From the Editor

One year now since the COVID shutdown, and at least here in the USA we have cause for optimism. The categories of people eligible for vaccination are being expanded weekly, and, informally, even people not strictly eligible are able in many cases to get surplus doses at the end of the day, available because of no-shows.

In the January issue I wrote: “It is great to see science and society at large working together so well.” It saddens me to have to walk some of this back. Unfortunately Europe, so hard hit, had a setback due to the politicians’ panic about fake news on the AstraZeneca brand. Politicians disregarded the sound scientific advice of the international agencies. They alleged “abundance of caution.” Having heard this sentence many times over the past year, I am persuaded that it is bureaucratese for “I am irrationally scared.” Macron’s comments on the alleged ineffectivity of the vaccine were on a trumpian scale. Unfortunately, cowardice is a common vice of the political class. University administrators are even worse: our students find it much easier to go to bars than to class.

Enough ranting. We have a nice issue. Our winner of the Szilard lectureship award has contributed a wonderful article on the Exploratorium. We even have a book review of a novel! I believe this is a first ever for this publication.

I also want to highlight the article about Park (and Randi). I was for many years a subscriber, and a fan, of his newsletter, and especially of his tagline: “opinions are not necessarily those of the APS but they should be.” I have been tempted more than once to use it. In this spirit, please send your contributions. Articles and suggestions for articles should be sent to me, and also letters to the editor. Book reviews should go to the reviews editor directly (ahobson@uark.edu). Content is not peer reviewed and opinions given are the author’s only, not necessarily mine, nor the Forum’s or, a fortiori, not the APS’s either. BUT maybe they should be.

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PHYSICS, PEACE, HUMAN RIGHTS

Sakharov 100: Celebrating Andrei Sakharov’s Contributions to Science and Humanity
May 21, 2021 | 11:00 am to 3:00 pm EST

To commemorate the 100th birthday of famed physicist and human rights activist Andrei Sakharov, a webinar event will cover his many contributions to astrophysics, fusion energy, arms control, and human rights, as well as their links to future developments in these areas. Details about registering for this free webinar will be forthcoming.

The event is sponsored jointly by the Russian-American Scientists Association, the International Committee on the Freedom of Scientists, and the APS Forums on International Physics, Physics & Society, and the History of Physics.
In December 1974, fresh out of graduate school and starting my career as physics faculty member at a liberal arts college in the Midwest, I took a winter break from the snow to travel to California, and specifically to go to San Francisco to visit the Exploratorium. Even then, only five years after its inauspicious beginnings, this place was well known in the physics community as a must visit. What I found was an informal, serious, whimsical, dynamic and unique public education environment that was as exciting to a scientist as it was to a twelve-year old scientist to be. Little did I know that three years later I would have the opportunity to join the staff and get to participate in the adventure of its development over its next 44 years.

BEGINNINGS

In 1966, the Smithsonian Institution sponsored a Conference on Museums and Education at the University of Vermont in Burlington. Organized by Charles Blitzer, Director of Education and Training for the Smithsonian, the goals of the conference were to “1) survey the present relations between museums and education; 2) explore possible methods of involving museums more directly and more fruitfully in the educational process at all levels; 3) formulate proposals for research and development activities relating to museums and education.” The conference brought together 40 prominent museum directors and educators who presented 15 papers and resulted in the book Museums and Education published by the Smithsonian Institution Press in 1968.

One of the invited participants was Dr. Frank Oppenheimer, a 54 year-old physicist and science educator from the University of Colorado. Frank’s career had already spanned a lifetime of adventure, from his research on nuclear physics, to his work with his brother on the Manhattan project, through his political troubles in the McCarthy era and his exile on a ranch in southwestern Colorado to his stint as a high school physics teacher and the restart of his academic career as a faculty member at the University of Colorado. At the university, Frank moved from physics research to science education, developing a unique freshman physics laboratory where students could freely choose their weekly experiments of the semester rather than complete the one assigned for that week. He also worked on implementing the new Physical Science Study Curriculum (PSSC) in local Colorado high schools, and participated in the development of the Elementary Science Study (ESS) elementary school science curriculum, two of the curriculum projects started in the late 50’s as part of NSF’s post war investment in science education.

At the conference he spoke eloquently about the role of science museums in education. In 1965, Frank and his wife Jackie had visited the major science museums in London, Paris and Munich during a fellowship year in Europe. After the conference, Frank decided to put his idea of building a new kind of museum into practice. He moved to San Francisco the next year and began looking for a location. He wrote a Rationale for a Science Museum for a 1968 issue of the Curator journal to sell the idea where he first used the word Exploratorium. In the spring of 1969, he was able to get a lease on the cavernous Palace of Fine Arts from the city of San Francisco for a dollar a year; in July he moved in and began to build exhibits. Like any good physicist he built a machine shop to create the instruments he needed to accomplish his work, in this case interactive exhibits. One summer day in the end of August 1969 the doors were propped-open and people began to wander in. They saw a few exhibits, a small staff building and a sign over the machine shop stating “Here is being created the Exploratorium, a community museum dedicated to awareness.” The Exploratorium was open.

A NEW KIND OF MUSEUM

The first ongoing science center in the US is arguably the Pacific Science Center which started as the remnant of United States Science Pavilion at the 1962 Seattle World’s Fair. The pavilion was programmed into a science space as part of the country’s response to the launch of Sputnik in 1957. In part of the pavilion, a gallery contained many exhibits and demos directly related to the NSF sponsored science curriculum work of the late fifties and early sixties. But the science center movement really took off in the years 1968-69 with the opening of three major North American Institutions, The Lawrence Hall of Science at UC Berkeley (September 1968), the Ontario Science Centre in Toronto (September 1969) and the Exploratorium (October 1969). Each of these institutions was developed as a direct response to the desire of advancing science education as part of the educational upheaval of the 1960’s with the two California projects having a direct relationship to the prior NSF curriculum work with some of the same principles involved in their creation.

Frank’s vision was to create a new kind of public science museum, one without the standard collection of artifacts and objects but rather with a collection of teaching exhibits...
somewhat like the library of experiments he had built at the University of Colorado. Originally, science museums had started from private collections of scientific instruments or natural curiosities. Later technical museums and museums of science and industry developed as part of the industrial revolution. The concept of a public exhibit space containing only a collection of interactive teaching props had its origins at the end of the nineteenth and the beginning of the twentieth century often in world fair settings or at places like Urania founded in Berlin in 1888. The modern science center with its focus on education really had its start as a part the major postwar focus on science education for students and the public at large.

Frank’s exhibit curriculum started with a phenomenological base (similar to the Elementary Science Study approach used by the elementary school science curriculum that Frank worked on eight years before.) The physical phenomena of light, color, sound, heat and temperature were paired with the perceptual phenomena of seeing, hearing, and touch. The exhibits were designed for the public to directly carry out experiments with the phenomena. The exhibits were tabletop in size, each containing a singular phenomenon one could play with, with minimal instructions. Over time the topics naturally extended from physics and physiology phenomena to examples of the phenomena in the visual arts, music, theater, poetry and dance with artists, composers, writers and choreographers added to the scientist developers. The connection of the physical phenomena with the personal senses made the exhibit experience an instant hit with visitors.

Over the years, the exhibit collection expanded from the early topic of light, color and sound, to electricity and magnetism, heat and temperature, mechanics (the basic high school physics cannon), the physiology and processing of the senses such as seeing, hearing, touch and smell, genetics and cells, language, cognition and more recently social science and living systems and the environment. By 1971, Frank convinced NSF to fund some exhibit development even though they were only funding universities up to that point. Over the years, physicists like Phil Morrison, Victor Weisskopf, Wolfgang Panofsky, Luis Alvarez, Fred Karplus, Don Glaser stopped by to help or joined the board along with business leaders like Gordon Moore, William Hewlett and David Packard.

The experience has evolved from developing interactive exhibits to creating public programs and producing media. In 1993, the museum joined the online world through creating a website and becoming one of the first museums online. Founded in part by an interest in supporting school science education, science centers and science museums like the Exploratorium have played an essential role in addressing science in society issues, providing the public with opportunities to understand social issues through a science lens. Exploratorium exhibits like What About AIDS 1991, NanoScape 2006 and Coronavirus 2020 were part of the field efforts to address current science topics with critical social dimensions. We receive 850,000 annual visitors physically and 12,000,000 online visitors. Interesting, the audience demographics have remained fairly stable over time, with two thirds of the visitors being over the age of 18 and one half of the adults coming without kids.

SCIENCE AND ART

Building exhibits takes time and with a 100,000 square foot empty space to fill, Frank asked everyone he knew for things of interest to put on display. NASA loaned a space capsule mockup. The Stanford Linear Accelerator donated an art exhibit that used pieces from their just completed accelerator. The Atomic Energy Commission provided a display. Someone contributed a beautiful glider. As part of this search, Frank contacted staff at the Smithsonian who suggested a show that was ending its run at the Corcoran Annex in Washington DC. Cybernetic Serendipity was a cybernetic art show curated by Jasia Reichardt that was first curated in 1968 at the Institute for Contemporary Arts in London. Filled with perceptual and kinetic exhibits designed by artists and scientists who were exploring the new world of computers, Cybernetic Serendipity explored the relationship between technology and creativity, perception and art.

In 1969 Frank flew to Washington to see the show and decided to bring it to the new Exploratorium. The exhibition was packed into a truck and Corcoran staff drove it across the country to San Francisco where it became the official opening exhibition for the museum in the fall of 1969. The exhibition became an instant success for the new museum. With little fanfare and hardly any publicity, the Exploratorium received over 100,000 visitors in the first year of its operation. Originally set for a six week run, the exhibition remained at the Exploratorium for two years and a number of the exhibits became part of the permanent collection.

This exhibition was a key influence for all that was to follow. The exhibits showcasing the investigations of the world by both scientists and artists and their connection to perception became the template for Exploratorium exhibit design. With their emphasis on real experience with phenomena, often with a raw presentation style using everyday objects and a lack of uniformity, the exhibit design diverged from the standard exhibition-based model that science museums were developing. Cybernetic Serendipity honored the research of the artists as much if not more so than the ultimate work of art. It that way it paralleled the intent to honor the inquiry-based research approach of scientists rather than the result of scientific. The phenomena based exhibits were designed to encourage experimentation on the part of the visitors. The Exploratorium became a museum of science, art and human perception. But in many ways it is actually a museum about the activity of scientists, artists and human perceivers (IE the visitors themselves.)
THE EXPLORATORIUM TODAY

In 2013, after 44 years in the Palace of Fine Arts, the Exploratorium relocated to its new home on Piers 15 and 17 on the San Francisco Embarcadero. This move allowed the Exploratorium to double exhibit space, enhance accessibility, increase classroom space five times, and tackle topics like the environment in a building that operates at 75% energy neutral.

The relocation was guided by four principles:

- Creative Studio – the building supports the ongoing creation of new learning tools and experiences through publically visible development workshops and visitor making studios
- Observatory – the facility supports opportunities for visitors to observe the natural and built environment through indoor and outdoor exhibits that take advantage of the location
- Town Square – the campus created by the two piers, the public plaza connected to the city street and a cabaret style theater provide a venue for public gatherings and social events
- Pier – the pier provides public access to the outdoors and the bay as well as a physical and online production facility to create experiences that reach a distant audience

One of the key innovations that Frank brought to the Exploratorium was combining the idea of a public exhibitions space with an educational research and development laboratory, creating a public science learning laboratory. Much like a natural history museum combines research on the natural world with the public exhibition of its findings, the Exploratorium combines research on science education with the public experience of its findings. The exhibit floor is a place to prototype new exhibit ideas, experiment with new program approaches and develop new teaching tools.

Last year as part of the fiftieth anniversary, the Exploratorium developed an R&D agenda for the future with four areas of work. Our R&D agenda is focused on 4 overarching themes:

- Advancing Inquiry: Broadening and deepening inquiry-based learning experiences
- Exploring Identity: The self in biology, psychology and society
- Engaging Ecology: Expanding place-based environmental pedagogies
- Enabling Civic Agency: Empowering individuals and communities through scientific inquiry

Each of these themes suggests a series of questions that lead to rich investigations. Although these themes can stand on their own, they form a natural progression from personal inquiry (Inquiry) to exploring otherness (Identity) to examining one’s relation to systems (Ecology) to participating in shaping the world that we live in (Civic Agency).

CONCLUSION

Over the past 44 years I have had the great fortune to work with so many talented colleagues on exhibit, public and educator program development and publishing, media and online programming. Along the way I have learned the power of paying attention to learner centered experience, rich educational design and the role that science centers like the
Exploratorium play as a critical part of a STEM education ecosystem. Frank Oppenheimer died in 1985 but I have had the wonderful opportunity to see how the education insights of a singular individual with the help of so many like minded people in the physics community and beyond has been able to create an organization that has sustained and grown over fifty years. It is that fundamental foundation that will serve it well as it enters its next fifty years.

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The Forum Loses Two Good Friends

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On April 29, 2020 Robert L. Park, Bob to almost the whole universe, died leaving behind his wife, Gerry, and two sons. The family did not release a cause of death but he had been ill for a long time following many surgeries for a tragic accident as well as a massive stroke a few years later. Bob was born January 16, 1931.

Bob became a physicist almost by accident; while serving in the United States Air Force, he was sent to radar school and quickly fell in love with physics. He received a PhD from Brown University in 1964 and was a Phi Beta Kappa graduate of the University of Texas in 1958. He spent most of the first decade after graduate school at Sandia National Laboratories rising to become head of the surface physics division. He then moved to the University of Maryland in College Park where he became chairman of the Department of Physics and Astronomy from 1978-1982.

But it was only in 1983 that he embarked on the second career for which he became internationally renowned. He founded the Washington office of the American Physical Society and served as the Society’s director of public affairs. In that job he employed the still–new Internet to create a listserv to distribute his weekly column “What’s New” in which Bob reported on developments in government, science, space, pseudoscience and anything else which he thought would appeal to his audience of scientists, some bureaucrats, some bureaucrats who were also scientists, and the general public. Bob used What’s New to educate, inform, and occasionally skewer.

His favorite topics were pseudoscience and pseudoscientists, developments in physics, government action, and fraud in physics. “Alternative” medicine, creationists, and advocates of manned space flight were equal opportunity targets for his word processor. He also mentored younger physicists hoping to engage with the government and public affairs; I was lucky enough to be one of those he took under his wing.

He didn’t like manned space flight, arguing passionately that for less money we could learn more about the solar system using robots than using people. He was probably objectively correct, but he missed the psychological benefits that would come from seeing human footprints on another world.

Perhaps his longest running battle was with the proponents of what some people called “free energy” or “over unity processes;” and what most physicists would call perpetual motion machines of one kind or another. In particular he took on a company then called Black Light Power (originally Hydrocatalysis), and now called Brilliant Light Power. BLP’s idea was that hydrogen atoms could be induced to drop into energy states “below the ground state” releasing tremendous amounts of energy with each downward transition. The CEO of BLP, a Harvard medical school graduate who also took physics courses at MIT, gave his below-ground-state objects a clever name, but since he has trademarked the word, I will refrain from using it.

When I was at the Arms Control and Disarmament Agency, a federal agency affiliated with the State Department, Bob pointed out to me that a conference on so-called Free Energy was to be held in State Department facilities, ostensibly under the patronage of Secretary of State Madeleine Albright. I investigated and found out that the Conference on Free Energy (COFE) was largely to be attended by adherents of the various perpetual motion theories and was to feature demonstrations of “working” over-unity technologies (over-unity means that the machine puts out more energy than it gets from its inputs such as electricity or chemical fuels). We got the conference canceled by the expedient of saying to the safety officials at State: just suppose some of these machines actually released the huge amounts of energy claimed, would you want to see it running in an office building full of high ranking government officials? The conference organizers wanted the space free of charge as well. COFE was moved from State to Commerce, and finally to a Holiday Inn in Bethesda, MD, almost totally because of Bob’s efforts. Bob was unafraid to take on dragons large and small, and he almost always emerged with the dragon impaled on his lance. He also attracted the ire and fire of a fair number of dragons.

His What’s New report was one of the most read APS publications, waited for expectantly by a large fraction of the
APS membership, science journalists, and others around the world. It was for his reporting and analysis in *What's New* that he was awarded the 1998 Burton/Forum Award of the APS. In 2005 he retired from the APS to return to full time work at the University of Maryland. He continued to write *What's New*, from then on appearing on the UMd website rather than being distributed by the APS.

Bob was a great friend of FPS. He was responsible for the respect shown to the Forum by APS leadership, for encouraging Forum representation on POPA, and in part for the recognition that the non-technical Forums of the Society should be recognized on an equal footing with the technical Divisions, even to the point of being able to name APS fellows on the same basis.

Park wrote two important books intended for the public, *Voodoo Science, The Road from Foolishness to Fraud,* and *Superstition: Belief in the Age of Science.* He puzzled over the existence of what he called the belief gene, something in the makeup of some people that predisposed them to believe, usually in the supernatural, despite convincing scientific evidence to the contrary. He had the starring role in an invited session on frauds and fallacies during the Centennial APS meeting in Atlanta, GA. The conference authorities thought that as many as a thousand people packed the ballroom, the largest number I, at least, have ever seen in a session organized by the Forum on Physics and Society. As session chair I had a good view of the standing room only crowd.

Bob’s last years were not comfortable. While out running near his home on September 3, 2000 he was struck and crushed by a falling tree, the root structure of which had likely been damaged by heavy rains. Bob was found and pulled to safety by two Catholic priests who happened by; his injuries appeared so grave that they gave him last rites on the spot. Bob, a skeptic, was in no position to refuse. He endured many surgeries including one to pin parts of his hand, and years of rehabilitation that was not completely successful. But there is a coda. After Bob was back in reasonable shape he ran by the site of the accident, only to find the same two priests there. They related to Bob how they found a man near death from the falling tree. And he surprised them by announcing that he was the victim they had found. I’m told they had quite a reunion.

On March 17, 2013 Bob suffered a terrible hemorrhagic stroke which left him with difficulties reading, writing, and speaking. The rehab began again but was slow and painful. The first *What’s New* column ever was published on January 9, 1987. The last, in which Bob reported that he was recovering from aphasia but hoped to resume writing his column, appeared on July 12, 2013. He was never able to publish another, but a run of 26 years isn’t bad.

On October 20, 2020, James (“The Amazing!”) Randi, friend of Bob Park, friend of mine, and friend of rational thinkers and scientists everywhere died of “age related causes.” He was 92. Randi, as he was always called, was born Randall James Hamilton Zwinge in Toronto, Canada. He told me that he took the legal name James Randi when he became an American citizen. Randi was one of the great stage magicians, but was best known for his investigations and debunking of claims of the paranormal. His investigations ranged from faith healing to “psychic surgery,” in which the operator appears to perform operations by mind power alone, or sometimes with a dull and rusty knife, to parapsychology, telepathy, and the spoon bending of Uri Geller, whom he called “a charlatan and a fraud.”

Randi established a $1,000,000 reward for anybody who could demonstrate an example of the paranormal under strictly controlled conditions; he never had to pay out a penny despite having many challengers apply for the prize. He was often sued for various things by those whose paranormal activities he debunked; again, he never paid a cent, although defending against those suits cost a pretty penny.

Among other purely scientific honors he received in his lifetime, Asteroid 3163, Randi, is named for him, he received a MacArthur Foundation “genius” Fellowship in 1986, the first Richard Dawkins Award (2003) as an exemplar of the values of rationalism, and an award from the Science and Engineering Society of the National Security Agency in 1997. Randi was proud to have received the Joseph A. Burton/Forum Award of the American Physical Society in 1989.

In presenting Randi the Burton/Forum Award outgoing president Val Fitch remarked that he had questioned why the APS would give a physics award to a magician for his work in debunking frauds; surely Physics had little need for such an investigator. But then, Fitch remarked that the night before had seen the first session of papers on cold fusion, and he instantly understood the FPS’s awards committee’s reasoning.

Randi and Bob Park were my friends and contributed greatly to the goals of the FPS. Their presence will be greatly missed. *What’s New* always ended with a disclaimer; so does this column: “Opinions are the author’s and are not necessarily shared by the American Physical Society, but they should be.”
The Ministry for the Future

As I write this review, there is terrible news of a glacier breaking down in northern India, causing serious flooding and many deaths. It is a scene eerily similar to the opening chapters of the book, which describe a fatal heat wave in northern India. Similar ‘natural’ catastrophes have occurred more and more frequently over the last decade or so. Some questions which naturally arise: Are these events part of the natural order? Or do human activities contribute significantly to their origin and frequency? If the latter is true, how bad are the projections for human existence on this only world we have? Could we improve matters for the biosphere and for us over a long time scale? What would accomplish this? In this novel, a fictional set of characters and events plays out some possible answers to such questions.

Other works of science fiction, such as those by Isaac Asimov, deal with technologies and events which are typically decades or centuries ahead of their realization if they are realized at all. But in this book the boundary between fiction and fact is quite narrow. We could be in the middle of some of the events narrated in the book, e.g. the rise in atmospheric CO₂ levels, melting of glaciers, increase in the mean sea level, warming temperatures, accelerated extinction of many species, and ocean acidification and extinction of marine life. This makes this book different from typical science fiction. As a recent review of this book by Bill McKibben put it: “It’s not science fiction.” Furthermore, the progress of events through this long book are optimistic even though the book begins with a dystopian catastrophe. This fictional progress is one plausible path for humankind to follow in order to avoid irreversible changes that threaten our existence.

The story: As part of the Paris Climate Agreement, The Ministry for the Future (MfF) is formed in 2025 to advocate for future unborn citizens as well as all the flora and fauna of the world. At the MfF, Mary Murphy and her team of diverse experts work for this cause. They speak for the voiceless citizens of our world and hope to pass a liveable planet on to them. The team explores solutions to climate change through science (glaciology, ecology, etc.), finance (a ‘YourLock’ account that invests mindfully), law (carbon taxes), and monetary policy (a carbon coin to incentivize activities that do not burn fossil fuels, or that sequester carbon). At some point, Mary reluctantly realizes that the usual ‘legal’ routes may not be strong or fast enough to halt our race to self-destruction. Badim Bahadur, Mary’s trusted MfF assistant, suggests a “black” wing of the MfF to enforce the changes through destructive action aimed at corporate powers standing in the way of real progress. It also seems that, even before Mary was informed about it, this black wing had operated with the help of extremist forces such as the ‘Children of Kali’ which apparently originated as a response to the unparalleled and tragic heat wave in India that is so graphically described in the book’s opening chapter. These two elements -- Mary’s legal team and Badim’s black wing -- although contrasting in their approaches, work together toward the same goal.

The two teams appear to be in sharp contrast to Frank May, an individual struggling to take action against the terrible things he has seen in the Indian heat wave, which he survived. What does a typical individual do when exposed to a tragic event due to climate change, brought about by myopic individuals and corporate power? The evolution of Frank May throughout this book is one answer to this question. First, he develops post-traumatic stress disorder (PTSD) from the heat wave experience: Every time he breaks a sweat, his PTSD returns -- a positive feedback loop. He tries to join extremist groups such as the ‘Children of Kali’ in order to take action, albeit violent, to relieve his PTSD. Following a failed attempt at this, Frank tries to cope through various means: therapy, working at a meat processing plant where even the cold conditions prove ineffective in preventing his PTSD, and working with refugees in various camps. Finally, he gets arrested and imprisoned for PTSD-induced violent actions of rage in Zurich.

The first encounter between Mary and Frank is interesting, and pushes Mary to take accelerated steps toward solutions to climate change. Frank, who has first-hand experience of the Indian heat wave, is more intent than Mary upon tackling climate change. Their unpleasant encounter brings out the difference in their personalities, while trying to address the same problem. However, this leads to a friendship-like relationship between them, which leads Mary at one point to visit Frank in prison and share memories of peaceful moments in the Alps.

The above paragraphs capture only a few of the story elements in this complex novel. The book explores several scientific approaches to climate change. The most technically challenging of these involves manipulation of the polar glaciers whose melting threatens the planet with catastrophic sea-level rise. The melting of ice at the interface between a glacier and the rocky surface underneath lubricates the interface, causing the glacier to slide over the rock. This in turn causes more melting at the interface due to frictional heat. The result is an accelerating feedback loop of melting, sliding, and more melting. The book’s scientists propose a solution: Pump the melt water from the glacier-rock interface to the top of the glacier where it can re-freeze. A massive international effort, using equipment formerly used to pump oil up from oil wells, undertakes this project. As an ironic helpful side-effect, the sudden demand for pumps decreases the supply of fossil fuels.

Habitat corridors are part of the “Half-Earth project,” which aims “to conserve half the land and sea to safeguard...
the bulk of biodiversity, including ourselves.” One example is a small town in the American mid-west that is vacated by humans in favour of animals. In the book and in our real world, highways become dotted with overpasses for animals to cross over, re-connecting some of the planet’s disjointed habitats.

The transformation from fossil fuel-based transportation to ones based on cleaner energies (solar-powered airships, sails, electric vehicles, etc.) is almost upon us in the real world. In this book, this transformation happens through a violent overturn of fossil fuel-based transportation systems. MftF’s black wing causes fossil-fueled airplanes to fall from the sky and fossil-fueled ships, especially oil tankers, to sink. This quickly ends fossil-fueled transportation. The book addresses the obvious moral dilemmas of such extreme actions taken to preserve a habitable planet.

From the monetary point of view, the team at MftF discuss the importance of a carbon coin with the leaders of the world’s central banks. This is aimed at rewarding individuals who keep fossil fuels in the ground, burn less carbon, and adopt better farming practices and carbon sequestration techniques. A carbon tax is used to decrease demand for fossil fuel, and the carbon coin adds a reward. The MftF advocates this ‘carrot-and-stick approach’ to the central banks as a measure to reduce CO2 in our atmosphere. The long debates and discussions it took to reach this point in the story also brings out perhaps the discomfort of the author with traditional money/profit-based economics. Robinson advocates for a biosphere-friendly economics where the maximizing parameter is not profit, but the health of the biosphere.

The book is timely and well-written. It’s a long read, but it brings out the key points and challenges to our society in addressing climate change. The central characters, namely Mary, Frank and Badim, exemplify different ways of dealing with these problems. Some of the initial actions supported by Badim and Frank are unorthodox at best and immoral at worst. Secondary characters complete the lives of the central characters, while also contributing to a discussion of the human and moral aspects of global warming. A couple of examples in this regard are the woman and her daughters (Syrine, Emma, and Hiba), whom Frank meets at one of the refugee camps, and Art the explorer who becomes a trusted companion of Mary toward the end of the book. Several short ‘riddle’ chapters interspersed throughout the book provide a good break and act as thought-provoking intermissions.

Today, one of the major hurdles to moving toward solutions seems to be a lack of agreement on the problem itself—on whether human activities indeed contribute significantly to an increase in the frequency and intensity of natural catastrophes. There are many ongoing debates about this in the U.S. Congress. The other barrier is the inherent inertia to breaking away from conventional destructive forms of energy. Intermingling the economics and politics associated with this inertia contributes to the first hurdle. This book presents potential pathways in overcoming these hurdles, some of which can be adopted or are already being adopted. Mary’s thoughts at the end of the book project optimism and a subtle call for action in the face of adversity: “…we will keep going, because there is no such thing as fate. Because we never really come to the end.”

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