing us with the great benefit of a new and splendidly large surplus, machines will have also destabilized, and perhaps destroyed, the human society for which those benefits are being provided.

B. Beneficial Precautions Against the Singularity

1. No Precautions or the Wait-and-See Approach

What should be our policy, at present, in the face of this uncertain but potentially disastrous possibility? One approach would be to do nothing and wait to see whether the Singularity actually occurs. If it does, governments could then tax the surplus away from technology firms and provide the massive funds resulting from this tax to the people who have lost their jobs, or to all people on the basis of their citizenship. There are various ways to structure such a tax, all of which involve complexities, but the problem does not seem insurmountable. Nor would such a tax destroy the economic incentive to continue innovating and expanding the automation surplus. Firms would continue to be motivated by competitive pressures, since a firm that failed to keep pace with its rivals would flounder or fail, and its owners

116. See MICHEL FOUCAULT, *DISCIPLINE AND PUNISH: THE BIRTH OF THE PRISON* 301 (Alan Sheridan trans., Vintage Books 2d ed. 1995) (1975); DAVID GARLAND, *THE CULTURE OF CONTROL: CRIME AND SOCIAL ORDER IN CONTEMPORARY SOCIETY* 39 (2003); DARIO MELOSSI & MASSIMO PAVARINI, *THE PRISON AND THE FACTORY* 121 (1981); JEFFREY H. REIMAN, *THE RICH GET RICHER AND THE POOR GET PRISON: IDEOLOGY, CLASS, AND CRIMINAL JUSTICE* 227 (11th ed. 2017) (1979); GEORG RUSCHE & OTTO KIRCHHEIMER, *PUNISHMENT AND SOCIAL STRUCTURE* 74 (5th ed. 2003) (1939); RANDALL G. SHELDEN, *CONTROLLING THE DANGEROUS CLASSES: A HISTORY OF CRIMINAL JUSTICE IN AMERICA* 5 (3d ed. 2017) (2007); JONATHAN SIMON, *GOVERNING THROUGH CRIME: HOW THE WAR ON CRIME TRANSFORMED AMERICAN DEMOCRACY AND CREATED A CULTURE OF FEAR* 15 (2007); LOIC WACQUANT, *PUNISHING THE POOR: THE NEOLIBERAL GOVERNMENT OF SOCIAL INSECURITY* 209 (2009).

117. See, e.g., ROBERT W. MCCHESENEY & JOHN NICHOLS, *PEOPLE GET READY: THE FIGHT AGAINST A JOBLESS ECONOMY AND A CITIZENLESS DEMOCRACY* 3 (2016); JOHN ROVITO, *AGE OF THE OBSOLETE: TECHNOLOGY, DEMOCRACY AND THE FUTURE OF WORK* 212 (2019); Yuval Noah Harari, *Why Technology Favors Tyranny*, ATLANTIC (Oct., 2018), <https://www.theatlantic.com/magazine/archive/2018/10/yuval-noah-harari-technology-tyranny/568330/> [https://perma.cc/2JWX-MX97]; Dirk Helbing, et al., *Will Democracy Survive Big Data and Artificial Intelligence?*, SCIENTIFIC AM. (Feb. 25, 2017), <https://www.scientificamerican.com/article/will-democracy-survive-big-data-and-artificial-intelligence/> [https://perma.cc/PZ27-LBD3]. The image of future society where inequality has led to comprehensive oppression is common in science fiction, a genre that specializes in predictions about the future. See, e.g., MARGARET ATWOOD, *ORYX AND CRAKE* 27 (2003); MARSHALL BRAIN, *MANNA* (2003); WILLIAM GIBSON, *NEUROMANCER* 7 (Neil Gaiman ed., Penguin Books 2016) (1984); KURT VONNEGUT, *PLAYER PIANO* 1 (1952).

would not only lose the fabulous surplus resulting from the Singularity but also whatever surplus they received before its advent.

It can be argued that a delayed response to the Singularity is rational. The delayed response to global warming has already resulted in irreversible damage and will lead to increased damage as long as we fail to respond effectively. In contrast, the effect of the Singularity appears reversible. But the whole point of the Singularity prediction is that the automation will *suddenly* enter a different phase and that phase will then proceed at electronic velocity. In other words, the prediction is that prior to the Singularity, the level of unemployment resulting from AI will be no greater, or at least not much greater, than exists at present. This is a problem that we know our democratic society has proved it can manage, if not well, at least without major disruption. If the Singularity occurs, the taxation and transfer of the resulting surplus can be instituted at that time just as effectively as it would be if instituted in advance.

But while the wait-and-see approach may be rational in the case of the Singularity, it does not seem advisable. It suffers from both policy and political defects. From a policy perspective, redistributing the surplus from the technology firms to the people who have lost their jobs would only be a partial solution. It would provide them with the means of subsistence, but it would not restore their position in society. Instead of a destitute proletariat, they would now be a dependent client class, constituting a large and increasing proportion of the citizenry. Their resulting sense of uselessness and demoralization might render them as incendiary and destabilizing as an equally large number of destitute people.

Such a solution, in addition to being suboptimal, also seems politically impossible to achieve. To begin with, an effort to redistribute the surplus would encounter sustained and powerful opposition from the business community, primarily on the basis of their self-interest, of course, but also on the basis of ideology. We know from the global warming situation that when political leaders are confronted with a crisis for which they are not prepared, their reaction is often to deny the "inconvenient truth."¹¹⁸ Given our prevailing Calvinist ideology, it would be easy for opponents of redistribution to claim that the rapid rise in unemployment (which, despite its electronic speed, will not be instantaneous) results from a general deterioration of the work ethic and the specific unwillingness of the displaced to seek alternative employment. To put the matter more crassly, it would be equally easy

118. This is, of course, Al Gore's memorable phrase for global warming. See AN INCONVENIENT TRUTH (Lawrence Bender Productions 2006).

for a consortium of technology firms to offer every member of the US Congress a billion dollars to encourage their agreement with this view. In contrast, the people who would be the apparent beneficiaries of a redistributive policy would be unlikely to support it, at least with the necessary commitment and enthusiasm. Historical experience indicates that democracies do not implement radical redistribution of wealth.¹¹⁹ Perhaps the normative force of property, whether land or machinery, is simply too great to be overcome through normal political processes, or perhaps the same belief system that renders work the defining feature of an individual's status in society precludes the extensive transfer of resources to those who do not work, even through no fault of their own. Overcoming such attitudes requires time and thought; it is a process that needs to be initiated before the crisis actually arrives.

Another possible solution that could be implemented once the Singularity occurs is to prevent it, using law to prohibit industrial enterprises from installing fully automated machinery. This is such a bad idea that there is no need to discuss it in detail. To begin with, it probably cannot be done in theory without abandoning our current system of free enterprise; the competitive advantages that hyperintelligent machines provide for any firm would be irresistible. Even if we could prohibit the use of such machinery, it could not be done in practice because the political power of machine owners in our society will be far too great for any national government to overcome. It seems likely, moreover, that any effective ban would need to be instituted by all the national governments acting in concert. Any single nation that attempted to ban the industrial progress would simply lose its competitive position in the global economy and would soon need to abandon the effort. And banning the progress of automation would deny society the wonderful new benefits that this progress might provide, including freedom from repetitive, unfulfilling jobs and new machine-made products that make current technological marvels look quaint.

Thus, it appears that it would be irresponsible for public policy makers to ignore the possibility that the Singularity will occur, given its potentially momentous consequences. The desirable course of action, here again, is to identify beneficial precautions—policies designed to combat the negative consequences of the Singularity while producing positive effects in the short run. Only such policies, moreover, have any real chance of being implemented in the real world. Long-standing

119. See Peter Beinart, *Will the Left Go Too Far?*, ATLANTIC (Dec. 2018), <https://www.theatlantic.com/magazine/archive/2018/12/democratic-party-moves-left/573946/> [<https://perma.cc/CPC6-E6P5>].

experience, recently confirmed with respect to climate change, demonstrates that it is extremely difficult in a democratic system to persuade people to endure present sacrifices to avoid future crises, particularly when the occurrence of those crises is uncertain.

2. Three Beneficial Precautions

With these considerations in mind, there are at least three identifiable policies for dealing with the possible occurrence of the Singularity.

a. Displaced Worker Retraining Programs

The first is to upgrade current employment and retraining services for displaced workers. If the Singularity occurs—and occurs with the rapidity that some AI experts predict—there will be massive job displacement and a corresponding need to retrain unemployed workers for those positions that are available in the new economy. This will require an administrative structure that enables us to provide retraining programs on a massive scale and implement them in an efficient manner. We will need information about what sort of retraining programs work in different situations and with different populations. Moreover, even those experts who readily predict massive unemployment are aware that they do not know which types of jobs will be eliminated, which types of jobs will continue but require different skills, and which types will remain in place. This means that we need vastly increased knowledge that will enable us to respond to unexpected and rapid changes in the labor market.¹²⁰ Once we have identified promising approaches, we will need to train skilled staff to implement

120. To take just one example, retraining is often conceivable in cognitive terms—that is, as the inculcation of specific skills. But there is some evidence that Attributional Retraining, derived from Attribution Theory, is more important with adult students. See, e.g., Shannan E. Jackson et al., *Getting the Job: Attributional Retraining and the Employment Interview*, 39 J. APPLIED SOC. PSYCHOL. 973 (2009); Raymond P. Perry et al., *Enhancing Achievement Motivation and Performance in College Students: An Attributional Retraining Perspective*, 34 RES. HIGHER EDUC. 687, 688 (1993); Neal F. Thompson, *Coping with Job Loss: An Attributional Model*, 131 J. PSYCHOL. 73, 78 (1996); Bernard Weiner, *An Attributional Theory of Achievement Motivation and Emotion*, 92 PSYCHOL. REV. 548, 549 (1985); see also FRITZ HEIDER, *THE PSYCHOLOGY OF INTERPERSONAL RELATIONS* 56 (1958). The theory predicts that people, particularly adults, look for features of their situation that have caused the negative consequences they experience and that this mentality has a powerful impact on their capacity for learning. It suggests the somewhat counterintuitive conclusion that retraining programs for workers displaced by automation should devote substantial attention to the reason they lost their jobs before proceeding to prepare them for new ones. Understanding that their job loss was the result of widespread changes in the structure of the workplace might not only improve their self-esteem, thus making them more effective learners, but also reconcile them to accepting jobs that they would otherwise regard as beneath them, such as teacher's or nurse's aides for those who were previously steelmakers or coal miners.

them. Given the proliferation and specialization of knowledge, training a trainer will necessarily take time because they will need to develop both generalized training skills and substantive knowledge in the individual fields for which the workers are being retrained. All of this is part of a planning model sometimes described as social learning,¹²¹ the gradual and interactive development of managerial and substantive capabilities.

At present, the United States is woefully unprepared to meet the retraining needs that the Singularity will present. In 2009, the year that the Government Accountability Office (GAO) studied in its last full-scale assessment of federal employment and training programs, total expenditures for these programs totaled about \$18 billion.¹²² This was divided among forty-seven programs administered by nine different agencies, with almost all the programs overlapping at least one other program. Despite concerted efforts by these agencies to coordinate their efforts, GAO's major finding was that this dispersed and confused organizational structure created inefficiencies in the operation of these programs and left potential beneficiaries uncertain about where to go and whom to consult when they wanted to receive the offered benefits.¹²³ Congress has long been aware of the need for single service-delivery facilities and made a concerted effort to provide for them in the Workforce Investment Act, its comprehensive reorganization of federal employment and training services,¹²⁴ but the problem has yet to be solved.¹²⁵

GAO also found inadequacies in the management of the individual programs, specifically the failure of the administering

121. See CHRIS ARGYRIS, REASONING, LEARNING AND ACTION: INDIVIDUAL AND ORGANIZATIONAL 100, 135 (1982); JOHN FRIEDMANN, PLANNING IN THE PUBLIC DOMAIN: FROM KNOWLEDGE TO ACTION 181–224 (1987). The approach derives its inspiration from John Dewey. See, e.g., JOHN DEWEY, EXPERIENCE AND EDUCATION 21 (1938).

122. U.S. GOV'T ACCOUNTABILITY OFF., GAO-11-92, MULTIPLE EMPLOYMENT AND TRAINING PROGRAMS: PROVIDING INFORMATION AND COLOCATING SERVICES AND CONSOLIDATING ADMINISTRATIVE STRUCTURES COULD PROMOTE EFFICIENCIES 5 (2011).

123. *Id.* at 30–32. The Report's carefully worded conclusion included the statement that "consolidating the administrative structures of these programs would potentially conserve resources and better serve customers." *Id.* at 31.

124. Workforce Investment Act of 1998, Pub. L. No. 105-220, 112 Stat. 963 (1998) (to be codified at 29 U.S.C. §§ 2901 et seq.). Section 121 of the Act, 29 U.S.C. § 2841 ("Establishment of One-Stop Delivery Systems") is explicitly designed to achieve this goal.

125. The GAO's 2009 report was at least the fourth time that it had advanced this recommendation over a period of a decade and a half. See U.S. GOV'T ACCOUNTABILITY OFF., *supra* note 122 at 4; U.S. GOV'T ACCOUNTABILITY OFF., GAO/AIMD-97-146, MANAGING FOR RESULTS: USING THE RESULTS ACT TO ADDRESS MISSION FRAGMENTATION AND PROGRAM OVERLAP 37 (1997); U.S. GOV'T ACCOUNTABILITY OFF., GAO/T-HEHS-95-70, MULTIPLE EMPLOYMENT TRAINING PROGRAM: MAJOR OVERHAUL NEEDED TO REDUCE COSTS, STREAMLINE THE BUREAUCRACY, AND IMPROVE RESULTS 20 (1995); U.S. GOV'T ACCOUNTABILITY OFF., GAO/HEHS-94-80, MULTIPLE EMPLOYMENT AND TRAINING PROGRAMS: OVERLAPPING PROGRAMS CAN ADD UNNECESSARY ADMINISTRATIVE COSTS 17 (1994).

agencies to determine whether the programs were actually achieving their stated goals.¹²⁶ The GAO Report states: “Little is known about the effectiveness of the employment and training programs we identified because only 5 reported demonstrating whether outcomes can be attributed to the program through an impact study, and about half of all the programs have not had a performance review since 2004.”¹²⁷ This represents a failure to develop the specialized, cumulative knowledge that has been our path to success in technological fields. The proliferation of programs might seem to offer the opportunity to assess a variety of options but in fact has led only to competition and confusion.¹²⁸ We need an integrated structure where different approaches can be systematically developed and effectively evaluated.

These inadequacies in organization and information are accompanied by inadequate funding. Since the GAO Report was issued, funding for employment and training programs has declined precipitously, from \$18 billion in 2009 (\$20 billion in current dollars) to \$14 billion in the 2018 budget.¹²⁹ In large part, the reason is that the 2009 budget was amplified by the American Recovery and Reinvestment Act of 2009,¹³⁰ a response to the 2008 financial crisis. But the decrease also results from specific funding reductions. The Department of Labor’s 2018 budget reduces funding for the Job Corps (which provides vocational training for low-income youths) by \$237.5 million and eliminates the entire \$433.5 million funding for the Senior Community Service Employment Program.¹³¹ In other words, federal employment and training programs suffer from poor management, lack quality control, are often funded in response to short-term considerations, and now suffer further cuts from the Trump administration’s service cuts that are specifically directed at vulnerable populations.

Upgrading this obviously unsatisfactory job training system would not only constitute a wise precaution against the Singularity but also provide immediate benefits as well. The Singularity may be a

126. U.S. GOV’T ACCOUNTABILITY OFF., *supra* note 122, at 11.

127. *Id.*

128. *Id.* at 30–32.

129. U.S. GOV’T ACCOUNTABILITY OFF., GAO-19-200 EMPLOYMENT AND TRAINING PROGRAMS: DEPARTMENT OF LABOR SHOULD ASSESS EFFORTS TO COORDINATE SERVICES ACROSS PROGRAMS 9, 12 (2019). As the title suggests, this GAO update reiterates the need for coordination as well as documentation of the overall decline in funding. Despite the decrease in funding by a full one-third, there remained forty-three separate programs, almost as many (91 percent) as before, which suggests even greater fragmentation.

130. American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, 123 Stat. 148 (2009).

131. U.S. DEP’T LABOR, EXEC. OFFICE OF THE PRESIDENT, BUDGET IN BRIEF, FISCAL YEAR 2019, at 11–12 (2018).

matter of controversy, but labor economists and AI experts are unanimously agreed that automation will cause significant shifts in employment patterns over the coming decades, even if it produces no decrease whatsoever in the total number of jobs.¹³² Additional shifts will occur as a result of changing trade patterns and consumer preferences. The response from parts of the American Right, most notably President Trump, and parts of the American Left, such as Bernie Sanders, has been to stop jobs from going “overseas” and bring the jobs that already fluttered away back to the United States by erecting trade barriers.¹³³ The experts in the relevant field—namely, economists—are as unanimous in condemning this approach as climatologists are in condemning the unabated release of greenhouse gases.¹³⁴ Retraining programs are a much better solution. They do not produce the decreases in consumer welfare that result from trade barriers, and they provide at least similar, and generally greater, benefits for the displaced workers.

A complete overhaul and substantial expansion of federal employment and retraining services would thus constitute a beneficial precaution. Clearly, the number of separate programs needs to be reduced, an ordered authority structure needs to be established, and

132. See BORDERS, *supra* note 81, at 75. In fact, no one is predicting that there will be no job displacement due to automation. Those with the most optimistic, or least cataclysmic, view of the future nonetheless predict extensive loss of jobs in certain sectors, with the new jobs that are the basis for their optimism in distinctly different sectors. See MANYIKA ET AL., *supra* note 81, at 111; MEISEL, *supra* note 81, at 52; SCHWAB, *supra* note 81, at 38; Frey & Osborne, *supra* note 81, at 259–60.

133. See Bernie Sanders, *Fading Fast: Vermont Manufacturing Jobs*, SANDERS.SENATE.GOV, <https://www.sanders.senate.gov/vermont/fading-fast-manufacturing-jobs> [<https://perma.cc/4BCN-VBW2>] (last visited Oct. 24, 2019); Bernie Sanders, *The Era of Outsourcing Is Over*, MEDIUM (Nov. 28, 2016), <https://medium.com/senator-bernie-sanders/the-era-of-outsourcing-is-over-a4e72bd8a613> [<https://perma.cc/B9LM-QJJH>]; Kimberly Amadeo, *Can Trump Bring Back American Jobs?*, BALANCE (June 25, 2019), <https://www.thebalance.com/trump-and-jobs-4114173> [<https://perma.cc/TKJ7-H5X8>]; *Donald Trump on Jobs*, ONTHEISSUES, https://www.ontheissues.org/celeb/Donald_Trump_Jobs.htm [<https://perma.cc/BZL7-RPGJ>] (last visited Oct. 24, 2019).

134. See Dan Fuller & Doris Geide-Stevenson, *Consensus Among Economists: Revisited*, 34 J. ECON. EDUC. 369, 376 (2003) (survey of members of American Economic Association finding disagreement on several issues but high degree of consensus on value of free international trade); Dan Fuller & Doris Geide-Stevenson, *Consensus on Economic Issues: A Survey of Republicans, Democrats and Economists*, 33 E. ECON. J. 81, 89 (2007) (same); Paul R. Krugman, *The Narrow and Broad Arguments for Free Trade*, 83 AM. ECON. REV. 362, 362 (1993) (“Economists have a notorious, only partly deserved reputation for disagreeing about everything. One thing that almost all economists have almost always agreed about, however, is the desirability of free trade.”). With respect to the current tariffs imposed by President Trump, see Stuart Anderson, *Tariffs Are Costing Jobs: A Look at How Many*, FORBES (Sept. 24, 2018), <https://www.forbes.com/sites/stuartanderson/2018/09/24/tariffs-are-costing-jobs-a-look-at-how-many/#12b003c57b26> [<https://perma.cc/Z5NZ-FRUM>]; Mary Amiti, Stephen J. Redding & David Weinstein, *The Impact of the 2018 Trade War on U.S. Prices and Welfare* 1–2 (Nat’l Bureau of Econ. Research, Working Paper No. 25672, 2019) (full incidence of the tariff falls on domestic consumers, with a reduction in US real income of \$1.4 billion per month by the end of 2018).

services need to be coordinated for intended beneficiaries through a single facility that will direct them to the optimal training programs. We need to evaluate existing programs to determine the sorts of strategies that are effective in providing workers with new skills and the necessary incentive to acquire them. To achieve these goals, greatly increased funding is essential. As a rough estimate, the 2009 funding level, instead of being reduced by a third, should have been doubled to \$40 billion per year.¹³⁵ That investment in employment and retraining services is an easily affordable amount, representing only about 1 percent of the current federal budget of \$4.4 trillion.¹³⁶

With careful, conscientious planning, these funds can be effectively deployed. Unlike the advent and the impact of the Singularity, a matter of great uncertainty and vague but terrifying consequences, the job dislocations that lie in our immediate future are not difficult for experts to predict. There is widespread agreement, for example, that prospects for less skilled workers are gradually deteriorating.¹³⁷ Possibilities for reemployment in advanced industrial economies can be predicted with reasonable accuracy, and training programs can be designed accordingly. The advantages are obvious, particularly for low-skilled and minority workers who are most vulnerable to job loss and continued unemployment. These advantages would readily justify the increased expenditure and effort of an employment retraining policy that would simultaneously develop the institutional structure, knowledge, and experience that will be essential if the Singularity occurs. With expenditures at that level, we have a chance to put the structures and capacities in place that we will need if automation rapidly displaces half the US labor force that currently numbers about 160 million people.¹³⁸ When the Singularity actually occurs, we would probably need to double the annual funding level again, to something like \$80 billion.¹³⁹

135. For the assumptions on which such an increase might be based, see *infra* note 154.

136. *Budget*, CONG. BUDGET OFF., <https://www.cbo.gov/topics/budget> [<https://perma.cc/F2ZV-VA3W>] (last visited Nov. 10, 2019).

137. See, e.g., Rebecca M. Blank, *Outlook for the U.S. Labor Market and Prospects for Low-Wage Entry Jobs*, in *THE WORK ALTERNATIVE: WELFARE REFORM AND THE REALITIES OF THE JOB MARKET* 33, 33 (Demetra Smith Nightingale & Robert H. Haveman eds., 1995).

138. *Civilian Labor Force*, FED. RES. BANK ST. LOUIS (last updated Dec. 6, 2019), <https://fred.stlouisfed.org/series/CLF16OV> [<https://perma.cc/G5VQ-2DFG>] (FRED data).

139. It is hard to imagine that an effective job training program could be implemented for less than \$15,000 per worker (consider the annual tuition at most universities and colleges). Funding of \$80 billion would thus provide a year of retraining for five million workers. Assuming as well that one year of training would be sufficient, the \$80 billion funding level would need to be continued for a decade to cover fifty million workers who were displaced and seeking reemployment. It might then need to be sustained at lower but still substantial levels (perhaps the prior \$40 billion) for the remaining workers as dislocations continue to occur. Of course, not all the displaced workers (half the labor force or eighty million possibly) might require retraining, and a

b. Increased Arts Funding

A second beneficial precaution would be to increase funding for the arts and specifically for arts-related activities by ordinary citizens. If the Singularity occurs, the number of paying jobs in the economy will decline significantly. Tens of millions of people will lose their positions and young people, including those who have spent many years acquiring vocational skills, will face the realistic prospect that they will be unable to obtain employment. Retraining, as described above, will enable some people to move into different positions, but the Singularity is likely to automate many different fields, and most of those who predict it believe that a large part of the current labor force will remain unemployed.¹⁴⁰ Policy makers must find some acceptable way to support these people and give them a sense that they continue to have a role in our society. To have vast numbers of people, particularly young people, who are destitute is likely to lead to social and political catastrophe; to have vast numbers of people, particularly young people, who are adequately nourished but have nothing to do is even more likely to produce that result.

Arts funding could support a broad array of activities that otherwise would not be carried out because people lack sufficient talent or connections to make money from them and lack the leisure time to pursue them without such remuneration. These would include live performances—plays, poetry readings, operas, ballets, folk dancing, and concerts—art shows, craft fairs, films, literary works, graphic novels, and various entertainments for children. All this material could be presented or re-presented on the internet, together with a variety of video products and games that can promulgated only through that means. Grants to produce it could either be specific to the work or provide general support for its creator.

Many people enjoy activities of this sort and derive a sense of pleasure and purpose from them.¹⁴¹ Those who could not find

good number might choose to leave the labor force. On the other hand, the employment available in a post-Singularity economy might require more than a year of retraining. The actual funding level could not be determined until the Singularity actually occurs. The point here is to develop the capacity to manage such a funding increase if it proves to be necessary.

140. FORD, *supra* note 81, at 240; MEISEL, *supra* note 81, at 50; SCHWAB, *supra* note 81, at 38; Frey & Osborne, *supra* note 81, at 254.

141. See ERIC WEINER, THE GEOGRAPHY OF BLISS 141–84 (2008). Extensive support for the arts is currently the policy in Iceland, identified by Ruut Veenhoven as the happiest nation on Earth. RUUT VEENHOVEN, HAPPINESS IN NATIONS: SUBJECTIVE APPRECIATION OF LIFE IN 56 NATIONS 1946–1992 (1993). Weiner recounts that most of the art is what can be charitably described as amateurship (i.e., not very good) but that people enjoy creating it, and that this activity (certainly not the climate) is responsible for much of the Icelandic people's sense of personal fulfillment. *Id.*

remunerative employment—through no fault of their own, after all—would then feel that they had a role in the society. They would wake up in the morning with a project to carry out and a sense that they needed to fulfill the terms of their grant, instead of looking for work that did not exist, passing desolate hours in despair, or making trouble of one sort or another to relieve their sense of purposelessness. Others would enjoy attending or purchasing the results of their efforts, particularly if they know or, better still, are related to the creator. In addition, increased artistic and artisanal production might strengthen and enrich local communities. Prior to the electronic era, music could only be performed in person; prior to the industrial era, almost all manufactured items were made by individual artisans in the area where they were sold. One need not succumb to the muddled nostalgia of Robert Putnam¹⁴² or the wistful regret of Oliver Goldsmith¹⁴³ to conclude that increased artistic production by ordinary citizens might improve the quality of life in America's localities and undo some of the damage that big box stores and superhighways have inflicted on them.

Arts grants obviously cannot be evaluated according to the same criteria that apply to retraining programs, but they present the same need for organizational infrastructure, experiential knowledge, and adequate funding. We need to develop the organizational structure and capacity to distribute grants on a fair and neutral basis and to effectively monitor the use of funds.¹⁴⁴ We also need to experiment with different types of grants and evaluate the results so that we will know what types of support enable people to feel that they have a continued role in the society and produce the greatest benefits for their audience, whether within their community or beyond it. This social learning approach is necessary if we are to be prepared to deal with the massive

142. See ROBERT D. PUTNAM, *BOWLING ALONE: THE COLLAPSE AND REVIVAL OF AMERICAN COMMUNITY* (2000). Putnam begins by bemoaning the end of a bridge club in Little Rock, Arkansas, and a charity club in Dallas where members met each Saturday morning to “sew, knit, and visit,” but they never quite noticed the gatherings that developed instead, like the climber’s base camp at El Capitan or the numerous science-fiction conventions held throughout the country. *Id.* at 15–16; see RUBIN, *supra* note 4, at 197–99.

143. OLIVER GOLDSMITH, *The Deserted Village*, in *THE POETICAL WORKS OF OLIVER GOLDSMITH* 37, 44–47 (1888) (2019) (“How often have I loiter’d o’er thy green, Where humble happiness endear’d each scene. . . . But times are alter’d; trade’s unfeeling train, Usurp the land, and disposes the swain.”).

144. GAO has never carried out a comprehensive review of the National Endowment for the Arts. It issued a fairly perfunctory report in 1991 responding to specific questions about the agency procedures for making grant decisions. See U.S. GOV’T ACCOUNTABILITY OFF., GAO/CCD-91-102FS, GRANT ADMINISTRATION: IMPLEMENTATION OF NATIONAL ENDOWMENT FOR THE ARTS REAUTHORIZATION ACT (1991).

job displacement and permanent unemployment that will result from the Singularity.¹⁴⁵

Arts funding, like employment services and retraining, is a beneficial precaution. As long as employment remains at its current level, this funding would not be based on need but on excellence. In other words, grants would be provided to people with real talent, not to people who simply lost their job and could not obtain another. Such grants would be beneficial to the grantee, who would presumably find the alternative work more rewarding. Being excellence-based, the grants would presumably yield products that were enjoyable for their audience or recipients. As long as there was no labor shortage, even a substantial grant program of this sort would not have any negative impact on the economy.

At present, government support for artistic activity in the United States is provided by the National Endowment for the Arts (NEA),¹⁴⁶ an independent agency with a budget of \$155 million for the 2019 fiscal year.¹⁴⁷ This represents about three-thousandths of 1 percent of the federal budget. Always subject to skepticism from conservative politicians,¹⁴⁸ NEA became the center of a political firestorm due to exhibitions by two of its grantees, Andres Serrano's 1988 exhibit at the Southeastern Center for Contemporary Art in Winston-Salem, North Carolina, that included a piece titled *Piss Christ* (consisting of a small crucifix immersed in urine) and Robert Maplethorpe's 1989 photographic display, scheduled for the Corcoran Gallery in Washington, D.C., that included homoerotic images.¹⁴⁹ Senator Jesse Helms (R-NC), who opposed every civil rights initiative that came before the Senate during the twenty-four years he served,¹⁵⁰

145. Regarding social learning as a planning strategy, see ARGYRIS, *supra* note 121, at 159–60.

146. NEA's mission statement is that its grants give "Americans the opportunity to participate in the arts, exercise their imaginations, and develop their creative capacities. . . . [T]he NEA supports arts learning, affirms and celebrates America's rich and diverse cultural heritage, and extends its work to promote equal access to the arts in every community across America." *About the NEA*, NAT'L ENDOWMENT FOR ARTS, <https://www.arts.gov/about-nea> [<https://perma.cc/X7AB-6FRK>] (last visited Oct. 18, 2019).

147. *National Endowment for the Arts Appropriations History*, NAT'L ENDOWMENT FOR ARTS, <https://www.arts.gov/open-government/national-endowment-arts-appropriations-history> [<https://perma.cc/K95Z-C4F3>] (last visited Oct. 18, 2019).

148. For the early history of NEA, see DONNA M. BINKIEWICZ, *FEDERALIZING THE MUSE: UNITED STATES ARTS POLICY AND THE NATIONAL ENDOWMENT FOR THE ARTS 1965–1980* (2004); FANNIE TAYLOR, *THE ARTS AT A NEW FRONTIER: THE NATIONAL ENDOWMENT FOR THE ARTS* (1984).

149. See RICHARD ELDRIDGE, *AN INTRODUCTION TO THE PHILOSOPHY OF ART 225* (2014); PAUL MONACO, *UNDERSTANDING SOCIETY, CULTURE, AND TELEVISION 100–01* (1998).

150. Chuck Smith, *The Case Against Jesse Helms*, *WALL ST. J.* (Sept. 4, 2001), <https://www.wsj.com/articles/SB122643894408618377> [<https://perma.cc/5R76-SX42>].

perceived these exhibits as a violation of American values.¹⁵¹ Through his high-pitched rhetoric and determined efforts, the NEA's budget was reduced from \$165 million in 1995 to \$99 million the following year, and it has yet to reach its former level, even in nominal dollars.¹⁵² President Trump has regularly called for the abolition of the agency.¹⁵³

In order for arts funding to serve as a beneficial precaution against the Singularity, and not only as a benefit, the funding level needs to be increased by a substantial amount, perhaps one hundredfold to \$15 billion. This is only about three-tenths of 1 percent of the current federal budget. It would be sufficient to develop the infrastructure that would be needed if arts funding were to be used as a response to the massive unemployment that the Singularity will cause. It will provide experience with a wide variety of grants, teaching us what displaced workers want to do, how much funding they need, and what will produce the most interesting and appealing products for their communities and for society in general. It would also teach us, from experiences such as the Serrano and Maplethorpe exhibits, what sorts of projects we might want to avoid and leave to private funding.

If the Singularity does in fact occur, and arts funding is to serve as a response to it, the level of expenditure would then need to be increased considerably above its previously increased level—perhaps another hundredfold, to \$1.5 trillion per year.¹⁵⁴ This would, of course, represent a partial taxation of the surplus away from the technology firms and to unemployed individuals (that is, consumer prices would remain roughly the same, or decrease only moderately, and the tax would constitute a transfer). But it would be more palatable than a purely redistributive policy.¹⁵⁵ People would be paid, after all, for doing

151. See BINKIEWICZ, *supra* note 148, at 1; Allan Parachini, *Government and the Arts: The Man Who Would Be Arts King*, L.A. TIMES (Sept. 22, 1989).

152. *National Endowment for the Arts Appropriations History*, *supra* note 147.

153. See *National Endowment for the Arts Update: Trump FY2018 Budget Calls for Elimination of NEA Funding*, AMS. FOR ARTS, <https://www.americansforthearts.org/newsroom/arts-mobilization-center/national-endowment-for-the-arts-update-trump-fy2018-budget-proposal-calls-for-elimination-of-nea> [<https://perma.cc/2C5A-6V2M>] (last visited Oct. 19, 2019). The agency's budget request for 2019 begins with the following statement: "The Administration has proposed terminating funding for the National Endowment for the Arts (NEA) in FY 2019. Toward this end, the FY 2019 Budget requests \$28.949 million to begin the orderly closure of the agency." NAT'L ENDOWMENT FOR ARTS, APPROPRIATIONS REQUEST FOR FISCAL YEAR 2019 (Feb. 2018), <https://www.arts.gov/sites/default/files/NEA-FY19-Appropriations-Request.pdf> [<https://perma.cc/5B4E-BBZN>].

154. This is based on a rough calculation that the Singularity will lead to the permanent unemployment of about half the current workforce of 160 million persons and that half of those will be supported by arts funding as opposed to some other means. See *supra* note 139. It assumes that each annual grant will need to be about \$40,000 in order to provide the person with a decent standard of living.

155. Transfer payments under federal mandatory spending programs, primarily social security, Medicare and Medicaid, but also food stamps, veterans' benefits, welfare, and other

work, and thus the program would not conflict with our prevailing Calvinist or Christian ethos. Moreover, the grant recipients would feel good about themselves because the grants would provide them with a work-related position in society.¹⁵⁶ Their products, even if no longer limited by the criterion of excellence, would be of at least some value to the general society.

More profoundly, if the Singularity occurs, people will need to have some sense of purpose and meaning apart from productive labor, which will no longer be available. This is actually an appealing prospect. Many of the jobs in our industrial society, while they are necessary for our national wealth and provide support for the worker, are unpleasant and unhealthful.¹⁵⁷ Others are merely dull, or simply unfulfilling for particular people.¹⁵⁸ Supporting themselves through artistic production would provide many people with much more pleasant and enjoyable lives, and would produce the collateral benefit of increased artistic and artisanal production while the machines are slaving away to produce the same industrial goods that are currently available.

c. Educational Reform

A third beneficial precaution would be a change in the content of education. There is, at present, widespread discussion about the way that AI and other digital technology will affect the process of instruction.¹⁵⁹ Another issue, of course, is whether instruction will be

programs, currently add up to about \$3 trillion per year. *May 2019 Historical Budget Data*, CONG. BUDGET OFF. (2018), <https://www.cbo.gov/about/products/budget-economic-data#2> [<https://perma.cc/D6R5-ZM7G>]. A 50 percent increase in these payments to deal with forty million unemployed Americans is not a disproportionate amount.

156. See RUUT VEERHOVEN, *CONDITIONS OF HAPPINESS* 215–29 (1984) (performing work for pay is a major source of happiness or fulfillment for many people).

157. Ilana E. Strauss, *Would a Work-Free World Be So Bad?*, ATLANTIC (June 28, 2016), <https://www.theatlantic.com/business/archive/2016/06/would-a-world-without-work-be-so-bad/488711/> [<https://perma.cc/5SE2-DHGW>].

158. See ARNE L. KALLEBERG, *GOOD JOBS, BAD JOBS: THE RISE OF POLARIZED AND PRECARIOUS EMPLOYMENT SYSTEMS IN THE UNITED STATES, 1970S TO 2000S* 3 (2013); JEFFREY S. ROTHSTEIN, *WHEN GOOD JOBS GO BAD: GLOBALIZATION, DE-UNIONIZATION AND DECLINING JOB QUALITY IN THE NORTH AMERICAN AUTO INDUSTRY* 3 (2016); Janette S. Dill, Jennifer Craft Morgan & Arne L. Kalleberg, *Making Bad Jobs Better: The Case of Frontline Healthcare Workers*, in *ARE BAD JOBS INEVITABLE?: TRENDS, DETERMINANTS AND RESPONSES TO JOB QUALITY IN THE TWENTY-FIRST CENTURY* 110 (Chris Warhurst et al. eds., 2012); Paul Osterman, *Job Quality in the US: The Myths that Block Action*, in *ARE BAD JOBS INEVITABLE? TRENDS, DETERMINANTS AND RESPONSES TO JOB QUALITY IN THE TWENTY-FIRST CENTURY* 45 (Chris Warhurst et al. eds., 2012).

159. See, e.g., IAN JUKES & RYAN L. SCHAAP, *A BRIEF HISTORY OF THE FUTURE OF EDUCATION: LEARNING IN THE AGE OF DISRUPTION* 4 (2019); LASSE ROUHIAINEN, *THE FUTURE OF HIGHER EDUCATION: HOW EMERGING TECHNOLOGIES WILL CHANGE EDUCATION FOREVER* 36 (2016); Edward L. Rubin, *Introduction*, in *LEGAL EDUCATION IN THE DIGITAL AGE 2* (Edward L. Rubin ed., 2013); BEN WILLIAMSON, *BIG DATA IN EDUCATION: THE DIGITAL FUTURE OF LEARNING, POLICY AND PRACTICE* 10 (2017).

partially or fully automated by AI, thereby displacing millions of teachers, or whether it will become more individualized and interpersonal, providing a haven from the labor deprivations of the Singularity. But the idea of beneficial precaution raises a somewhat different question: Are there changes in the educational system that might prepare us for the Singularity but simultaneously provide immediate benefits that would justify their implementation in the face of uncertainty?

To answer this question, we need to consider the sort of education that might prepare people for the roles that they would fulfill if the Singularity occurs. At present, our educational system, particularly at the elementary and secondary levels, remains heavily bound by tradition and justified by the ability of these traditional courses to prepare students for future employment, often after learning more specialized skills in college. But if the Singularity occurs, many people will never obtain jobs and will need to rely on arts grants, as described above, or social welfare payments that will leave them with large amounts of leisure time. Others will be in the same situation because they have lost their jobs, or they will need to be retrained, as also described above. At the same time, however, the remaining jobs are likely to be those that are most difficult to automate. While some of these may be low-level service jobs, like teacher's or nurse's aides, others will likely be the most high-level ones, demanding exceptional skills and obtained only through intense competition.¹⁶⁰ These demands on the educational system seem to move in opposite directions, with the further problem that the Singularity may not occur, and the skills needed for employment may not be particularly different from the ones that are currently demanded.

One obvious precaution that the educational system can implement is to rethink the learning process in terms of a more direct and interactive relationship between humans and computers. Skills such as computation, informational retrieval, and problem-solving all need to be reconceived, from the very earliest stages of education, as intrinsically connected to AI. If the Singularity occurs, intelligent machines will be so widespread and so powerful that many of our life activities, both vocational and personal, will depend on them entirely. It will be essential to understand how to use intelligent machines to carry out computations, retrieve information, and solve problems as part of a human-machine totality.¹⁶¹

160. See, e.g., COWEN, *supra* note 81, at 19–44; MEISEL, *supra* note 81, at 88–100; SCHWAB, *supra* note 81, at 35–49.

161. This is still quite short of the future envisioned by Ray Kurzweil, one of the leading AI experts predicting the Singularity, who argues that “the Singularity . . . will result from the

An educational system of this sort would teach general principles and information retrieval techniques, rather than the detailed knowledge that the present systems attempt to convey. For example, a standard component of current high-school biology courses is the Krebs cycle by which cells release energy stored in proteins, fats, and carbohydrates.¹⁶² Very few people remember this information once their education has ended, and even fewer—including physicians—have a use for it. Requiring students to memorize such material is equivalent to requiring them to recite *The Iliad* from memory, which was a necessity in eighth-century BC Greece before the revival of writing. An educational approach that prepared people for the Singularity would teach them how to either find the information on a computer or have the computer itself find and apply it for whatever purpose the user needed.

This change in education is a beneficial precaution because we are already at the stage where we rely on computers to provide us with the information we need. It is important for children to understand the concept of multiplication, but in a society where everyone carries out computations on their cell phone, personal computer, or workstation, it is simply not necessary to memorize multiplication tables. It is important to understand the basic structure of living organisms but

merger of the vast knowledge embedded in our own brains with the vastly greater capacity, speed, and knowledge-sharing ability of our technology.” KURZWEIL, *supra* note 81, at 20. By 2030, he believes, “[n]anobot technology will provide fully immersive, totally convincing virtual reality. Nanobots will take up positions in close physical proximity to every intentional connection coming from our senses.” *Id.* at 313. A cynic might be reminded of the famous Futurama exhibit at the 1939 New York World’s Fair, designed by Norman Ben Geddes, which predicted that in twenty years, we would have automated highways, food-producing factories, and individual flying machines landing on rooftop platforms. See NICOLAS P. MAFFEI, NORMAN BEL GEDDES: AMERICAN DESIGN VISIONARY, 156–57 (2018). Eighty years after that exhibit, General Motors still cannot produce a truly functional electric car. See e.g., Paul A. Eisenstein, *May the Chevy Volt RIP: Tesla Helped Kill It, but It Taught GM a Lot About Electric Cars*, CNBC (Feb. 28, 2019, 3:38 PM), <https://www.cnbc.com/2019/02/28/may-the-chevy-volt-rip-tesla-helped-kill-it-but-gm-learned-a-lot.html> [<https://perma.cc/3F6Y-VT27>]. On the other hand, twenty or even thirty years after Futurama, professional workers still had secretaries typing their written work and placing their phone calls, but twenty or thirty years after that, all these workers are almost permanently attached to a computer and use it for virtually all their writing and communication. Abby Quillen, *From Secretary to Administrative Assistant: How the Admin Role Has Evolved Over Time*, QUILL.COM BLOG (June 30, 2017) <https://www.quill.com/blog/office-tips/from-secretary-to-administrative-assistant-how-the-admin-role-has-evolved-over-time.html> [<https://perma.cc/BA4A-US25>]. The point, once again, is the Yogi Berra-ism that “[i]t is tough to make predictions, especially about the future.” Robert Oldershaw, MEDIUM (Mar. 5, 2017), <https://medium.com/@rloldershaw/as-yogi-berra-and-niels-bohr-famously-stated-it-is-tough-to-make-predictions-especially-about-a5e0c4506822> [<https://perma.cc/Q4T6-U569>].

162. See, e.g., N.Y. EDUC. DEPT, LIVING ENVIRONMENT: CORE CURRICULUM 15–16, <http://www.nysed.gov/common/nysed/files/programs/curriculum-instruction/livingen.pdf> [<https://perma.cc/8M8T-QBRQ>]; Robert Krulwich, *Lord, Save Me from the Krebs Cycle*, NPR (Sept. 14, 2011, 10:57 AM), <https://www.npr.org/sections/krulwich/2011/09/14/140428189/lord-save-me-from-the-krebs-cycle> [<https://perma.cc/7JYP-W9QG>].

hardly useful to memorize details like the Krebs cycle if one can access more information than the average biology major knows in about twenty seconds. If the Singularity does not occur, there may come a point where we have become too dependent on computers and need to place some sort of limit on the extent to which we rely on machines instead of our own ability to calculate, remember, and analyze. But we are nowhere near that point at present.

All AI experts, including those who reject the Singularity and believe that employment levels will remain relatively stable, agree that the pattern of employment will change, with high-skilled, computer-based jobs replacing the low-skilled jobs that are currently prevalent in our economy.¹⁶³ Our educational system has not responded adequately to this situation. While devices have been supplied to many schools, teachers have not been adequately trained to make use of them and, still more importantly, the curriculum has not been rethought to reflect the extent to which computers have transformed the current workplace.¹⁶⁴ A sustained commitment to educational programs of this sort would produce immediate benefits and develop our capacity to respond if the Singularity occurs and computers transform the entire structure of society.

A rather different but equally promising precaution against the occurrence of the Singularity would be to increase elementary- and high-school education in aesthetics. The common argument for arts education at this level is that it will aid students in learning the subjects that really matter, thereby raising academic grades and standardized test scores.¹⁶⁵ Given the current paucity of arts education in our schools,¹⁶⁶ it is certainly understandable why proponents would advance instrumental arguments of this nature. The argument here, however, is that arts education is valuable on its own terms. If the

163. See MANYIKA ET AL., *supra* note 81, at 2; RIDLEY, *supra* note 81, at 114; SCHWAB, *supra* note 81, at 37; Arntz et al., *supra* note 81.

164. See, e.g., LARRY CUBAN, *OVERSOLD AND UNDERUSED: COMPUTERS IN THE CLASSROOM* 93 (2001); BOB JOHNSTONE, *NEVER MIND THE LAPTOPS: KIDS, COMPUTERS AND THE TRANSFORMATION OF LEARNING* (2003).

165. See, e.g., JAMES S. CATTERALL, *DOING WELL AND DOING GOOD BY DOING ART: A 12-YEAR NATIONAL STUDY OF EDUCATION IN THE VISUAL AND PERFORMING ARTS* 16 (2009); DALLAS BIG THOUGHT, *CREATIVE LEARNING: PEOPLE AND PATHWAYS* (2010); CHAMPIONS OF CHANGE: *THE IMPACT OF THE ARTS ON LEARNING* (Edward B. Fiske ed., 1999); MILBREY W. McLAUGHLIN, *COMMUNITY COUNTS: HOW YOUTH ORGANIZATIONS MATTER FOR YOUTH DEVELOPMENT* (2000); Shirley Brice Heath et al., *Living the Arts Through Language-Learning: A Report on Community Based Organizations*, 2 *AMS. FOR ARTS* 1, 3 (1998).

166. See PRESIDENT'S COMM. ON THE ARTS & HUMANITIES, *REINVESTING IN ARTS EDUCATION: WINNING AMERICA'S FUTURE THROUGH CREATIVE SCHOOLS* 11 (2011) ("Recent analyses revealed that the schools with students who could most benefit from the documented advantages of arts strategies are often those that either do not recognize the benefits of arts education or do not have the resources to provide it to their students.") The Report describes arts education in the United States as occurring in "pockets." *Id.* at 10.

Singularity occurs, vast numbers of people will be unemployed, no matter how much vocation-oriented training they have received. Aesthetic education can be viewed as supporting the previous proposal to provide these people with a livelihood and a role in our society through arts grants.¹⁶⁷ It would prepare some people to produce artistic products and other people to provide an audience or market for these products through their increased appreciation. More basically, however, it would simply be an independent precaution, a means of preparing people to enjoy a life in which they cannot be gainfully employed. Perhaps more people will choose to spend their time playing sports, traveling, or raising children. But in the past, artistic activity was quite popular among the small minority of people who were wealthy enough to live without working. Now, with machines doing so much of the work, perhaps there are many more people who will find artistic activity arts fulfilling.

Aesthetic education is also a beneficial precaution because producing or consuming art of various kinds can be a pleasurable leisure time activity for people who must work for a living and currently have jobs. In terms of relating to the natural world, for example, children would benefit more from learning to sketch and take good photographs than from memorizing the Krebs cycle. In our effort to prepare students for work, and in downgrading aesthetic education to minor subjects or after school activities, we are cutting them off from the cultural traditions and achievements of humankind and thereby denying the students important sources of pleasure and fulfillment in later life.

We know how to develop and encourage educational innovations to achieve the goals of improved technological and aesthetic education. Under the Elementary and Secondary Education Act (ESEA),¹⁶⁸ funding was originally provided for innovative programs,¹⁶⁹ in addition

167. Other evaluations of arts programs have found that these programs show success in lowering school dropout rates or improving students' attitudes and interest in learning. See DOUGLAS ISRAEL, THE CTR. FOR ARTS EDUC., *STAYING IN SCHOOL: ARTS EDUCATION AND NEW YORK CITY HIGH SCHOOL GRADUATION RATES 2* (2009); Rollinda Thomas & Alice Arnold, *The A+ Schools: A New Look at Curriculum Integration*, 37 VISUAL ARTS RES. 96, 96 (2011) (gains from arts integration in North Carolina's A+ schools were affective rather than cognitive). While this seems to be another instrumental argument for arts education, it might also point to a more generalized improvement in motivation and self-esteem—qualities that will be of value for people in developing fulfilling lives in the absence of gainful employment. See PRESIDENT'S COMM. ON THE ARTS & HUMANITIES, *supra* note 166, at 47–55.

168. Elementary and Secondary Education Act of 1965, Pub. L. No. 89-10, 79 Stat. 27 (codified as amended in scattered sections of 20 U.S.C.).

169. See CHRISTOPHER CROSS, *POLITICAL EDUCATION: SETTING THE COURSE FOR STATE AND FEDERAL POLICY* 29, 42 (2d. ed. 2014). This was the original Title III of the ESEA. *Id.* at 29. That title, 20 U.S.C. § 6801, now deals with "Language Instruction for English Learners and Immigrant Students." Part of the No Child Left Behind Act, Pub. L. 107-110, 115 Stat. 1425, its goal is to

to ESEA's basic support to schools with disadvantaged populations.¹⁷⁰ The most effective programs were then disseminated through the National Diffusion Network, which involved a catalogue, demonstration projects, and designated state facilitator to coordinate the effort. Funding was always meager, no more than \$14 million per year, but the results were significant.¹⁷¹ The program was abolished by the Contract with America Congress, ironically at the same time that it terminated the Office of Technology Assessment.¹⁷² It is difficult to think of more ill-advised ways of saving money, except perhaps for our current failure to deal with the reality of global warming. A reasonable level of funding for the development of technology and aesthetic education programs might be about \$5 billion in each category, which is one-tenth of 1 percent of the federal budget or about three-tenths of 1 percent of the military budget.¹⁷³

Concededly, there is a certain tension between these two educational precautions—that is, between preparing children for a world run by machines and providing them with aesthetic education such as sketching, playing an instrument, or appreciating art and music. In fact, there is ample room for both if we are willing to rethink the educational curriculum and pry ourselves away from long-standing traditions. The excruciating detail of most high-school classes is more likely to obscure basic issues than to reveal them, and few people retain very much of this knowledge once they have passed the exam. The dual goals of teaching students how to function in the modern, technologically driven world and how to derive pleasure from their personal lives will provide immediate benefits for them and represent wise precautions against the possibility of massive unemployment.

suppress and devalue the Spanish language as an instrument of classroom instruction. Bruce A. Evans & Nancy H. Hornberger, *No Child Left Behind: Repealing and Unpeeling Federal Language Education Policy in the United States*, 4 LANGUAGE POL'Y 87, 88 (2005). It replaced the Bilingual Education Act of 1968. *Id.*

170. For a general assessment of the ESEA, see CROSS, *supra* note 169, at 20–44; JULIE ROY JEFFREY, EDUCATION FOR CHILDREN OF THE POOR: A STUDY OF THE ORIGINS AND IMPLEMENTATION OF THE ELEMENTARY AND SECONDARY EDUCATION ACT OF 1965 100 (1978); Janet Y. Thomas & Kevin P. Brady, *The Elementary and Secondary Education Act at 40: Equity, Accountability, and the Evolving Federal Role in Public Education*, 29 REV. OF RES. EDUC. 51, 51 (2005).

171. See, e.g., Bill Guise, *The National Diffusion Network: A Career Education Bonus*, 15 J. CAREER DEV. 275, 275 (1989); Shirley Boes Neill, *The National Diffusion Network: A Success Story Ending?*, 57 PHI DELTA KAPPAN 598, 598 (1976).

172. See BRUCE BIMBER, THE POLITICS OF EXPERTISE IN CONGRESS: THE RISE AND FALL OF THE OFFICE OF TECHNOLOGY ASSESSMENT 69–77 (1996).

173. See Ernest Morrell, Critical Literacy, *Education Investment, and the Blueprint for Reform: An Analysis of the Reauthorization of the Elementary and Secondary Education Act* 54 J. ADOLESCENT & ADULT LITERACY 146, 147 (2010) (inadequate educational progress due to lack of federal funding); *Budget*, CONG. BUDGET OFF. (Aug. 21, 2019), <https://www.cbo.gov/about/products/budget-economic-data#2> [<https://perma.cc/F9X6-XPRG>].

IV. CONCLUSION

For a long time, people dreamed of machines that could fly through the air, devices that would enable them to speak instantly with distant loved ones, hot food without a fire, cold drinks in summer, and elves to wash the dishes and clean the laundry. The Industrial Revolution gave us all these things, but the devil's bargain was that their production is frying and poisoning our world. Automation might provide us with an even starker contrast. It might offer us the possibility of prosperity without labor, of still more fabulous products and nearly limitless leisure to enjoy them, something close to most people's image of paradise. But unless we prepare for automation, unless we develop the policies and practices to respond, automation might rip society apart, producing a destitute or demoralized underclass whose fury will then bring humane and democratic government to an end.

It is always difficult to take action in the present for an uncertain future; we have certainly proven that point in recent years. This Article proposes a strategy for dealing with severe, potential dangers that some experts in a given field predict but others doubt or reject. In other words, it addresses uncertain dangers whose likelihoods a policy maker will be unable to determine. What it recommends is beneficial precaution: policies that will address the potential danger while providing benefits at present. This is what we should have done when the possibility of anthropogenic climate change was recognized. We should have begun developing solar and wind energy, mass transit, and intelligent buildings. In preparation for the looming but uncertain danger of the Singularity, we now should take serious precautions that provide immediate benefits. We should institute large-scale, effective retraining for displaced workers, upgrade our support for the arts, and reorient education toward the dual goals of living in a machine-controlled world and deriving pleasure from the leisure time that such a world provides. As with the climate change strategies, instituting these responses will require the expenditure of funds. But the requisite expenditure will be limited and manageable;¹⁷⁴ the cost of being unprepared may destroy us.

174. The three proposals presented here add up to about \$65 billion. At present, the military budget is \$1.3 trillion, or about twenty times as much. William D. Hartung & Mandy Smithberger, *America's Defense Budget Is Bigger than You Think*, NATION (May 7, 2019), <https://www.thenation.com/article/tom-dispatch-america-defense-budget-bigger-than-you-think/> [<https://perma.cc/6Q4E-P4GW>]. But no foreign nation poses nearly as much danger to our way of life as the possibility that eighty million Americans will lose their jobs.