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What we can learn from books in the digital age

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Abstract
Though books are often considered "old media" in the digital age, their production in this period in fact has been continually reimagined and redefined through new technologies of printing, especially paper and ink manufacturing. This paper explores how three specific recent printed books demonstrate this point in both form and content: David Brower's *Let the Mountains Talk, Let the Rivers Run* (1995), William McDonough and Michael Braungart's *Cradle to Cradle* (2002), and the 2008 HarperCollins *Green Bible*. Brower's book was printed on paper made from kenaf, a sustainable alternative to wood-based paper. *Cradle to Cradle* was printed on a synthetic polymer that could be endlessly remade into other products. *The Green Bible* was printed on recycled paper and used soy-based ink, and all verses with environmental content were printed in green. In each case, in form these printed books were meant to model innovative industrial information production while also through their content to motivate enhanced environmental consciousness.

Keywords
paper, ink, materiality, print, sustainability, recycling, media revolution

1 Introduction

Among media historians, printed books are considered revolutionary new media, but for the most part that revolution is understood to have been a development of the early modern period (Pettegree, 2010). Scholars differ in their assessments of the character and pace of the cultural changes promoted by a new form of mechanically printed knowledge, but there is general agreement that what we now understand as a media revolution happened in the fifteenth and sixteenth centuries as a new kind of book began circulating widely across Europe (Eisenstein, 2002; Johns, 2002). Having started a media revolution, however, books in many historical accounts then remain mostly static forms until rendered "old media" in the twentieth century by the various "new media" that emerged. The communications scholar Neil Postman (1985/2006, p. 8) went so far as to describe this as the "decline of the Age of Typography and the ascendency of the Age of Television." This is a misconception that the historian Paul Duguid (1996, p. 65) calls a misguided "notion of *supersession* – the idea that each new technological type vanquishes or subsumes its predecessors." In fact, print evolved and persisted alongside the development of cinema, radio, television, and it continues to do so in the age of the Internet.

Two of the primary reasons for this widely misunderstood element of media history are the practices of making hard turning points out of the diffusion of new technologies and the tendency to overlook important evolutionary developments in specific media. By focusing so much attention on the ruptures *between* successive media, scholars have been inattentive to innovations *within* forms of media. In the case of print media, this means that scholars have ignored a range of technical and commercial advances in the nineteenth and twentieth centuries. Some of these involved the development of new ways to add images to books, magazines, and newspapers, which enhanced the visual appeal of printed materials (Brown, 2002; Harris, 1990). Other less-heralded innovations have been similarly important, for example the development of the softcover paperback book, which aided significantly in the diffusion of serious literature in the mid-twentieth century (Menand, 2022, pp. 354–363). As this essay will show, other important advance-

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ments in printing and papermaking technologies, in particular the development and evolution of industrial printing and the adoption of wood as the raw material for papermaking in place of recycled cotton rags, enabled major changes in the circulation and content of books and newspapers (McGaw, 1987). In the expansion of its production and circulation networks, the "old medium" of print in fact was defined by constant innovation, and this continues into the digital age.

One way to see the ongoing transformation of the printed book is to consider how publishers have used it as a vehicle to model sustainable industrial mass production in an age in which concerns about the environment have become prominent. Among scholars focusing on the materiality of media, there is increasing awareness of the ways that media production can harm the environment, including deforestation and chemical waste production in paper manufacturing, mineral extraction and processing in smartphone manufacturing, and heavy energy usage by data centers (Hogan, 2015; Kaminska & Ruiz, 2021; Maxwell & Miller, 2012; Merchant, 2017; Stamm, 2018). The use of printed books to promote sustainability and alternative thinking about industrial manufacturing remains a vital project in the contemporary world. For radio listeners, television viewers, and Internet users, the quest to be informed, entertained, and connected has placed increasing demands on the natural resources necessary to produce media objects. Projects aiming to create a sustainable industrial print culture provide important lessons to those who are continuing attempts to solve this problem in the digital age. Considering efforts led by those in the print sector to refashion and make sustainable the manufacturing of books, magazines, and newspapers offers ways of rethinking and possibly refashioning the industrial supply chains producing the media devices and content that are giving the digital age its name.

This essay analyzes three specific recent printed books about the environment that provide lessons in what "old media" can teach digital age readers about materiality and sustainability in both their form and content: David Brower's *Let the Mountains Talk, Let the Rivers Run* (1995), William McDonough and Michael Braungart's *Cradle to Cradle* (2002), and the 2008 HarperCollins *Green Bible*. Sierra Club President Brower's book was printed on paper made from kenaf, a similar crop to hemp that could be produced in a more sustainable and less polluting manner than wood-based paper. *Cradle to Cradle* was printed on a synthetic polymer paper that could be endlessly remade into other products. *The Green Bible* was printed on recycled paper and used soy-based ink, both important late twentieth-century innovations, and all verses with environmental content were printed in green. Over a quarter century spanning major developments in digital media, the "old" medium of the book persisted and evolved. Books were not superseded by newer media but were continually reshaped by technological innovations. Authors and printers imagined and developed new ways to manufacture books, in the process modeling new forms of industrial mass production that could be used in and beyond the media industries. In each case discussed in this essay, these printed books were meant to have content that stimulated thinking about the environment while showing how as objects they could model a more sustainable form of industrial information production.

2 Sustainability and print media

In the 1960s and 1970s, one of the most important developments in United States politics was the emergence of the environmental movement. Increased popular usage of the term "environment" reflected a growing understanding that human actions affected the natural world even when people were not physically in "natural" settings. Modern life in cities and suburbs, particularly when oriented around mass consumption, had consequences that rippled across the planet through various natural systems (Caradonna, 2014, pp. 89–95).

Print media have played a paradoxical role in the rise of environmentalism. Some of the most important motivators of the environmental movement were books, including major monographs like Aldo Leopold's *A Sand County Almanac* (1949) and Rachel Carson's *Silent Spring* (1962), both of which

have sold more than two million copies since their initial publications (Aldo Leopold Foundation, 2022; Griswold, 2012, p. SM38). The mass consumption of these influential environmentalist books was part of a dramatic increase in the circulation of printed materials in the second half of the twentieth century. Between 1950 and 1995, U.S. newsprint consumption increased from 5 937 000 to 11 261 000 tons (Stamm, 2018, p. 267), the number of periodical titles published from 6 960 to 11 179, and the number of book titles published from 11 022 to 57 353 (Carter et al., 2006, Tables Dg275–286 and Dg225–252). The production of all that paper had environmental consequences, as Richard Maxwell and Toby Miller (2012, p. 46) note: "Two important properties of paper-mill technology deepened the printed word's relationship to the Earth's ecosystems, causing effects that are familiar to modern readers: water pollution and deforestation." Some of the effects include the release of noxious odors into the air and carcinogenic substances like dioxin into local waterways. Knowledge production affected the natural landscapes surrounding industrial paper production.

Some of those seeking a way out of this paradox that learning about the environment could harm the environment were inspired by the Club of Rome's 1972 report *The Limits to Growth*, another widely circulated and influential monographic motivator of environmentalism. The book, which has been translated into thirty languages and sold more than thirty million copies (Nørgård, Peet, & Ragnarsdóttir, 2010), offered a vision of a bleak future if society stayed on its current path of "resource depletion" (Meadows, Meadows, Randers, & Behrens, 1972, p. 29). This perception of limitations influenced many people in the media industries. Gar Smith, the editor of the radical magazine *Earth Island Journal*, adopted this language in 1990 in claiming that "[a]t some point in the not-too-distant future, there will be limits to publishing. How many newspapers, magazines, comic books, books of poetry, fiction or nonfiction can be sustainably produced in a given year?" For Smith (1990, p. 33), the central problem with print culture was that "civilization is as fundamentally addicted to woodpulp as industry is held hostage to oil."

In many respects, publishing projects like the ones discussed below reflected this new understanding of the limits of natural resources and the environmental damage done by industrially produced media. They took place not only against the backdrop of the emergence of the environmental movement but also in relation to a developing discourse around what became known as "sustainability." As was the case with the idea of the "environment," the concept of "sustainability" reflected an old term taking on a new meaning in the late twentieth century. As historian Jeremy Caradonna notes, the concept was used in the early modern period in relation to forestry, but in the 1970s and 1980s the term came to denote prescriptive actions aiming to mitigate environmental degradation and climate change and to create a more equitably functioning capitalism (Caradonna, 2014, pp. 5–8). Over the subsequent half century, print media have been vital means of circulating information about sustainability, and many in that sector used their production to model sustainable industrial production. These are the lessons of the three innovative books discussed below. By developing new sources of raw materials for paper and ink, and in promoting paper recycling programs, book and periodical publishers aimed through content and form to promote the idea that sustainability was a desirable and viable practice that was portable to other media industries.

3 New materials for old media

As the production of books, magazines, and newspapers continued to increase after World War II, chemists and manufacturers sought alternative sources of raw materials to lessen the amount of forest resources being utilized in papermaking. In the late twentieth century, one of the most important emerging sources for making paper on a mass scale was kenaf, an "annual, nonwood fiber plant native to east-central Africa" (Kugler, 1988, p. 2). In the field, kenaf grows to a height of four to six meters and resembles both okra and cotton plants, and it can be grown in same regions as the latter crop (Wood, 1988, p. 17). In 1960, after considering over five

hundred other annual plants as possible raw materials for paper, the United States Department of Agriculture (USDA) deemed kenaf the "most promising nonwood fiber plant" (Kugler, 1988, p. 3). Scientists estimated that the costs of making paper from it could be a quarter lower and that the manufacturing would generate less pollution than with wood. Kenaf also offered the benefit of being more practically renewable, as it matured in under three months, a far shorter growing period than decades-long process for pulpwood trees (Wood, 1987).

Experiments with kenaf continued throughout the 1970s, and in 1986 the USDA and the private firm Kenaf International formed the Kenaf Demonstration Project (KDF) as a "public-private partnership with the principal objective of gaining acceptance of kenaf as a fiber source for the manufacture of newsprint" (Kugler, 1987, pp. 2–5). By 1987, KDF thought that its kenaf process had developed sufficiently to merit a public demonstration, and on July 13 the *Bakersfield Californian* used this paper to print that day's main and sports sections. In a front-page story, the *Californian* told readers that the paper that they were holding "never saw a forest" (Stevenson, 1987, p. A1). In California's Central Valley, or one over from its emerging Silicon, one of the forefronts of media production was a new method of paper manufacturing.

Even on the cusp of the digital age, many environmentalists believed, extending this Bakersfield project to more publications would have major environmental benefits. The most prominent national demonstration of the possibilities of kenaf came in 1995, when HarperCollins published David Brower's *Let the Mountains Talk, Let the Rivers Run* on paper made from it. Brower was the first executive director of the Sierra Club, and his book was part autobiography and part manifesto, and in tone it was consistent with Brower's strident public persona (McPhee, 1971). Brower had grand aspirations to fix environmental problems in the developed world that he believed were long in the making and that had reached a crisis point. "In the years since the Industrial Revolution," Brower (1995, p. 2) argued "we humans have been partying pretty hard. We've ransacked most of the Earth for resources." This had happened across industries, Brower argued, including media. "No tree is safe," he warned. "The information society demands more, not less, paper for printers, copiers, and fax machines … Democracy means more newsprint, and higher literacy calls for more books" (Brower, 1995, p. 62).

However, Brower noted, experiments with kenaf meant that "We are on the verge of a forest revolution. It is not necessary to make paper from trees" (Brower, 1995, p. 62). His own book, Brower claimed, was evidence that this could be done. "The words you are reading right now have not been printed on paper pulped from any tree. I write upon flowers, as it were" (Brower, 1995, p. 66). Through buying and reading books printed on kenaf paper, Bower told his readers, they were "helping build the demand that will encourage others to meet it. And there is further reward in your knowing that the unpulped trees can keep a lot of forest beautiful in perpetuity" (Brower, 1995, p. 76). Reading this way, Brower concluded, promoted environmentalism and sustainability. "I like to read. I like forests on the sides of my mountains" (Brower, 1995, pp. 68–69). For David Brower, the lesson of the form and content of *Let the Mountains Talk, Let the Rivers Run* was that print media could be readily made and distributed from a renewable resource offering a clearly viable alternative to prevailing methods employing wood-based papermaking. Though Brower's book retained the medium's old form, he also pointed to a new configuration of the commodity chains involved in producing it.

4 Recycling and upcycling

Alongside the continued search for new raw materials, some paper manufacturers began viewing the recycling of wood-based paper as a realistic way to print more sustainably. If wood was to remain the base of paper's commodity chain, a starting point toward more sustainable production was developing mechanisms to shift away from the single use and disposal of the manufactured item.

Paper manufacturers in the United States benefited from the widespread development of recycling programs around the

country starting in the 1950s and 1960s (Quimby, 1975). By the 1970s, paper and paperboard had become the largest component of American municipal solid waste. Between 1983 and 1991, half of the states in the U.S. passed laws either requiring or promoting recycling, and the number of American municipalities with "active collection programs" quadruped from 1000 to 4000, with paper products a "major focus" of them, as a U.S. Forest Service report noted (Ince, 1996, p. 2). By 2014, some 87 percent of Americans had either curbside pickup or relatively accessible drop off locations to recycle paper, and recycled paper comprised 38 percent of the material for the manufacture of new paper (Bajpai, 2014, pp. 2, 6). In aiming to make the production of print media more sustainable, however, recycling was not a panacea, as even the best policies and technologies had limitations. As a practical matter, as historian Finn Arne Jørgensen notes, paper "cannot be endlessly recycled" (Jørgensen, 2019, p. 43). The quality of the fiber deteriorates with each successive recycling, and current technologies allow for five to seven cycles, within each of which some new fiber must be added to bolster the weakened source material (Bajpai, 2014, p. 17). Even though it had benefits, some sustainability advocates believed, recycling remained an imperfect solution because it left existing commodity chains intact. There might be, some argued, a better way to make books.

One of the most important demonstrations of this came in 2002, when designer William McDonough and chemist Michael Braungart published *Cradle to Cradle: Remaking the Way We Make Things*, a book arguing that all industries needed to fundamentally rethink their supply chains away from "cradle-to-grave" design and instead look to nature's "cradle-to-cradle" system of material flows while embracing a new paradigm in which "waste does not exist" (McDonough & Braungart, 2002, pp. 102–104). McDonough and Braungart called their approach "upcycling" rather than "recycling," and they promoted a vision for the industrial production of all goods that would be completely sustainable.

Like David Brower, McDonough and Braungart intended their book to offer lessons in what readers could learn in both form and content from print. *Cradle to Cradle* opened with the statement that "This book is not a tree" (McDonough & Braungart, 2002, p. 5), and the authors went on to show how their book was an example of their philosophies of sustainability in action. *Cradle to Cradle* was "printed on a synthetic 'paper'" (McDonough & Braungart, 2002, p. 5) made using new materials and processes. "Unlike the paper with which we are familiar, it does not use any wood pulp or cotton fiber but is made from plastic resins and inorganic fillers," McDonough and Braungart remarked, and they offered *Cradle to Cradle* as a "prototype for the book as a 'technical nutrient,' that is, as a product that can be broken down and circulated infinitely in industrial cycles – made and remade as 'paper' or other products" (McDonough & Braungart, 2002, p. 5). The use of new and non-wood sources for paper in *Cradle to Cradle* "expresses our intention to evolve away from the use of wood fibers for paper as we seek more effective solutions" to mass production, and they added that their book "represents one step toward a radically different approach to designing and producing the objects we use and enjoy, an emerging movement we see as the next industrial revolution" (McDonough & Braungart, 2002, pp. 5–6). As a material object, *Cradle to Cradle* was an attempt to show how, even in the digital age, the printed book might offer an example of a reconceptualized industrial capitalism.

McDonough and Braungart argued that their book was a step toward the book of the future, and they claimed that successive developments could make its production completely sustainable. With imminently available production changes in the mass production of books, that was what the reader could soon be holding in her hands, a printed object made from a new kind of synthetic paper that did not "require cutting down trees or leaching chlorine into waterways" (McDonough & Braungart, 2002, p. 70). The remainder of the book would be similarly designed for upcycling, as the inks and glues in the binding could be cleaned readily and the cover made from the same material as the pages. By virtue of its design, the authors concluded, the "entire book can be reclaimed

by the publishing industry" (McDonough & Braungart, 2002, p. 71).

Cradle to Cradle, McDonough and Braungart later noted, "signaled our intention to design for a human industry without waste, and it forwarded a strategy of hope" (McDonough & Braungart, 2013, p. 19). Their book offered a demonstration of how the industrial production of printed knowledge could be done with modest environmental effects, even on a mass scale. Books could propagate knowledge not only in their content but in their material upcycling. In this reimagined new materialization of an old medium, "[b]ooks become books become books over and over again, each incarnation a sparkling new vehicle for fresh images and ideas. Form follows not just function but the evolution of the medium itself, in the endlessly propagating spirit of the printed word" (McDonough & Braungart, 2002, p. 71).

5 Read your vegetables

The mass circulation of printed information had environmental consequences not only from the manufacture of paper but also from the manufacture of ink, which for much of the twentieth century was "derived from petrochemicals" and often contained "toxic heavy metals" such as cadmium and lead (Assmann, 1992, p. 21). As was the case with commodity chains for paper, some inventors and firms sought ways of redesigning them using less polluting and more sustainable methods, and in both cases what seemed like viable solutions led back to farms. For paper, kenaf offered tremendous promise, and for ink soy did the same in creating a vehicle that replaced petroleum products.

In the U.S., the increase of soybean production in the twentieth century was meteoric. From "near zero" in 1900 to 1629 acres under cultivation in 1909, by 2000 there were some 70 million acres planted with soybeans (Roth, 2018, p. 1). Some cultivation was for human food, but a great deal was also for chemical byproducts, one of the most important of which was ink, which offered two primary environmental benefits. First, in contrast to petroleum-based inks, soy relied upon renewable resources. And second, soy ink usage generated far less pollution, as it did not release volatile organic compounds during the printing process (Munger, 2008). In the 1970s, as Americans experienced spikes in petroleum prices and supply because of actions by OPEC, soy ink also became desirable for economic reasons. The Newspaper Association of America (NAA) directed its technical staff to develop an alternative to petroleum-based ink, and Larry Diedrich, the President of the American Soybean Association, noted that the NAA's move was "not in response to environmental concerns" but stemmed from "their concern during the petroleum shortages back in the 1970's that they needed to have some sort of alternative" (US House, 1995, p. 25). While Americans in their cars were waiting anxiously in long lines at gas stations hoping to fill up their tanks, U.S. publishers were responding to the crisis by trying to find a way to make ink with a more readily available domestic source. In 1987, the *Cedar Rapids Gazette* conducted test printings using soy ink and was pleased with the results (US House, 1995, p. 29). This was a catalyst for other newspapers around the country, and numerous publications began making the switch to soy inks. These included the *Boston Globe*, *Los Angeles Times*, *Detroit Free Press*, *USA Today,* and the *Christian Science Monitor*. As the manager of the *Monitor*'s Arizona printing plant noted, soy ink was the "wave of the future […] It is a cleaner ink, easier to control. It's good for us and for the farmers" (Siems, 1992, p. 13). By the early 1990s, soy ink had clearly taken hold among American newspaper publishers, for both environmental and economic reasons.

The shift toward soy ink also had the benefit of making paper recycling more convenient. For most of the twentieth century, one of the biggest practical challenges to using recycled paper involved removing the ink. Re-pulping the paper was relatively easy, but making it look new was not, and when the ink was removed, it contained significant amounts of "barium, copper and heavy metals" that made the process costly and hazardous (Carrere & Lohmann, 1996, p. 26). By the mid-1990s, researchers had found that "soy ink is easier to remove from paper pulp before recycling. This paper does not have to be bleached as much, resulting in a cleaner pa-

per at a lesser cost" (US House, 1995, p. 26). Soy ink proved itself to be a vital part of more sustainable printing, and supplies had gone up and prices down. With wood remaining the dominant source for newsprint production, and with more publishers and paper manufacturers looking to recycled pulp as a sustainable and economical source for papermaking, soy ink offered the additional advantage of making that process more cost effective.

6 The good book

These histories of innovative paper and ink manufacturing were recently brought together in the printing of a Bible showing the ways that books have not only persisted but have remained avatars of innovative industrial production. As virtually all histories of the book note, the first major work printed using a mechanical press was Johannes Gutenberg's fifteenth century Bible. Gutenberg's Bible had tremendous cultural significance, and in a commercial sense it demonstrated that mechanical printing could produce knowledge on an unprecedented scale (Pettegree, 2010). In 2008, HarperCollins, David Brower's publisher, brought book history full circle in issuing what it called *The Green Bible*. The book's pages were made from recycled paper and the ink printed on them was soy-based. The cover was made entirely from linen and cotton that was "produced in a green friendly environment" in which "all air is purified before exhausting into the atmosphere and all water is purified and recycled" (*The Green Bible*, 2008, p. I–2). *The Green Bible* took a cue from the so-called "red-letter editions" of the Bible that have the words directly spoken by Jesus printed in red rather than black ink by offering a "green-letter edition" in which each of the more than one thousand verses that the editors believed "speak directly to how we should think and act as we confront the environmental crisis facing our planet" (*The Green Bible*, 2008, p. I–15) was printed in green.

The Green Bible was bold in both form and content and aimed to remind readers that book production could motivate thinking about the environment and sustainability. In its content – the green soy-based text printed on recycled paper – the book also encouraged readers to interpret some verses with fresh eyes, and to, as Archbishop Desmond Tutu noted in his foreword, become more "responsible stewards preserving our vulnerable, fragile planet home" (*The Green Bible*, 2008, p. I–13). *The Green Bible*, in other words, encouraged readers to consider both heaven and earth.

In the book of Genesis, rendered in *The Green Bible*'s green text, nature provided information about the world, though initially in the form of eating rather than reading material. When God places Adam in the Garden of Eden, he offers him the freedom to "eat of every tree" except for the "tree of the knowledge of good and evil" (*The Green Bible*, 2008, Genesis 2:16–17, p. 2). Adam disobeys this prohibition, and afterward with Eve is sent out into the world to "till the ground from which he was taken" (*The Green Bible*, 2008, Genesis 3:23, p. 3). In that world as in the Garden of Eden, the descendants of Adam and Eve follow God's dictum to "Be fruitful and multiply, and fill the earth and subdue it" (*The Green Bible*, 2008, Genesis 1:28, p. 1). This ethic has created the modern system of print media. Trees are still the sources of much of our knowledge of good and evil. The subjugation and instrumentalization of nature, in media industries and most others, has created some of the most pressing environmental problems in the world today. And yet, in media, as *The Green Bible* aims to show, there are alternatives. Trees are not the only material basis of knowledge and, even when they are, they can be better and more sustainably used. As Job prayed, "For there is hope for a tree, if it is cut down, that it will sprout again, and that its shoots will not cease" (*The Green Bible*, 2008, Job 14:7, p. 488). This lesson has persisted through its widespread circulation in print, and in this sense, books have remained central to media innovations from Gutenberg to *The Green Bible*. The original mechanical book of the fifteenth century models the sustainable book of the twenty-first century.

7 Conclusion

Projects like *The Green Bible* suggest a way of rethinking the notion of print as "old media," which has been a common trope for nearly a century now. Back to the early days of radio broadcasting in the 1920s, futurists have been incorrectly forecasting the demise of print. There is a mistaken tendency to assume that the newest medium of the day is the only medium of the day, but over the past century the so-called "new media" instead have added to public discourse and created new forms and channels for it, while print has thrived. Print is "old" in the sense of having been around longer than many other forms of media in widespread contemporary usage, but it is not "old" in terms of being near the end of its lifecycle. Some have taken to calling print "legacy media," but we might more accurately call it "persistent media." As the books in this essay show, print remains subject to constant and active innovation, and it continues to adapt and evolve.

One of the striking things about this evolution is that the object at hand remains the printed book. Recent decades have seen numerous attempts to create electronic books that might render paper obsolete. "A change is upon us," the essayist Sven Birkerts wrote in 1994, and "nothing could be clearer. The printed word is part of a vestigial order that we are moving away from – by choice and by societal compulsion." As the "printed sheet is heading for obsolescence … The screen is where the information and entertainment wars will be fought" (Birkerts, 1994/2006, pp. 118, 120). These predictions of electronic hegemony as yet have failed to come to pass, an observation made with a mixture of resignation and scorn by scholars of media and technology taking longer views of those histories (Striphas, 2009; Vinsel & Russell, 2020).

If we examine the technologies and things that we use most in our daily lives, historian David Edgerton shows, we find that many of them are based on innovations that are decades and perhaps even centuries old, and the book is exemplary of this. Indeed, the opening lines of Edgerton's introduction to the second edition of his book made this point. Upon the publication of the first edition in 2006, he noted, many thought that books "were on the way out" (Edgerton, 2007/2019, p. vii). And yet, he remarked in 2019, "even in a world of supposedly ever-accelerating, disruptive change, in which creative destruction makes the world anew, here the book still is" (Edgerton, 2007/2019, p. vii). As this essay has shown, the printed book was not only perpetually present but also continually innovative, and manufacturers consistently have sought means of more sustainable manufacturing. Book futurism has not just been about the transition to e-readers or digital text, as many have had it, and there have been important innovations among publishers and materials scientists aiming to improve the printed book.

In some respects, they have been responding to understandings of the environmental impacts of their own industry, which as Richard Maxwell and Toby Miller show, have remained significant. As they note, total energy usage by the U.S. papermaking industry in 2006 was exceeded only by firms in petroleum production. Maxwell and Miller estimate that the average printed book in the United States weighing half a kilogram generates an average carbon dioxide emission of four kilograms, and in 2006, book production generated aggregate emissions comparable to "between two and seven million cars, depending on which account you trust" (Maxwell & Miller, 2012, pp. 50–51). While some attempts to create alternative forms of book production have proven successful and durable on a mass scale, most importantly soy ink, others like kenaf paper remain available but not widely adopted, mostly because of the costs involved in remaking the extensive and capital-intensive network of paper mills utilizing wood as the raw material. Still, the utility of alternative materials like kenaf and synthetic polymers have been proven as concepts. The alternatives are there and, as the examples in this essay show, practical.

In important areas of the media industries, the quest for sustainability modeled in the form and content of books about the environment has had significant success. One can see this in the conduct of Apple, the world's most valuable corporation and a dominant presence in the digital economy. On its website, Apple prominently promotes its efforts to do more sustainable manufac-

turing, and in many respects its core philosophy mirrors what progressive book publishers have been doing for decades in trying to reconceive and reconfigure their industrial production. As Apple notes, it "sells hundreds of millions of products each year. Each product represents an opportunity to reduce our carbon footprint – small changes can yield enormous results" (Apple Computer, 2022, p. 16). In its 2022 *Environmental Progress Report*, the company touts its commitments to such actions as using only renewable energy, becoming carbon neutral, reducing water usage, and utilizing as much recycled material as possible in the production of its devices and packaging. "Natural resources make our work possible," Apple remarks, "and we take responsibility for how we source, use, and recycle the materials we rely on to create our products" (Apple Computer, 2022, p. 34).

There is no indication in Apple's *Environmental Progress Report* that the company was motivated directly by the specific examples of the books discussed in this essay. However, the company's outlook and practices are clearly and profoundly shaped by concerns raised by participants in the environmental movement since World War II, and many of those ideas circulated in printed books. The examples traced here show how some books have attempted to provide lessons for media corporations not only in their content but in their form. As concerns about sustainability and the environment continue to circulate widely in society, and as scholars increasingly explore the environmental consequences of media production, books like these offer models for responsible industrial production. In form and content, we still have much to learn from books.

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Conflict of interest

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