A New Environmentalism:

The Need for a Total Strategy for Environmental Protection

Scott Fulton and David Rejeski

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A New Environmentalism: The Need for a Total Strategy for Environmental Protection.

On the first Earth Day in 1970, Sen. Edmund Muskie called for "A total strategy to protect the total environment."[1] Over 50 years later, the parameters of a "total strategy" are at last coming into view. Environmental quality has no doubt improved, but the pace of change is leaving in the dust the linear strategies of the past. As Klaus Schwab of the World Economic Forum succinctly put it: "We are moving from a world in which the big eat the small to a world in which the fast eat the slow."[2]

What constituted a strategy 15, or even 10 years ago—analyze, plan, execute—no longer works in operating environments that are increasingly unpredictable, fragmented, and characterized by high rates of technological change, big data, crowd communication, young industries, and an incessant drive for competitive advantage.[3] In this world, the kinds of government strategy development contemplated by the Government Performance and Results Act, or annual planning-budgeting cycles, seem both quaint and prescriptions for strategic failure.

The total strategy of the future needs to create a much more robust option space for organizations and hedge against uncertainties. It must build resilience and organizational flexibility. It should help reduce surprises while guarding against organizational stagnation, not just in government, but in other key sectors, such as businesses, nongovernmental organizations (NGOs), think tanks, and universities.

We were once, of course, without any strategy at all. On the first Earth Day, we were feeling the consequences. The Cuyahoga River in Ohio caught fire in 1969 (for the 13th time since 1868) and air quality in many metropolitan areas was order of magnitudes worse than today's standards. Laws were passed to fill the void, and the rule of law emerged as our primary strategy. Laws passed in the 1960s and throughout the 1970s, like the Clean Air and Clean Water Acts, Toxic Substances Control Act, Resource Conservation and Recovery Act, provided a legal basis for actions based on a clear bifurcation of actors—industry and government. In the words of Yale political scientist David Mayhew, the real story of this period "is the prominent, continuous lawmaking surge that lasted from late 1963 through 1975 or 1976."[4] Command-and-control regulations provided an externally mandated, top-down approach well-suited to hierarchical social and organizational structures prevalent at the time, and to addressing the discrete and massive end-of-pipe pollution problem that then loomed large and obvious.

Tough government enforcement, effective public education about pollution, and the introspection invited by transparency mechanisms like the toxic release inventory, ushered in a new phenomenon in environmental behavior.[5] In the early 1990s, as a new generation of environmentally sensitive leaders came of age, environmental norms began to be internalized by, and enculturated within, businesses. This trend was furthered by voluntary initiatives relying on market/price mechanisms and some clever "carrot and stick" maneuvers by the U.S. Environmental Protection Agency (EPA). An early signal of this shift was EPA's 33/50 program, launched in early 1991 to reduce the release of 17 high-priority chemicals by 33% by the end of 1992 and by 50% by the end of 1995, with the aim of demonstrating that voluntary programs could bring about pollution reductions faster than command-and-control regulations. It actually worked, beyond most expectations, and, together with EPA's audit policy, which incentivized the establishment of internal compliance management system, helped birth a new era in which "private environmental governance"[6] moved environmental objectives inside the walls of business and within supply chains and began to significantly multiply the number of leverage points for environmental improvement.

Environmental goal-setting within firms often depended on high-level buy-in from CEOs and was increasingly validated through external stakeholders such as environmental NGOs or international standard-setting bodies, such as the International Organization for Standardization (ISO). Essentially, environmental governance became internalized. In 1995, the World Business Council for Sustainable Development was founded, beginning a movement of corporations that supported collective goal-setting focused on shared objectives. This integration of environmental and social norms into business operating procedures has become increasingly commonplace, even generating new financial structures, like Public Benefit Corporations.[7]

The 1990s represented a critical turning point for a number of other reasons: the emergence of what the Organization for Economic Cooperation and Development (OECD) called *knowledge-based economies*, and the creation of the worldwide web, which facilitated knowledge-sharing through a connected, global network. As the knowledge intensity of our economy grew, some researchers pointed out, "neither market or hierarchy, nor any combination of the two, is particularly well suited to the challenges of the knowledge economy."[8]

The shift to a knowledge-based economy built on networks coincided with an increasing awareness that the environmental threat structure was changing. A 2002 EPA report noted that, "We are about to enter a new era of environmental protection . . . [requiring] tools and technologies that help us deal with countless small businesses, farms, homes, cars and other non-point/area and mobile sources of pollution."[9]

Looking forward, the networked, knowledge economy will continue to expand—Wikibon estimates that data production will be 44 times greater in 2020 than it was in 2009. Yuval Harari discusses the implications of this data deluge in his new book *Homo Deus*: "As both the volume and speed of data increase, venerable institutions like elections, political parties and parliaments may become obsolete—not because they are unethical, but because they cannot process data efficiently enough."[10] The next big challenge for the environmental movement is to drive social and environmental norms into data-intensive networks—networks of things, people, and algorithms.

There are currently 1.1 billion machine-to-machine (M2M) connections worldwide[11] and, of those, 521 million are cellular M2M connections as of 2017. It is predicted that there will be 2.6 billion total M2M connections by 2020, and that 980 million of them will be cellular connections.[12] This so-called Internet of Things (IoT) provides a ready platform for enhancing and integrating sensing and control opportunities in ways that promise to increase our environmental understanding and reduce our individual and collective environmental impacts if IoT-based systems are effectively designed, deployed, and managed.

Linked to many of these devices are networks of people who have increasingly mobilized around environmental issues. There are presently over 20,000 volunteers throughout the United States that collect real-time data on rain, hail, and snow, and 1,600 volunteer groups engaged in water quality monitoring. In 2016, BioBlitzes across the United States in our national parks tapped into on-line communities to mobilize 80,000 volunteers to monitor and map species. Researchers at the University of Washington estimate that in-kind contributions of 1.3-2.3 million citizen science volunteers to biodiversity research have an economic value of up to $2.5 billion per year.[13] Though citizens have engaged in science for decades, or centuries, this explosion of activities over the past few years has been driven by the networked connectivity of mobile devices with increasingly sophisticated capabilities, such as high-resolution cameras and geo-location through GPS, and the rapid growth of low-cost sensor technologies as add-ons.[14]

Many challenges remain, such as how to interface networks of humans and machines with each other and our legacy systems used to collect environmental information, but the expanding human-machine system built on cheap computing and networking opens new opportunities for environmental science and management.

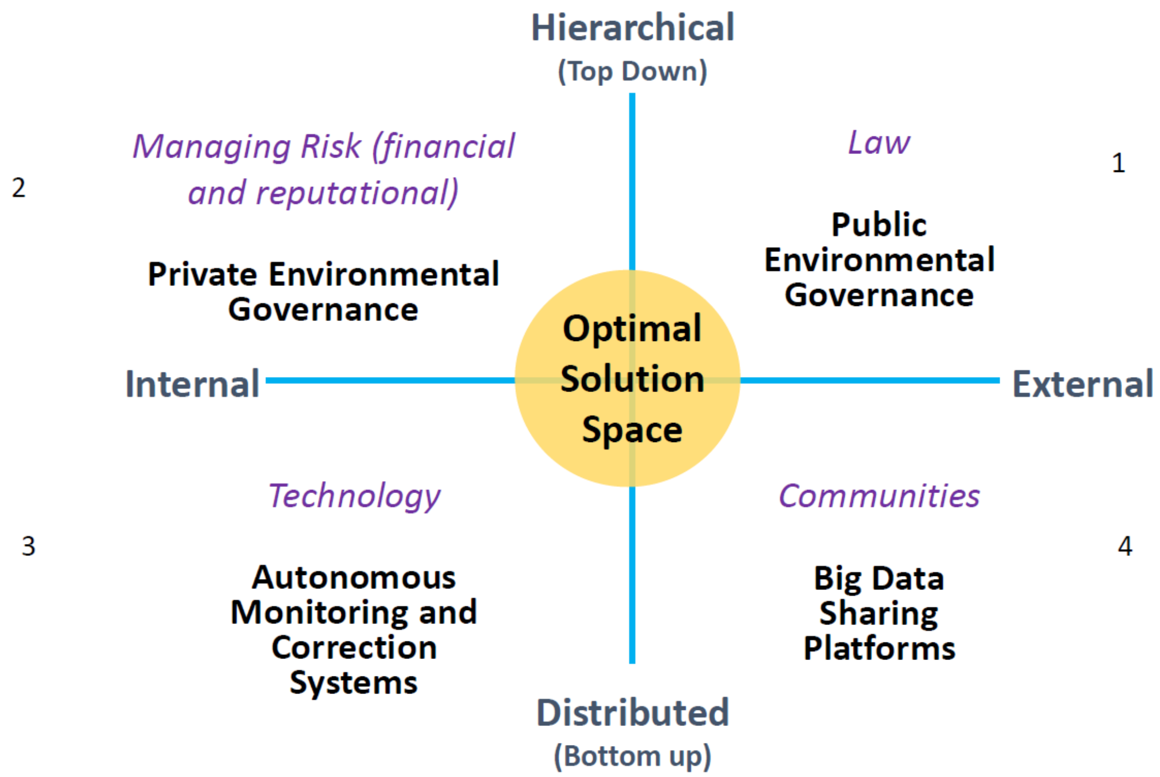
Finally, there is the world of algorithms, which author Franklin Foer has termed as ". . . a novel problem for our democracy."[15] The recent discovery of emissions-defeat software in motor vehicles stands as testament that changing a few lines of code can cause major compliance problems with serious downstream environmental and public health implications.[16] As venture capital investor, Marc Andreessen, once noted, "Software is eating the world."

Increasingly, environmental decisionmaking will be internalized in software in ways that allow for automated self-correction, and such software will become smarter and less dependent on humans to learn and advance (using so-called machine learning, or artificial intelligence (AI)). Early indications of the reach of AI in this regard can be seen in internal applications by AI pioneers. For instance, Google is using its machine-learning capacity—DeepMind—to reduce the energy consumption of its server farms.[17] It is easy to imagine, by extension, AI-based systems for monitoring and self-correcting all manner of environmental emission scenarios. An illustration of this potential is the sensor network that is being used to monitor snow pack in the Sierra Nevada mountains and provide water volume predictions that then determines hydroelectric dam operation, and as well as how water is distributed for irrigation, flood control, etc. There is an AI dimension to this in that the system is getting smarter and more refined and instructive as it collects more data.[18] A challenge that will track this accelerating capacity is how to proactively ensure the transparency and accountability of algorithmic-based, environmental decisionmaking. Added to these advances in AI are the potential impacts of blockchain, a rapidly advancing technology that can support distributed ledgers and smart contracts and potentially improve our ability to track everything from emissions, to genetic resource, or products in supply chains.[19]

A New Ecosystem of Drivers

Considered together, the shifts described above create new challenges, but also point to an emerging ecosystem of drivers that promise to shape environmental behavior and performance in ways that can improve environmental quality around the planet. As with natural ecosystems, elements within this system are interrelated, but each has its own life and vitality. Figure 1 below plots these spaces out along two axes, one focused on the proximity of the driver (external to internal), and the other on the type of dominant organizational form, from hierarchies (top-down) to networks (bottom-up). Notionally, we might call these quadrants: law, reputation, technology, and communities.[20]

Figure 1: Ecosystem of Drivers



This diagram's vertical axis reflects that some of the drivers are top-down in operation, while some are bottom-up. The horizontal axis reflects that some drivers are externally induced, while others are internally driven. Each of the quadrants in this diagram attempts to describe both a driver and a system that emerges from that driver.

People who have worked with scenario planning know there are dangers inherent in representing the world using two axes. Our goal here is simply to provide a jumping-off point for exploring multiple futures and solutions spaces that can capture some of the subtleties of change, without overdue complexity, and also shine a light on the advantages and disadvantages inherent in different approaches. For instance, top-down systems can suffer from bureaucratic distance from an issue, lack of ownership and buy-in, variable leadership, and political disruptions, while bottom-up efforts can struggle with focus, consensus failure, and a lack of skills needed to properly identify and address environmental problems.[21]

A few clarifying thoughts about the quadrants. Working counterclockwise, the driver in quadrant 1 is law and the resulting system is traditional government action—variations of command and control. In quadrant 2, the driver is risk management, and the system is private environmental governance that aims to manage and reduce that risk. In quadrant 3, the driver is technology, and the system is autonomous monitoring and correction systems. In quadrant 4, the driver is community engagement—in particular on-line communities—and the system is big data-based community platforms for sharing those data and the stories that they tell. As data volume increases, these systems will operate at light speed and create a data-rich pressure cooker for corrective response.

These quadrants are, of course, interactive and cross-influential. For example, data-based community pressure can influence both private and public governance behaviors and approaches. Autonomous systems should reduce the need for public or private governance interventions. And effective private governance measures should, in theory, reduce the need for government response.

All of these drivers will remain important parts of the equation, although their proportionality may shift over time. So, for example, there will always be a need for public governance, but the public governance contribution may well grow smaller over time as the need for government intervention decreases by virtue of the other drivers.

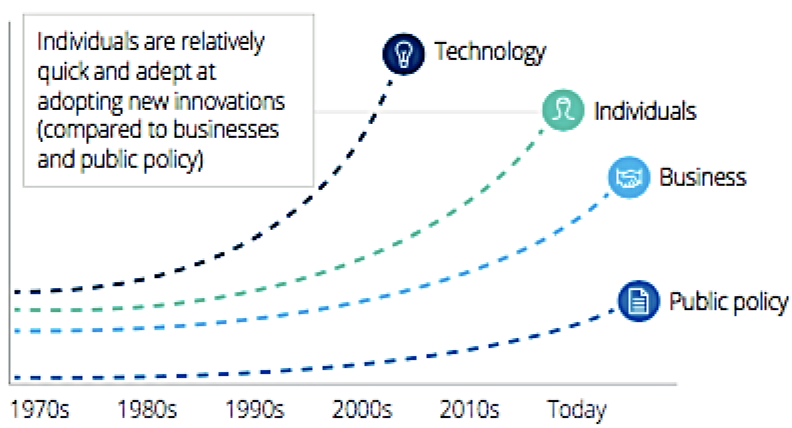
The most evolved of these systems are the hierarchical systems—quadrants 1 and 2. Quadrants 3 and 4 are emerging and are not without challenges. Regarding quadrant 3, as noted, the recent problems with motor vehicle emissions control systems demonstrate that autonomous systems are only as good as the algorithms imbedded within them. How will we ensure quality control in the software that guides these systems? Who is to manage or oversee that? These are important questions.

And quadrant 4—this idea of environmental big data and community platforms—presents even bigger challenges, ranging from accuracy of the data generated from low-cost sensors, to impacts on privacy, to the potential for data to be mischaracterized or misinterpreted, to the use of data as a tactical weapon for political or market advantage. There are big challenges in this space, but the data tsunami is visible on the horizon and is coming. Leadership will be needed to normalize this space so that it emerges as a constructive part of the environmental protection enterprise rather than a relentless third rail.

Solutions can occur within any of these quadrants, but the circle in the middle of the diagram intends to suggest that the closer solutions are to the point of quadrant intersection, the more complete and durable they promise to be.

It is important to note that each of these quadrants moves at a different tempo or what some observers have called *clockspeed*—the time required to change products, processes, and organizational behaviors.[22] Legislation can take decades to create and later modify to deal with emerging social and technological realities. The Clean Air Act, first passed in 1963, was amended in 1970 to address mobile sources and again 20 years later to deal with emerging issues of ozone, acid rain, and toxic air pollutants. Given the existing gridlock in government, it is doubtful whether public policies can begin to keep pace with or address the environmental impacts of rapidly advancing technologies. This so-called pacing problem is well-known and can lead to a widening gap between emerging technologies and legal oversight.[23] Businesses are faster to adapt but may still lag behind individuals or technological systems that are purposefully designed to incorporate environmental goal-seeking and ensure compliance through the use of embedded intelligence. Figure 2 below notionally reflects the clockspeeds of various sectors or actors that might be leveraged as part of a broader change strategy.

Figure 2: Clockspeed of Sector/Actors[24]



Conclusion

Today, the number of strategies that can be brought to bear on existing and emerging environmental challenges are far greater than any time in our history, especially when we think about the synergies between drivers. For instance, our regulatory system under statutes like the Clean Water Act is already amenable to the use of citizen-generated data. How do we make more use of that potential? Can citizens be mobilized to fill data gaps? How can the voluntary commitments by companies be further internalized into algorithms that drive energy and environmental decisions in facilities and supply chains? How can law-based systems anticipate and prevent software tampering and manipulation. And, on the flip side, how do we embed environmental norms into software design going forward?

And more broadly, we face questions that harken back more than 50 years ago to the long-forgotten Ash Council. The council, which was tasked with recommending an organizational structure for environmental protection to then-President Richard Nixon, observed at that time that, "Our National Government is neither structured nor oriented to sustain a well-articulated attack on the practices which debase the air we breathe, the water we drink and the land that grows our food. Indeed, the present departmental structure for dealing with environmental protection defies effective and concerted action."[25] This is perhaps an Ash II moment, calling into question whether existing structure and modalities are equipped to contend with, enable, harness, and lead the change that is upon us.

How should we organize the environmental protection enterprise today, and into the future, in view of the new ecosystem of drivers? The danger is that we try to execute on variations of old business models, when we need to step back, identify, and embrace new ones. This will require transformational leadership, which is in short supply.[26] It will also require an experimental mind set, perhaps running many small experiments, failing fast if needed, and learning from failure—an agile and adaptive development approach done with partners in both the public and private sectors.[27] It is unclear who will take this on, but it might be the biggest challenge of all in shaping our environmental future.

ENDNOTES

[1] Sen. Edmund S. Muskie (D-Me.), Philadelphia Earth Week Rally, Philadelphia, Pennsylvania, April 22, 1970, http://abacus.bates.edu/muskie-archives/ajcr/1974/Earth%20Day.shtml.
[2] Geraldine Beddell, *Slow Down, You Move Too Fast*, THE GUARDIAN, Feb. 3, 2001, at https://www.theguardian.com/theobserver/2001/feb/04/featuresreview.review1.
[3] MARTIN REEVES ET AL., YOUR STRATEGY NEEDS A STRATEGY: HOW TO CHOOSE AND EXECUTE THE RIGHT APPROACH (Harvard Business Review Press 2015).
[4] DAVID R. MAYHEW, PARTIES AND POLICIES: HOW THE AMERICAN GOVERNMENT WORKS (Yale Univ. Press. 2008).
[5] U.S. Environmental Protection Agency, Toxics Release Inventory (TRI) Program, https://www.epa.gov/toxics-release-inventory-tri-program.
[6] On private environmental governance, see, for instance, Michael P. Vandenbergh, *Private Environmental Governance*, 99 CORNELL L. REV. 129 (2013).
[7] "Public Benefit Corporation" is a new class of corporation that allows companies to pursue profit as well as a strong social and environmental mission. *See* Kyle Westaway, *California Creates New Corporation Types That Reward Doing Good*, VENTURE BEAT, Oct. 11, 2011, at https://venturebeat.com/2011/10/11/benefit-corporations-californi/. Today, there are over 4,000 PBCs across the United States, which include the crowdfunding sites Kickstarter, Patagonia, Warby Parker, and increasing numbers of startups.
[8] Paul S. Adler, *Market, Hierarchy, and Trust: The Knowledge Economy and the Future of Capitalism*, 12 ORG. SCI. 215 (2001), *available at* https://doi.org/10.1287/orsc.12.2.215.10117.
[9] LOCAL GOVERNMENT ADVISORY COMMITTEE, OFFICE OF THE ADMINISTRATOR , U.S. ENVIRONMENTAL PROTECTION AGENCY, TOOLS AND TECHNOLOGIES FOR ENVIRONMENTAL DECISION MAKERS IN THE 21ST CENTURY (2002), *available at* https://archive.epa.gov/ocir/scas_lgac/pdf/toolstech.pdf. This observation is similar to how military analysts saw the emerging threat structure: "Threats are likely to be more diffuse, dispersed, nonlinear, and multidimensional than were industrial-age threats . . . the protagonists will become widely dispersed and more decentralized than ever before." These two views of a post-industrial, networked world may ultimately require a convergence of governance strategies. For example, the recent appearance of a powerful, inexpensive, and distributed biotechnology production infrastructure creates challenges for both biosafety and biosecurity (for EPA and the FBI; for domestic and international agencies). Drones present a similar set of opportunities and threats, as does 3-D printing. Environmental protection may need the same type of net-centric, strategic thinking that the military has adopted in response to the digital revolution.
[10] YUVAL HARARI, HOMO DEUS: A BRIEF HISTORY OF TOMORROW (Random House 2016). Harari makes the further point that, "Humans are relinquishing authority to the free market, to crowd wisdom and to external algorithms partly because we cannot deal with the deluge of data."
[11] Statista, Number of Machine-to-Machine (M2M) Connections Worldwide From 2014 to 2021 (in billions), https://www.statista.com/statistics/487280/global-m2m-connections/.
[12] *Id.*
[13] Data from ELIZABETH TYSON & DAVID REJESKI, THE FUTURE OF FEDERAL CITIZEN SCIENCE AND CROWDSOURCING (Wilson Center 2016).
[14] Beth Baker, *Frontiers of Citizen Science*, 66 BIOSCI. 921 (2016).
[15] FRANKLIN FOER, A WORLD WITHOUT MIND: THE EXISTENTIAL THREAT OF BIG TECH (Penguin Books 2017).
[16] Guillaume P. Chossière et al., *Public Health Impacts of Excess NO_x Emissions From Volkswagen Diesel Passenger Vehicles in Germany*, 12 ENVTL. RES. LETTERS 034014 (2017), http://iopscience.iop.org/article/10.1088/1748-9326/aa5987/pdf.
[17] GOOGLE, ENVIRONMENTAL REPORT (2016), https://environment.google/projects/environmental-report-2016/. The application of machine learning brought about a 40% reduction in energy for cooling and a 15% reduction in overall energy use in test data centers.
[18] Ziran Zhang et al., *Technical Report: The Design and Evaluation of a Basin-Scale Wireless Sensor Network for Mountain Hydrology*, 53 WATER RESOURCES RES. 4487 (2017),

https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1002/2016WR019619.
[19] David Rejeski & Lovinia Reynolds "Blockchain Salvation," ENVIRONMENTAL FORUM, Spring/Summer, 2017.
[20] Experience has shown that there are advantages in developing clever names for scenarios, which become "sticky" and speed understanding and adaption by organizations. *See* Charles Roxburgh, *The Use and Abuse of Scenarios*, MCKINSEY QUARTERLY, Nov. 2009, at https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/the-use-and-abuse-of-scenarios.
[21] Marena Brinkhurst et al., *Achieving Campus Sustainability: Top-Down, Bottom-Up, or Neither?*, 12 INT'L J. SUSTAINABILITY IN HIGHER EDUC. 338 (2011), https://doi.org/10.1108/14676371111168269.
[22] CHARLES FINE, CLOCKSPEED: WINNING INDUSTRY CONTROL IN THE AGE OF TEMPORARY ADVANTAGE (Perseus Books 1998).
[23] THE GROWING GAP BETWEEN EMERGING TECHNOLOGIES AND LEGAL-ETHICAL OVERSIGHT (Gary E. Marchant et al. eds., 2011).
[24] DELOITTE, EXPONENTIAL TECHNOLOGIES IN MANUFACTURING, fig. 9 (2018), *available at* https://www2.deloitte.com/us/en/pages/manufacturing/articles/advanced-manufacturing-technologies-report.html.
[25] Memorandum from Roy L. Ash et al., President's Advisory Council on Executive Organization, to the U.S. President on Federal Organization for Environmental Protection (April 29, 1970).
[26] The challenges of environmental leadership are described in Joanna B. Ciulla, *Environmental Leadership in Government*, *in* ENVIRONMENTALISM AND THE TECHNOLOGIES OF TOMORROW: SHAPING THE NEXT INDUSTRIAL REVOLUTION (Robert Olson & David Rejeski eds., 2005).
[27] *See* Steve Blank, *Why the Lean Start-Up Changes Everything*, HARV. BUS. REV., May 2013, at https://hbr.org/2013/05/why-the-lean-start-up-changes-everything.