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PHYSICS & SOCIETY

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Editor's Comments

The mid-term elections are fast approaching and with that in mind, this edition of the newsletter focuses on physicists and politics. As many of you know, there are only two physicists in Congress, and that number will drop down to just Bill Foster when Rush Holt retires at the end of this current term. Of course some of us have held public office at a variety of other levels, from state to local. An interesting question to consider is what role, if any, should being a physicist play in public office?

In this issue you will find commentaries from two people that share their own experiences and consider whether or not we, as scientists, have a bigger obligation than others to seek out and hold public office. First, Maury Goodman who was a member of the Warrenville, Illinois City Council for 14 years shares his experiences dealing with several issues before the Council, how his training as a scientist informed his own decision-making, and how his peers perceived his scientific background. Then, I offer my own thoughts after running in a Congressional primary election this past spring to succeed Rush Holt. Interestingly, we reach opposite conclusions in regards to the question of the role of a scientist in politics.

What do you think? Do we have any greater role than others in regards to public office? I would appreciate hearing from you about this and your own experiences in politics. We also have a commentary from one of our student members who was a Society of Physics Students intern assigned to the US House of Representatives Committee on Science, Space, and Technology. That experience, along with others, has confirmed her desire to "bridge the gap" between physics, science policy, and law.

Not all elections are political and our Chair, Micah Lowenthal, has a message about both the upcoming FPS elections to the Executive Committee and the APS vote on corporate reform. We end with two book reviews on topics that will interest most – papers from a short course on Nuclear Weapons Issues and a history of bicycle design.

As always, we are looking for people that would like to publish articles of interest to our readership. Please let me know if you or one of your colleagues would like to submit an article for an upcoming newsletter.

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Message from the FPS Chair Micah Lowenthal

Elections are nearly upon us and it is a time not only to vote for your favorite candidates for political office but also to vote for vice chair and new members of the executive committee of the Forum on Physics and Society (FPS). In addition, there is an American Physical Society (APS) vote on changes to the bylaws to reform the structure of APS. I'm writing to urge all of you to vote and, for those willing and able to get more engaged, to offer to run for elected office.

Why vote?

The people who lead the unit help shape the activities of the unit, so you should vote to help select them in addition to getting engaged and even standing for election to affect what FPS does. FPS is a unique and very active organization:

- FPS sponsors several invited sessions at the March and April meetings addressing issues at the intersection of physics and society: the 2014 sessions included Science and Secrecy, The Impact of Physics Research on the Economy, Hyperloop and other Transportation Ideas, and Physics and Innovation, among others.
- At the annual meetings, FPS makes senior scientists available to meet with graduate students interested in incorporating policy into a physics career.
- Every year or two, FPS sponsors a conference or a short course: most recently FPS sponsored a short course on nuclear weapon issues in the 21st Century and a conference on the Physics of Sustainable Energy.
- FPS nominates candidates for APS fellowship and for the Burton Forum Award and Szilard Lectureship.
- FPS puts out this newsletter, *Physics & Society*, which for over 40 years has provided a venue for publication of non-peer-reviewed articles of real substance.

We are holding the election earlier this year and in future years to ensure that the elected members are better able to execute their duties pertaining to the activities above. So please vote to help FPS sustain and improve its activities. FPS members will receive election details and instructions via e-mail.

On a separate matter, I also urge you to vote on the APS reform. APS has to make some corporate reforms to comply with regulations governing nonprofit organizations. The vote is happening right now. For more information, see http://www.aps.org/about/reform/.

Physics is at the heart of many critical issues facing society today, and the kind of thinking that physicists bring to problem solving could help address many more critical issues. I'm proud to say that FPS is helping physicists to engage these challenges, encouraging new and rising physicists to make these issues part of their thinking and their careers, and providing opportunities to share ideas and interact thus creating a network of physicists with like interests. Frankly, you FPS members are some of the most interesting people we meet. We'd like to hear from more of you and more from all of you.

UPCOMING FPS ELECTION INFORMATION

The FPS Election will be held from November 3, 2014 to December 1, 2014, more information will be coming in an email to FPS members.

The following persons are running for two At-Large Member of Executive Committee positions:

ROBERT A BARI, Senior Physicist at Brookhaven National Laboratory

ALAN SWEEDLER, Professor of Physics at San Diego State University

ANNA M QUIDER, Director of Federal Relations at Northern Illinois University

ROBERTO MERLIN, Professor of Physics at the University of Michigan

ELIZABETH BEISE, Professor of Physics at the University of Maryland College Park

The following persons are running for one Vice-Chair position:

GEOFFREY FORDEN of Sandia National Laboratories

ALLEN SESSOMS, of the American Association of State Colleges and Universities

Proposed Changes to APS Governance and Leadership Structures

APS is in the process of reforming its 100-year old plan of governance, and all members will be asked to vote on the new plan in October and early November.

The Council and the Executive Board worked very hard for the past year to come up with the proposed plan of governance. The guiding principles in the governance reform were to preserve our physics culture, to ensure greater coherence in the operations across the Society, and to clarify roles and responsibilities (and hence accountability) thereby making our Society stronger and more effective in its enduring mission "to advance and diffuse the knowledge of physics." Those involved took the matter very seriously and there was much debate and thoughtful discussion that went into the new plan. The key task now is for you to learn about the proposed changes so you can cast an informed vote.

A special issue of APS News was sent out several weeks ago with information about the new plan. More information can be found at http://www.aps.org/about/reform/. The member voting period is October 6 - November 10.

ARTICLES

Physics of Politics: Commentary

Maury Goodman

There is a great deal of interest in some of our physicist colleagues who have run for office to become a member of the United States Congress, some of them successfully and others with valiant but losing campaigns. Of course there are many other offices at the state and local level, so this article is my description of some experiences as a member of a City Council; in particular the office of Alderman in the city of Warrenville, Illinois (population 13,318 in 2012). I served over a period of 14 years, for five terms. In a slightly related endeavor, I also was a slated candidate for delegate to the Democratic National Convention, unsuccessfully for Bill Clinton in 1992, successfully for Clinton in 1996, and unsuccessfully for Bill Richardson in 2008.

It is not obvious what parts of this interesting experience are worth sharing in the Forum on Physics and Society. From Tip O'Neill's advice that "all politics is local" to Andrew Lloyd Weber's refrain that "politics is the art of the possible", the activities were varied and complex at times, but rewarding. Activity in local politics is highly probable in Illinois, where there are more than twice as many elected positions than any other state. School boards, park boards, library boards, and many other taxing districts are separate entities with separate elections. My city deals with land use and zoning, police protection, and road maintenance, along with water and sewer and issues of civic pride.

How did I become interested in local politics? I've always had some interest in the political process at every level. I grew up in Washington D.C. where it was a notable fact (at that time) that the citizens had no role at all in their local government. The particular issue that took me to a city council meeting was a report about an annexation agreement where a bank held some land in trust for an individual, and decided it would be in his interest to develop the property and kick him out, when he was living there and wanted no such thing. That offended my sense of fairness. As I became involved, most of the issues were not related to my background as a scientist. Some issues, such as should we spray for mosquitos, might have a scientific aspect to them, but that was as much beyond my expertise as anyone else's. I will touch base on three Warrenville City Council issues that seem plausibly relevant: magnetic fields, Fermilab as a neighbor and finances.

Running through Warrenville was an abandoned railroad line that had become a bike trail called the prairie path, and the electric power company decided it wanted to put some high voltage power lines along the path. This became a big local environmental issue, a valid one in my mind because several trees would need to come down, and there were aesthetic issues as well. But some of the opponents also loudly latched on to the claim that electromagnetic fields from the power lines would be a health issue. One person stated that he didn't care if the claim was true or not, if they could use it to stop the power lines. A power line opponent brought a "model ordinance" to the city, which banned magnetic fields greater than 2 milligauss at the site boundary of a switching station. I opposed the ordinance, claiming that the earth's magnetic field was 500 milligauss so the ordinance was unreasonable. Maybe they meant AC rather than DC, but they didn't say so and it would have been just as silly. The idea that either AC or DC magnetic fields were dangerous always struck me as silly. A non-scientist might not realize that it was silly, but ought to

try to find out before making claims. I remember as a student at MIT, the school newspaper ran a headline on April Fools Day about claims that electromagnetic radiation from the sun was as dangerous as ionizing radiation. A motion to direct the attorney to prepare the ordinance passed 5-3. But the attorney came back saying that regulating the power company was a state responsibility and outside the power of the city, so he never prepared it.

I had the opposite experience with my powers of persuasion when the police chief said some officers were concerned about the health effects of radar guns, and he wanted me to attend a staff meeting and talk about the issue. I gave a 5-minute lecture that biology was chemistry and chemistry was physics, and there was no way that radar could affect a biological process. Later when the chief brought forward an order for some radar equipment, he told me that my visit had settled the issue for them.

Fermi National Accelerator Laboratory, where I conduct some of my research, abuts the western boundary of Warrenville. When I was first elected, I imagined that I could be a resource for any issues that came up with that neighbor. It never happened. One time there was a proposal to provide Warrenville water to the residents of the Fermilab village, the former village of Weston. (It was actually the creation of Weston that spurred Warrenville to incorporate in 1967, long after its founding in 1833.) The agreement was worked out between our public works director and Fermilab and I was never involved, other than voting for it just as all the other aldermen did. I was involved in some outreach from time to time, but my position on the city council played no special role.

The one place where my education ironically seemed to play a role was in the budget and finances. My ability to understand numbers quickly became apparent to the others, and they soon made me the chair of the city finance committee. I worked with city staff to prepare the budgets each year, and they always passed unanimously, with some discussion but little controversy. But it was when finance issues came up outside the budget process that I was most frustrated. I characterized my colleagues' position as saying that $5000 was a lot of money, and $5,000,000 was a lot of money, and that they treated these two things the same. Despite considering myself a liberal within a group that was intrinsically conservative, I usually found myself on the no side of many funding issues. Most of my so-called conservative colleagues, seemed happy to spend all the revenue that the City collected.

Let me give one example. Road repair is an expensive proposition. The city had several pots of money that could be partially dedicated to this, general fund, road taxes, sales tax, state income tax, etc. Each year the public works director would plan maintenance on as many roads as he could afford that year. I felt we should make a long term plan balancing expenses and revenues over the lifetime of all the roads in town. This was done, putting all roads on a schedule for maintenance. To get the numbers to work, we had to pass a utility tax. To me, this has turned a haphazard endeavor into a successful long-term program. In subsequent years, when people proposed additional expenditures without a long-term funding source, such as building sidewalks here and there, I found myself in opposition.

I think being a scientist did affect the way that I looked at things. I wanted to see evidence that something would give the desired benefit before approving it. I wanted to see quantitative results from past programs and compared benefits across the budget, not in isolation. But in the long run, it was just a way of looking at things which complemented the way that others in business, the service industry, retirees and homemakers came to their decisions. I did feel a sense of satisfaction from trying to contribute to the community, and some of my ideas became reality. This helped motivate me to continue for many terms. While those who decide how research dollars should be spent should have a deep understanding of the scientific issues involved, physicists have no special role in local government, but neither would it be proper if we shirked such a role.

Maury Goodman is a high energy physicist at Argonne National Laboratory. He works on neutrino experiments at Fermilab and in Minnesota, South Dakota and France.

Physics of Politics: Commentary

Andrew Zwicker

Neil deGrasse Tyson, astrophysicist and host of the television series "Cosmos" once wrote that, "The good thing about science is that it is true whether or not you believe in it." If only things in politics were that simple.

Federal investment in basic research not only fosters new discoveries and new innovations, it has helped power economic growth in the US for decades. Yet, as many of us are acutely aware, the percent of discretionary spending by the US in research and development is at an all-time low and our global leadership in technology and innovation continues to slip. In parallel, there is an increase in an anti-science attitude that is evident among some members of Congress with the result that important scientific challenges have become partisan political battles (eg. climate change mitigation).

What is going on?

One thing to note is the background of our elected leaders. The number of members of Congress who identify their professions as lawyers, business people, or career politicians is at an all-time high. There are a handful of physicians, a few engineers and currently only two scientists, both physicists. One of them, Rush Holt (D-NJ12), recently announced that he will step down at the end of the current term leaving Bill Foster (D-IL11) as the sole member of Congress who is actually a scientist. This leads to situations where the background of the 40 members of the US House of Representatives Committee on Science, Space, and Technology consists of more than half as either lawyers or self-identified career politicians, two engineers, and exactly zero scientists. While technical issues are clearly within the natural purvey of a scientist/politician, the interesting question to ask is whether a scientific background is valuable in dealing with other issues such as the economy, education, or social security.

Carl Sagan, the astronomer and host of the original Cosmos series, once wrote, "In science it often happens that scientists say, 'You know that's a really good argument; my position is mistaken,' and then they would actually change their minds and you never hear that old view from them again. They really do it. It doesn't happen as often as it should, because scientists are human and change is sometimes painful. But it happens every day. I cannot recall the last time something like that happened in politics..."

And that's exactly the point. Scientists are, by our nature and training, perpetually skeptical and constantly open to new ideas. As scientists, we are guided by data, by facts, by evidence to make decisions and come to a conclusion. We strive to understand the "big picture," and we understand the limitations of our conclusions and predictions.

Imagine how different the political divide would be if both sides used a data-driven scientific approach to guide policy and create legislation instead of an approach based on who can make the best argument for their version of the "facts."

Should we only elect scientists? Of course not. But if we want to start to move out of our current stalled state of affairs, we need more scientists and more critical thinkers in all levels of government.

Given that as a background, I decided to do more than just think about these issues or complain about the current state of affairs. As it turns out, I live in Rush Holt's congressional district and I decided to run for his seat in the NJ Democratic primary against three people with extensive political experience even though I have never held public office.

This was not an easy decision. First, there was the consideration that running for political office is a full-time job and I would have to take a leave of absence from work. For many of us, our research is all-consuming, time-sensitive and stepping away from it is difficult. There was also the personal decision of entering a field that currently has a rather poor reputation and would involve not only an enormous amount of time, but also significant stress. Did I really want to be scrutinized, judged, and spend day and night campaigning?

After many discussions with my family and scientists that have both held office or run unsuccessfully for office the message was clear – Congressional seats open up rarely and the opportunity to run for one, regardless of the odds is even more rare so it was either now or never. My odds of winning were small, but I felt that as long as the probability was greater than zero I had to give it a try. So I co-opted Holt's bumper-sticker slogan, "My Congressman IS a Rocket Scientist," changed it to "Keep your Congressman a Rocket Scientist," and jumped into the political arena.

I only had 3 months to put together a campaign team (we may have had the largest number of PhDs on a campaign staff in the history of American politics!) and we had to learn everything on the fly. The goal was to build up my name recognition as quickly as possible so we put out 2,000 lawn signs before anyone else, went to street fairs, private homes, carnivals, town hall meetings, anywhere that I could meet voters and talk about the issues.

People ask me all the time about the experience, whether it was positive or negative, was I disillusioned by the "politics," why would I want to ever become a politician. In the end, I can honestly say that it was (mostly) enjoyable, surprisingly stressful, and incredibly rewarding. I met so many new people, those that I never would have met otherwise and talked about issues that they cared about – taxes, health care, gun control, job creation, the environment, and more. I participated in a series of debates with the other candidates that felt like a general oral exam from graduate school, where I was asked anything and judged by strangers. But I was very well prepared and did what we always do as scientists, when asked a question I answered it directly. That stood out in the political arena and was greatly appreciated everywhere I spoke.

Of course that doesn't mean that a scientist automatically will make a good politician. In fact, the opposite can be true. Politics is about emotions while science is about facts. The trick is to learn how to combine the two. Thus, I learned to open my responses with an anecdote about a student I helped or my mother's social security check before launching into a fact-based response.

For many people, knowing that I was a scientist was a sufficient reason to vote for me because having more scientists in politics was that important to them. Republicans and Libertarians supported me too, typically because they were in a technical field and saw the advantage of a scientist representing them.

Of course being a scientist could only get me so far and I didn't win. I came in last with a bit more than 7% of the vote, which was significantly more than what political observers expected. The reality was that there was simply not enough time to get my name out there, to build up a network that

would let me truly compete with people that have held public office for decades.

In the end I think it is clear, scientists are uniquely trained and uniquely qualified to serve in public office. It's not for everyone, but if you have ever considered it, at any level, it is well worth the effort, regardless of the outcome.

As for me, if at first you don't succeed…

Andrew Zwicker is the Editor of this newsletter, a plasma physicist, and the Head of Science Education at the Princeton Plasma Physics Laboratory.

"Bridging the Gap" Between Physics and Law

Ashley Finger

My name is Ashley Finger and presently I am a Fulbright Research Fellow at the University of Luxembourg studying thin-film solar cells at the Laboratory for Photovoltaics for one year, after which I will be attending the University of Virginia School of Law. Almost always, my decision to attend law school is met with surprise and confusion, but to me the transition seems natural. With my wide range of interests and intellectual restlessness, I found that I fit perfectly in the niche between science and law—science policy. This past summer I had the privilege of working in the field of science policy with the United States House of Representatives Committee on Science, Space, and Technology through the Society of Physics Students summer internship program.

Leading up to the internship, I was an undergraduate studying physics and mathematics at Davidson College where I was actively involved in several environmental organizations and worked in the library as a peer research advisor. I became involved with Davidson's SPS chapter in my junior year, when not long after officially declaring my major, I received the opportunity to attend the 2012 Quadrennial Physics Congress, where I was introduced to the greater physics community. I left PhysCon completely reassured in my decision to major in physics and excited for the opportunities ahead.

My positive experience there was instrumental in my decision to pursue research and an undergraduate Honors thesis the following year. In turn, my research experience shaped my career path. Presenting at conferences built my confidence and my excitement over the project itself (the movement of charge carriers in GaAs) inspired me to apply for the Fulbright grant. Undertaking long term research also allowed me to realize that while I was enjoying my project, academia was not my calling. Fortunately and remarkably, the same conferences I attended to present academic research introduced me to alternative career paths such as science policy and opportunities like the SPS internship.

I applied to the science policy internship position with the hope that it would reaffirm my decision to diverge from scientific research and to go to law school in order to pursue a career along the boundary of science and law. Within the first week, it did.

The work that the professional staff on the Committee on Science, Space, and Technology takes on is impressive. They work on issues that range from particle physics and human spaceflight to environmental protection and transportation technology. I loved the energy, the sense of urgency, and the vast range of topics and tasks. I did everything from collect background information, write memorandums, and engage in social media outreach. Even towards the end of my ten weeks when I approached some semblance of a routine, there was always something new and different.

Over the course of the summer, several things struck me with respect to the intersection between science and law. Most people view the two as completely distinct entities. We tend to separate "right brained" and "left brained" activities, the verbal and the mathematical intellect. To me, they were different but never distinct—I've always loved writing as much as mathematics, reading as much as laboratory experiments—but I was led to believe that was unusual. Here, on the committee, a crossover understanding and passion for both science and law was the norm. In the office there are PhD scientists working to write laws, and lawyers invested in science.

The connection between the scientific and legal mindset extends beyond certain individuals "bridging the gap," however. If you think about it, the process of writing a law has remarkable parallels to publishing scientific research. You begin with the past—reading relevant literature and determining where the issue at hand stands in the present. Then you spend some time determining "what next?" You ask yourself: where are the problems? Where are the gaps in our understanding? What can I do now that will benefit others the most in the future? At this point, the physicist sets off deriving equations and performing experiments while the legislators read and write, but after a period of time the two experiences re-converge with a draft at which point they obtain feedback from their peers, re-think, and re-work until there is a final version presentable to the public eye.

Perhaps the largest difference occurs at this stage. While some scientists may say that their laboratories are "political" it can in no way compare to the ideological hurdles in Congress. In science, your work may be less ground-breaking than you

had hoped but in Congress, your work can become void due a tangentially related ideological belief. You also must face a wider range of perspectives and agendas. Whereas scientific motivation is primarily factual and evidence based, legal motivation taps into emotions and balances on interpersonal relations and societal context.

In the committee, even the most abstract scientific research becomes tangible in terms of societal benefits. The job of a congressman is to represent the people in his or her district and so they are constantly thinking in terms of benefits to their constituents. Often, it is not obvious that funding Fermilab or the James Webb Space Telescope will yield benefits beyond scientific discovery, but in order to convince the government to continue funding a scientific project, the benefits to greater society must be demonstrated. In congressional hearings, therefore, you hear about how CERN invented the worldwide web, or how human spaceflight inspires the next generation of scientists. In the Committee science becomes, more so than in the eyes of the general public or the confines of a laboratory alone, a force for driving our nation forward.

Granted, there are many political hurdles, and granted our government is in a time of extreme partisanship and public criticism; but even now, the intermixing of science and law provides a powerful point of departure for scientific and societal advancement.

Ashley Finger is currently a Fulbright Research Fellow at the University of Luxembourg studying thin-film solar cells and will attend the University of Virginia School of Law.

REVIEWS

Nuclear Weapon Issues in the 21st Century

Pierce S. Corden, David W. Hafemeister, & Peter Zimmerman, eds. American Institute of Physics Conference Proceedings #1596, 2014. v + 266 pp., graphs and illustrations, ISBN 978-0-7354-1230-9, hardcover.

For many members of the public, nuclear weapons have largely faded as a political issue since the breakup of the Soviet Union, garnering attention only when Iran, North Korea, or perhaps Pakistan makes the news. Many of this reviewer's acquaintances and students are often surprised to learn that America and Russia still deploy thousands of such weapons and that billions of dollars will be spent over coming years on maintenance and modernization plans. Nuclear weapons may be in the political background, but are still very much with us and will be for decades to come.

This volume comprises papers presented at a "Short Course" sponsored by the George Washington University Elliott School of International Affairs and the Forum on Physics and Society which was held at George Washington University over 2-3 November 2013; the course was organized by the editors. There is perhaps no more telling recognition of the continuity and growth of nuclear weapons issues than that this is the fourth such course held over the last 30 years. The first, titled "Short Course on the Arms Race," was held in January 1982 and was described in the April 1982 edition of P&S. Papers presented at the following two short courses were published as AIP Conference Proceedings numbers 104 ("Physics, Technology, and the Nuclear Arms Race"; 1983) and 178 ("Nuclear Arms Technologies in the 1990s"; 1988 — reviewed in the January 1989 edition of P&S). This reviewer attended the most recent course but did not present or contribute a paper. Paralleling the presentations made at GWU, this volume gathers contributions under five headings: Nuclear Weapons and Arms Control, Comprehensive Nuclear Test-Ban Treaty, Ballistic Missile Defense, Nuclear Proliferation, and Mass Casualty Terrorism. An appendix prepared by David Hafemeister offers a handy chronology of the development of nuclear arms and related world events.

Over an intense two days, some 140 participants listened to two dozen talks by acknowledged experts in the above-listed areas. All but two talks are included in these proceedings; the two missing are a lunch-time discussion of future weapons policies by James Acton, a senior associate in the Nuclear Policy Program at the Carnegie Endowment, and a presentation on bioweapons by Daniel Gerstein, the Acting Under Secretary for Science and Technology in the Department of Homeland Security. For background, the proceedings include reproductions of seven articles (most from *Physics Today*) on issues as diverse as gas centrifuges and nuclear diplomacy.

The pleasure of reviewing a proceedings volume is that one is not constrained to read linearly: you can dip in where your interests take you. For this reviewer, the most striking aspect of attending and now reviewing these lectures is how much more numerous and complex nuclear-weapons issues have become. Some contributions address technical and policy issues that are long-established but continue to be relevant due to the emergence of new threats and/or improved technologies: verification of weapons destruction under the terms of various treaties; the United States Senate and the Comprehensive Test-Ban Treaty (CTBT); ballistic missile defense (now in

the context of North Korea); problems with ground-based missile defense; technical strategies to aid non-proliferation efforts; monitoring techniques for detecting illicit tests; and detection of nuclear material smuggled in vehicles or shipping containers. Other papers address matters that would have barely if at all been on the radar 25 years ago: the Indian, Pakistani, Iranian and North Korean nuclear programs; risks of non-state nuclear terrorism; costly modernization efforts that seemingly run counter to the spirit if not the word of the Nuclear Non-Proliferation Treaty; logistics of on-site CTBT inspections; future technical and workforce needs to ensure responsible stockpile stewardship; and nuclear forensics. Yet other contributions offer perspectives on the Soviet response to the Strategic Defense Initiative and the current status of both "horizontal and "vertical" proliferation threats (horizontal refers to country-to-country proliferation, whereas vertical speaks to improvements in weapons systems within a given country). Whether one approaches nuclear weapons from a policy or technical perspective–-the two are sides of a coin which cannot be separated from each other--this volume can be strongly recommended to readers who are familiar with the issues as well as novices who seek a primer on the current nuclear landscape.

I would recommend beginning exploration of this volume by reading Pierce Corden's contribution. He reviews the course and sets out a menu of future issues that will need to be addressed if the world is to move toward being free of nuclear weapons – an endpoint he unquestioningly believes would contribute to global security and stability. (Some strategists would argue that nuclear weapons have provided and continue to provide a measure of such stability; this debate could be the subject of a short course in its own right.) Corden uses the physics concept of a metastable state to characterize the current configuration of the nuclear world. Many powerful forces (treaties, export controls, monitoring systems) in play work to nudge the situation toward a more stable condition, but others push in the opposite direction: the thousands of weapons still in existence, the rise of non-state terrorism, and possible unpredictable perturbations to international order which could lead to events spinning catastrophically out of control. Overall, however, Corden concludes that what he calls the "vector" of the threat posed by nuclear weapons is pointed in the downward direction (that is, toward a more stable state). This said, many issues lie ahead, including the need for future negotiations to address control, inspections, and safeguarding of enrichment facilities; spent-fuel storage; safe development of nuclear power generation; and the use of highly-enriched uranium in naval reactors.

I have a few quibbles with the quality of production of this volume. All photos, graphs, and charts are printed in grayscale; this makes those that were originally in color difficult to read, and a number appear grainy or blurry. Course participants received copies of this volume as part of their registration fees; other readers can access individual papers from the AIP website, but the $28 per-paper fee may dissuade many readers, especially students.

I imagine that some years hence another reviewer will be offering comments on a similar volume; it will be interesting to see what has changed and what has remained the same. Corden's threat vector has a long way to go to reach zero, and the continued contributions of civic-minded physicists will be necessary to help provide the incremental impulses to get it there.

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Bicycle Design: An Illustrated History

by Tony Hadland and Hans-Erhard Lessing, with contributions by Nick Clayton and Gary W. Sanderson (MIT Press 2014), 576 pp, $34.95, ISBN 978-0-262-02675-8 (hardcover)

This book, the product of a collaboration between two historians of bicycles and bicycling, aims to redress the circumstance that, in spite of the fact that about a billion bicycles have been produced to date, "few areas within the history of technology have been as neglected as the history of the bicycle." The authors succeed admirably in their attempt.

The book's sixteen chapters are titled: (1) Velocipedes and Their Forerunners; (2) Front Drive; (3) Wire Wheels; (4) Indirect Drive; (5) The Safety Bicycle; (6) Comfort; (7) Improving Transmission; (8) Braking; (9) Saddles, Pedals, and Handlebars; (10) Lighting; (11) Luggage; (12) Racing Bicycles; (13) Military Bicycles; (14) Mountain Bikes; (15) Small-Wheeled Bicycles; (16) Recumbent Bicycles.

The authors use a section heading every several pages to divide each chapter into recognizable and easily searchable sections. For example, the five sections of Chapter 7 are titled Evolution of the Automatic Freewheel; The Early Development of Multi-speed Gearing; Epicyclic Gearing ; Derailleurs; Automatic and Continuously Variable Gears.

The book's subtitle "An Illustrated History" is amply justified: there are about 300 numbered figures (line drawings and black-and-white photographs). This total is an underestimate, since many of the figures are arrays of several graphics each. The illustrations display the stunning variety of designs: two-wheeled, three-wheeled, and four-wheeled; front drive and rear drive; big-wheeled and small-wheeled; and so on.

In the very first chapter, the authors describe how the "year without a summer" (1816) necessitated the adoption of horseless means of transport in Europe. This reviewer also learned from the book how the first velocipedes drew upon roller-skating technology and about the extent to which technology developed for cycling influenced automotive and aviation developments.

As the chapter titles indicate, the authors are methodical. The treatment of design is thorough, and almost all figures have some referencing discussion in the narrative. Appendices include debunked priority hoaxes, reports from the nineteenth century, bicycle aesthetics, and a labeled diagram of parts of a bicycle. Also in the end papers, the book includes about a hundred items of "Select Literature" and approximately 300 references.

This reviewer would have liked a glossary of terms; in places it seemed that the authors were assuming significant knowledge of the nomenclature of bicycling. One other apparent omission: there was no real discussion of children's tricycles and bicycles.

Although one of the authors (Lessing) is a past professor of physics, there are only a few places in the text with statements or explicit applications of physical principles. However, several books on bicycling science are mentioned. Two of these should be especially useful to the reader seeking more detailed treatment of the physics of bicycles and cycling: Archibald Sharp's Bicycles and Tricycles: An Elementary Treatise on Their Design and Construction, originally published in 1896 and reprinted by the MIT Press in 1977, and David Gordon Wilson's Bicycling Science, now in its third edition (MIT Press, 2004). Hadland and Lessing focus their attention on bicycle design and history, including commercial history.

The text is often dry, but there are wonderful passages of deadpan humor, especially in the descriptions of the joys and hazards of riding in the early days of cycling. On second-generation velocipedes, the "rider sat so high that he could no longer reach the ground with his feet." Hadland and Lessing then quote a passage from Joseph Firth-Bottomley's 1869 book on those machines: "When the rider comes better to understand his machine, he will mount it by running alongside for three or four yards and vaulting into the saddle, but of course for a tyro [beginner] to attempt such a method of ascent would be suicidal, and almost certain to end in discomfiture."

Regarding high-wheelers, the authors write: "One particular joy was coasting. The approved method for enjoying a descent, where the road to the bottom could be seen to be clear, was to hang the legs over the handlebars. Barring mechanical failure or unforeseen misadventure, such as the tire leaving the rim, the practice was less dangerous than it might seem. In the event of misfortune the rider was at least propelled clear of the bicycle, rather than being centrifugally smashed into the roadway."

Different types of readers will likely approach the book in different ways. Because the book is organized topically rather than strictly chronologically, persons with particular interest in bicycle racing or in mountain biking can read only the most relevant chapter. Many of the chapters are self-contained, and where it is necessary, the authors refer to other chapters. Only the most devoted student of bicycle design and manufacturing history will be likely to read this book cover to cover. However, almost anyone who has ridden a bicycle will find something of interest, and this reviewer can recommend the book highly.

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