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<a href="#">Home</a>	<a href="#">About</a>	<a href="#">Features</a>	<a href="#">Editions</a>	<a href="#">Press</a>	<a href="#">Events</a>	<a href="#">Dinner</a>	<a href="#">Question Center</a>	<a href="#">Video</a>	<a href="#">Subscribe</a>
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**AFTERWORD** [6.18.10]  
**By Stewart Brand**

An afterword blurs a book in time. My final draft of April 2009 is here made unfinal. And what you have here is only a sample of the time smear I'm attempting with the online version of the book at [www.sbnotes.com](http://www.sbnotes.com), where the text (much of it) dwells in a living thicket of its origins and implications. Instead of static footnotes there are live links to my sources, including some better ones that turned up after the writing. You should be able to follow my quotes upstream to the articles and Google Books pages they come from. There you can conduct your own version of my research and perhaps draw different conclusions. I continue to add updates in the margins of the text, along with pages of photographs, diagrams, and videos, plus the kind of additions that usually go in an appendix. I'll try to maintain the service as long as it has traffic. Maybe all nonfiction books will soon offer such online immersive versions of their material.



**Foreword to Afterword**  
**By Kevin Kelly**

Information wants to be free, but it doesn't want to be final. The merry superconductivity of a bit of information means that updates, corrections, additions, deletions, re-interpretations, misinterpretations, anti-information, and denials of that same bit quickly follow.

The blessings, and curse, of a printed paper book are that its words, once stamped in ink, are fixed. But the rest of our fast-forward lives, and the slippery digital

universe we swim in, tear at that fixity and demand that books keep improving, just like our iPhones do. Can books be upgraded?

Many readers of Stewart Brand's recent book, *Whole Earth Discipline*, praise it for its heretical synthesis of "edgy" ideas on a wide range of frontiers. And that it is. But I found Brand's book far more interesting as case study on how one can use information to adopt a permanent, mindful stance of flexibility. On every vector within his book Brand traced how his thinking was changed by a steady stream of informational evidence. Sometimes he altered his position more than once. The thrill of the book was watching how a top-notch thinker kept upgrading his views.

*Whole Earth Discipline* was published in the autumn of 2009. Nine months later whole worlds of science have lurched forward, digital news accelerated, and "what we know" is now different. If information wants to change, shouldn't an author have different ideas from the now frozen book he previously wrote?

Someday keeping a text constantly fresh will become both routinely possible and a chore for all of us. While a few authors/publishers have created successfully eternal ebooks, Brand has written a marvelous Afterword to his book which does several things. First, in great detail it updates the news he first reported. This update is so well written that it can be appreciated even if you have not read the original book. But more importantly, and most remarkably, Brand courageously indicates how this news has changed his mind since he wrote the book.

When the liquid containers of electronic texts demand that we revise them yet again, I hope we can use Stewart Brand's "Afterword" as an inspiration to not only upgrade our facts, but also upgrade our made-up minds.

— Kevin Kelly, Editor-At-Large, *Wired*; Author, *What Technology Wants*

STEWART BRAND is cofounder and co-chairman of The Long Now Foundation. He is the founder of the *Whole Earth Catalog*, cofounder of The Well, and cofounder of Global Business Network.

He is the original editor of *The Whole Earth Catalog*, (Winner of the National Book Award). The Afterword is written for the paperback edition of latest book, *Whole Earth Discipline: An Ecopragmatist Manifesto*, which will be published in September.

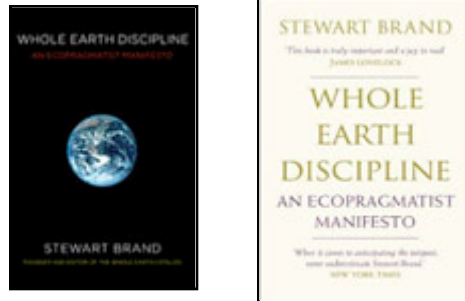
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## AFTERWORD

May 2010 . . .



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And what you have here is only a sample of the time smear I'm attempting with the online version of the book at [www.sbnotes.com](http://www.sbnotes.com), where the text (much of it) dwells in a living thicket of its origins and implications. Instead of static footnotes there are live links to my sources, including some better ones that turned up after the writing. You should be able to follow my quotes upstream to the articles and Google Books pages they come from. There you can conduct your own version of my research and perhaps draw different conclusions. I continue to add updates in the margins of the text, along with pages of photographs, diagrams, and videos, plus the kind of additions that usually go in an appendix. I'll try to maintain the service as long as it has traffic. Maybe all nonfiction books will soon offer such online immersive versions of their material.

What belongs in an afterword? I did promise in this book that I would change my mind as needed, and I can already report a couple of such veerings. Of course history that has moved on from what I described in 2009 should be indicated. And books have come along that expound some of my topics better than I; I wish I'd had them in hand before.

Start, as the book does, with climate. In December 2009, the UN Climate Change Conference in Copenhagen was undermined by a suspiciously sophisticated hack of emails among climatologists at the University of East Anglia, England. Once again, climate change deniers dominated the public discourse and prevented action on greenhouse gases. I responded with a *New York Times* op-ed titled "Four Sides to Every Story," suggesting that it helps to distinguish four kinds of views about global warming according to whether they are driven mainly by ideology or by evidence. "Denialists" and "Skeptics" both have doubts about climate change, but only the science-based Skeptics change their opinions with changing evidence. Likewise, ideological "Calamatists" and scientific "Warners" are alarmed about climate, but only the Warners respond to contradictory evidence.

James Lovelock, for example, a Warner, has softened his sense of alarm about the pace of climate change. He is persuaded by "sensible skeptic" Garth Paltridge's book *The Climate Caper* (2009) that climate scientists have become overly politicized, and a paper in *Science* by Kevin Trenberth, head of Climate Analysis at the U.S. National Center for Atmospheric Research, led Lovelock to conclude, "The solar energy is coming in but much of it is going to some unknown destination. Sea level rise shows the Earth is warming as expected, but surface temperatures do not rise as they should." Something unknown appears to be slowing the rate of global warming.

In the first chapter this book I emphasized the many unknowns in climate dynamics that could trigger "abrupt" climate change — positive feedbacks and tipping points. Let me add further current unknowns in the climate system that might drive the pace of warming slower or faster than we expect. Trenberth (and Lovelock) is puzzled by the "missing energy" in the global net energy budget. Also there is a large and mysterious sink of carbon that varies from year to year. That "missing carbon" *might* be absorbed by woody plants or by microbes in the ocean or soils. We don't know yet, so we don't know how to assist the process. Climatologist James Hansen deplores our lack of good data on aerosols, and thus the overall impact of "global dimming" is uncertain. We're not sure yet whether an increase in clouds has a negative or positive feedback effect, and the same goes for the added moisture in the air that warming brings — it all depends on research that remains to be done on altitude effects. In other words, the progress of climate science is likely to keep on alternately terrifying and mollifying us till midcentury at least.

As Lovelock put it to me by email in May 2010:

The plot thickens. We do not know when the heat will turn on.

The missing energy: Down welling would be intellectually satisfying, especially since it would probably require a corresponding upwelling of cold bottom water, which stays at 4 degrees C in the lower parts of the ocean. It would help explain the current cool spell.

The aerosols over East and South Asia could be a cause of global cooling. I discussed this in *The Revenge of Gaia*. The effect of clouds is difficult to distinguish from the aerosol effect.

Increased biotic uptake seems unlikely but could be an arctic surprise as more cool algal-rich water is exposed by melting surface ice.

Increased atmospheric moisture, especially in the upper troposphere and lower stratosphere, could have a large positive effect on heating. Do not forget that much of the water in the stratosphere comes from methane oxidation.

Richard Betts from the Hadley Centre was here yesterday and had the good news that their huge model that includes Gaia has just been turned on and after a year of tests and settling down should be giving results.

Apart from a few friends like Richard Betts my name is now mud in climate science circles for having dared to consort with sceptics. Amazing how tribal scientists are.

The take home message is that it is now even more unwise for government to spend heavily on renewable energy and other green dreams. Use the gain in time to prepare for sensible adaptation.

All that I would add to my city chapters may be found in two outstanding books

published after mine. Kevin Kelly's *What Technology Wants* (2010) can be read as a companion volume to *Whole Earth Discipline*, because he makes it inescapably clear that biophilia and technophilia are not contradictory, but both are part of one long continuity. "Cities are technological artifacts," Kelly writes, "the largest technology we make." Humanity pours into cities by the millions for the simple reason that, like all technology, cities offer more options.

A book by science journalist Fred Pearce, *The Coming Population Crash: And Our Planet's Surprising Future* (2010), was full of revelations for me. He tracks the eugenicist agenda behind most population-control theory, the life-sapping depression in areas losing population (such as eastern Europe), the smart ambition of migrants, the room for growth in Africa, and the possibility that the permanent aging of society will be a boon.

Nuclear has the most news. President Obama shut down Yucca Mountain and assigned a blue ribbon committee to come up with a practical nuclear waste storage policy for the United States. One intriguing alternative being explored uses deep borehole technology developed by the oil and gas industry. At any reactor site you can drill a hole three miles deep, a foot and a half wide. Down there in the basement rock the water is heavily saline and never mixes with surface fresh water. You can drop spent fuel rods down the borehole, stack them up a mile deep, pour in some concrete, and forget about the whole thing.

Obama also committed \$54 billion in loan guarantees to cover the building of up to ten new reactors to restart the industry in America. That settled the argument within the administration about expanding nuclear power. Outsiders like Al Gore and Amory Lovins lobbied against it, but pronuclear insiders like Energy Secretary Steven Chu and science adviser John Holdren prevailed. Also leaders in the Democratic Party, such as House Speaker Nancy Pelosi and energy bill coauthor John Kerry, pushed nuclear in new legislation. Republicans have always been pronuclear.

Amory Lovins attempted a preemptive strike on my nuclear chapter on the day of the book's publication with a 20,000-word critique titled "Four Nuclear Myths: A Commentary on Stewart Brand's *Whole Earth Discipline* and on Similar Writings," plus a summary at Grist.org. You can download the paper from Rocky Mountain Institute. It suffers a bit because Lovins had not read the rest of the book, nor did he know there was a Web site with all of my source material. He rightly busts me for misspelling a name and for two misuses of technical terminology — corrected in this edition. The rest of his argument was the familiar Lovins deluge; I didn't respond to it because I already had in the chapter. At the Nuclear Energy Institute blog David Bradish wrote a detailed countercritique of Lovins's paper.

The one surprise was that Lovins did not address my material on microreactors — "small modular reactors," or "SMRs," as they're called these days. Elsewhere, though, he dismissed them as "fundamentally a fantasy." In March 2010 Secretary Chu wrote an op-ed for the *Wall Street Journal* promoting small reactors and noting, "In his 2011 budget request, President Obama requested \$39 million for a new program specifically for small modular reactors." A new player in the emerging industry is Babcock & Wilcox, builder of U.S. Navy reactors for half a century. The company is designing a 125-megawatt manufacturable light water reactor it calls "mPower."

One new book does an expert job of shattering Lovinsesque hopes that a stringent program of conservation, wind, and solar is all we need to make our energy climate-safe. It is *Sustainable Energy: Without the Hot Air* (2009), by David MacKay (pronounced "ma-KIE"), who is a Cambridge physicist and chief scientist for Britain's Department of Energy and Climate Change. The book provides ruthless analysis, winningly told and illustrated, of what it will take for Great Britain to reduce its greenhouse gas emissions enough to make a difference to climate. As in the analyses by his ally Saul Griffith, the needed measures are horrifying to contemplate in aggregate, but they can get the job done. A quote of his that has gone viral is, "I'm not trying to be pro-nuclear, I'm just pro-arithmetic."

I owe to MacKay one of my changes of mind since finishing this book. On page 103 I'm pretty dismissive of "clean coal." Over dinner MacKay persuaded me that coal *will* keep being burned by nearly everybody, especially China and India, because it is so cheap. Therefore we have to figure out a way to burn it cleanly, capturing the carbon dioxide and burying it, or bonding it into concrete, or whatever it takes. In that light, Al Gore's expensive TV ads deriding clean coal are a public disservice.

In another shift, my fond hopes for space-based solar (page 81) have been dashed by Elon Musk, CEO of rocket-launching SpaceX and chairman of SolarCity. He informed me vehemently that even if access to orbit were *free*, the inefficiencies of energy collection and transmission rule space solar out as a viable source of baseload power on the ground.

In a final energy comeuppance, I came to regret leaving fusion out of my nuclear chapter. Like most, I figured it was too good to be possible — zero mining (the fuel is hydrogen), zero greenhouse gases, zero waste stream, zero meltdown capability, zero weaponization. Then I visited the National Ignition Facility at Lawrence Livermore National Laboratory in California. There a vast array of lasers aims to focus 500 terawatts of energy for a billionth of a second on a BB-sized target made of hydrogen isotopes and ignite it in a fusion reaction. Impressive early tests suggest that successful ignition could occur by 2011. From that point it might be as short as a decade to a working prototype of a 1-gigawatt fusion power plant.

There's been significant news in biotech as well. The environmental and economic benefits of GE crops in the United States were confirmed by an authoritative 250-page study from the National Academy of Sciences. It reported that GE farmers have the advantage of lower costs, higher yields, and greater safety than non-GE farmers, and that significant environmental gains come from their use of less pesticides, less toxic herbicides, and especially from no-till farming enabled by herbicide-resistant GE crops.

The next generation of transgenic crops is now called "functional foods," described as "any modified food or food ingredient that may provide a health benefit beyond that of the traditional nutrients it contains." A Pew Research Center survey of current GE research noted that "food enhancements cover a wide range, including improved fatty acid profiles for more heart healthy food oils, improved protein content and quality for better human and animal nutrition, increased vitamin and mineral levels to overcome widespread nutrient deficiencies throughout the world,

and reduction in anti-nutritional substances that diminish food quality and can be toxic." Organic farmers should be allowed to grow those crops. If they can't, they may be left with nothing but a diminishing nostalgia market of people willing to pay extra for less healthy food.

In a book called *Hybrid: The History and Science of Plant Breeding* (2009), by Noel Kingsbury, I found a story that belongs in this book, so I'll add it here. Back in 1998 in India, while Mahyco-Monsanto was running test plots of Bt cotton, Vandana Shiva was denouncing the technology as "seeds of suicide, seeds of slavery, seeds of despair." Meanwhile, Kingsbury writes:

Farmers . . . were desperate to obtain cotton that would not fall victim to bollworm and to avoid the costs and dangers of using pesticides. . . Seeds of the Bt cotton "escaped" from Mahyco-Monsanto's test plots and were used to breed new "unofficial" Bt cotton varieties. . . .

By 2005, it was estimated that 2.5 million hectares were under "unofficial" Bt cotton, twice the acreage as under the ones that had been sown from Monsanto's packets. . . . A veritable cottage industry had sprung up, a state described as "anarcho-capitalism," whereby small-scale breeders were crossing reliable local varieties with the caterpillar-proof Bt plant. The world's first GM landraces had arrived.  
..

Shiva's "Operation Cremate Monsanto" had spectacularly failed, its anti-GM stance borrowed from Western intellectuals had made no headway with Indian farmers, who showed they were not passive recipients of either technology or propoganda, but could take an active role in shaping their lives. What they did is also perhaps more genuinely subversive of multinational capitalism than anything GM's opponents have ever managed.

"Synbio" crossed the threshold into "synlife" with the announcement in May 2010 that Craig Venter's team had successfully booted up a living, replicating cell with a genome totally created by means of chemistry and computers. The team's paper in *Science* noted, "If the methods described here can be generalized, design, synthesis, assembly, and transplantation of synthetic chromosomes will no longer be a barrier to the progress of synthetic biology."

Decades ago I suspect that environmentalists would have risen up in outrage and alarm against technology like Venter's, but I have found them surprisingly noncommittal about synthetic biology, even while they continue to complain about transgenic crops. While the uproar about nuclear power persists (though it is fading into a more primary focus on coal plants), I bet that fusion will be largely welcomed by Greens, if it comes to pass. Legacy resistance against old new tech continues, but new new tech appears not to arouse the fears and activism of old.

I should add an excellent online source for environmental news: Environment 360 — "Opinion, Analysis, Reporting & Debate" — run by the Yale School of Forestry and Environmental Studies.

There was significant geoengineering news. A step toward asteroid control was

taken by the Obama administration. While canceling a return to the moon by NASA, the president proposed that the next deep-space human mission should be to an asteroid, which could occur by about 2025. His science adviser John Holdren remarked that developing the ability to nudge asteroids "would demonstrate once and for all that we're smarter than the dinosaurs and can therefore avoid what they didn't."

Two good books on geoengineering finally arrived: *How to Cool the Planet* (2010) by Jeff Goodell and *Hack the Planet* (2010) by Eli Kintisch. Both writers talked to most of the early players: Ken Caldeira, Lowell Wood, John Latham, Stephen Salter, Russ George, David Keith, James Lovelock, and David Victor. One new scheme has been put forward by Harvard's Russell Seitz to brighten parts of the ocean by aerating the water with microbubbles.

Geoengineers gathered in cautionary mode at the Asilomar Conference Center in California, echoing the recombinant DNA gathering there back in 1975. Environmental organizations were invited, and so was I. The conference adopted terminology from an influential report by the Royal Society, noting that geoengineering comes in two major forms — solar radiation management (SRM) and carbon dioxide removal (CDR). The view emerged that carbon dioxide projects would necessarily be slow and in most cases benign and therefore in less need of global regulation, but the opposite is true of efforts to manage sunlight with stratospheric sulfur dust or brightened clouds. The three days of discussion basically reaffirmed the "Oxford Principles" first proposed in a 2009 memorandum to the British Parliament by Steve Raynor from Oxford University:

- Geoengineering regulated as a public good
- Public participation in geoengineering decision-making
- Disclosure of geoengineering research and open publication of results
- Independent assessment of impacts
- Governance before deployment

In other words, one way to geoengineer wrong would be for a private company to start injecting sulfur dioxide into the stratosphere without disclosing research plans or research results, without outside monitoring of effects, and without permission of a public governance body.

At the same time that the hardcover edition of this book was making its way in the world, a film called *Earth Days*, on the origins of the contemporary environmental movement, was released in theaters and on TV. I'm in it, along with others from this book such as Paul Ehrlich and Rusty Schweickart. The movie is really carried by Earth Day founder Denis Hayes and energy maven Hunter Lovins (Amory's former wife), but director Robert Stone gave me the concluding statement. What I said over a photograph of the Earth there will perhaps serve here as well:

We're engaging in a set of activities which go way beyond the individual life span, way beyond children, grandchildren, way beyond parents, grandparents, great-grandparents, to the whole frame of at



least civilizational life. Once you get comfortable with that, then you start to go further out still, to three and a half billion years of life on Earth, and maybe we'll do another three and a half billion years. That's kind of interesting to try to hold in your mind. And once you've held it in your mind, what do you do on Monday?

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